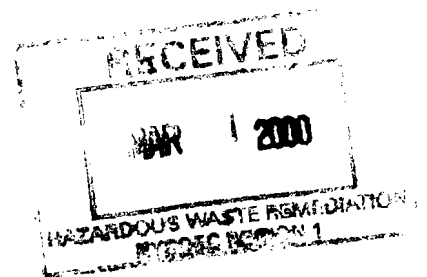


**TECHNICAL SPECIFICATIONS
FOR THE
MODIFIED IRM GROUNDWATER TREATMENT SYSTEM
FORMER UNISYS FACILITY
GREAT NECK, NEW YORK**



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Prepared for

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Disclosure Statement

The laws of New York State require that the corporations which render engineering services in New York be owned by individuals licensed to practice engineering in the State. ARCADIS Geraghty & Miller, Inc. cannot meet that requirement. Therefore, all engineering services rendered to Lockheed Martin Corporation in New York are being performed by GM Consulting Engineers, P.C., a New York professional corporation qualified to render professional engineering in New York. There is no surcharge or extra expense associated with the rendering of professional services by GM Consulting Engineers, P.C.

ARCADIS Geraghty & Miller, Inc. is performing all those services which do not constitute professional engineering and is providing administrative and personnel support to GM Consulting Engineers, P.C. All matters relating to the administration of the contract with Lockheed Martin Corporation are being performed by ARCADIS Geraghty & Miller, Inc. pursuant to its Amended and Restated Services Agreement with GM Consulting Engineers, P.C. All communications should be referred to the designated project manager at ARCADIS Geraghty & Miller.

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CONSENT, INDEX #WI-0787-96-12**

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**SECTION 01010
SUMMARY OF WORK**

PART 1 - GENERAL

1.01 SECTION INCLUDES:

- A. Contract Description.
- B. Definitions.
- C. Scope of Work.
- D. Principal Features.
- E. Responsibilities.
- F. Ownership.
- G. CONTRACTOR'S Use of Site and Premises.
- H. Offsets.
- I. Quality Assurance.
- J. Materials and Equipment.
- K. Warranties.
- L. References.
- M. Submittals.
- N. Project/Site Conditions.

1.02 CONTRACT DESCRIPTION

- A. Lockheed Martin Corporation (LMC) has retained ARCADIS Geraghty & Miller, Inc. and GM Consulting Engineers, P.C. to prepare these Technical Specifications and Construction Drawings for the Modified IRM Groundwater Treatment System at the Former Unisys Facility in Great Neck, New York.

1.03 DEFINITIONS

- A. For the purpose of these Technical Specifications, Construction Drawings, and other contract documents, the following definitions apply:

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1. OWNER: Lockheed Martin Corporation (LMC).
2. CONSULTANT/ENGINEER: ARCADIS Geraghty & Miller, Inc. and GM Consulting Engineers, P.C.
3. CONTRACTOR: The individual, firm, partnership, or corporation designated as the CONTRACTOR in these contract documents.
4. VENDOR, SUPPLIER or MANUFACTURER: The individual, firm, partnership, or corporation selected to supply specific system equipment components.
5. SITE: The area as indicated on Construction Drawing No. C-1.

1.04 SCOPE OF WORK

- A. The Construction Drawings and these Technical Specifications shall constitute the design and construction requirements for this project. The CONTRACTOR shall provide the necessary supervision, labor, materials, equipment, tools, and appurtenances as required to affect a complete Work, acceptable to the permitting authorities, the CONSULTANT/ENGINEER, and in compliance with the respective codes. Work under this Contract Document includes the following list of items which is meant as a guide and as a general description of the CONTRACTOR'S scope of work.
1. Obtain all necessary permits, except demolition permits.
 2. Mobilize materials and equipment.
 3. Obtain access to and locate all required utilities necessary for completion of the Work, including, but not limited to the following: electric power, natural gas, telephone, sewer, steam, and water (potable and process).
 4. Demolish and replace/modify existing structures in accordance with the Construction Drawings and these Technical Specifications.
 5. Construct a one-story treatment building, including, but not limited to the following: excavation; setting reinforcing steel; placing concrete for the anchors, footings, and foundations; and the construction of a treatment building as shown on the Construction Drawings; backfilling; site work and final grading, landscaping and driveway.

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6. Coordinate the delivery and installation of the tower air strippers, blower, vapor phase granular activated carbon (VPGAC) unit, duct heater, and associated ducts with the CONSULTANT/ENGINEER. The CONSULTANT/ENGINEER'S VENDOR for the tower air strippers will deliver and install two tower air strippers, blower, and associated ducting to the blower to the duct heater. The CONSULTANT/ENGINEER'S VENDOR for the VPGAC unit will deliver and connect the VPGAC unit to the associated ducts. The CONTRACTOR shall be available to assist in the above process equipment installations. This shall include but not be limited to preparing access routes, tie in duct supports, break and seal access holes through wells and walls, and provide any miscellaneous materials and labor necessary to complete a workable system in accordance with the Construction Drawings and these Technical Specifications.
7. Coordinate the delivery of clearwell pumps with the CONSULTANT/ENGINEER and install the clearwell pumps and associated piping and electrical controls in accordance with the Construction Drawings and these Technical Specifications and MANUFACTURER'S recommendations.
8. Provide and install all necessary wiring, electrical devices, control panels, instrumentation, and controls to provide for integrated system operation, except as noted in Section 1.05, F.
9. Install and connect electrical devices to appropriate electrical service.
10. Perform system start-up.

1.05 PRINCIPAL FEATURES

This section provides an overview and summary of the different processes associated with the treatment system and the components associated with each portion of the Work to be completed by the CONTRACTOR in accordance with the Construction Drawings and Technical Specifications.

A. Groundwater Recovery System

1. The groundwater recovery system shall be comprised of one existing recovery well (EW-1) and two newly installed recovery wells (RW-1RS and RW-1RD) which shall be equipped with submersible pumps, interconnecting piping, electrical power and controls. Recovery well EW-1

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is located below grade on the first floor of a two story structure. The second floor of the structure shall be demolished in accordance with Construction Drawing C-2 and equipped with necessary piping, appurtenances and controls. Existing well house RW-1 shall be demolished in accordance with Construction Drawing C-2. The CONSULTANT/ENGINEER will arrange the drilling and installation of recovery wells RW-1RS and RW-1RD during the construction of the Modified IRM Groundwater Treatment System. Upon completion of recovery wells RW-1RS and RW-1RD, the CONTRACTOR shall furnish two new below grade vaults including necessary piping, appurtenances and controls.

2. The piping from each groundwater recovery well shall be manifolded together into the existing 10-inch cast iron pipe. The existing 10-inch cast iron pipe presently runs from the area of well house EW-1 to the area of well house EW-3. Proposed pipe shall be connected to the existing pipe and installed between the existing 10-inch cast iron pipe and the treatment building.

B. Groundwater Treatment System

1. Groundwater from the recovery wells shall be directed to the first air stripper of a two air stripper system. Once the groundwater has passed through the first air stripper, the partially treated water will be pumped from a clearwell beneath the first air stripper into the second air stripper for further treatment. Treated water will then be pumped from a separate clearwell beneath the second air stripper to the discharge piping network. The discharge piping shall also be equipped to direct treated water back into the first air stripper tower.
2. A purge water treatment train connection from the south side of the treatment building into Clearwell No. 1 shall be provided in accordance with the detail shown on Construction Drawing P-2. This connection will be used during groundwater sampling events. The CONTRACTOR shall construct and equip the water treatment train with the necessary piping, appurtenances and controls.

C. Vapor Treatment System

1. The off-gas resulting from the air stripping process (7,225 scfm) shall be conveyed from the second air stripper to a vapor phase granular activated carbon (VPGAC) system for treatment. The treated off-gas will be discharged to the atmosphere through a single stack mounted to the side of the second air stripping tower.

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2. The VPGAC system shall be mounted on a reinforced concrete slab adjacent to the air stripping towers. The concrete slab shall be constructed in accordance with Construction Drawing S-3.

D. Treatment Building

1. The treatment system shall be partially housed in an above-grade structure, as shown on the Construction Drawings. The proposed treatment building will be comprised of; (1) three rooms that will house the influent and effluent piping, draft induction blower, the electrical controls, and a lavatory, (2) two below-grade clearwells beneath and adjacent to the southern and western side of the treatment building, and (3) a concrete pad to support the building VPGAC unit for off-gas treatment. The three rooms of the Modified IRM groundwater treatment structure house the lavatory, the electrical controls (Control Room), and the process equipment (Equipment Room) which will house the draft induction blower, process piping and various monitoring equipment and appurtenances and the flowmeter, strainers, flow control valves, and pressure indicators associated with the influent and effluent piping.
2. The treatment building shall include heating, ventilation, lighting and a lavatory to maintain a standard operating environment.

E. Piping

1. Piping includes pipe supports (within above-grade structures), thrust blocks (at below-grade fittings in pipe trenches), and all other associated appurtenances.

F. Electrical System

1. Provide and install all necessary wiring, electrical devices, control panels, instrumentation, and controls to provide for integrated system operation:
 - a. Electrical Devices: Some electrical devices which currently exist in the EW-1 and RW-1 existing well houses and in the existing OU-I treatment building will be made available for the CONTRACTOR to utilize for the Modified IRM Groundwater Treatment System. Specifics of available electrical devices will be discussed during the Bid Walk. The CONTRACTOR shall be responsible for the dismantling and reuse of these electrical devices and the

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dismantling and storage of all other electrical components in an area designated by the CONSULTANT/ENGINEER.

2. The electrical system shall include conduit, wiring, transformers, panel boxes, Motor Control Center (MCC), devices, instrumentation, and all other items necessary to make the system functional.
3. The control center for all system operations shall be a Main Control Panel (MCP) equipped with a Programmable Logic Controller (PLC) that can be monitored remotely.

1.06 RESPONSIBILITIES

A. The CONSULTANT/ENGINEER'S responsibilities:

1. Review the CONTRACTOR'S Health and Safety Plan to ensure its consistency with the overall plan for the site.
2. Stop work should it not comply with the terms of the Contract.
3. Review shop drawings, product data, and product samples.
4. Render approvals, clarifications, instructions, change orders, etc. (when appropriate).
5. Inspect materials and equipment as required.
6. Observe and verify construction activities.
7. Perform oversight of testing, obtain results of those tests, and evaluate for compliance with specifications.
8. Provide design interpretation and technical support.
9. Approve changes in the Work in writing.
10. Obtain demolition permits.

B. The CONTRACTOR'S responsibilities:

1. Adhere to these Technical Specifications and the Construction Drawings.

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2. Conduct all work in accordance with applicable local, State, and Federal regulations.
3. Review and fulfill requirements (where applicable) of the NYSDEC Order on Consent Index #WI-0787-96-12
4. Apply for and pay all permit and inspection fees.
5. Prepare, submit, and implement a site-specific Health and Safety Plan.
6. Provide access to all areas of work for inspections by the CONSULTANT/ENGINEER and the New York State Department of Environmental Conservation staff.
7. Provide 40-hour hazardous waste remediation training and certification for workers exposed to any hazardous areas or materials.
8. Supply all utilities required for construction (electricity, water, etc.).
9. Provide accurate schedules, adhere to the schedules, and receive approvals from the CONSULTANT/ENGINEER for modifications to the schedules, if necessary.
10. Attend weekly progress meetings with the CONSULTANT/ENGINEER.
11. Submit shop drawings, product data, samples and test results for the products, components, and equipment to be used to the CONSULTANT/ENGINEER for approval.
12. Perform testing, submit results, and receive approvals from the CONSULTANT/ENGINEER for all materials prior to delivery to the site.
13. Arrange for delivery, receive, and unload materials and equipment at site; inspect for completeness or damage. Replace any items damaged after receipt.
14. Coordinate the delivery and installation of the tower air strippers, its associated blower and ducts, the duct heater, and the VPGAC unit with the CONSULTANT/ENGINEER. The CONSULTANT/ENGINEER's VENDOR will deliver and install the above mentioned process equipment. CONSULTANT/ENGINEER will be responsible for payment of the above mentioned process equipment to the associated VENDOR.

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CONTRACTOR shall be responsible for any extra costs incurred by the CONSULTANT/ENGINEER in the event of a rush in the manufacturing, delivery and installation schedule is required to make up for delays in schedule caused by the CONTRACTOR. The CONTRACTOR shall furnish and install electrical supply and controls required to operate all process equipment.

15. Coordinate the delivery of one (1) submersible RW-1RD recovery well pump with the CONSULTANT/ENGINEER. CONTRACTOR shall furnish all labor, materials, incidentals, supervision and operations required to install one (1) new submersible RW-1RD recovery well pump and the removal, cleaning, switch and installation of the existing RW-1 pump to RW-1RS. The existing EW-1 submersible pump shall remain in the EW-1 recovery well. CONSULTANT/ENGINEER will be responsible for payment of the one (1) new submersible RW-1RD recovery well pump to their associated VENDOR.
16. Coordinate the delivery of two (2) vertical turbine clearwell pumps with the CONSULTANT/ENGINEER. CONTRACTOR shall furnish all labor, materials, incidentals, supervision and operations required to install the two (2) vertical turbine clearwell pumps. CONSULTANT/ENGINEER will be responsible for payment of the two (2) vertical turbine clearwell pumps to the associated VENDOR.
17. Store and secure all materials and equipment, as required.
18. Take all necessary precautions to ensure that all work under this contract shall be performed in such a manner that any adverse environmental impacts directly related to performing the Work are reduced to a level that is acceptable to the CONSULTANT/ENGINEER.
19. Provide and install all materials and equipment as specified, and perform testing to document that installation meets contract requirements. Submit test results to CONSULTANT/ENGINEER for review and approval.
20. Submit changes in the Work to the CONSULTANT/ENGINEER for written approval. Obtain written approval from the CONSULTANT/ENGINEER prior to the commencement of such changes in the Work.
21. Accompany the CONSULTANT/ENGINEER for a final inspection upon completion of the Work. The CONSULTANT/ENGINEER will prepare

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punch list and the CONTRACTOR shall make tradesmen available to make corrections to the system after the inspection.

22. Prepare and submit a complete set of operation and maintenance (O&M) instruction manuals for all equipment furnished by the CONTRACTOR.
23. Maintain a complete set of marked-up contract drawings to reflect all approved field changes and as-built information for the CONSULTANT/ENGINEER to develop record drawings.

1.07 OWNERSHIP

- A. The Construction Drawings and Technical Specifications prepared by the CONSULTANT/ENGINEER are the property of the CONSULTANT/ENGINEER. They are not to be used on other projects or extensions to this Project except by agreement in writing from the CONSULTANT/ENGINEER. Submissions or distribution to meet official regulatory requirements, or other purposes in connection with this Project, is not to be construed as publication in derogation of the CONSULTANT/ENGINEER'S and OWNER'S rights.

1.08 CONTRACTOR'S USE OF SITE AND PREMISES

- A. In accordance with Section 01012 (Special Conditions), the CONTRACTOR shall be responsible for making sure the locations of all underground and overhead utilities and structures are known. Before doing any work at the site, the CONTRACTOR shall notify the CONSULTANT/ENGINEER of the locations of all utilities and structures in the area where construction activities will be taking place.
- B. The CONTRACTOR shall take all steps necessary to prevent disruptions or interference to areas adjacent to the site.
- C. The CONTRACTOR shall limit construction operations to areas noted on Construction Drawings and designated by the CONSULTANT/ENGINEER.
- D. The CONTRACTOR shall restore all areas disturbed by construction activities to existing conditions unless otherwise specified by the CONSULTANT/ENGINEER.
- E. All work shall be conducted during hours deemed appropriate by the CONSULTANT/ENGINEER, OWNER, and/or local ordinance.

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1.09 OFFSETS

- A. The Construction Drawings are diagrammatic in nature. Required size and termination of pipes, and suggested routings are shown to conform to the site requirements, avoid creating obstructions, and preserve clearances. However, it is not the intention of these documents to indicate all required offsets. It is the specific responsibility of the CONTRACTOR to provide for offsets, horizontal and vertical control points and other surveying requirements in such a manner as to conform to the site features, and make all equipment requiring inspection, maintenance, and repair accessible.

1.10 QUALITY ASSURANCE

The CONTRACTOR shall be responsible for quality assurance of the Work as summarized below and in accordance with Section 01400 (Quality Control). The CONTRACTOR shall:

- A. Monitor quality control over SUPPLIER'S, MANUFACTURER'S, products, services, site conditions, and workmanship, to produce Work of specified quality.
- B. Comply fully with MANUFACTURER'S instructions, including each step in installation, startup, and operating sequence.
- C. Should MANUFACTURER instructions conflict with Contract Documents, request clarification from the CONSULTANT/ENGINEER before proceeding.
- D. Comply with specified standards as a minimum quality for the Work except when more stringent tolerances, codes, or specified requirements indicate higher standards or more precise workmanship.
- E. Have the Work performed by persons qualified to produce workmanship of specified quality.

1.11 MATERIALS AND EQUIPMENT

The CONTRACTOR shall be responsible for materials and equipment as summarized below and in accordance with Section 01600 (Materials and Equipment):

A. Products

- 1. Products: means new material, components, fixtures, and systems comprising the Work. Does not include machinery and equipment used for

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preparation, fabrication, conveying, and erection of the Work. Products may also include existing materials or components required for reuse.

B. Storage and Protection

1. Equipment, products, backfill material, and all other construction materials shall be stored in an area designated by the CONSULTANT/ENGINEER.
2. Store and protect products in accordance with MANUFACTURER'S instructions, with seals and labels intact and legible. Store sensitive products in weather-tight, climate controlled enclosures.
3. The CONTRACTOR will be responsible for providing heating and weather protection for equipment and materials that require that level of care.

C. Substitutions

1. Substitutions after project initiation may be considered when a product becomes unavailable through no fault of the CONTRACTOR.
2. Substitution of components is allowed as follows:
 - a. Where specified as "or equal" shall mean that the CONTRACTOR may use a material of equal quality, function, and value.
 - b. Where specified as "or approved equal" means that substitution is allowed upon approval by the CONSULTANT/ENGINEER.
 - c. Where specified as "no substitutions" means substitutions will not be allowed unless compelling reasons exist to require the substitution, and the CONSULTANT/ENGINEER concurs with the CONTRACTOR and approves substitution
3. A request for substitution constitutes a representation that the CONTRACTOR:
 - a. Has investigated the proposed product and determined that it meets or exceeds the quality level of the specified product.
 - b. Will provide the same warranty for the substitution as for the specified product.

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- c. Will coordinate installation and make changes to other Work, which may be required for the Work to be complete, with no additional cost to the CONSULTANT/ENGINEER.
- d. Waives claims for additional costs or time extension which may subsequently become apparent.
- e. CONSULTANT/ENGINEER'S approval of a request shall place the responsibility under this section on the CONSULTANT/ENGINEER.

1.12 WARRANTIES

The CONTRACTOR shall obtain warranties and bonds in accordance with Section 01012 (Special Conditions) and as summarized below.

- A. Warranties and bonds shall be executed in duplicate by responsible SUBCONTRACTORS, SUPPLIERS, and MANUFACTURERS, at least ten (10) days prior to shipment or completion of the applicable item of Work. Except for items put into use with CONSULTANT/ENGINEER permission, leave date of beginning of time of warranty blank until the Date of Substantial Completion is determined.

1.13 REFERENCES

- A. In addition to other applicable local, State, and Federal requirements, the CONTRACTOR shall comply with the specific codes and standards cited in each section.
- C. Applicable National Fire Protection Association (NFPA) codes shall also be adhered to.

1.14 SUBMITTALS

The CONTRACTOR shall be responsible for providing submittals in accordance with Section 01300 (Submittals) and as summarized below:

- A. Submit as follows:

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1. Identify Project, CONSULTANT/ENGINEER, CONTRACTOR, SUBCONTRACTOR, or SUPPLIER; pertinent Drawing sheet and detail number(s), and specification Section number, as appropriate.
 2. Identify variations from Contract Documents and product or system limitations which may be detrimental to successful performance of the completed Work.
- B. Documents Required:
1. Submit the number of copies which the CONSULTANT/ENGINEER requires, three (3) copies of which will be retained by the CONSULTANT/ENGINEER.
 2. Mark each copy to identify applicable products, models, options, and other data. Supplement MANUFACTURERS' standard data to provide information unique to this Project.
- C. Submit shop drawings and product data grouped to include complete submittals of related systems, products, and accessories in a single submittal.
- D. Mark dimensions and values in units to match those specified.
- E. Proposed Products List: Submit information on all products and equipment specified for the Project.
- F. Proposed Supplier List: Submit a complete list of suppliers with product, name, and address.
- G. Other submittals shall include (but are not limited to): MANUFACTURER'S instructions; product test results; proposed subcontractor list; site-specific Health and Safety Plan (HASP); construction progress schedules and reports; Operations and Maintenance (O&M) manuals; and record drawings.

1.15 PROJECT/SITE CONDITIONS

- A. Install Work in locations shown on Construction Drawings, unless prevented by unforeseen conditions.

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PART 2 - PRODUCTS

- A. Products are referenced and specified throughout these specifications by registered trade names. This does not constitute a recommendation of these products to the exclusion of other products. Equivalent products must be approved by the CONSULTANT/ENGINEER before being used (see paragraph 1.11, above). Impact to system layout, cost, and project schedule must be accounted for by the CONTRACTOR in all requested changes in accordance with Section 01600 (Materials and Equipment).

PART 3 - EXECUTION

Not Used.

END OF SECTION

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**SECTION 01012
SPECIAL CONDITIONS**

PART 1 - GENERAL

1.01 SECTION INCLUDES

- A. Utilities.
- B. Ordinances, Permits, Licenses.
- C. Emergency Responsibility.
- D. Environmental Protection.
- E. Equipment Adjustment and Calibration.
- F. System Start-up and Operation.
- G. Operation and Maintenance Instruction Manuals.
- H. Warranties.
- I. CONSULTANT/ENGINEER'S Authority.

1.02 UTILITIES

- A. Repair of damaged utilities caused by the CONTRACTOR'S work is the responsibility of the CONTRACTOR. Utilities such as sewer, water, natural gas, telephone and electric lines encountered in the work shall be protected from injury and maintained in service until removed, replaced, or abandoned as required for the complete work.

1.03 ORDINANCES, PERMITS, AND LICENSES

- A. The CONTRACTOR shall at all times follow all applicable local, state, and federal laws. Neither the CONSULTANT/ENGINEER, OWNER, nor any other party shall be liable or held responsible if CONTRACTOR violates any of the above laws.
- B. The CONTRACTOR must apply and pay for the cost of all local building permits.
- C. The required state environmental permits shall be in place before start of construction.

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- D. The CONSULTANT/ENGINEER shall be responsible for obtaining the following permit:
 - a. Air permit.

1.04 EMERGENCY RESPONSIBILITY

- A. In case of emergency which threatens damage of property and/or safety of life, the CONTRACTOR shall act, without previous instructions from the CONSULTANT/ENGINEER or OWNER, as the situation may warrant. The Health and Safety Plan (HASP) required under Section 01300 (Submittals) shall contain all relevant information regarding emergency response and be completed per Part 3 of this section of the Technical Specifications. The CONTRACTOR shall notify the CONSULTANT/ENGINEER of any emergencies immediately thereafter. Any claim for compensation by the CONTRACTOR, together with substantiating documents regarding expenses, shall be submitted to the CONSULTANT/ENGINEER and the amount of compensation shall be determined by agreement between the CONTRACTOR and CONSULTANT/ENGINEER.

1.05 ENVIRONMENTAL PROTECTION

- A. General Requirements - The CONTRACTOR shall provide and maintain environmental protection during the life of the Contract. Environmental protection shall be provided to correct conditions that develop during all phases of construction. The CONTRACTOR'S operations shall comply with all federal, state, and local regulations pertaining to water, air, solid waste, and noise pollution.
- B. Protection of Natural Resources - It is intended that the natural resources within the site and outside the limits of permanent Work performed under this Contract be preserved in their existing condition or be restored to an equivalent or improved condition upon completion of the Work. Construction activities shall be confined to areas defined by the Contract Documents.
 - 1. The CONTRACTOR shall restore damaged areas of the site to "Original Conditions" as applicable after performing required work. An inspection by the CONSULTANT/ENGINEER shall determine completion of work and shall approve the repair and restoration prior to the acceptance of the work. All restoration operations shall be performed at the CONTRACTOR'S expense.

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2. Signs of temporary construction facilities such as haul roads, work areas, structures, foundations of temporary structures, stockpiles of excess or waste materials, and other vestiges of construction shall be eliminated in an approved way. Upon completion, all areas shall be clean and natural looking to the maximum extent possible.
 3. All Work under this contract shall be performed in such a manner that any adverse environmental impacts are reduced to a level that is acceptable to the CONSULTANT/ENGINEER and the New York State Department of Environmental Conservation (NYSDEC).
 4. Special measures shall be taken to prevent oily or hazardous substances from entering the ground, drainage areas, or local bodies of water.
- C. Erosion and Sediment Control Measures - Earthwork brought to final grade shall immediately be finished as summarized below and as specified in Section 02211. Side slopes and back slopes shall be protected immediately upon completion of rough grading. Earthwork shall be planned and conducted in such a manner as to minimize the duration of exposure of unprotected soils. Erosion and sediment control shall be utilized in accordance with Section 02270 (Temporary Erosion and Sediment Control) to effectively prevent erosion and control sedimentation, including, but not limited to, the following:
1. The rate of runoff from the construction site shall be mechanically retarded and controlled. This includes construction of diversion ditches, benches, and berms, to retard and divert runoff to protected drainage courses.
 2. Borrow will not be permitted in areas where suitable environmental controls are not possible.
 3. Temporary protection will be provided on all side and back slopes as soon as rough grading is completed or sufficient soil is exposed to require protection to prevent erosion.
 4. All soil piles created as part of excavation activities shall be provided with temporary cover and run-off control.
- D. Control of Wastes - Wastes shall be picked up and placed in containers which are emptied on a regular schedule. Handling shall be conducted in a way that prevents contamination of the site and any other areas.

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1. All waste shall be transported and disposed of in a manner that complies with federal, state, and local requirements by the CONSULTANT/ENGINEER. The CONSULTANT/ENGINEER shall maintain a copy of any state and/or local permits or licenses which reflect such agency's approval and compliance with applicable solid waste disposal regulations. The permits or licenses and the location of the disposal area shall be provided prior to transporting any waste material.
 2. During construction, the CONTRACTOR shall use chemical toilets or comparably effective units with sanitary wastes periodically emptied into municipal or county sanitary sewage systems. Provisions shall be made for pest control and for elimination of odors.
 3. Fueling and lubricating of equipment and motor vehicles shall be conducted in a manner that affords the maximum protection against spills and evaporation. Lubricants and waste oil shall be disposed of by the CONTRACTOR at his expense, in accordance with approved procedures meeting federal, state, and local regulations.
- E. Dust Control - Dust shall be suppressed at all times, including non-working hours, weekends, and holidays. Soil at the site, haul roads, and other areas disturbed by the construction operations shall be sprinkled with water as necessary to control dust. Upon the start of construction activities, a minimum coarse gravel base of 4-inches thick by 20-feet wide by 40-feet long shall be placed at the entrance/exit of the access road to Marcus Avenue in order to prevent off-site dust migration. During the construction activities this gravel area shall be re-graded if necessary. No dry power brooming will be permitted. Vacuuming, wet mopping, or wet power brooming shall be used instead. Air blowing will be permitted only for cleaning off nonparticulate debris, such as reinforcing bars. No sandblasting will be permitted unless the dust therefrom is confined. Only wet cutting of concrete blocks, concrete, and asphalt will be permitted. No unnecessary shaking of bags will be permitted where concrete mortar and plaster milling is done.
- F. Noise Control - The maximum use of "low-noise emission products" as certified by the Environmental Protection Agency shall be made when available. When not available, screens and/or barriers shall be used for noise control. No blasting or use of explosives will be permitted.
- 1.06 EQUIPMENT ADJUSTMENT AND CALIBRATION
- A. All mechanical equipment and electrical equipment, including related control systems, shall be subjected to preliminary operation and testing before the

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individual facilities and systems are put into operation. Tests shall be made to determine whether the equipment has been properly assembled, aligned, adjusted, wired, or connected.

- B. The demonstration test of each piece of equipment shall include check-out from each remote control point. All alarm systems and safety lockout systems shall also be demonstrated for proper function along with all process instrumentation and controls.
- C. The CONTRACTOR shall coordinate and be present during all such tests. The equipment SUPPLIER shall be responsible for testing and demonstrating the equipment supplied in accordance with Section 01650 (Starting of Systems) and the relevant equipment specification section.

1.07 SYSTEM START-UP AND OPERATION

- A. The CONTRACTOR shall place the various items of equipment into operation, along with the related piping and metering systems. After satisfactory start-up of these individual systems, including all of the related equipment, they will remain in continuous or intermittent operation as required.
- B. All equipment and accessories shall be adjusted and calibrated prior to any start-up as specified under these Special Conditions. Any equipment placed into temporary operation prior to final completion of the total project shall be readjusted and/or calibrated.
- C. The CONTRACTOR shall supervise, control, and be responsible for the operation and maintenance of the new equipment and/or system after each individual item is placed into operation. An adequate number of competent start-up personnel shall be furnished until the equipment is functional and working properly. The CONTRACTOR shall remain responsible for making any required changes, repairs, or replacements to the new installation during the start-up period.

1.08 OPERATION AND MAINTENANCE INSTRUCTION MANUALS

- A. In accordance with Section 01300, the CONTRACTOR shall prepare and submit a complete set of operation and maintenance instruction manuals for the overall project, covering all equipment furnished. Manuals shall include complete parts lists for all equipment. Manuals shall be prepared specifically for the particular equipment furnished and shall consider the specific operation of this equipment in the particular process system involved. Complete lubrication requirements shall be listed, including recommended lubricant and lubricating intervals or schedule.

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1.09 WARRANTIES

- A. In accordance with Section 01300 (Submittals) and these Special Conditions, the CONTRACTOR shall obtain and submit in writing warranties and bonds, executed in duplicate by responsible SUPPLIERS, and MANUFACTURERS. Except for items put into use with the CONSULTANT/ENGINEER'S permission, the beginning of the time of warranty will be the Date of Substantial Completion.
- B. The MANUFACTURER shall guarantee and furnish MANUFACTURER'S warranty against manufacturing and mechanical defects on all equipment provided for a period of two (2) years from date of initial operation.
- C. In the event any material, part, or equipment proves defective during this period, the MANUFACTURER shall, at his expense (including labor), furnish and replace the defective item.
- D. The MANUFACTURER shall guarantee in writing the structural integrity of all equipment for a period of five (5) years.
- E. The MANUFACTURER shall guarantee the performance of the equipment and its components for a period of two (2) years.
- F. All warranties shall be provided in writing, signed by an officer of the Manufacturing company.

1.10 CONSULTANT/ENGINEER'S AUTHORITY

- A. When performing the work, the CONTRACTOR shall abide by all orders, directions, and requirements of the CONSULTANT/ENGINEER. The work shall be performed to the satisfaction of the CONSULTANT/ENGINEER at the times and places, the methods, and in the manner and sequence the CONSULTANT/ENGINEER may require. The CONSULTANT/ENGINEER shall determine the amount, quality, and acceptability of all phases of the work. The CONSULTANT/ENGINEER shall interpret the plans, specifications, contract documents, and any extra work orders. The CONSULTANT/ENGINEER shall decide all other questions in connection with the work. Upon request, the CONSULTANT/ENGINEER shall confirm in writing any oral orders, directions, requirements, or determinations.

PART 2 - PRODUCTS

Not used.

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PART 3 - EXECUTION

3.01 FIELD QUALITY CONTROL

- A. The CONTRACTOR shall collect samples and conduct tests in accordance with Section 01400 (Quality Control) and all applicable standards related to the item or system being tested.

3.02 HEALTH AND SAFETY

- A. The CONTRACTOR shall be responsible for implementing the site-specific HASP prepared in accordance with Section 01300 (Submittals).
- B. The CONTRACTOR shall provide adequate health and safety personal protection equipment (PPE) for his/her employees and others who might be affected by excavation and construction activities.
- C. Work procedures shall conform to all applicable OSHA, State of New York, county, local government, and other federal regulations.

3.03 PROJECT SCHEDULE

- A. Time is of the essence for construction. The CONTRACTOR is responsible for meeting the system start-up deadline.
- B. The CONTRACTOR shall be responsible for achieving round-the-clock operation of the treatment system and address all punch list items within 6 months of the notice to proceed.
- C. The CONTRACTOR shall develop, implement, and maintain a project schedule that runs 6 months and 1 week from notice to proceed to completion of all punch list items and fully automatic operation.
- D. The CONTRACTOR will be responsible for all fines and extra costs associated with the CONTRACTOR'S failure to meet the deadline specified herein and in the Contract Documents.

END OF SECTION

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**SECTION 01039
COORDINATION AND MEETINGS**

PART 1 - GENERAL

1.01 SECTION INCLUDES

- A. Site Progress Meetings.
- B. Coordination.

1.02 RELATED SECTIONS

- A. Section 01010 - Summary of Work.
- B. Section 01012 - Special Conditions.
- C. Section 01300 - Submittals.
- D. Section 01400 - Quality Control.

1.03 SITE PROGRESS MEETINGS

- A. The CONSULTANT/ENGINEER shall designate, as necessary, progress meetings that will be conducted to review the progress of the Work, and any unexpected conditions or situations that may have arisen. The CONSULTANT/ENGINEER will ensure conformance with the financial plan. The CONTRACTOR shall be fully responsible for any and all of the subcontractors and shall be responsible for subcontractor attendance and/or input into the meetings.
- B. The meetings shall be documented by the CONSULTANT/ENGINEER and copies of the minutes of the meetings shall be distributed to the CONTRACTOR.
- C. Progress meetings shall be held approximately once a week, at which time the weekly progress report will be reviewed.

1.04 COORDINATION

- A. All on-site work shall be coordinated by the CONTRACTOR, with the approval of the CONSULTANT/ENGINEER.
- B. Site, facility, and utility access shall be coordinated through the CONSULTANT/ENGINEER and/or the appropriate utility authority.

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- C. Issues related to design and construction of the specified system shall be handled through the CONSULTANT/ENGINEER in accordance with Sections 01010 (Summary of Work), 01012 (Special Conditions), 01300 (Submittals), and 01400 (Quality Control).

PART 2 - PRODUCTS

Not used.

PART 3 - EXECUTION

Not used.

END OF SECTION

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COORDINATION AND MEETINGS**

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**SECTION 01090
REFERENCE STANDARDS**

PART 1 - GENERAL

1.01 REFERENCE STANDARDS

Where standards of the following organizations or any other standards, codes, or specifications are referred to in the Technical Specifications, the reference is to the particular standard, code, or specification cited, together with all amendments applicable at the date of the opening of Bids; and shall apply except to the extent that said standards and requirements may be in conflict with applicable laws or ordinances.

<u>Acronym</u>	<u>Organization</u>
AASHTO	American Assn. of State Hwy. & Trans. Officials
ACI	American Concrete Institute
AI	The Asphalt Institute
AMCA	Air Moving and Conditioning Association
ANSI	American National Standards Institute
API	American Petroleum Institute
ASME	American Society of Mechanical Engineers
ASTM	American Society of Testing and Materials
AWS	American Welding Society
AWWA	American Water Works Association
BOCA	Building Officials Conference of America
CRSI	Concrete Reinforcing Steel Institute
IEEE	Institute of Electrical and Electronic Engineers
JIC	Joint Industrial Council
NCMA	National Concrete Masonry Association
NEMA	National Electrical Manufacturer's Association
NFPA	National Fire Protection Association
NYDOT	New York Department of Transportation
NYSDEC	New York State Department of Environmental Conservation
OSHA	Occupational Safety and Health Administration
PCA	Portland Cement Association
SSPC	Steel Structures Painting Council
UL	Underwriters Laboratories

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REFERENCE STANDARDS**

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PART 2 - PRODUCTS

Not Used.

PART 3 - EXECUTION

Not Used.

END OF SECTION

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REFERENCE STANDARDS**

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**SECTION 01300
SUBMITTALS**

PART 1 - GENERAL

1.01 SECTION INCLUDES

- A. General
- B. Submittal Procedures.
- C. Shop Drawings.
- D. Product Data.
- E. MANUFACTURER'S Instructions.
- F. Warranties
- F. Product Test Results.
- G. Proposed SUPPLIER List.
- H. Proposed Subcontractor List.
- I. Health and Safety Plan (HASP).
- J. Construction Progress Schedules.
- K. Operation and Maintenance Manuals.
- L. Record Drawings.

1.02 GENERAL

- A. All submittals shall be complete, neat, and orderly.
- B. Submittals shall be provided according to the Contract Schedule.

1.03 SUBMITTAL PROCEDURES

- A. Transmit three (3) copies of each submittal to the CONSULTANT/ENGINEER.
- B. Sequentially number the transmittal forms. Resubmittals to have original number with an alphabetic suffix.

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- C. Identify project, CONTRACTOR name, subcontractor or supplier name, submission date, pertinent drawing sheet and detail number(s), and specification section number(s) as appropriate.
- D. Apply CONTRACTOR'S stamp, signature or initials certifying that review, verification of products, field dimensions, adjacent construction work, and coordination of information, is completed as required.
- E. All submittals are to be submitted to and approved by the CONSULTANT/ENGINEER in writing prior to commencing work for the item which requires submittal.
- F. Distribute copies of reviewed submittals to concerned parties. Instruct parties to promptly report any inability to comply with provisions.
- G. Provide space for CONSULTANT/ENGINEER to place review stamp.
- H. Revise and resubmit submittals as required by the CONSULTANT/ENGINEER until approved; identify all changes made since previous submittal.

1.04 SHOP DRAWINGS

- A. The CONTRACTOR shall furnish Shop Drawings to the CONSULTANT/ENGINEER for review and approval within 21 calendar days after award of contract.
- B. Shop Drawings shall show how the CONTRACTOR intends to perform the Work.
- C. The Shop Drawings shall include, but are not limited to:
 - 1. Complete arrangement, connection/anchoring details, and structural details (as applicable) of: access hatches, stairs, air inlets, and grate platforms.
 - 2. The location, elevation, size, and anchoring details of all interior access doorways and service (mechanical and electrical) penetrations.
 - 3. Design tolerances (plumbness, wall thickness, etc.).
 - 4. Concrete mix design.
 - 5. Concrete formwork design.

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6. Proposed extents of excavations and sitework.
 7. Erosion and sediment control plan in accordance with Sections 01012 (Special Conditions) and 02270 (Temporary Erosion and Sediment Control).
 8. Demolition plans in accordance with Section 02060 (Building Demolition).
 9. Jacking Plans for all road crossings (electrical and piping) beneath Marcus Avenue.
 10. Warranties extended by the CONTRACTOR for the Work to be completed.
- D. Three (3) copies of the drawings and data submitted by the CONTRACTOR will be returned by the CONSULTANT/ENGINEER to the CONTRACTOR with comments such as, "No Exceptions Noted," "Exceptions Noted," or "Returned for Resubmission." The CONTRACTOR shall make all necessary revisions, corrections, or clarifications, if required, and resubmit three (3) copies of the revised drawings and data within (7) calendar days.

1.05 PRODUCT DATA

- A. The CONTRACTOR shall supply the CONSULTANT/ENGINEER with a proposed products list within 7 calendar days after award of contract. This list shall be subject to approval by the CONSULTANT/ENGINEER.
- B. The proposed products list shall indicate all products that the CONTRACTOR believes will be incorporated. This list shall be interpreted as agreement by the CONTRACTOR to use the specified products. Omission from this list of any product required by the contract documents shall not relieve the CONTRACTOR of the responsibility for providing that product and completing the associated work as specified.
- C. The CONTRACTOR shall submit for the CONSULTANT/ENGINEER'S approval, all information and product data related to the products in the proposed products list. The product data shall be submitted with the shop drawings and include data called for under the specifications or requested by the CONSULTANT/ENGINEER, including but not limited to:
 1. MANUFACTURER descriptions, specifications, and data for each component specified that will not be fabricated on-site.

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2. MANUFACTURER warranties in accordance with Section 01012 (Special Conditions).
3. Submittals shall indicate that material or product conforms to or exceeds specified requirements. Submit supporting data or certifications as appropriate.

1.06 MANUFACTURER'S INSTRUCTIONS

- A. CONTRACTOR shall submit printed instructions for delivery, storage, assembly, installation, and maintenance of specified components that will not be fabricated on-site to the CONSULTANT/ENGINEER. Instructions shall be provided a minimum of seven (7) calendar days prior to delivery.

1.07 PRODUCT TEST RESULTS

- A. Test results shall be submitted to the CONSULTANT/ENGINEER for review within 5 calendar days of receipt of results, but no later than 30 calendar days after sample is collected for testing.

1.08 PROPOSED SUPPLIER LIST

- A. A complete list of SUPPLIERS with product, name, and address shall be submitted to the CONSULTANT/ENGINEER for review within 7 calendar days after award of contract.

1.09 PROPOSED SUBCONTRACTOR LIST

- A. A final list of subcontractors with name, address, and experience shall be submitted to the CONSULTANT/ENGINEER for review within 7 calendar days after award of contract.
- B. No work on the contract shall commence until all the proposed subcontractors have been approved by the CONSULTANT/ENGINEER in writing.

1.10 HEALTH AND SAFETY PLAN

- A. The CONTRACTOR shall prepare a construction health and safety plan (HASP) in accordance with the HASP presently in place at the site. The HASP shall be submitted to the CONSULTANT/ENGINEER for review within 7 calendar days after award of contract.

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- B. CONTRACTOR shall be responsible for implementing the HASP in accordance with Section 01012 (Special Conditions).
- C. No work shall commence at the Site until a HASP is in place.

1.11 CONSTRUCTION PROGRESS SCHEDULES

The CONTRACTOR shall:

- A. Submit initial project schedule within 7 calendar days after award of contract.
- B. Submit revised schedules as substantial variations are identified or as required by the CONSULTANT/ENGINEER.
- C. Show complete sequence of construction by activity, identifying Work in separate stages and in logically grouped activities. Indicate the start and finish dates and duration. Presentation shall be neat and accurate utilizing MS Project® or comparable project tracking software package.

1.12 OPERATION AND MAINTENANCE MANUALS

- A. The CONTRACTOR shall provide operation and maintenance instruction manuals and warranty and service information from equipment manufacturers to the CONSULTANT/ENGINEER within fifteen (15) days of (prior to) system startup. The CONTRACTOR shall prepare an operation and maintenance manual which addresses the following items:
 - 1. Operating Procedures: start-up, break-in, and routine normal operating instructions and sequences; regulation, control, stopping, shut-down, and emergency instructions; summer, winter, and any special operating instructions.
 - 2. Maintenance Requirements: routine procedures and guide for trouble-shooting, disassembly, repair, and reassembly instructions, and alignment, adjusting, balancing, and checking instructions.
 - 3. MANUFACTURER'S parts list, illustrations, assembly drawings, and diagrams required for maintenance.
 - 4. MANUFACTURER'S record drawings and any additional submittal information.

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1.13 RECORD DRAWINGS

- A. The CONTRACTOR shall furnish drawings with all technical information (including product data, manufacturer's instructions and certificates) and all field modifications clearly indicated to the CONSULTANT/ENGINEER. All information necessary for the generation of record drawings shall be provided by the CONTRACTOR within 14 calendar days of substantial completion of construction.

PART 2 - PRODUCTS

Not used.

PART 3 - EXECUTION

Not used.

END OF SECTION

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**SECTION 01400
QUALITY CONTROL**

PART 1 - GENERAL

1.01 SECTION INCLUDES

- A. Contractor Quality Control and Assurance of Installation.
- B. Workmanship.
- C. References.
- D. Field Inspection of Contractor's Work.
- E. On-Site and Laboratory Testing.
- F. Manufacturer's Field Services and Reports.

1.02 RELATED SECTIONS

- A. Section 01039 - Coordination and Meetings.
- B. Section 01090 - Reference Standards.
- C. Section 01300 - Submittals.

1.03 CONTRACTOR QUALITY CONTROL AND ASSURANCE OF INSTALLATION

The CONTRACTOR shall:

- A. Monitor quality control over SUPPLIERS, MANUFACTURERS, products, services, site conditions, and workmanship, to produce Work of specified quality.
- B. Comply fully with MANUFACTURER'S instructions, including each step in installation and startup sequence.
- C. If MANUFACTURER'S instructions conflict with Contract Documents, CONTRACTOR shall request clarification from the CONSULTANT/ENGINEER before proceeding.

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- D. Comply with specified standards as a minimum quality for the Work except when more stringent tolerances, codes, or specified requirements indicate higher standards or more precise workmanship.
- E. Perform Work by persons qualified to produce workmanship of specified quality.
- F. Secure products and equipment in place with positive anchorage devices designed and sized to withstand stresses, vibration, physical distortion, or disfigurement.
- G. During freezing or inclement weather, or other adverse conditions, no work shall be performed except that which can be performed in a manner which will ensure first-class construction throughout.

1.04 WORKMANSHIP

- A. The intent of these Technical Specifications is to describe definitively and fully the character of materials and workmanship required with regard to all ordinary features, and to require first-class work and material in all particulars.
- B. For any unexpected features arising during the progress of the Work and not fully covered herein, the specifications shall be interpreted by the CONSULTANT/ENGINEER to require first-class work and materials; and such interpretation shall be accepted by the CONTRACTOR.
- C. All labor shall be performed in the best and most workmanlike manner by mechanics skilled in their respective trades. The standards of the Work required throughout shall be of such grade as will bring only first-class results.
- D. Materials and methods used in the assemblage of the equipment shall comply with relevant standards, codes, or specifications related to the manufacture and operation of the specified equipment.

1.05 REFERENCES

- A. Conform to current reference standards, including those listed in Section 01090 (Reference Standards), by contract documents' date of issue.
- B. Obtain copies of standards when required by contract documents.
- C. Should specified reference standards conflict with contract documents, request clarification from CONSULTANT/ENGINEER before proceeding.

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- D. The contractual relationship of the parties to the Contract shall not be altered from the contract documents by mention or inference otherwise in any reference document.
- E. Where a field sample is specified to be removed in individual sections, clear area after field sample has been accepted by CONSULTANT/ENGINEER.

1.06 SUBMITTALS

- A. Three (3) certified copies of each test report shall be mailed directly to the CONSULTANT/ENGINEER within 24 hours after the sample is taken, except in those instances when tests cannot be immediately performed because of required curing or incubation periods, or lengthy testing procedures. The CONTRACTOR shall make arrangements with the laboratory to secure copies.
- B. Each report shall be in writing and shall include the testing method used, the test results, the specified results, the exact location of where the test specimens were taken, the date taken, Project identification, CONTRACTOR'S name and other pertinent information required for a complete and meaningful test report.
- C. Each report shall be signed and certified by a responsible officer of the testing laboratory.
- D. The laboratory shall verbally communicate test results when requested by the ENGINEER. This does not eliminate nor replace the requirements for a written report.

1.07 FIELD INSPECTION OF CONTRACTOR'S WORK

- A. The CONSULTANT/ENGINEER will provide periodic inspection of the CONTRACTOR'S Work which will ensure that the Work is being performed in accordance with the Construction Drawings and these Technical Specifications such that the end product will be in conformance with the Construction Drawings and Technical Specifications.
- B. The CONTRACTOR is responsible for complete conformance to the Construction Drawings and Technical Specifications for all Work performed on the project, including all subcontractors.

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- C. The CONTRACTOR will provide ample opportunity for safe and easy access to the inspectors for proper inspection of the Work.
- D. Inform the CONSULTANT/ENGINEER in advance of periods when the CONTRACTOR does not intend to work due to, but not limited to, inability to obtain materials or equipment or expected inclement weather.
- E. Upon completion of the Work, the CONTRACTOR shall notify the CONSULTANT/ENGINEER for the final inspection of the system. The CONTRACTOR, or his representative, must accompany the CONSULTANT/ENGINEER on the final inspection. The CONTRACTOR shall have tradesmen available or on call to make changes or corrections to the system after or during the inspection, as determined by the CONSULTANT/ENGINEER.

1.08 ON-SITE AND LABORATORY TESTING

- A. The CONTRACTOR shall be responsible for collecting samples and conducting tests related to the work performed under this contract. Testing shall include, but not be limited to: concrete tests, compaction tests, pipeline and interconnecting piping pressure tests, metering, electrical and control device testing.
- B. Unless listed otherwise, all performance tests and field and laboratory analyses will be conducted by the CONTRACTOR as detailed in the relevant sections of the Technical Specifications.
- C. Except where otherwise specified, the CONSULTANT/ENGINEER will determine the number of samples to be taken, the date and time samples will be taken and tests made, the number and type of tests to be performed, who will collect the samples, how they will be handled and stored and when laboratory personnel are required on site.
- D. The CONSULTANT/ENGINEER will notify the CONTRACTOR of his/her decision to take samples and/or have tests made and provide him/her with the pertinent information. The CONTRACTOR is responsible for notifying the testing laboratory and for having the testing performed, on schedule.
- E. In addition to the above, the CONTRACTOR shall make his own arrangements for the sampling and testing of materials he proposes to incorporate into the work.
- F. Notify CONSULTANT/ENGINEER at least 72 hours in advance of the times at which scheduled samples or tests will be conducted.

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- G. If samples and/or tests cannot be collected or performed when required, delay the work until such time that they can be accomplished. Where possible, any work which has been installed but has not been sampled or tested as required, shall be tested by other means. Upon CONSULTANT/ENGINEER'S request, uncover any work which has been buried or covered and perform special tests designated by CONSULTANT/ENGINEER. If the work cannot be tested by other means, the ENGINEER may declare the work unacceptable. All costs associated with noncompliance and for special testing shall be borne by the CONTRACTOR.
- H. Should the testing laboratory be scheduled to take or collect samples or to perform tests, and finds that it is unable to do so as a result of delays in construction, inclement weather, or any other reason, reschedule the tasks for a date acceptable to the CONSULTANT/ENGINEER. Costs associated with times testing laboratory is unable to perform scheduled services shall be borne by the CONTRACTOR.
- I. Plan all work and operations to allow for the taking and collection of samples and allow adequate time for the performance of tests. Delay the progress of questionable work until the receipt of the certified test reports.

1.09 TESTING REQUIREMENTS

- A. Compaction Testing – Soil:
 - 1. Perform compaction testing in accordance with ASTM D2922, Standard Test Methods for Density of Soil and Soil-Aggregate in Place by Nuclear Methods (Shallow Depth) or ASTM D1556 Density and Unit Weight of Soil In Place by the Sand Cone Method.
 - 2. Perform tests and analysis of fill material in accordance with ANSI/ASTM D698 – Test Methods for Moisture-Density Relations of Soils and Soil-Aggregate Mixtures, using 55-lb. Rammer and 12-inch Drop.

1.10 TESTING SCHEDULE

- A. Compaction Testing of Soil:
 - 1. Pipe Installation: Perform compaction tests at 50 foot intervals after each two vertical feet above crown of pipe and at finished subgrade elevation.
 - 2. Concrete Flatwork: One test per 400 square feet of flatwork.

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3. Pavement Subgrade: One test per 500 square feet of subgrade immediately prior to placing subbase.
4. EW-1 Backfill: Perform one compaction test for every 3 vertical feet of backfill.

1.11 MANUFACTURERS' FIELD SERVICES AND REPORTS

- A. When specified in individual specification sections, the CONTRACTOR is responsible for coordinating required material or product suppliers or manufacturers to provide qualified staff personnel to observe site conditions, conditions of surfaces, conditions of installation, quality of workmanship, testing, as applicable, and to initiate instructions when necessary.
- B. CONTRACTOR must report to the CONSULTANT/ENGINEER observations and site decisions or instructions given to applicators or installers that are supplemental or contrary to MANUFACTURER'S written instructions.
- C. Submit report under provisions of Section 01300 (Submittals) within 30 calendar days of observation, or as specified in relevant sections of the Technical Specifications, whichever is shorter, to CONSULTANT/ENGINEER for review.
- D. The CONTRACTOR shall furnish to the CONSULTANT/ENGINEER copies of certificates from suppliers/MANUFACTURERS showing that all units conform to the requirements of these specifications, in accordance with Section 01300 (Submittals).

PART 2 - PRODUCTS

Not used.

PART 3 - EXECUTION

3.01 EXAMINATION

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

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- B. Examine and verify specific conditions described in individual specification sections.
- C. Verify that utility services are available, of the correct characteristics, and in the correct locations.

3.02 FIELD QUALITY CONTROL

- A. Allow representatives of the testing laboratory access to the work at all times.
- B. Provide all equipment, labor, materials and facilities required by the laboratory to properly perform its functions.
- C. Cooperate with and assist laboratory personnel during the performance of their work.
- D. Test specimens and samples shall be taken by the person(s) designated in other Sections, or as directed by the Engineer. Conduct field sampling and testing in the presence of the CONSULTANT/ENGINEER.

3.03 PREPARATION

- A. Clean substrate surfaces prior to applying next material or substrate.
- B. Seal cracks or openings of substrate prior to applying next material or substance.
- C. Apply manufacturers required or recommended substrate primer, sealer or conditioner prior to applying any new material or substance in contact or bond.

END OF SECTION

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QUALITY CONTROL**

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**SECTION 01450
TESTING**

PART 1 - GENERAL

1.01 SECTION INCLUDES

- A. Testing of piping.
- B. Pipe leakage testing shall comply with the limitations established in the attached Schedule.

1.02 DEFINITIONS

- A. Leakage (or exfiltration) – The quantity of water to be supplied into the newly laid pipe, any valved section thereof, manhole, or other appurtenance, necessary to maintain the specified leakage test pressure after the pipe has been filled with water and the air expelled.
- B. Infiltration – The quantity of water which enters into any pipe, manhole, or other appurtenance when the static groundwater elevation is at the maximum elevation above the pipe or appurtenance as specified hereinafter.

1.03 QUALITY ASSURANCE

The CONTRACTOR shall:

- A. Prior to Substantial Completion, pressure pipes and non-pressure pipes shall meet specific leakage requirements. These leakage requirements shall be satisfied by the basic materials alone. Where joint filters and the like have been specified, primarily to protect jointing materials, and secondarily to provide a factor of safety, they shall not be applied until after leakage tests have been completed and have been accepted by CONSULTANT/ENGINEER.
- B. Tests will be witnessed by the CONSULTANT/ENGINEER. Tests not witnessed will be considered as not having been performed.
- C. Work shall not be closed or covered up until it has been observed for proper and satisfactory construction and installation in compliance with the Contract Documents. Should incomplete or unacceptable work be covered, the

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CONTRACTOR shall, at his/her own expense, uncover all work so that it may be properly observed. After such observations, repair and replace the work that was found defective, unsatisfactory, and not in accord with the Contract Documents. After such repair and replacement, bring all work to completeness and status as it was before it was closed and covered, all at the CONTRACTOR'S own expense. The CONTRACTOR shall submit for review and approval means and methods for correcting failed systems.

- D. Successful completion of required tests shall be in no way interpreted as relieving the CONTRACTOR of responsibility for defects that become apparent subsequent to the time of testing. It shall be the sole right of the CONSULTANT/ENGINEER to determine whether defects exist. Retest all portions of the work deemed necessary by the CONSULTANT/ENGINEER prior to Substantial Completion.

1.04 SUBMITTALS

- A. Submit under provisions of Section 01300.
- B. Complete details and specifications on testing apparatus.
- C. At CONSULTANT/ENGINEER'S discretion, additional sections of pipelines may be required to be tested as soon as pipe is laid and prior to backfilling when working conditions or the standard of workmanship have been altered.

PART 2 - PRODUCTS

2.01 TESTING APPARATUS

- A. Provide labor, plugs, measuring equipment, and other apparatus, complete, to perform testing.
- B. Provide clean water, air, nitrogen, and other materials as required to accomplish testing.
- C. Provide plugs and caps capable of withstanding test pressures.
- D. Provide temporary flanges, plugs, bulkheads, thrust blocks, weighing, bracing and other items necessary to prevent joints from separating, and to prevent injuries or damage.

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PART 3 - EXECUTION

3.01 PREPARATION

- A. Plug open ends, adequately block bends, tees, ends, and other fittings, and do whatever is necessary to brace piping system so that it will safely withstand the pressures developed under the tests and so that no damage or injury occur to the pipeline, people or property.
- B. Before tests are conducted, isolate, or remove any regulator, gauge, trap, or other apparatus or equipment which may be damaged by test pressures.

3.02 GENERAL

- A. Trapped Air: Trapped air may cause a false indication of the rate of leakage. Points of concern include ends of lines, stubs, house connections and high points in pipelines. No credit will be made for this condition and no adjustment will be made to the allowable leakage. When trapped air is suspected of causing a test failure, do whatever is necessary to evacuate the air and repeat tests until the actual leakage is equal to or less than allowable rate of leakage.
- B. Water Absorption: No credit will be given for absorption of water in pipe and manhole walls. If necessary, fill pipes and manholes with water well in advance of testing and allow them to soak in order to eliminate or minimize the effects of absorption..

3.03 TESTS FOR NON-PRESSURE PIPING

A. General

- 1. Leakage shall be determined by exfiltration testing. The CONSULTANT/ENGINEER reserves the right to also require infiltration testing.
- 2. Air testing is not permitted.
- 3. Leakage testing shall include the main non-pressure pipe, house connections, and appurtenances on the section of pipeline being tested.
- 4. Limit pipeline test sections to runs between adjacent structures. Manholes may be tested simultaneously with pipes.

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5. Adequately plug ends of house connections, stubs, and openings from which water may escape.
6. Use clean water for exfiltration tests.

A. Exfiltration Test on Pipes Only

1. The minimum water level required for testing is 2 feet above the crown of the upstream (highest) end of the pipe being tested or 2 feet above the maximum groundwater level along the test section, whichever is greater.
2. Install a watertight plug in the downstream end of the manhole pipe.
3. Fill upstream manhole with water and conduct test for six (6) hours.
4. Upon satisfactorily completing the test, remove the downstream plug in the presence of CONSULTANT/ENGINEER. Do not touch nor remove anything until approved by CONSULTANT/ENGINEER.
5. Allowable exfiltration is one hundred (100) gallons per inch diameter per mile per day.

B. Infiltration Tests

1. The minimum head of groundwater required for infiltration testing is 2 feet above the crown of the pipe at the upstream end but must in all cases reach its normal level.
2. Infiltration may be measured with an approved graduated container capable of intercepting all inflow, by a pipeline V-notch weir, or by other approved methods. When using instream type measuring devices, do not measure flows until steady state conditions are established.
3. Allowable infiltration is one hundred (100) gallons per inch diameter per day per mile of pipe.

3.04 TESTS FOR PRESSURE PIPES

B. General

1. Leakage shall include the main exiting pipe, service connections, and other appurtenances on the section of pipeline being tested.

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2. Test pipes prior to applying insulation and before they are concealed or furred-in.
3. Provide all necessary gauges. Gauges shall be standard pressure type with a minimum 6 inch diameter dial and a pressure range not in excess of 50% of the maximum required test pressure.
4. Provide and maintain at the site a gauge stand with an approved laboratory calibrated test gauge. Periodically check test gauge used for testing against the test gauge, and whenever requested by CONSULTANT/ENGINEER.
5. Where it is necessary for testing, tap pipes and insert approved plugs after testing is completed.
6. Provide a hand or motor driven compressor to maintain the required test pressure constant throughout the duration of the test. If a water pump is used, pump water from a container with a known volume of water. If an air or inert gas pump is used, leakage shall be determined and calculated by the cycling or the pump.
7. Provide test gauges at each end of the line being tested.

C. Underground Pipes

1. Conduct leakage test in accordance with the requirements contained in paragraph 3.07 herein.

3.05 ALLOWABLE LEAKAGE

- A. The maximum allowable leakage for the various piping systems is presented in the schedule.
- B. It is the intent of this contract to secure piping systems without leakage. Each section of pipe and within each structure shall not exceed the allowable leakage. It is also the intent to secure a piping system free from visible drips, streams and leaks. Therefore, even if a portion of the system meets the requirements for allowable leakage, visible leaks are not permitted and shall be repaired.
- C. Leakage tests will be considered satisfactorily passed when the rate of leakage is equal to or less than the stipulated allowances, there is no evidence of visible leaks, and there is no evidence of other system defects.

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3.06 RETESTING

- A. Pipes and manholes (clearwells) not passing the tests shall have all defects corrected with methods approved by the CONSULTANT/ENGINEER to the inspection and satisfaction of CONSULTANT/ENGINEER, and shall be retested and recorrected as often as is necessary until the test requirements have been met.
- B. It is the intent of this Contract to obtain work meeting test requirements on their own and solely through the use of the normal integral sealing components. Joint leaks shall not be stopped using concrete, caulking, mortar, or other patching materials. Leaking pipe joints shall be rejoined and leaking manhole joints shall have joints reset, or replaced if necessary.
- C. Methods other than rejoining, resetting or replacing joint seals shall require the written approval of CONSULTANT/ENGINEER.

3.07 SCHEDULE

LEAKAGE TESTING REQUIREMENTS

SERVICE	FLUID	PRESSURE	DURATION (Hrs).	ALLOWABLE LEAKAGE ^(a)		
				UNDERGROUND		EXPOSED
				Infil.	Exfil.	
Non-Pressure Piping	Water	4ft.	6	100	100	None
Pressure Piping	Water	(6)	(6)	-0- -0-	-0- -0-	-0- -0-

SCHEDULE NOTES:

- a. Maximum allowable leakage in gallons/day/inch diameter/mile of pipe, or gallons/day/inch diameter/vertical foot for manholes. Where a percentage is shown, the loss shall not exceed the percentage of the starting test pressure.
- b. Maintain 100 psi for 1 hour.

END OF SECTION

**01450-6
TESTING**

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**SECTION 01500
CONSTRUCTION FACILITIES**

PART 1 - GENERAL

1.01 SECTION INCLUDES:

- A. Field Conditions and Measurements.
- B. Access and Drainage.
- C. Temporary Sanitary Facilities.
- D. Contractor Storage Area.
- E. Erosion and Siltation Control Measures.
- F. Staging Areas, Storage and Field Offices.
- G. Security.
- H. Project Identification and Signs.

1.02 RELATED SECTIONS

- A. Section 02270 - Temporary Erosion and Sediment Control

1.03 FIELD CONDITIONS AND MEASUREMENTS

- A. The CONTRACTOR shall base all measurements, both horizontal and vertical, from established benchmarks and monuments. The CONTRACTOR shall be responsible for field verification of all dimensions and conditions at the job site.
- B. Should the CONTRACTOR discover any discrepancy between actual conditions and those indicated, which prevent following good practice or the intent of the Construction Drawings and these Technical Specifications, he shall notify the CONSULTANT/ENGINEER; request clarification and instructions; and, shall not proceed with his Work until he has received the same from the CONSULTANT/ENGINEER, provided that such wait does not unduly delay the progress of the Work.
- C. No claims shall be made for extra payment or extensions of Contract completion time if the CONTRACTOR fails to notify the CONSULTANT/ENGINEER of any discrepancy before proceeding with the aspect of the Work.

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1.04 ACCESS AND DRAINAGE

- A. The CONTRACTOR shall keep all natural drainage and water courses unobstructed or provide equal courses effectively placed, and prevent accumulations of surface water. The CONTRACTOR shall construct grade and stabilize access roads, and provide temporary mobilization, parking and storage areas for his use during construction within areas approved by the CONSULTANT/ENGINEER.
- B. Access roads and mobilization, parking, and storage areas shall be maintained in a stable and smooth condition throughout the life of the Contract.

1.05 TEMPORARY SANITARY FACILITIES

- A. The CONTRACTOR shall furnish and maintain the necessary temporary self-contained sanitary facilities in accordance with all applicable regulations. The use of these facilities shall be available for the CONTRACTOR'S employees as well as the CONSULTANT/ENGINEER.

1.06 PROJECT OFFICES

- A. The CONTRACTOR shall provide an office trailer (in clean condition) for use by the CONSULTANT/ENGINEER and the CONTRACTOR throughout the duration of the project. The office trailer shall be adequately sized to accommodate a minimum of two (2) personnel on-site throughout the duration of the project.

The office trailer shall include, but not be limited to, the following:

- 1. A minimum of 200 square feet of floor space.
- 2. Two (2) office desks with multiple chairs.
- 3. Two (2) four-drawer, lockable file cabinets.
- 4. One (1) telephone with hands-free capabilities and dedicated telephone lines.
- 5. One (1) telephone answering machine.
- 6. One (1) telefax machine.
- 7. One (1) photocopy machine.
- 8. Air conditioning and/or heat, as appropriate.
- 9. Water cooler.
- 10. Coffee Maker (with supplies).
- 11. Refrigerator

The CONTRACTOR shall be responsible for all utility connection fees to the office trailer and the cost of all utility services throughout the duration of the project. The CONSULTANT/ENGINEER will reimburse the CONTRACTOR for all documented long distance telephone calls made by the CONSULTANT/ENGINEER.

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1.07 UTILITIES

- A. The CONTRACTOR shall be responsible for providing the following utilities for use at the project site throughout the duration of the project.
1. Electrical Power
Electrical power, as appropriate and necessary of the anticipated equipment requirements, shall be provided for the CONTRACTOR work force and the office trailer.
 2. Telephone
Telephone line(s) shall be supplied to the office trailer. The telephone lines provided shall also accommodate a telefax machine.
 3. Water Supply
The CONTRACTOR shall make arrangements for obtaining water for personnel consumption, or other purposes in connection with the Work under this Contract. The CONTRACTOR shall also make arrangements for the routine delivery of bottled water to the office trailer.
 4. Sanitary Facilities
A sufficient number of chemical-type sanitary structures shall be provided for personnel on the project. They shall be located near the points of the Work, and shall be cleaned and adequately serviced daily.

1.08 CONTRACTOR STORAGE AREA

- A. A storage area will be designated by the CONSULTANT/ENGINEER on the project site for use by the CONTRACTOR for storage of his materials, tools, equipment, office, and other items necessary for construction. The exact limits of the storage area will be designated in the field by the CONSULTANT/ENGINEER. The CONTRACTOR shall be fully responsible for the preparation of this area, its maintenance, and its security, including fencing, watchmen, and other means of security. Under no circumstances will the OWNER be responsible for the security of any property belonging to the CONTRACTOR, his subcontractors, or any of his work forces.
- B. The CONTRACTOR shall be fully responsible for the payment of all utilities at no additional cost to the CONSULTANT/ENGINEER throughout the Work; these utilities include but are not limited to power, telephone, water and, sanitary facilities.

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1.09 EROSION AND SILTATION CONTROL MEASURES

- A. Adequate control of erosion and siltation of both a temporary and permanent nature on areas disturbed by the Work shall be provided under this Contract subject to the approval of the CONSULTANT/ENGINEER. As stipulated in Section 02270 (Temporary Erosion and Sediment Control) there will be a joint on-site inspection prior to commencing work, with CONTRACTOR, and the CONSULTANT/ENGINEER to determine specific siltation control requirements.
- B. Erosion control shall comply with all applicable State and County Regulations.
- C. Specific erosion control measures to be taken for this work include:
 - 1. Compliance with the provisions of the Nassau County Soil and Water Conservation District.
 - 2. Compliance with all rules and regulations as issued by the State of New York.

1.10 STAGING AREAS, STORAGE AND FIELD OFFICES

- A. The CONTRACTOR may, during the course of this project, start construction, store materials, or erect temporary field office only within areas approved by the CONSULTANT/ENGINEER. The CONTRACTOR shall not interfere with the operation of the adjacent OWNER facilities.

1.11 SECURITY

- A. Security for the purpose of this project will be defined as fencing and lighting. The existing fencing and outside lighting will provide adequate security for the project.
- B. Protect Work premises and operations from theft, vandalism, and unauthorized entry by fencing, gates, locks, and appropriate security measures.
- C. The right of access to this Work whether it is in preparation or progress shall be extended to the OWNER'S representatives as well as the NYSDEC, and local authorities.
- D. Allow entrance only to authorized persons with proper identification.

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1.11 PROJECT IDENTIFICATION AND SIGNS

- A. The project shall consistently be referred to as:
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- B. Signage shall be prepared by the CONTRACTOR and posted prominently at one key location to be designated by the CONSULTANT/ENGINEER. The sign shall be 3 feet by 5 feet and constructed of sheet metal or approved equal. The sign shall contain the information provided in Section A and the print shall be of 3 inch black lettering on a white background.
- C. Signage shall be specified and approved by the CONSULTANT/ENGINEER prior to installation.

PART 2 - PRODUCTS

Not used.

PART 3 - EXECUTION

Not used.

END OF SECTION

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**SECTION 01600
MATERIALS AND EQUIPMENT**

PART 1 - GENERAL

1.01 SECTION INCLUDES:

- A. Equipment and Products Specified.
- B. Storage and Maintenance of Materials.
- C. Equipment and Material Installation.
- D. Cutting, Patching, and Painting.

1.02 RELATED SECTIONS

- A. Section 01300 - Submittals
- B. Section 01400 - Quality Assurance

1.03 EQUIPMENT AND PRODUCTS SPECIFIED

- A. In the various detailed sections of the specifications where any item of equipment or product is specified by proprietary name or trade name, with the addition of such expressions as "or approved equal", it is to be understood that equal-quality equipment or products of either a MANUFACTURER named or of a MANUFACTURER not named which meet the detailed requirements of the Specifications, are intended, subject to the approval of the CONSULTANT/ENGINEER as to the equality thereof. The CONTRACTOR must also demonstrate that there will be no adverse impact to the project schedule and no additional cost to the CONSULTANT/ENGINEER.
- B. Substitutions after project initiation may also be considered when a product becomes unavailable through no fault of the CONTRACTOR.
- C. The CONSULTANT/ENGINEER shall review the technical data for substitutions and shall accept or reject the offered substitution.
- D. The CONTRACTOR is responsible for all delays in the project schedule associated with the review of offered substitutions. Such delays shall be

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incorporated into the CONTRACTOR's projected construction schedule and shall be compensated for such that the overall project schedule is not affected.

E. Substitution of components is allowed as follows:

1. Where specified as "or equal" shall mean that the CONTRACTOR may use material of equal quality, function, and value.
2. Where specified as "or approved equal" means that substitution is allowed upon approval by the CONSULTANT/ENGINEER.
3. "No substitution," or unspecified, means substitutions will not be allowed unless compelling reasons exist to require the substitution, and the CONSULTANT/ENGINEER concurs with the CONTRACTOR and approves the substitution.

F. A request for substitution constitutes a representation that the CONTRACTOR:

1. Has investigated proposed Product and determined that it meets or exceeds the quality level of the specified Product.
2. Will provide the same warranty for the Submission as for the specified Product.
3. Will coordinate installation and make changes to other Work, which may be required for the Work to be complete, with no additional cost to CONSULTANT/ENGINEER or delay to the project schedule.
4. Waives claims for additional costs or time extension which may subsequently become apparent.
5. Understands that the CONSULTANT/ENGINEER'S approval of a requested change does not place the responsibility under this section on the CONSULTANT/ENGINEER.

1.04 STORAGE AND MAINTENANCE OF MATERIALS

- A. All materials provided and Work performed under this Contract shall be protected from damage before and after installation. The CONTRACTOR shall be

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responsible for Work, equipment, and materials until inspected, tested, and finally accepted in accordance with this Section and these Technical Specifications.

- B. All arrangements for delivery, storage, and handling of equipment specified herein shall be the CONTRACTOR'S responsibility. The CONTRACTOR shall store equipment and materials so as to ensure the preservation of their quality and fitness for work. When considered necessary, they shall be placed on wooden platforms, or other hard, clean surfaces and shall be placed under cover when directed. Stored materials shall be located so as to facilitate prompt inspection.
- C. Where materials or products called for under this Contract are installed before the erection of adequate protective structures, the CONTRACTOR without additional compensation therefore, shall provide approved, effective and durable covers for fully protecting such materials or products against damage from the elements or from any other causes.
- D. All machinery, equipment, piping, and accessories and appurtenances shall be adequately supported and safeguarded against all damage or injury during performance of Work under this Contract. The CONTRACTOR shall be responsible for all damage or injury resulting from his operations and shall repair such damage immediately and to the satisfaction of the CONSULTANT/ENGINEER.
- E. The CONTRACTOR shall store and protect products in accordance with the MANUFACTURER'S recommendations and the requirements specified in these Contract Documents and shall submit the MANUFACTURER'S storage and maintenance instructions prior to delivery.
- F. The CONTRACTOR shall make all arrangements and provisions necessary for the storage of materials and equipment. All excavated material, construction equipment, and materials and equipment to be incorporated into the Work shall be placed so as not to injure any part of the Work or existing facilities, and so that free access can be achieved at all times to all parts of the Work, to all unrelated portions of the OWNER'S facility, and to all public utility installations in the vicinity of the Work. Materials and equipment shall be kept neatly and compactly stored in locations that will cause a minimum of inconvenience to other contractors, public travel, adjoining owners, tenants, occupants and the OWNER.
- G. Areas available on the job site for storage of materials and equipment shall be as shown, specified or designated and approved by the CONSULTANT/ENGINEER. All materials and equipment must be consigned to the CONTRACTOR directly. No delivery of materials and equipment will be accepted by the

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CONSULTANT/ENGINEER, and all expenses incurred by the CONSULTANT/ENGINEER in handling materials or equipment which have been consigned or directed to the CONSULTANT/ENGINEER will be charged to the CONTRACTOR.

- H. Materials and equipment which are to become the property of the OWNER shall be stored to facilitate their inspection and ensure preservation of the quality and fitness of the Work, including proper protection against damage by freezing and moisture. They shall be placed inside storage areas, unless otherwise shown, specified or acceptable to the CONSULTANT/ENGINEER.
- I. CONTRACTOR shall be fully responsible for loss or damage to stored materials.
- J. Any material or equipment which, in the opinion of the CONSULTANT/ENGINEER, has been damaged due to improper storage and/or handling and is unfit for its specified or intended use shall be properly removed from the site or Work. The CONTRACTOR shall receive no compensation for the damaged material or its removal or replacement. The CONTRACTOR shall be responsible for replacing any such materials with undamaged material as specified and shall be liable for any damages associated with removal and replacement of damaged materials, as well as damages - direct or consequential - resulting from delays in the project schedule that occur due to the damaged materials.

1.05 EQUIPMENT AND MATERIAL INSTALLATION

- A. Install per MANUFACTURER'S instructions and specifications.
- B. Maintain plumbness and be within specified tolerances.
- C. Locate and install in accordance with plans and specifications.
- D. Install in accordance with accepted quality construction practice to assure proper operation and full design life of the system and components.

1.06 CUTTING, PATCHING AND PAINTING

- A. The CONTRACTOR shall perform all cutting and patching required for the proper installation of the equipment. If cutting will harm the structural integrity or mar the appearance, consult the CONSULTANT/ENGINEER for approval before proceeding. Patching shall meet the approval of the CONSULTANT/ENGINEER.

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- B. Equipment furnished by the CONTRACTOR in a painted condition shall be free from scratches, blemishes, or rust spots. Equipment with painted surfaces cracked, chipped, rusted, or peeled shall be repaired as approved by the CONSULTANT/ENGINEER and as per Section 09900 - Painting, before final acceptance.
- C. CONTRACTOR shall request CONSULTANT/ENGINEER'S approval before cutting or altering items specified in Contract Documents.

PART 2 - PRODUCTS

Not used.

PART 3 - EXECUTION

Not used.

END OF SECTION

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MATERIALS AND EQUIPMENT**

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**SECTION 01650
STARTING OF SYSTEMS**

PART 1- GENERAL

1.01 SECTION INCLUDES

- A. Scope.
- B. Division of Responsibilities.
- C. Process Testing.

1.02 RELATED SECTIONS

- A. Section 01010 - Summary of Work.
- B. Section 01012 - Special Conditions.
- C. Section 01039 - Coordination and Meetings.
- D. Section 01300 - Submittals.
- E. Section 01400 - Quality Assurance.
- F. Section 01600 - Materials and Equipment.

1.03 SCOPE

- A. This Job Instruction delineates the division of responsibilities between the CONSULTANT/ENGINEER and CONTRACTOR for activities which occur during the startup/shakedown and turnover period after substantial construction has been accomplished.

1.04 DIVISION OF RESPONSIBILITIES

- A. Certain specific activities are to be completed before the final Turnover Notice will be issued to the CONTRACTOR to signify Substantial Completion of a portion (or all) of the work. Following issue of a Turnover Notice, the CONTRACTOR shall continue to complete all unfinished work covered by a "Punch-List" resulting from known deficiencies.
- B. There will undoubtedly be a certain amount of "make-good" work required after issuance of a Turnover Notice; for example, insulation, paint, fireproofing, or

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paving may require repair through no fault of the OWNER and/or the CONSULTANT/ENGINEER. In such instances, the CONTRACTOR will be expected to make such repair promptly.

- C. CONTRACTOR shall be responsible for having tradesmen, including but not limited to the SUBCONTRACTOR, vendor representatives/technicians, and mechanics, available on the site during the first run-in of equipment and for arranging for MANUFACTURERS to check out equipment as required at the appropriate time. The CONTRACTOR shall provide SUBCONTRACTOR and vendor services at no charge to the CONSULTANT/ENGINEER for all SUBCONTRACTORS and vendors contracted through the CONTRACTOR.

1.05 PROCESS TESTING

- A. MANUFACTURER'S representative shall perform functional testing during start-up. MANUFACTURER'S representative shall be available (on-site) during start-up, in accordance with the relevant section(s) of the Technical Specifications.
- B. Instrumentation, controls, and complete system integration shall be tested by the CONTRACTOR under the observation of the CONSULTANT/ENGINEER and MANUFACTURER.
- C. CONSULTANT/ENGINEER shall collect samples for evaluation and/or laboratory analyses to verify the performance of the process equipment.

PART 2 - PRODUCTS

Not used.

PART 3 - EXECUTION

Not used.

END OF SECTION

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STARTING OF SYSTEMS**

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**SECTION 01700
CONTRACT CLOSEOUT**

PART 1 - GENERAL

1.01 SECTION INCLUDES

- A. Procedures
- B. Clean-up.
- C. Substantial Completion.
- D. Final Inspection.
- E. Project Record Documents.
- F. Contractor's Closeout Submittals.

1.02 RELATED SECTIONS

- A. Section 01300 - Submittals.

1.03 PROCEDURES

- A. Comply with requirements stated in Conditions of the Contract and in Specifications for administrative procedures in closing out the work.

1.04 CLEAN-UP

- A. Remove all waste, debris, rubbish, tools, equipment, machinery and surplus materials to the satisfaction of the CONSULTANT/ENGINEER.
- B. Dispose all wastes, debris, and rubbish in accordance with applicable federal, state, and local regulations.
- C. Clean all sight-exposed surfaces. Leave work clean and ready for possession by the OWNER.

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1.05 SUBSTANTIAL COMPLETION

- A. When the CONTRACTOR considers that the work is substantially complete, he/she shall submit to the CONSULTANT/ENGINEER the following:
 - 1. A written notice that the work, or designated portion thereof, is substantially complete.
 - 2. A list of items to be completed or corrected.
- B. Within a reasonable time after receipt of such notice, the CONSULTANT/ENGINEER will make an inspection to determine the status of completion.
- C. Should the CONSULTANT/ENGINEER determine that the work is not substantially complete, the following shall occur:
 - 1. The CONSULTANT/ENGINEER will promptly notify the CONTRACTOR, in writing, giving the reasons thereof.
 - 2. The CONTRACTOR shall remedy the deficiencies in the work and send a second written notice of substantial completion to the CONSULTANT/ENGINEER.
 - 3. The CONSULTANT/ENGINEER will re-inspect the work.
- D. When the CONSULTANT/ENGINEER finds that the work is substantially completed, the CONSULTANT/ENGINEER will:
 - 1. Prepare and deliver to the OWNER a tentative Certificate of Substantial Completion with a tentative list of items to be completed or corrected before final payment.
 - 2. After consideration of any comments made by the OWNER as provided in Conditions of the Contract, the CONSULTANT/ENGINEER will execute and deliver to the CONTRACTOR a definite Certificate of Substantial Completion with a revised tentative list of items to be completed or corrected.

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1.06 FINAL INSPECTION

- A. When the CONTRACTOR considers the work to be complete, the CONTRACTOR shall submit written certification that:
 - 1. The contract documents have been reviewed.
 - 2. Work has been inspected for compliance with Contract Documents.
 - 3. Work has been constructed in accordance with Contract Documents.
 - 4. Equipment and systems have been tested and are operational.
 - 5. Work is completed and ready for final inspection.
 - 6. Certificate of Completion.
- B. The CONSULTANT/ENGINEER will make an inspection to verify the status of completion with reasonable promptness after receipt of such certification.
- C. Should the CONSULTANT/ENGINEER consider that the work is incomplete or defective, the following shall apply:
 - 1. The CONSULTANT/ENGINEER will promptly notify the CONTRACTOR in writing, listing the incomplete or defective work.
 - 2. The CONTRACTOR shall take immediate steps to remedy the stated deficiencies and send a second written certification to the CONSULTANT/ENGINEER.
 - 3. The CONSULTANT/ENGINEER will re-inspect the work.
- D. When the CONSULTANT/ENGINEER finds that the work is acceptable under the contract documents, the CONSULTANT/ENGINEER shall request that the CONTRACTOR make closeout submittals.

1.07 PROJECT RECORD DOCUMENTS

- A. The CONTRACTOR shall legibly mark on the Construction Drawings actual construction showing horizontal and vertical location of underground utilities, field changes of dimension and detail, and changes made by change orders and details not included on the original Construction Drawings.

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- B. The CONTRACTOR shall deliver record documents (as-builts), consisting of annotated Construction Drawings as indicated to the CONSULTANT/ENGINEER at the completion of the project to be used in preparation of the as-built drawings.

1.08 CONTRACTOR'S CLOSEOUT SUBMITTALS

- A. Evidence of payment and release of liens shall be done according to the requirements of the submittal procedures and Special Conditions.

PART 2 - PRODUCTS

Not used.

PART 3 - EXECUTION

Not used.

END OF SECTION

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CONTRACT CLOSEOUT**

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**SECTION 02060
BUILDING DEMOLITION**

PART 1 - GENERAL

1.01 SECTION INCLUDES

- A. Demolition of designated structures and removal of materials from site.
- B. Demolition and removal of foundations and slabs.
- C. Disconnecting and removal or capping of all utilities.
- D. Closure of the hydropneumatic tanks.
- E. Refer to items as indicated.

1.02 RELATED SECTIONS

- A. Section 01010 - Summary of Work
- B. Section 01012 - Special Conditions
- C. Section 01300 - Submittals
- D. Section 01600 - Materials and Equipment.
- E. Section 01700 - Contract Closeout.
- F. Section 02211 - Rough/Final Grading
- G. Section 02223 - Backfilling.

1.03 SUBMITTALS

- A. The CONTRACTOR shall prepare and submit to the CONSULTANT/ENGINEER Shop Drawings in accordance with Section 01300 (Submittals).

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BUILDING DEMOLITION**

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- B. The Shop Drawings shall indicate the demolition and removal sequence; the location of salvageable items; the location and construction of barricades, fences and temporary work.

1.04 PROJECT RECORD DOCUMENTS

The CONTRACTOR shall:

- A. Submit project record documents under the provisions of Section 01700 (Contract Closeout).
- B. Accurately record actual locations of capped utilities, subsurface and obstructions.

1.05 REGULATORY REQUIREMENTS

The CONTRACTOR shall conduct all Work in accordance with Sections 01010 (Summary of Work) and 01012 (Special Conditions) and shall:

- A. Conform to applicable federal, state and local laws and regulations for demolition of structures, safety of adjacent structures, dust control, runoff control, and disposal.
- B. Obtain required permits from authorities.
- C. Notify affected utility companies before starting work and comply with their requirements.
- D. Do not close or obstruct roadways, sidewalks and hydrants without permits.
- E. Conform to applicable regulatory procedures when discovering hazardous or contaminated materials.

1.06 SCHEDULING

- A. Work schedules shall be submitted to the CONSULTANT/ENGINEER in accordance with Section 01300 (Submittals).
- B. Work shall be scheduled to coincide with site excavation work and new construction.

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- C. A complete description of demolition removal procedures and schedule shall be provided.

1.07 FILL MATERIALS

Backfilling shall be completed in accordance with Section 02223 (Backfilling). Fill material shall consist of approved materials substantially free from organic materials, loam, wood, trash, and other objectionable materials which may be compressible. Fill materials shall not be excessively wet or saturated. Snow, ice, and frozen soil also shall not be permitted.

1.08 PREPARATION

The CONTRACTOR shall:

- A. Provide, erect, and maintain temporary barriers and security devices to assure the protection of human health.
- B. Protect existing landscaping materials, appurtenances, and structures which are not to be demolished.
- C. Prevent movement or settlement of adjacent structures. Provide bracing and shoring.
- D. Determine and mark the location of utilities in accordance with Sections 01010 (Summary of Work) and 01012 (Special Conditions).

1.09 DEMOLITION REQUIREMENTS

- A. Demolition activities shall be conducted to minimize interference with adjacent structures.
- B. Operations shall cease immediately if adjacent structures appear to be in danger. The CONTRACTOR shall notify the CONSULTANT/ENGINEER immediately if such conditions should arise. Operations shall not resume until directed by the CONSULTANT/ENGINEER.
- C. Operations shall be conducted with minimum interference to public or private access routes. Maintain egress and access routes at all times.
- D. Written permission or access agreements must be obtained from adjacent property

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owners when demolition equipment will traverse, infringe upon or limit access to their property.

- E. The CONTRACTOR shall ensure that environmental controls are maintained for the duration of the Work, in accordance with Section 01012 (Special Conditions).

PART 2 - PRODUCTS

Not used.

PART 3 - EXECUTION

3.01 DEMOLITION

The CONTRACTOR shall:

- A. Break up concrete slabs on grade to permit natural moisture drainage.
- B. Empty hydropneumatic tanks located within demolition area. Render hydropneumatic tanks inert by filling with clean sand. Remove appurtenances associated with buried tanks (components, piping, etc.) from the site.
- C. Remove materials to be re-installed or retained in manner to prevent damage. Store and protect in accordance with requirements of Section 01600 (Materials and Equipment).
- D. Backfill open pits and holes caused as a result of demolition, in accordance with Section 02223 (Backfilling).
- E. Rough grade and compact areas affected by demolition to maintain site grades and contours in accordance with Section 02211 (Rough/Final Grading).
- F. Remove demolished materials from site.
- G. Do not burn or bury materials on site. Leave site in clean condition.
- H. Remove temporary work.

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3.02 SCHEDULES

- A. Items to be removed, stored, and protected for re-installation; items to be removed and kept by the OWNER; and items to be discarded by the CONTRACTOR will be determined by the CONSULTANT/ENGINEER prior to initiation of demolition activities.

END OF SECTION

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**SECTION 02163
TEMPORARY SHEETING & BRACING**

PART 1 - GENERAL

1.01 SECTION INCLUDES

- A. Wood and steel sheeting.
- B. Sheeting box.

1.02 RELATED SECTIONS

- A. Section 02222 – Excavation.
- B. Section 02223 - Backfilling.

1.03 REFERENCES

- A. Occupational Safety and Health Standards – Excavations; Final Rule (29 CFR Part 1926) – OSHA Standards.

1.04 SUBMITTALS FOR INFORMATION ONLY

- A. Submit under provisions of Section 01300.
- B. Shop Drawings: Indicate materials and methods to be used during excavation.

1.05 QUALITY ASSURANCE

- A. Perform all work of this section in accordance with OSHA Standards and approved shop drawings.

1.06 COORDINATION

- A. Coordinate work with all other sections requiring temporary sheeting and bracing.

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PART 2 - PRODUCTS

2.01 MATERIALS

- A. Wood Sheeting: Hardwood species of size and dimensions capable of being driven to the required depths and capable of supporting excavation sides and soil pressures when braced; free from wormholes, and shakes, loose knots, decayed or unsound portions or defects which would impair its strength or tightness; 2 inches (50 mm) thick minimum.
- B. Steel Sheeting: Corrugated "Z" shape cross-section; of size and dimensions capable of being driven to the required depths and capable of supporting excavation sides and soil pressures when braced; structurally sound; special shapes for corner construction and transition points.
- C. Sheeting Boxes: Steel, of size and dimensions capable of supporting excavation sides and soil pressures; structurally sound.

PART 3 - EXECUTION

3.01 EXAMINATION

- A. Verify existing substrate and site conditions.
- B. Verify elevations and grades are as indicated on the plans.
- C. Verify proposed locations of excavations are as indicated on the plans.

3.02 PREPARATION

- A. Excavate to a depth no greater than 4 feet (1.2m) from existing grade.
- B. Assemble and drive the sheeting in accordance with approved shop drawings.

3.03 INSTALLATION - SHEETING

- A. Drive sheeting in place to thoroughly support both sides of the excavation using a sheeting hammer. Use a steam or pneumatic hammer for steel sheeting.
- B. Water jetting of sheeting will not be permitted. Do not loosen adjacent ground which might result in collapse.

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TEMPORARY SHEETING & BRACING**

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- C. Install wales and braces or shores tight and in accordance with approved shop drawings.

3.04 INSTALLATION – SHEETING BOX

- A. Place box in trench utilizing a means which will not damage structural integrity of the box.
- B. Excavate ahead of the sheeting box only enough to advance the sheeting box and only immediately prior to moving the sheeting box.
- C. Backfill on both sides of the sheeting box as it is moved.

3.05 REMOVAL OF SHEETING

- A. Remove sheeting only as backfilling progresses.
- B. Carefully remove sheeting such that compacted backfill is not displaced. Add additional backfill to the areas vacated by the sheeting.
- C. All sheeting is to be removed from the site once its use is no longer required.
- D. The CONTRACTOR may request permission to leave sheeting or bracing in place. The ENGINEER may grant permission on the condition that the cost of sheeting and bracing be borne by the CONTRACTOR.

END OF SECTION

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**SECTION 02211
ROUGH/FINAL GRADING**

PART 1 - GENERAL

1.01 SECTION INCLUDES

- A. Clearing.
- B. Topsoil.
- C. Field Engineering.
- D. Grading.

1.02 RELATED SECTIONS

- A. Section 02222 - Excavation.
- B. Section 02223 - Backfilling.
- C. Section 02270 - Temporary Erosion and Sediment Control.

1.03 CLEARING

- A. All vegetation, shrubs, and brush within the construction area shall be removed. Stumps shall be removed entirely. Roots shall be grubbed out to at least 18 inches below the finished grade. Brush, refuse, roots, etc. shall be transported and deposited off the premises.

1.04 TOPSOIL

- A. Material from the excavation, suitable for topsoil, shall be deposited in piles separate from other excavated material. Piles of topsoil shall be located so that the material can be used readily for the finished surface grading in areas that were stripped of topsoil during construction. When used for finished surface grading, topsoil shall be spread uniformly (minimum four inches thick, if sufficient material is available) over the areas to receive it.

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1.05 FIELD ENGINEERING

- A. Prior to start of construction, CONTRACTOR shall (1) locate and protect survey control and reference points, (2) verify setbacks and easements, confirm drawing dimensions and elevations, and (3) confirm existing grading elevations.

1.06 GRADING

- A. The CONTRACTOR shall restore all areas disturbed by construction activities to existing conditions unless otherwise specified by the CONSULTANT/ENGINEER.
- B. The CONTRACTOR shall grade disturbed areas, to smooth uniformity between datum points. Form subgrade to proper shapes and contours, work out swales and other earth features, and complete the earthwork to receive fine grading, base coarse or topsoil.
- C. Final grades shall be carried to the lines, grades, and slopes established by the baseline survey, within a tolerance of 0.1 foot.
- D. All material encountered, of whatever nature, within the limits indicated, shall be used as backfill or removed and disposed in accordance with Sections 02222 and 02223.
- E. During the process of grading, the subgrade shall be maintained in such condition that it will be well drained at all times. The graded area shall be protected from surface water run-on and temporary erosion and sediment control shall be installed as required by local authorities and in accordance with Section 02270.
- F. The right is reserved by the CONSULTANT/ENGINEER to make minor adjustments or revisions in lines or grades, if found necessary as the work progresses in order to obtain satisfactory construction.
- G. CONTRACTOR is responsible for protection and relocation, if necessary, of all above and below grade pipelines, utilities, adjacent existing structures, and, relocation, if necessary.
- H. New areas designated to be grassed and grassed areas disturbed by construction shall be graded with topsoil, as specified above, fertilized and seeded.

PART 2 - PRODUCTS

- A. Fertilizer shall be a suitable commercial 10-6-4 mixture (50% organic) spread evenly at the rate of 10 lbs. Per 1,000 square feet.

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- B. Seed shall be one of the following mixtures spread at the rate of 8 lbs. per 1,000 square feet.

<u>Primary</u>	-	45% Baron Kentucky Bluegrass 25% Ram I Kentucky Bluegrass 15% Glade Kentucky Bluegrass 15% Citation Perennial Ryegrass
<u>Secondary</u>	-	40% Citation Perennial Ryegrass 40% Adelphi Kentucky Bluegrass 20% Creeping Red Fescue
<u>Shade</u>	-	36% Penlawn Red Fescue 32% Yorktown Perennial Ryegrass 32% Jamestown Red Fescue

- C. Dolomite Limestone (granular type) shall be added to all newly seeded areas at the rate of 50 lbs. per 1,000 square feet.

PART 3 - EXECUTION

- A. The CONTRACTOR shall adhere to the following:
1. All utilities that pass through the Work Area or structures in or adjacent to the Work area shall be maintained and protected.
 2. The CONTRACTOR shall take steps to control dust wherever the CONTRACTOR performs work.
 3. Where seed is placed on sloped surfaces, stabilizing must be employed to prevent erosion, in accordance with Section 02270.

END OF SECTION

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ROUGH/FINAL GRADING**

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**SECTION 02222
EXCAVATION**

PART 1 - GENERAL

1.01 SECTION INCLUDES

- A. Excavation.
- B. Protection.
- C. Submittals.

1.02 RELATED SECTIONS

- A. Section 01300 - Submittals
- B. Section 02211 - Rough/Final Grading.
- C. Section 02223 - Backfilling.
- D. Section 02270 - Temporary Erosion and Sediment Control.

1.03 EXCAVATION

- A. This section covers excavation for all foundations, slabs, concrete trenches, concrete sumps, and underground piping.
- B. Excavations shall be kept free from water while construction therein is in progress. Any clay pockets, soft spots, vegetable and other foreign material shall be removed and replaced with sound material as directed by the CONSULTANT/ENGINEER (see paragraph 3.01). Excavations shall be refilled to the proper grade with suitable material and compacted as specified in Section 02223.
- C. Unless directed otherwise by the CONSULTANT/ENGINEER, all footings must rest on undisturbed soil.
- D. Excavations shall be along straight lines.
- E. Excavations shall be shored and sheeted as required, with material of sufficient size and arrangement to prevent injury to persons, damage to structures, injurious caving, or erosion. Shoring, sheeting, and bracing shall be removed as the excavations are backfilled; care shall be exercised to prevent injurious caving during the removal of the shoring and/or sheeting.

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EXCAVATION**

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- F. Excavation shall be performed in such a manner that excavated areas and the area immediately surrounding the excavation for a distance of approximately 25 feet, including slopes and ditches, shall be continually and effectively drained. Water shall not be allowed to pond at the extremities of the drainage area and temporary erosion and sediment control shall be installed as required by local authorities and in accordance with Section 02270.

1.04 PROTECTION

The CONTRACTOR shall:

- A. Comply with all federal, state and local codes, ordinances and laws governing excavation.
- B. Protect existing structures and paving from damage caused by execution of the Work and equipment.
- C. Protect above and below grade utilities that exist in the vicinity of the excavation.
- D. Protect excavation by the use of bracing and/or shoring where required to prevent side wall caving or excessive groundwater in-flow.
- E. Notify the CONSULTANT/ENGINEER of unexpected subsurface conditions interfering with normal construction methods and discontinue Work in the area until given written notice to resume Work.
- F. Repair any damages.

1.05 SUBMITTALS

- A. The CONTRACTOR shall submit drawings to the CONSULTANT/ENGINEER showing the locations and dimensions of proposed excavations with details of the proposed construction techniques and sheeting/shoring equipment, etc. in accordance with applicable rules and regulations.
- B. Submittals will be made in accordance with Section 01300.

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PART 2 - PRODUCTS

Not used.

PART 3 - EXECUTION

3.01 PREPARATION

- A. Survey Controls - The CONTRACTOR shall identify the required benchmarks for horizontal and vertical control. Closures for vertical and horizontal control shall be ± 0.01 feet.
- B. Clearing - In accordance with Section 02211, all portions of the Work area shall be cleared of vegetation, roots, topsoil peat, trash, or other deleterious materials.
- C. Excavation of Unsuitable Material - The CONTRACTOR shall remove and replace with compacted fill any subgrade material which is designated as "unsuitable" by the CONSULTANT/ENGINEER. Compaction of the fill placed in such areas will conform to the requirements for fill placement and compaction herein specified.
- D. Water Supply - The CONTRACTOR shall provide water on the site as required to maintain proper moisture content of fill and to suppress fugitive dust emissions. Source of water supply shall be approved by the CONSULTANT/ENGINEER.
- E. Before the start of any work, the CONTRACTOR shall do the following:
 - 1. Identify all underground utilities. Identify and mark the location and depth of any existing underground pipelines and other utilities.
 - 2. Identify and mark the location of surface and overhead utilities.
 - 3. Identify and mark the areas that will be excavated.
 - 4. Identify and assess the impact of excavation on nearby utilities, pipelines, equipment, electrical poles and other surface features.
 - 5. Maintain and protect the utilities and pipelines which pass through the Work area and are to remain in use.

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3.02 EXCAVATION

- A. The CONTRACTOR shall identify and mark on the existing surface, the location of the proposed excavation Work.
- B. Excavated materials shall be used to grade the landscaped berm around the proposed treatment building.
- C. Should saturated materials containing free water be encountered, the CONTRACTOR shall notify the CONSULTANT/ENGINEER.
- D. The CONTRACTOR shall adhere to the following guidelines:
 - 1. Excavation shall not be done in excess of that authorized by the CONSULTANT/ENGINEER. Unnecessary and excessive excavation shall be backfilled with suitable structural fill at no expense to the CONSULTANT/ENGINEER.
 - 2. The CONTRACTOR shall take steps to control dust wherever the CONTRACTOR performs work. This includes using a water spray to moisten any areas where it is thought dust may be a problem.
 - 3. Temporary erosion and sediment control shall be installed as required by local authorities and in accordance with Section 02270.
 - 4. Excavated materials may be used for backfill if judged appropriate by the CONSULTANT/ENGINEER.
 - 5. Excavated material, not reused, shall be stockpiled as directed by the CONSULTANT/ENGINEER and shall be disposed of in a suitable manner in accordance with federal and state regulations by the CONSULTANT/ENGINEER.
 - 6. The CONTRACTOR shall adhere to the general guidelines as defined in paragraph 1.03.

3.03 FIELD QUALITY CONTROL

- A. The CONTRACTOR shall conduct routine visual inspections of the excavation activities for compliance with these Specifications.

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- B. The CONTRACTOR shall conduct routine visual inspections of excavated soils to determine the presence of organic or petroleum contamination during excavation. Any such contamination is to be reported to the CONSULTANT/ENGINEER immediately.

END OF SECTION

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EXCAVATION**

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**SECTION 02223
BACKFILLING**

PART 1 - GENERAL

1.01 SECTION INCLUDES:

- A. References
- B. Filling

1.02 RELATED SECTIONS

- A. Section 02211 - Rough/Final Grading.
- B. Section 02222 - Excavation.
- C. Section 03300 - Cast-in-Place Concrete

1.03 REFERENCES

- A. ASTM D-1557 - Moisture-Density Relations of Soils and Soil-Aggregate Mixtures Using 10-lb Rammer and 18-in. Drop.
- B. ASTM D-2922 - Density of Soil in Place by Nuclear Methods.
- C. ASTM D-422 - Standard Method for Particle Size Analysis of Soils.
- D. ASTM D-1556 - Density of Soil in Place by the Sand-Cone Method.

1.04 FILLING

- A. The CONTRACTOR shall be responsible for (1) backfilling and compacting the base for footings and structural slabs, (2) backfilling and compacting around footings to grade, (3) backfilling and compacting areas associated with pipeline and utility trenches, (4) backfilling and compacting in other areas disturbed by construction activities as directed by the CONSULTANT/ENGINEER, and (4) grading of transported material from the excavations.

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- B. With the exception of those stockpiles of materials or other sources of materials made available to the CONTRACTOR by the CONSULTANT/ENGINEER, the CONTRACTOR shall be responsible for procuring suitable materials for the performance of the Work and providing documentation of their suitability.

PART 2 - PRODUCTS

2.01 MATERIALS

- A. Suitable fill material shall include on-site excavated material or borrow material which is capable of being compacted to the required density at the proper moisture content, containing a maximum of 30 percent by dry weight of particles passing a No. 200 sieve, and of such type and characteristics approved by the CONSULTANT/ENGINEER. No rock, broken concrete, demolition material, frozen material, top soil, nor any material designated as unsuitable in Paragraph B shall be used for fill material.
- B. Unsuitable material shall include, but not be limited to, all grass, weeds, vegetation of any type, roots, trash, rocks, boulders, debris, demolition materials, or any layer, strata, formation, or deposit of soil determined by the CONSULTANT/ENGINEER to be unsuitable for support of footings, slabs, or any other intended purpose. No material will be classified as unsuitable solely on the basis of excessive moisture content.
- C. Granular material shall be the same as defined for "Suitable Material" above, except that it shall contain a maximum of 12 percent by dry weight of particles passing the No. 200 sieve, and a maximum of 40 percent passing the No. 40 sieve.
- D. Borrow material shall be the same as defined for "Suitable Material" above, except that it shall be obtained from approved sources off the site. The CONTRACTOR shall provide verification and documentation to the CONSULTANT/ENGINEER that proposed borrow material is certified clean fill acceptable to the CONSULTANT/ENGINEER and the New York State Department of Environmental Conservation.

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2.02 COMPACTED STRUCTURAL FILL

A. Material furnished shall be suitable and conform to the following requirements:

1. Gradation - the material shall have the following gradation:

<u>Sieve Size</u>	<u>% Passing by Weight</u>
4-inch	100
No. 40	0 - 70
No. 200	0 - 15

2. Soundness - the material shall be substantially free of shale or other soft, poor durability particles.

B. The material shall be used for bedding under slabs and footings.

PART 3 - EXECUTION

3.01 INSPECTION

Prior to actual placement of backfill materials, the following will be field verified:

A. Verify that all materials have been approved for use by the CONSULTANT/ENGINEER.

B. Verify that areas to be backfilled are free of miscellaneous debris, or standing water.

3.02 PLACING FILL

The CONTRACTOR shall:

A. Place all fill, unless otherwise specified, in approximately horizontal lifts not exceeding 12 inches in loose thickness. So far as practical, each layer of materials shall extend the entire length and width of the area being filled.

1. Before compaction is started, the material shall be leveled by means of bulldozers, blade graders, or other equipment as approved by the CONSULTANT/ENGINEER.

2. The use of dragline excavators or similar equipment which excavate and deposit material in large unit masses will not be permitted unless all

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materials excavated are spread in the manner and to the thickness specified herein.

3. Material shall not be placed on surfaces that are muddy, frozen, or which contain frost. No frozen fill shall be placed.
 4. Backfill around structures shall be placed to the extent practicable, as the work progresses. Backfilling against concrete shall be done only when directed by the CONSULTANT/ENGINEER.
- B. Reduce the moisture content of the fill by aeration or increased the moisture content by uniform sprinkling of water as necessary, to achieve optimum moisture content to facilitate compaction. The moisture content of the fill shall be within ± 3 percentage points of optimum. Fill shall not be placed in water.
 - C. Slope the fill surface to facilitate the removal of run-off from the site and to prevent ponding of surface water. During periods of anticipated inclement weather, the surface of the fill shall be graded and sealed as directed by the CONSULTANT/ENGINEER to preclude percolation of surface water.
 - D. Place the backfill or bedding material in 12-inch lifts that conform to the dimensions as shown on the Construction Drawings.
 - E. Compact the backfill using suitable compaction equipment such as rammers or plate compactors.
 - F. Remove and properly dispose of all surplus backfill materials.
 - G. Grade backfill to existing elevations as specified in Section 02211.
 - H. Replace any paving that is damaged from the excavation activities, and match the repaved area with the existing elevations.

3.03 COMPACTION

The CONTRACTOR shall:

- A. Use steel wheel vibratory rollers for compaction of predominantly granular soils. The use of sheepsfoot or tamping rollers shall be limited to the compaction of fine grained, plastic soils.

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- B. Compact each layer of material to a minimum of at least 85 percent of maximum dry density determined in accordance with ASTM D1557 (Modified Proctor) unless otherwise specified.
- C. Make sufficient passes in order to obtain the specified densities.
- D. As compaction of fill in each Work area has been completed, leave the area undisturbed for a reasonable period of time for testing. Do not place fill over a layer which has not been tested and accepted by the CONSULTANT/ENGINEER.
- E. Maintain moisture content of the exposed lift; desiccation cracking shall result in removal and reinstallation of affected area by the CONTRACTOR at his own expense.
- F. Be directed by the CONSULTANT/ENGINEER to correct, at the CONTRACTOR'S expense, any unsatisfactory compacted materials by removal and replacement or by scarifying, aerating, or sprinkling (as needed), and recompaction and retesting, in-place prior to placement of a new lift.

END OF SECTION

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BACKFILLING**

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Former Unisys Facility
Great Neck, New York**

**SECTION 02270
TEMPORARY EROSION AND SEDIMENT CONTROL**

PART 1 - GENERAL

1.01 DESCRIPTION

- A. The Work covered by this Section consists of furnishing all materials, equipment, tools and labor to construct temporary erosion and sediment control systems as shown on Construction Drawing C-6.
- B. The Work to be performed includes, but is not limited to, silt fences, straw bales, conveyance channels, and site surface drainage.

1.02 RELATED SECTIONS

- A. Section 01300-Submittals.
- B. Section 02211-Rough/Final Grading.
- C. Section 02222-Excavation.

1.03 SUBMITTALS

- A. Product data shall be submitted as indicated in Section 01300.

PART 2 - PRODUCTS

2.01 SURFACE-WATER CONTROL MATERIALS

- A. Silt Fence: The CONTRACTOR shall supply silt fence in sufficient quantities to control surface-water runoff and sediment. Acceptable silt fence material shall be as follows:
 - 1. Propex-Silt Stop
 - 2. Mirafi 100X
 - 3. Beltech 755, or
 - 4. An approved equal.

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The CONTRACTOR shall submit Manufacturer's product data to the CONSULTANT/ENGINEER for approval a minimum of one week prior to installation. Silt fence shall be replaced at a frequency consistent with the Manufacturer's directions, or as directed by the CONSULTANT/ENGINEER.

- B. Straw Bales: The CONTRACTOR shall supply straw bales in sufficient quantities to be used for sedimentation control as needed. Straw bales shall be replaced at a minimum of every two months, or as directed by the CONSULTANT/ENGINEER.

PART 3 - EXECUTION

3.01 HANDLING

- A. Materials shall be handled in such a manner as to prevent damage to the material. Materials shall not be dropped or dragged over the ground. Any materials damaged shall be replaced at no expense to the CONSULTANT/ENGINEER.

3.02 SURFACE-WATER CONTROL STRUCTURES

- A. Silt Fence: The CONTRACTOR shall install silt fence in accordance with these Specifications and installation instructions provided by the Manufacturer, or as directed by the CONSULTANT/ENGINEER. Presiding authority shall be as follows, in descending order: CONSULTANT/ENGINEER'S direction, Specifications, Manufacturer's installation instructions.
- B. Straw Bales: The CONTRACTOR shall install straw bales in the locations indicated on the Construction Drawings, or as directed by the CONSULTANT/ENGINEER.

END OF SECTION

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**SECTION 02510
ASPHALT CONCRETE PAVING**

PART 1 - GENERAL

1.01 WORK INCLUDED

- A. The Work covered by this Section consists of furnishing all equipment, tools, and labor necessary for the installation of asphalt concrete paving including a base course, tack coat, and surface course at the locations shown on the Construction Drawings.

1.02 RELATED SECTIONS

- A. Section 01010 - Summary of Work.
- B. Section 01300 - Submittals.
- C. Section 01400 – Quality Controls.
- D. Section 02211 - Rough/Final Grading.

1.03 REFERENCES

- A. The Asphalt Institute - Manual MS-4 - The Asphalt Handbook.
- B. The Asphalt Institute - Manual MS-13 - Asphalt Surface Treatments and Asphalt Penetration Macadam.
- C. ASTM D-1557 - Laboratory Compaction Characteristics of Soil Using Modified Effort.
- D. ASTM D-946 - Asphalt Cement for Use in Pavement Construction.
- E. New York State Department of Transportation (DOT) Specifications - Section 400: Bituminous Pavements, and Section 407 - Tack Coat.

1.04 SYSTEM PERFORMANCE

- A. Paving shall withstand the anticipated short-term daily use by construction equipment, and shall withstand heavy-duty heavy vehicular traffic after the completion of construction activities at the site.

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1.05 QUALITY ASSURANCE

The CONTRACTOR shall:

- A. Perform work in accordance with The Asphalt Institute specifications and the New York State DOT Standard Specifications for Road and Bridge Construction.
- B. Obtain materials from the same local, reputable supplier throughout the project.

1.06 REGULATORY REQUIREMENTS

- A. The CONTRACTOR shall conform to applicable local regulations for paving on private property.

1.07 TESTS

- A. Testing and analysis of the asphalt concrete paving mix will not be conducted as specified in Section 01400. However, the CONTRACTOR shall also provide a performance guarantee for a minimum two-year period and repair any damage at no cost to the CONSULTANT/ENGINEER during the guarantee period.
- B. The CONTRACTOR shall submit proposed mix designs to the CONSULTANT/ENGINEER for review and approval a minimum of three weeks prior to the commencement of the Work.
- C. Asphalt used shall have a minimum field density of 95 percent of the required laboratory density (Marshall Method) for the mix used.

1.08 SUBMITTALS

The CONTRACTOR shall submit:

- A. All data in accordance with Section 01300.
- B. Technical product data to the CONSULTANT/ENGINEER a minimum of three weeks prior to commencement of the Work.
- C. Documentation for the asphalt pavement, which includes mix type, sealer, and other technical data to the CONSULTANT/ENGINEER for review and informational purposes a minimum of three weeks prior to the commencement of the Work.

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- D. MANUFACTURER'S instructions for asphalt repair prior to commencement of the Work.

1.09 ENVIRONMENTAL REQUIREMENTS

- A. The CONTRACTOR shall not place asphalt when the base surface temperature is less than 50 °F, unless prior approval is given by the CONSULTANT/ENGINEER.

PART 2 - PRODUCTS

2.01 MATERIALS

- A. Base Course: Granular material or crushed stone, which is dry and free of deleterious materials. The base course shall conform to the State of New York DOT Specifications for Base Course "Type 2". The asphalt cement shall be AC-20.
- B. Surface Course: Sand type or approved substitute as per Asphalt Institute Manual MS-4. The surface course shall conform to the State of New York DOT Specification for Top Course "Type 7." The surface course asphalt cement shall be 85-100 penetration asphalt cement.
- C. The tack coat shall conform to the State of New York DOT Specification Material Designation 702-3401.
- D. The CONTRACTOR shall use primer, tackcoat, asphalt cement and aggregates conforming to ASTM D-946 and to those normally used in the geographical locality of the site.
- E. The asphalt concrete shall consist of a combination of coarse aggregate, fine aggregate and mineral filler uniformly coated and mixed with asphalt cement.
- F. Aggregate and filler shall conform to the appropriate State DOT Specification and meet the requirements and gradations of the specified mix.

2.02 ASPHALT PAVING MIX

The CONTRACTOR shall use:

- A. Dry materials to avoid foaming and for uniform mixing.
- B. A base course that is between 4.5 to 6 percent of the asphalt cement by weight in mixture.

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- C. A surface course that is between 5 to 7 percent of asphalt cement by weight in mixture.

2.03 EQUIPMENT

- A. Compacting: A minimum of one steel wheel roller and a pneumatic-tired roller or (3) steel wheel rollers will be required in large areas.
- B. Steel Wheel Rollers: The steel wheel rollers shall be conventional 12-ton minimum weight, three wheel or tandem two-wheel types (approximately 400 lbs. per linear inch).
- C. Pneumatic-Tired Rollers: The pneumatic-tired roller shall be conventional self-propelled types (approximately 90 psi tire pressures) and shall consist of two axles on which are mounted multiple pneumatic-tired wheels having a minimum operating weight of 2,000 pounds per tire.
- D. Finishing: The finishing equipment shall consist of an approved self-propelled mechanical spreader to place the mix to grades required by the CONSULTANT/ENGINEER.

PART 3 - EXECUTION

3.01 INSPECTION

The CONTRACTOR shall:

- A. Stabilize any subbase to be paved a minimum of 12 inches below the bottom of the base material by compacting and tamping with heavy smooth-wheeled rollers.
- B. Verify that the compacted granular material or crushed stone base has been properly prepared and is dry and ready to support paving and imposed loads. The base shall be compacted in 6-inch lifts to 90 percent of the maximum dry density using Modified Proctor compaction effort (ASTM D-1557).
- C. Verify gradients and elevations of the base are correct prior to placing the asphalt concrete mix.
- D. Accept the granular material or crushed stone base as suitable prior to the installation of asphalt.

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3.02 BASE COURSE INSTALLATION

- A. After the subbase has been compacted, and approved by the CONSULTANT/ENGINEER, an asphalt concrete base course shall be constructed as herein specified to a compacted thickness as indicated on the Construction Drawings.
- B. Base Course Mixing, Transporting and Placing: The mixing, including the plant used in the preparation of the mix; transporting and placing of the mix, shall be in accordance with the New York State DOT Specification for Base Course Type 2 and in accordance with standard practices for quality work.
- C. The compaction of the mixture shall be accomplished by the steel wheel roller. Immediately following the initial rolling, the asphalt concrete shall be compacted using pneumatic-tired or steel wheel rollers operating in a sequence to assure the most efficient results. Rolling of the mixture shall begin immediately behind the finishing or laying machine. For breakdown, the steel wheel roller shall be used. The pneumatic-tired roller, if utilized, shall be used for secondary rolling; the finish rolling shall be accomplished with the steel wheel roller.
- D. The speed of the rollers shall not exceed (2½) miles per hour and shall at all times be slow enough to avoid displacement of the hot mixture and any displacement occurring as a result of reversing the direction of the roller, or from any other cause, shall at once be corrected by the use of rakes and of fresh mixture where required. Rolling shall proceed continuously until all roller marks are eliminated and no further compression is possible. To prevent adhesion of the mixture to the roller, the wheel shall be kept properly moistened, but excess of either water or oil will not be permitted. The rollers shall be in good condition, capable of reversing without backlash. They shall be operated by competent and experienced rollermen and must be kept in continuous operation as nearly as practicable in such a manner that all parts of the pavement shall receive substantially equal compression.
- E. At all places not accessible to the roller, thorough compaction must be secured by means of hot tampers.
- F. Surface Requirements: The course after final compression shall be smooth, of uniform texture, and true to the established grade. It shall have an average thickness as specified on the Construction Drawings. Any low or defective places shall immediately be remedied by cutting out the course at such spots and replacing it with fresh, hot mixture which shall be immediately compacted to conform with the surrounding area and shall be thoroughly bonded to it. The surface of the finished

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pavement shall be free from depressions exceeding one-eighth (1/8) inch as measured with a ten (10) foot straight edge.

- G. Asphalt Concrete Mixture Density: After final compression, the finished course shall at no point have a density less than ninety-five (95) percent of the laboratory compacted density.
- H. Longitudinal and Transverse Joints shall be made in a careful manner. Well-bonded and sealed joints are required. Joints between old and new pavements or between successive days' work shall be carefully made in such a manner as to insure a thorough and continuous bond between the adjoining surfaces. The edge of the previously laid course shall be cut back to its full depth so as to expose a fresh surface, after which the hot mixture shall be placed in contact with it and raked to a proper depth and grade. Infra-red joint heaters shall be carefully employed in such a manner as to heat up all joints sufficiently (without burning) to insure a proper bond. Before placing mixture against them, all contact surfaces or longitudinal joints, shall be painted with a thin uniform coating of hot asphalt cement or asphalt cement dissolved in naphtha or emulsified asphalt.
- I. In making the joint along any adjoining pavement, and after the hot mixture is placed by the finishing machine, just enough of the hot material shall be carried back to fill any space left open. This joint shall be properly "set-up" with the back of a rake at proper height and beveled to receive the maximum compression under rolling. The work of "setting-up" this joint shall be performed always by competent workmen, who are capable of making a correct, clean and neat joint.
- J. Patching of Deficient Areas: For repairs at joints or other areas behind the paving machine, the mixture shall be hand raked immediately in a fan-shaped pattern and the loose mix left slightly higher than the surrounding mat and immediately rolled. Mix shall be dumped into areas deficient in material, carefully mixed, smoothed and rolled. "Broadcasting" of the mixture will not be permitted at any time.
- K. After compaction has been completed, joints shall be painted with RC liquid asphalt.

3.03 TACK COAT INSTALLATION

- A. Tack coat shall be applied only when the existing surface is dry, and when the atmospheric temperature is above 50 °F. The liquid asphalt shall be applied at a uniform rate by an approved pressure distributor at a spraying temperature and application rate specified hereinafter.

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- B. All equipment used in the distribution of the tack coat shall have measuring and recording devices in good working order so as to accurately measure and record the quantities of bituminous materials distributed.
- C. Immediately before applying the tack coat, the full width of surface to be treated shall be swept. Care shall be taken to remove all loose dirt, asphalt or other loose objectionable material.
- D. After the operation of removing the dust has been completed, and prior to the application of the tack coat, an inspection shall be made of the surface to determine its fitness to receive the asphalt cement. That portion of the surface of the course proposed for immediate treatment must be dry and altogether in a satisfactory condition.
- E. The tack coat shall be applied to the surfaces of existing pavement upon which surface course material will be placed as shown on the Construction Drawings and to exposed edges of existing pavement surfaces to be in contact with new pavement. Tack coat shall completely cover the surface to be paved and shall not be applied more than 12 hours before the overlaying course is laid. Rate of application shall be between 0.03 to 0.07 gallons per square yard. The exact amount will be determined in the field as directed by the CONSULTANT/ENGINEER.
- F. Following the application, the surface shall be allowed to cure without being disturbed for such period of time as may be necessary to permit drying out and settling of the tack coat. That period shall be determined by the CONSULTANT/ENGINEER. The surface shall then be maintained until the next course has been placed. Suitable precautions shall be taken by the subcontractor to protect the surface against damage during this interval, including any sand necessary to blot up excess asphalt cement.

3.04 WEARING SURFACE INSTALLATION

- A. After the tack coat or the stabilized base course has thoroughly cured, an asphalt concrete wearing surface course shall be constructed, as herein specified, to a compacted thickness as indicated on the Construction Drawings.
- B. Surface Course Mixing, Transporting and Placing: The mixing, including the plant used in the preparation of the mix; transporting and placing of the mix, shall be in accordance with the New York State DOT Specification for Top Course Type "7" and in accordance with standard practices for quality work.

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- C. The compaction of the mixture shall be accomplished by the steel wheel roller. Immediately following the initial rolling, the asphalt concrete shall be compacted using pneumatic-tired or steel wheel rollers operating in a sequence to assure the most efficient results. Rolling of the mixture shall begin immediately behind the finishing or laying machine. For breakdown, the steel wheel roller shall be used. The pneumatic-tired roller, if utilized, shall be used for secondary rolling; the finish rolling shall be accomplished with the steel wheel roller.
- D. The speed of the rollers shall not exceed (2½) miles per hour and shall at all times be slow enough to avoid displacement of the hot mixture and any displacement occurring as a result of reversing the direction of the roller, or from any other cause, shall at once be corrected by the use of rakes and of fresh mixture where required. Rolling shall proceed continuously until all roller marks are eliminated and no further compression is possible. To prevent adhesion of the mixture to the roller, the wheel shall be kept properly moistened, but excess of either water or oil will not be permitted. The rollers shall be in good condition, capable of reversing without backlash. They shall be operated by competent and experienced rollermen and must be kept in continuous operation as nearly as practicable in such a manner that all parts of the pavement shall receive substantially equal compression.
- E. At all places not accessible to the roller, thorough compaction must be secured by means of hot tampers.
- F. Surface Requirements: The course after final compression shall be smooth, of uniform texture and true to the established grade. It shall have an average thickness as specified on the Construction Drawings and shall at no point vary more than one-quarter (1/4) inch from this thickness. Any low or defective places shall immediately be remedied by cutting out the course at such spots and replacing it with fresh, hot mixture which shall be immediately compacted to conform with the surrounding area and shall be thoroughly bonded to it. The surface of the finished pavement shall be free from depressions exceeding one-eighth (1/8) inch as measured with a ten (10) foot straight edge.
- G. Asphalt Concrete Mixture Density: After final compression, the finished course shall at no point have a density less than ninety-five (95) percent of the laboratory compacted density.
- H. Longitudinal and Transverse Joints shall be made in a careful manner. Well-bonded and sealed joints are required. Joints between old and new pavements or between successive days' work shall be carefully made in such a manner as to insure a thorough and continuous bond between the adjoining surfaces. The edge of the previously laid course shall be cut back to its full depth so as to expose a fresh

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surface, after which the hot mixture shall be placed in contact with it and raked to a proper depth and grade. Infra-red joint heaters shall be carefully employed in such a manner as to heat up all joints sufficiently (without burning) to insure a proper bond. Before placing mixture against them, all contact surfaces or longitudinal joints, shall be painted with a thin uniform coating of hot asphalt cement or asphalt cement dissolved in naphtha or emulsified asphalt.

- I. In making the joint along any adjoining pavement, and after the hot mixture is placed by the finishing machine, just enough of the hot material shall be carried back to fill any space left open. This joint shall be properly "set-up" with the back of a rake at proper height and beveled to receive the maximum compression under rolling. The work of "setting-up" this joint shall be performed always by competent workmen, who are capable of making a correct, clean and neat joint.
- J. Patching of Deficient Areas: For repairs at joints or other areas behind the paving machine, the mixture shall be hand raked immediately in a fan-shaped pattern and the loose mix left slightly higher than the surrounding mat and immediately rolled. Mix shall be dumped into areas deficient in material, carefully mixed, smoothed, and rolled. "Broadcasting" of the mixture will not be permitted at any time.
- K. After compaction has been completed, joints shall be painted with RC liquid asphalt.

3.05 FIELD QUALITY CONTROL

- A. The CONSULTANT/ENGINEER will perform a field inspection for conformance with these Specifications.

3.06 PROTECTION

- A. The CONTRACTOR shall, immediately after placement of the asphalt, protect the pavement from mechanical injury until the pavement has fully hardened and is capable of supporting vehicular traffic without sustaining damage.

3.07 REPAIR

- A. The CONTRACTOR shall repair all damage to existing asphalt concrete paving which occurs during execution of the Work.

END OF SECTION

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**SECTION 02530
SANITARY SEWER**

PART 1 - GENERAL

1.01 SECTION INCLUDES

- A. Pipe and fittings for gravity sanitary sewer.
- B. Precast concrete structures.
- C. Cast iron frames and covers.
- D. Non-shrink grout.
- E. Lock joint flexible sleeves.

1.02 RELATED SECTIONS

- A. Section 02222 - Excavation

1.03 REFERENCES

- A. ACI 304 – Recommended Practice for Measuring, Mixing, Transporting and Placing Concrete.
- B. ACI 308 – Standard Practice for Curing Concrete.
- C. ANSI/ASTM A185 – Welded Steel Wire Fabric for Concrete Reinforcement.
- D. ASTM A48 – Gray Iron Casting
- E. ASTM A74 – Cast Iron Soil Pipe and Fittings.
- F. ASTM A615 – Deformed and Plain Billet Steel Bars for Concrete Reinforcement.
- G. ASTM A746 – Ductile Iron Gravity Sewer Pipe.
- H. ASTM C33 - Concrete Aggregates.
- I. ASTM C55 – Concrete Building Brick.

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- J. ASTM C109 – Test Method for Compressive Strength of Hydraulic Cement Mortars Using 2-inch or 50-mm Cube Specimens.
- K. ASTM C150 – Portland Cement.
- L. ASTM C191 – Test Method for Time of Setting of Hydraulic Cement by Vicat Needle.
- M. ASTM C478 – Precast Reinforced Concrete Manhole Sections.
- N. ASTM C564 – Rubber Gaskets for Cast Iron Soil Pipe and Fittings.
- O. ASTM C827 – Test Method for Early Volume Changes of Cementitious Mixtures.
- P. ASTM C923 – Resilient Connectors between Reinforced Concrete Manhole Structures and Pipe.
- Q. ANSI/ASTM D698 – Test Methods for Moisture – Density Relations of Soils and Soil Aggregate Mixtures. Using 5.5 lb. Rammer and 12 inch drop.
- R. ASTM D2321 – Recommended Practice for Underground Installation of Flexible Thermoplastic Sewer Pipe.
- S. ASTM D3139 – Specification for Joints for Plastic Pressure Pipes using Flexible Elastomeric Seals.
- T. ASTM F477 – Elastomeric Seals (gaskets) for Joining Plastic Pipe.
- U. ASTM D3212 – Joints for Drain and Sewer Plastic Pipes Using Flexible Elastomeric Seals.
- V. Great Lakes – Upper Mississippi River Board of State Sanitary Engineers – Recommended Standards for Sewage Works (Ten State Standards).
- W. UNI-B-5-89 – Recommended Practice for the Installation of Polyvinyl Chloride Sewer Pipe.
- X. ASTM D3034 – Type PDM Polyvinyl Chloride (PVC) Sewer Pipe and Fittings.
- Y. CRSI 63 – Recommended Practice for Placing Reinforcing Bars.

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1.04 SUBMITTALS

- A. Submit under provisions of Section 01300.
- B. Product Data: Provide on pipe materials, pipe fittings, accessories and detectable marking tape.
- C. Manufacturer's Installations: Indicate special procedures required to install products specified.
- D. Manufacturer's Certificate: Certify that products meet or exceed specified requirements.
- E. Precast Concrete Structures: Indicate structure dimensions, sleeve locations, elevation and size, concrete strength and reinforcing bars. Submit manhole schedule showing all necessary structure information used to fabricate the unit.
- F. Frames and Covers: Indicate material, loading capability and dimensions.
- G. Non-Shrink Grout: Indicate shrinkage and expansion characteristics, strength, setting time, and composition.
- H. Manufacturer's Certificate: Certify that products meet or exceed specified requirements.
- I. Submit description of proposed method of control for line and grade during sanitary sewer installation.

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1.05 PROJECT RECORD DOCUMENTS

- A. Submit under provisions of Section 01300.
- B. Accurately record actual locations of piping mains, fittings, accessories and invert elevations.
- C. Identify and describe discovery of uncharted utilities.
- D. House Connection Records:
 - 1. Horizontal Ties – Measure and record 3 ties to the end of each hose connection. When possible, these ties shall be to the building to be served by the connection; otherwise, to permanent, physical objects on the same side of the street as the end of the house connection.
 - 2. Vertical Ties – Measure the depth of each house connection and record. Depths shall be measured from the pipe invert to a permanent, fixed reference point. The reference point shall be a porch, garage floor, first floor level or other similar point on the building being served by the connection, when possible, otherwise, to an adjacent house or a permanent physical object. Also, provide invert elevations, using the same datum as that used on the Drawings. Accuracy of vertical measurements shall be plus or minus 1 inch.
 - 3. Wyes and Tees – Record the survey station for each wye, tee, and vertical house connection installed, and identify the item installed. Measure and record the depth of the upper end of vertical house connections.

1.06 QUALITY ASSURANCE

- A. Perform work in accordance with Ten State Standards and Nassau County Department of Public Works requirements.
- B. PVC Pipe: Manufacturer's name, size, letter "PVC", Sewer Pipe" and manufacturer's code, cell classification and ASTM designation stamped on pipe.

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1.07 DELIVERY, STORAGE AND HANDLING

- A. Deliver, store, protect and handle products in accordance with manufacturer's instructions to prevent soiling, disfigurement or damage.
- B. Protect piping systems from entry of foreign materials by temporary covers, completing sections of work and isolating parts of completed systems.

1.08 ENVIRONMENTAL REQUIREMENTS

- A. Do not install underground piping when bedding is wet or frozen.
- B. Do not mix or place mortar and non-shrink grout if ambient temperature is below 40 degrees F.
- C. Do not backfill over or with frozen materials.

PART 2 - PRODUCTS

2.01 MANUFACTURERS

- A. PVC pipe: CERTIFIED J.M. MANUFACTURING CO., INC., CARLON.
- B. Precast concrete: AFCC PRECAST, INC., CARLSON PRECAST, INC., COASTAL PIPELINE PRODUCTS.
- C. Frames and Covers: CAMPBELL, NEEHAH

2.02 MATERIALS

- A. Sewer Pipe: ANSI/ASTM D3034, Type PSM, Polyvinyl Chloride (PVC) material; inside nominal diameter as indicated, integral bell and spigot end joints, Class SDR 18 or SDR35 as indicated on plans. Joints meet or exceed ASTM D3212.
- B. Plastic Pipe Joint Gasket: ANSI/ASTM F477, Elastomeric compression gasket. Gaskets shall be factory installed.

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- C. Sewer Pipe Fittings: Same material as pipe molded or formed to suit pipe size and end design in required tee, bends, elbows, cleanouts, reducers, traps and other configurations required.
- D. Building Sewer Pipe Buried Beyond 5 feet of Building: AWWA C900, Class 150 (DR 18), Polyvinyl Chloride (PVC) material; inside nominal diameter as indicated, integral bell and spigot end joints, with rubber gaskets.
- E. Concrete:
 - 1. Cement: ASTM C150 Type II.
 - 2. Fine and Coarse Aggregates: ASTM C33.
 - 3. Water: Clean and not detrimental to concrete.
 - 4. Mix concrete with a minimum 28-day compressive strength of 4000 psi.
- F. Reinforcing Steel:
 - 1. ANSI/ASTM A185 or ASTM A615, 60 ksi yield grade, plain finish.
 - 2. Tie Wire: Minimum 16 gauge, annealed type.
- G. Frames and Covers: ASTM A-48 cast iron construction, manufactures by Campbell Foundry Company or approved equal, with date of cast on underside of cover, "SANITARY SEWER" inscription on cover, painted with one coat asphaltum.
- H. Manhole Frame and Cover: Pattern No. 1453 with Type A cam lock.
- I. Cleanout Frame and Cover: Pattern No. 1736.
- J. Non-Shrink Grout:
 - 1. Cement- Based Grout: Pre-measured and prepackaged materials supplied by the manufacturer, requiring only the addition of water. The manufacturer's instructions must be printed on the outside of each bag.
 - 2. Water: Potable, not detrimental to concrete.
 - 3. Use the minimum water necessary for proper installation.

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4. Grout Characteristics:

- a. Non-Shrink: No shrinkage (0.0%) and a maximum 4.0% expansion when tested in accordance with ASTM C-827. No shrinkage (0.0%) and a maximum of 0.2% expansion in the hardened state when tested in accordance with CRD-C-621.
- b. Compressive Strength: A minimum 28-day compressive strength of 5,000 psi when tested in accordance with ASTM C-109.
- c. Setting Time: A minimum initial set time of 60 minutes when tested in accordance with ASTM C-191.
- d. Composition: Shall not contain metallic particles such as aluminum powders, iron filings, or expansive cement.

K. Lock Joint Flexible Sleeves: ASTM C923 – Resilient Connector between manhole and piping.

L. Manhole Steps: Copolymer polypropylene plastic steel reinforced manhole steps, M.A. INDUSTRIES, Model PS2-PF, set into manhole wall.

M. Precast Reinforced Concrete Manhole Sections: ASTM C478, cylindrical shape.

N. Concrete Brick Units: ASTM C55, Grade N, Type I – moisture-controlled, weight.

O. Mortar: A 1:1:5 ration of Portland cement, masonry cement and sand, respectively.

2.03 ACCESSORIES

- A. Marking Tape: Marker tape installed over all direct burial sanitary sewer lines shall be six (6") inches in width, and shall be Terra Tape "D" detectable as manufactured by Griffolyn, Inc. or approved equal. The tape shall be an inert, bonded layer plastic material with a metallized foil core, so that sanitary sewer line locations can be determined with a metal detector. The color of the tape shall be green with the following imprints:

"CAUTION! BURIED SANITARY SEWER LINE BELOW!"

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- B. Pipe Connectors: Elastomeric PVC with Series 300 stainless steel bands by FERNCO, Davison, MI.
- C. Flexible Pipe to Manhole Connector: NPC, INC. KOR-N-SEAL I which meets or exceeds the requirements of ASTM C923. Installation band to secure to opening in manhole wall and pipe clamp shall be Series 304 stainless steel.
- D. Sewer Plugs: Flexible PVC FERNCO Qwik Cap with stainless steel band.

2.04 SOURCE QUALITY CONTROL

- A. Notify ENGINEER at least 48 hours before pouring precast concrete sections.
- B. Mark precast concrete structures in accordance with ASTM C478.
- C. Provide compressive strength test results of concrete used in making precast concrete structures. Provide data for cylinders tested in accordance with ASTM C39 at seven days and twenty-eight days.
- D. Age precast concrete structures at least one week before shipment.

PART 3 - EXECUTION

3.01 EXAMINATION

- A. Verify that excavations are to required grade, dry and not overexcavated.

3.02 PREPARATION

- A. Remove scale and dirt, on inside and outside, before assembly.
- B. Remove large stones or other hard matter that could damage pipe or impede consistent backfilling or compaction.
- C. All walls, fences, signs, sheds and other existing improvements encountered shall be carefully taken-up and stored for subsequent replacement. If damaged, full new replacement will be required at no additional expense to the OWNER. Comply with specifications contained elsewhere.

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- D. Do not disturb property markers unless necessary. If it becomes necessary to disturb or remove a property marker, have a licensed land surveyor provide four (4) ties to the marker. The licensed land surveyor shall replace the marker as soon as possible
- E. Remove and dispose of all other obstructions which will affect the work or which are specifically designated to be removed.
- F. Hand trim excavations to required elevations. Correct over excavation with Type C fill as defined in Section 02315.

3.03 INSTALLATION

- A. Maintain separation of sanitary sewer from piping in accordance with regulations of NCDH, New York State Department of Environmental Conservation and the Recommended Standards for Wastewater Facilities.
- B. Parallel Water and Sewer Lines – Pipelines carrying sewage, sludge or other wastewater, whether treated or not, shall not be located any closer than 10 ft. horizontally from a potable water pipeline. If it is not possible to maintain horizontal separation, the lines may be located at least 4 ft. horizontally from each other, provided that there is at least 18 inches of clear vertical separation, with the sewer line being below the water line.
- C. Water and Sewer Line Crossings – Whenever water and sewer lines must cross, the sewer must be situated below the water line with at least an 18 inches of clear vertical separation. In no case shall a water line pass under a sewer.
- D. Special Conditions – Parallel Lines – When it is impossible to achieve the requirements of paragraph 3.03 (B), immediately notify CONSULTANT/ENGINEER. If CONSULTANT/ENGINEER concurs. He will order the construction of the sewer with ductile mechanical joint pipe and may order the reconstruction of the existing water line. Regardless, sewer shall be installed at a lower elevation than the water line and sewer line and the reconstructed water line shall be pressure tested for leakage in accordance with Section 01450.
- E. Special Conditions – Crossing Lines - When it is impossible to achieve the requirements of paragraph 3.03 (C), immediately notify CONSULTANT/ENGINEER. If CONSULTANT/ENGINEER concurs, he will order 1) the water pipe raised, 2) the construction of the sewer line with ductile

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mechanical joint pipe. Regardless, sewer shall be installed at a lower elevation than the water line. The full length of sewer pipe shall be centered under the crossing line. The joint shall not be closer than 9.5 ft. to the crossing.

- F. Unusual Conditions – Immediately notify CONSULTANT/ENGINEER when it is impossible to achieve any of the above conditions. The CONSULTANT/ENGINEER will prescribe the procedures to be followed.
- G. Install plastic pipe, fittings, and accessories in accordance with ASTM D2321 and manufacturer's instructions. Seal joints watertight. Select pipe and fittings so that there will be as small a deviation as possible at the joints and so that inverts present a smooth surface. Pipe and fittings which do not fit together to form a tight fitting joint are not permitted.
- H. Route pipe in straight line.
- I. Install pipe to allow for expansion and contraction without stressing pipe or joints.
- J. Lay pipe to slope gradients noted on drawings with maximum variation from the slope of 1/ inch in 10 feet.
- K. Establish elevations of buried piping to ensure not less than 4 feet of cover. Backfill and compact trench in accordance with Section 02223.
- L. Plug or close every open pipe end before leaving work at night, and when pipe installation is not in progress.
- M. After partially backfilling, install marking tape 18" to 24" above crown of pipe. Place as straight as possible. Hold tape in position by adding backfill with hand shovels before using mechanical equipment to finish the backfill.
- N. Install precast concrete base, shaft, and slab top of precast plumb and level. Establish elevations and pipe inverts for inlets and outlets as indicated. Locate manhole rungs as directed by the CONSULTANT/ENGINEER relative to the top slab opening.
- O. Adjust lock joint flexible sleeve or install non-shrink grout to provide water-tight pipe penetration. Mount lid and frame level in grout, secured to top section to elevation indicated.

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- P. Perform all mixing, surface preparation and grouting in accordance with manufacturer's recommendations.
- Q. Provide concrete bench in base of manhole.
- R. In each stretch of underground pipe, light shall be visible from one end to the other and the pipe shall be true to line and grade. All deposits found in the pipes, protruding cement or packing shall be removed and the sewer bore left clean and free through its entire length. There shall be no visible leakage into any stretch of sewer. Refer to paragraph 3.08. All manholes and other appurtenance shall be of the specified size and form and of neat appearance, and their tops shall be set to the proper grade. If the Work is found to be in any condition other than in accordance with these specifications, it shall be brought to proper condition by cleaning, pointing, or if necessary, excavating and rebuilding.
- S. Install pipes to the lines and grades as given on the drawings. Engineer reserves the right to disapprove a method of control, including those previously accepted, if, in CONSULTANT/ENGINEER'S opinion, the method of control is not providing the accuracy required under the CONTRACT.
- T. Drainage of construction excavations through sanitary sewers is not permitted.
- U. Maintain the excavation free of water during the progress of the Work. No pipe shall be laid in water nor shall there be any joints made up in water. No separate allowance for pumping or otherwise removing water will be made. All slides or cave-ins of the trenches or cuts shall be remedied at the expense of the CONTRACTOR, and to the satisfaction of the CONSULTANT/ENGINEER.
- V. Make connections between pipes of different materials with approved adapters. The encasement of adapter made connections with concrete is not permitted. Commence pipe laying at the lowest point, with the spigot ends pointing in the direction of flow.
- W. All adjustments to the line and grade of pipe laid on earth foundation shall be done by scraping away or filling in the earth under the barrel of the pipe, and not by blocking or wedging. Where excavation has been carried too deep but not in excess of six (6) inches, the CONTRACTOR may replace with suitable earth and hand tamp same to provide a firm foundation. Wherever the CONTRACTOR has excavated to a depth in excess of six (6) inches, the CONSULTANT/ENGINEER may order broken stone or gravel fill without additional compensation to the

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CONTRACTOR. In all cases the trench under the joint shall be excavated to permit an even bearing for the barrel of the pipe.

- X. When unsuitable materials and/or conditions are encountered, the CONSULTANT/ENGINEER may direct the excavation to continue below grade and the trench filled with gravel or crushed stone foundation, or the CONSULTANT/ENGINEER may order other corrective measures.
- Y. Where required, holes and spaces to be used for joints shall be sufficiently large to leave the joint of each pipe free and not resting on the ground at any point. Every joint shall be made up in the trench.

3.04 BUILDING CONNECTION INSTALLATION

- A. Install building connections where shown and as detailed on the Drawings. When locations are not shown on the Construction Drawings, CONSULTANT/CONSTRUCTION ENGINEER will determine the actual location of house connections in the field on the basis of the most convenient and economical location at accommodate sewage flow for each structure or lot to be serviced. When locations are determined in the field, they will be provided to CONTRACTOR in advance of the pipe laying.
- B. Install wye branches, tees, pipe adapters, and other fittings where required.
- C. It is the intent to install house connections perpendicular to the main sewer at a uniform slope of $\frac{1}{4}$ inch foot, and at a depth which allows for the collection of sewage generated in first floors, by gravity, when possible and when elevations permit. Actual depths and slopes will be determined by CONSULTANT/ENGINEER.
- D. Install tees and vertical house connections where required by the detail on the Construction Drawings, and where directed by CONSULTANT/ENGINEER.
- E. Provide a watertight plug in the end of each house connection. Plugs shall be of a type specially made for this purpose and shall be so constructed and installed that their removal will not damage the pipe at the time a future connection is made.

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- F. Install marker stakes of 2-inch x 2-inch oak, or other approved hardwood, at the end of each house connection. Extend stake approximately ½ inch above grade and paint with a coat of approved asphaltum.

3.05 PVC PIPE INSTALLATION

- A. Excavate and shape the trench to conform with the details shown on the Construction Drawings. If accidental or intentional overexcavation of the trench occurs, in depth or width, such corrective measures as are, in the opinion of the CONSULTANT/ENGINEER necessary to rectify the conditions shall be taken by the CONTRACTOR. No additional compensation will be made therefor. This requirement applies equally in the case of cave-in of the trench walls, by failure to apply necessary sheeting measures.
- B. Join sections of pipe by hand only, without the use of levers or other mechanical aids. Both the sealing gasket and the adjoining spigot end shall be thoroughly cleaned and coated with lubricant. The spigot end shall be placed in the bell end only as far as the reference mark provided on each spigot end, to allow for expansion, contraction, and deflection, and not “pushed home”.
- C. Pipe lengths of twenty foot (20') shall be utilized, except that shorter lengths of 12-½', or random lengths, may be utilized where connections to manholes, house connection wyes and tees, or similar circumstances are present, only inasmuch as is necessary to properly effect the joint(s) in the desired location. In all cases, the number of pipe joints shall be minimized. In the case of random lengths or pipe, provide proper reference marks on spigot ends prior to assembling.
- D. Perform field cutting of pipe to ensure a perfectly square cut. After cutting, the cut end shall be beveled to match that of a factory finished beveled end. Bevels shall be formed with the use of a beveling tool, which will automatically produce the correct taper. The CONTRACTOR is cautioned that the bevel angle required differs between PVC Sewer Pipe and PVC Pressure Pipe. Take care to ensure that the correct bevel angle is produced.
- E. Place and compact embedment materials in accordance with Paragraph 5.10.2, “Methods of Placing Embedment materials”, of Recommended Standard UNI-B-5 of the Uni-Bell Plastic Pipe Association, subject to the conditions of the Plans and these Specifications. Pipe haunching and initial backfill shall be brought up and compacted equally on either side of the pipe, to preclude disturbance of the pipe, in layers not to exceed four inches in height, by use of hand tamping supplemental

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by mechanical compacting using hand-operated compactors, similar to "Whacker" or equal. Flooding, puddling and jetting of initial backfill are prohibited for PVC pipe installations.

- F. Place and final backfill in accordance with Section 02223, as modified herein. "Hydrohammers" and similar compacting equipment, which, in the opinion of the CONSULTANT/ENGINEER, may cause disturbance to the pipe and/or the materials in the pipe zone (bedding, haunching, and initial backfill) shall not be utilized within four feet (4') of the pipe. This shall not be construed to preclude the use of mechanical compactors, "hoe-packers", and the like, which may be demonstrated, by the CONTRACTOR, to produce no deleterious effects on the embedment materials. Such demonstration shall be the responsibility of the CONTRACTOR. The use of mechanical equipment shall be in accordance with the pipe manufacturer's recommendations, and as approved by the CONSULTANT/ENGINEER.
- G. The CONTRACTOR'S specific attention is directed towards the critical nature of effecting and maintaining the specified compaction of the embedment materials in the pipe zone. Lower limit for sheeting driven and pulled shall be one foot above the top of the pipe. All sheeting placed below this level shall be cut off at said point and left in place. Compensation therefore will be made only if ordered to drive below this level, by the CONSULTANT/ENGINEER.
- H. Use of a moveable "trench box" when moved, may cause disturbance to the materials in the pipe zone. Usage of a trench box, for protection of personnel in accordance with OSHA requirements, will be permitted only under one of the following conditions, which shall be the CONTRACTOR'S responsibility to propose and employ:
 - 1. Position the moveable trench box on a shelf above the pipe springline, with the pipe installed in a narrow, vertical walled subditch. The width of the subditch shall not exceed the O.D. of the pipe plus 9 inches on each side; or
 - 2. Increase the overall trench width to produce a minimum clearance of 2-1/2 pipe diameters between the pie barrel and the trench box on each side of the pipe after embedment has been placed and compacted, In utilizing this option, all voids left in the embedment material as the result of trench box removal shall be filled and compacted. Disturbance to the loss of compaction density in the pipe zones is not permitted.

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3. The CONTRACTOR shall submit his proposed method of meeting the above-specified conditions to the CONSULTANT/ENGINEER, for approval. No additional compensation will be made for meeting these conditions, nor for additional excavation, backfill, repaving, or similar items, outside of the payment limits as shown on the Drawings.
- I. Compaction of embedment materials, including bedding, haunching, and initial backfill shall be shown on the Drawings, and initial backfill shall be as shown on the Drawings, but in no case shall the density attained be less than that required for the final backfill above. The CONTRACTOR'S attention is directed toward compaction requirements for pavement sub-base material, specified elsewhere in the specifications.

3.06 EXFILTRATION TESTING

- A. Test each section of pipe between manholes individually. Continuous sections shall not be tested simultaneously.
- B. The minimum positive head of water for exfiltration testing shall be two feet above the exterior crown of the pipe at the highest point of the line under test, or two feet above the groundwater level when groundwater levels are above the exterior crown of the pipe.
- C. Immediately upon completion of the test, remove the downstream plug in the presence of the CONSULTANT/ENGINEER, to verify that all test water flows freely from the pipe and upstream manhole under test.
- D. The maximum allowable quantity of exfiltration shall be as specified in Section 01450. There will be no separate exfiltration allowance for manholes, except that their width will not be deducted from the length of pipe used in computing the total allowable leakage for the section under test.
- E. Allow testing to be observed by the CONSULTANT/ENGINEER.

3.07 SITE TOLERANCES

- A. Maximum variation from proposed rim elevation shall be ¼ inch.

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3.08 FIELD QUALITY CONTROL

- A. Request inspection prior to and immediately after placing backfill.
- B. Compaction testing shall be performed in accordance with ASTM D2922.
- C. If tests indicate work does not meet specified requirements, remove work, replace, and retest at no cost to OWNER.

3.09 PROTECTION

- A. Protect pipes, structures and appurtenances from damage or displacement during backfilling..

END OF SECTION

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**SECTION 02660
WATER SUPPLY SYSTEM**

PART 1 - GENERAL

1.01 SECTION INCLUDES

- A. Domestic water piping system from tap into existing water main to lavatory and eyewash station in the treatment building.
- B. Valves and fittings, including corporation stop and curb stop.

1.02 RELATED SECTIONS

- A. Section 002222 - Excavation.

1.03 REFERENCES

- A. ASME 16.26 – Cast Copper Alloy Fittings for Flared Copper Tubes.
- B. ASTM B88 – Seamless Copper Water Tube.
- C. AWWA C800 – Underground Service Line Valves and Fittings.

1.04 SUBMITTALS

- A. Submit under provisions of Section 01300.
- B. Product Data: Provide data on pipe materials, pipe fittings, valves, and accessories. Provide manufacturers catalog information. Indicate valve data and ratings.
- C. Manufacturer's Installation Instructions: Indicate special procedures required to install products specified.
- D. Maintenance Data: Include installation instructions, spare parts lists, exploded assembly views.

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1.05 QUALITY ASSURANCE

- A. Valves: Manufacturer's name and pressure rating marked on valve body.
- B. Manufacturer: Company specializing in manufacturing the Products specified in this section with minimum three years documented experience
- C. Installer: Company specializing in performing the work of this section.

1.06 REGULATORY REQUIREMENTS

- A. Perform Work in accordance with New York State Plumbing Code, Nassau County Department of Health and Water Utility requirements.
- B. Manufacturer: Company specializing in manufacturing the Products specified in this section with minimum three years documented experience.

1.07 DELIVERY, STORAGE AND HANDLING

- A. Deliver, store, protect and handle products in accordance with manufacturer's instructions to prevent soiling, disfigurement of damage.
- B. Accept valves on site in shipping containers with labeling in place. Inspect for damage.
- C. Provide temporary protective coating on cast iron and steel valves.
- D. Provide temporary end caps and closures on piping and fittings. Maintain in place until installation.
- E. Protect piping systems from entry of foreign materials by temporary covers, completing sections of the work, and isolating parts of completed system.

1.08 ENVIRONMENTAL REQUIREMENTS

- A. Do not install underground piping when bedding is wet or frozen.

1.09 SCHEDULING

- A. Notify appropriate water utility as required prior to any work on water mains or interruption of service.

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PART 2 - PRODUCTS

2.01 WATER PIPING, BURIED BEYOND 5 FEET OF BUILDING

- A. Copper Tubing: ASTM B88, Type K.
 - 1. Fittings: ASME B16.26, cast bronze
 - 2. Joints:
 - a. Flared or compression type
 - b. ANSI/AWS A5.8, BCUP silver braze

2.02 FLANGES, UNIONS AND COUPLING

- A. Pipe size 2 inches and under:
 - 1. Copper tube and pipe: 150 psig bronze unions with soldered joints. NO LEAD SOLDER WILL BE PERMITTED.
- B. Dielectric connections: Union with galvanized or plated steel threaded end, copper solder end, water impervious isolation barrier.

2.03 CORPORATION STOPS

- A. Manufacturers:
 - 1. MUELLER COMPANY, Model No. H-15000.
 - 2. Other acceptable manufacturers offering equivalent products to be specifically approved.
- B. Water service bronze body with AWWA standard thread inlet and copper AWWA outlet, complete with straight coupling nuts.

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2.04 CURB STOPS (PLUG VALVES AND EXTENSION SERVICE BOXES)

A. Manufacturers:

1. MUELLER COMPANY, Model No. H-15210 Curb Stop; Model No. H-10310 Extension Service Box.
2. Other acceptable manufacturers offering equivalent products to be specifically approved.

B. Curb stop to have water service bronze body with AWWA standard thread inlet and outlet; with combined tee and cap and an inverted tapered key with ¼ inch hole drilled in cap for attaching a stationary rod; valve shall open to the left (counterclockwise).

C. Extension service box MUELLER COMPANY No. H-10314 to have extra grade gray iron cover and base, steel extension pipe, complete with stationary inside stop rod MUELLER Company No. 82862, 33" length, and one-piece lid with two holes for removal with spanner wrench.

2.05 TAPPING SLEEVES

A. Manufacturers:

1. Mueller Company, Model No. H-10530.
2. Other acceptable manufacturers offering equivalent products to be specifically approved.

B. Ductile iron double strap saddle, complete.

2.06 TAPPING SERVICE CLAMP

A. MUELLER COMPANY DB2A Series, ductile iron body, forged steel strap, rolled strap threads, corrosion resistant, neoprene gaskets cemented in place.

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2.07 ACCESSORIES

- A. Marking Tape: Marker tape installed over all direct burial water supply lines shall be six (6") inches in width, and shall be Terra Tape "D" detectable as manufactured by Griffolyn, Inc. or approved equal. The tape shall be an inert, bonded layer plastic material with a metallized foil core, so that water supply line locations can be determined with a metal detector. The color of the tape shall be blue with the following imprints:

"CAUTION! BURIED WATER SUPPLY LINE BELOW!"

PART 3 - EXECUTION

3.01 EXAMINATION

- A. Verify that excavations are to required grade, dry and not over-excavated.
- B. Verify services connection size, water main size, location and inverts.

3.02 PREPARATION

- A. Ream pipe and tube ends. Remove burrs. Bevel plain end ferrous pipe.
- B. Remove scale and dirt, on inside and outside, before assembly.
- C. Prepare piping connections to equipment with flanges or unions.

3.03 BEDDING

- A. Excavate pipe trench in accordance with Section 02222 for work of this section. Hand trim excavation for accurate placement of pipe to elevations indicated.
- B. The subbase of the pipe in any rock excavation shall be a minimum of 4-inches thick and consists of sand, gravel and crushed stone.
- C. Backfill around sides and to top of pipe with fill, tamp in place and compact to 95% of Standard Proctor Density in accordance with ASTM D698 and Section 02225.
- D. Maintain optimum moisture content of bedding material to attain required compaction density.

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3.04 INSTALLATION

- A. Perform wet tap into existing main in accordance with requirements of regulatory agencies having jurisdiction and water supplier.
- B. Install in accordance with manufacturer's instructions.
- C. Provide non-conducting dielectric connections wherever jointing dissimilar metals.
- D. Establish elevations of buried piping outside the building to ensure not less than 4.5 feet of cover.
- E. Install valves with stems upright, not horizontal or inverted.
- F. Service pipe shall be one continuous piece between the corporation stop and the curb stop.

3.05 APPLICATION

- A. Install unions downstream of valves and at equipment or apparatus connections.
- B. Install brass male adapters each side of valves in copper piped system. Sweat solder adapters to pipe.
- C. Install gate valves for shutoff and to isolate equipment, part of systems, or vertical risers.

3.06 FIELD QUALITY CONTROL

- A. Test water piping in accordance with Plumbing Code.

3.07 DISINFECTION OF DOMESTIC WATER PIPING SYSTEM

- A. Prior to starting work, verify system is complete, flushed and clean.
- B. Ensure pH of water to be treated is between 7.4 and 7.6 by adding alkali (caustic soda or soda ash) or acid (hydrochloric).
- C. Inject disinfectant, free chlorine in liquid, powder, tablet or gas form, throughout system to obtain 50 to 80 mg/L residual.

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- D. Bleed water from outlets to ensure distribution and test for disinfectant residual at minimum 15% of outlets.
- E. Maintain disinfectant in system for 24 hours.
- F. If final disinfectant residual tests less than 25 mg/L, repeat treatment.
- G. Take samples no sooner than 24 hours after flushing, from 2% of outlets and from water entry, and analyze in accordance with AWWA C651.

END OF SECTION

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**SECTION 03110
CONCRETE FORMWORK**

PART 1 - GENERAL

1.01 WORK INCLUDED

This section prescribes materials and methods to be used in fabricating, erecting, and removing forms for cast-in-place concrete. The CONTRACTOR shall furnish all form design, forms, shoring, ties, form coating, and materials and all labor, equipment, and other items necessary or convenient to the CONTRACTOR for the fabrication, erection, and removal of formwork.

1.02 RELATED SECTIONS

- A. Section 01300 - Submittals
- B. Section 03300 - Cast-in-Place Concrete

1.02 GENERAL

- A. Forms shall be fabricated, erected, and removed as specified herein and shall be of a type, size, shape, quality and strength to produce hardened concrete having the shape, lines, and dimensions indicated on the Construction Drawings. The forms shall be true to line and grade in accordance with the tolerances as specified in Section 03300 (Cast-in-Place Concrete) and shall be mortar tight and sufficiently rigid to resist deflection during concrete placement. The surfaces of forms shall be smooth and free from irregularities, dents, sags, and holes that would deface the finished surfaces.
- B. The CONTRACTOR shall be responsible for designing, erecting, supporting, bracing, and maintaining formwork to support vertical and lateral loads that might be applied until such loads can be supported by the concrete structure. It shall be the responsibility of the CONTRACTOR to correctly assess and analyze the erection stresses induced upon the structure, its elements and supporting foundations during construction. Since the CONSULTANT/ENGINEER does not dictate or determine the CONTRACTOR'S sequence of operations of construction, the CONSULTANT/ENGINEER cannot determine erection stresses and therefore assumes no responsibility or obligation to do so.
- C. The CONTRACTOR shall be responsible for adequate formwork design for construction of cast-in-place reinforced concrete.

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- D. Except as modified herein, form design, fabrication, and erection shall conform to the requirements of the latest editions of ACI 347 and ACI 318 and shall be acceptable to the CONSULTANT/ENGINEER. Design criteria for plywood shall conform to APA Form V345.
- E. Formwork shall comply with the requirements of ANSI A10.9 and OSHA Construction Standards, Part 1926, Subpart Q, "Concrete, Concrete Forms, and Shoring."

1.03 SUBMITTALS

- A. The CONTRACTOR shall submit to the CONSULTANT/ENGINEER for review Shop Drawings and design calculations for formwork the CONTRACTOR intends to use during construction in accordance with Section 01300 (Submittals).
- B. Product data for the formwork shall be submitted as indicated in Section 01300 (Submittals).

1.04 STORAGE

All form materials and accessories shall be stored above-ground on framework or blocking and shall be covered with a suitable water-proof covering providing adequate air circulation and ventilation.

PART 2 - PRODUCTS

2.01 FORMS

- A. Forms for surfaces which will be exposed to view when construction is completed shall be prefabricated plywood panel forms, job-built plywood forms, or forms that are lined with plywood or fiberboard.
- B. Plywood or lined forms will not be required for surfaces which are normally below grade or not ordinarily exposed to view. Other types of forms, such as steel or unlined wooden forms, may be used for surfaces which are not restricted to plywood or lined forms, and may be used as backing for form linings. Forms are required above all extended footings.
- C. Forms for cast-in-place concrete shall conform with the following requirements:

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- Prefabricated Steel Forms shall be Simplex "Industrial Steel Frame Forms," Symons "Steel Ply," Universal "Uniform," or equal.
 - Plywood Forms shall be Product Standard PS-1, waterproof, resin- bonded, exterior type douglas fir. For normal finish, face adjacent to concrete Grade B or better. For architectural finish, face adjacent to concrete Grade B or better with plastic overlay.
 - Lumber Forms Straight, dressed all sides, uniform width and thickness, and free from knots, offsets, holes, dents, and other surface defects.
 - Fiberboard Forms Federal Specification LLL-B-810, Type IX, tempered, waterproof, screenback, concrete form hardboard.
 - Chamfer Strips Clear white pine, surface against concrete planed.
- D. Reuse of job-built plywood forms shall be permitted only when specifically approved by the CONSULTANT/ENGINEER. Plywood shall be furnished and placed in 48-inch widths and in uniform lengths of not less than 96 inches, except where the dimension of the component to be formed is less. Where plywood is attached directly to studs or joists, the panels shall be not less than 5/8 inch thick. Studs shall be provided sufficiently sized and spaced to prevent bulging of the plywood sheeting.
- E. Where earth is too unstable to serve as a form for sides of footings and foundations, the sides against the earth may be formed with 3/4 inch thick No. 2C Yellow Pine with tight butt joints, securely braced to hold a straight line.

2.02 FORM TIES

Form ties shall be approved by the CONSULTANT/ENGINEER and shall be of the snap cone or she-bolt with cone type as manufactured by a recognized manufacturer of concrete forming accessories. Cones shall leave a hole or depression in the concrete no larger than 7/8-inch in diameter. Plain snap ties or flat bar ties, unless otherwise approved by the CONSULTANT/ENGINEER, shall not be used. Ties shall be of a type that will accurately tie, lock, and spread the forms. Tie spacing shall be designed to withstand concrete pressures without bulging, spreading, or lifting of the forms. The tie shall be of such a design that when forms are removed no metal shall be within 2 inches of any surface unless stainless steel ties are used, in which case no metal shall be within 1 inch of any surface. Permanently embedded portions of form ties which are not provided with threaded ends shall be constructed so that the removable ends are readily broken off without damage to the concrete.

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2.03 FORM COATINGS

Where specified herein, forms shall be coated with a nonstaining form release agent prior to concrete placement. Form coatings shall be Industrial Lubricants "Nox-Crete Form Coating," L&M "Debond," Prater "Pro-Cote," Richmond "Rich Cote," or equal.

PART 3 - EXECUTION

3.01 FABRICATION AND ERECTION

- A. Forms shall be substantial and sufficiently tight to prevent leakage of concrete. Forms shall be braced or tied to maintain the desired position, shape, and alignment during and after concrete placement. Walers, studs, internal ties, and other form supports shall be sized and spaced so that proper working stresses are not exceeded. Joints in forms shall be bolted tightly and shall bear on solid construction. Forms shall be constructed so they can be removed without hammering, wedging, or prying against the concrete. Form ties in exposed surfaces shall be uniformly spaced and aligned in horizontal and vertical rows. The forms shall produce finished surfaces that are free from off-sets, ridges, waves, and concave or convex areas.
- B. Forms to be reused shall be thoroughly cleaned and repaired. Split, frayed, delaminated, or otherwise damaged forms shall not be used.
- C. All form panels shall be placed in a neat, symmetrical pattern with horizontal joints level and continuous. The CONTRACTOR shall place special attention on mating forms to previously placed walls so as to minimize steps or rough transitions. Form panels shall be of the largest practical size to minimize joints and to improve rigidity.
- D. Beams and slabs supported by concrete columns shall be formed so the column forms may be removed without disturbing the supports for the beams or slabs.
- E. Wherever the top of a wall will be exposed to weathering, the forms on at least one side shall not extend above the top of the wall and shall be brought to true line and grade. At other locations forms for concrete which is to be finished to a specified elevation, slope, or contour, shall be brought to a true line and grade, or a wooden guide strip shall be provided at the proper location on the forms so that the top surface can be finished with a screed or template. At horizontal construction joints in walls the forms on one side shall not extend more than 2 feet above the joints.

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- F. Temporary openings shall be provided at the bottom of column and wall forms and at other points where necessary to facilitate cleaning and inspection prior to concrete placement.
- G. Unless shown otherwise specified by the CONSULTANT/ENGINEER, all salient corners and edges of beams, columns, walls, slabs, and curbs shall be provided with a 3/4- by 3/4-inch chamfer formed by a wood or metal chamfer strip.
- H. Forms for exposed surfaces and all steel forms shall be coated with a nonstaining form release agent which shall be applied just prior to placement of steel reinforcement. After coating, any surplus form release coating on the form surface shall be removed. Wood forms for unexposed surfaces may be thoroughly wetted with water in lieu of coating immediately before concrete placement, except in freezing weather form release coating shall be used.
- I. Should misalignment of forms or screeds, excessive deflection of forms, or displacement of reinforcement occur during concrete placement, immediate corrective measures shall be taken to ensure acceptable lines and surface to required dimensions and cross sections.
- J. If any forms bulge or show excessive deflection, in the opinion of the CONSULTANT/ENGINEER, the concrete shall be removed and the forms rebuilt and strengthened at the expense of the CONTRACTOR.

3.02 FORM REMOVAL

- A. Forms shall not be removed or disturbed until the concrete has attained sufficient strength to safely support all dead and live loads. Shoring beneath beams or slabs shall be left in place and reinforced as necessary to carry any construction equipment or materials placed thereon.
- B. No forms shall be removed without the approval of the CONSULTANT/ENGINEER. In general and under normal conditions the CONSULTANT/ENGINEER will approve removal of forms after the following time has elapsed:

<u>Item</u>	<u>Time After Placement</u>
Elevated Slabs and Beams	14 days
Columns	7 days
Walls	3 days

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Other Concrete

2 days

- C. When ambient air temperatures during the curing period fall below 45°F, form removal will take place based on job-cured test cylinder strength only.
- D. Care shall be taken in form removal to avoid surface gouging, corner or edge breakage, or other damage to the concrete. Immediately after form removal, any damaged or imperfect work shall be repaired as specified in "Cast-in-Place Concrete" of these Specifications.

END OF SECTION

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**SECTION 03200
CONCRETE REINFORCEMENT**

PART 1 - GENERAL

1.01 WORK INCLUDED

- A. The CONTRACTOR shall furnish all required materials and shall properly place for imbedment in the concrete, at locations to be specified by the CONTRACTOR, or as directed by the CONSULTANT/ENGINEER, all required reinforcing steel for properly reinforcing all structures built as part of this Work. This shall include the steel reinforcing as shown on the Construction Drawings:

1.02 RELATED SECTIONS

- A. Section 01300 - Submittals
- B. Section 03300 - Cast-in-Place Concrete

1.03 SUBMITTALS

- A. The location, size, and configuration of the reinforcing steel shall be specified by the CONTRACTOR and submitted in the Shop Drawings as indicated in Section 01300 (Submittals).
- B. Product data shall be submitted as indicated in Section 01300 (Submittals).

1.04 REFERENCES

- A. ACI 301- Specification for Structural Concrete for Buildings.
- B. ACI 315 - Details and Detailing of Concrete Reinforcement.
- C. ACI 318 - Building Code Requirements for Reinforced Concrete.
- D. American Welding Society (AWS) D1.4- Structural Welding Code- Reinforcing Steel.
- E. ASTM A184 - Fabricated Deformed Steel Bar Mats for Concrete Reinforcement.
- F. ASTM A185 - Steel Welded Wire Fabric, Plain, for Concrete Reinforcement.

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- G. ASTM A615 - Deformed and Plain Billet Steel Bars for Concrete Reinforcement.

PART 2 - PRODUCTS

2.01 QUALITY AND GRADE

- A. Reinforcing Bars: Reinforcing bars shall be deformed billet-steel bars conforming to ASTM A 615. All bars No. 4 and larger shall be Grade 60. All bars No. 3 and smaller shall be Grade 40. All bars shall be shop-fabricated and bent cold. Bars shall be free from defects and kinks and from bends not indicated on the Drawings or approved bending diagrams.
- B. Mesh Reinforcement: Mesh reinforcement shall be electrically-welded, cold-drawn, mild-steel, plain wire fabric conforming to ASTM A 185. Wire shall be cold-drawn steel conforming to ASTM A 82.
- C. Support Chairs: Reinforcement supports shall conform to Product Standard PS7 and CRSI *Manual of Standard Practice*, Class D or E. Reinforcement support chairs shall be stainless steel or shall be plastic-tipped when used in walls and elevated slabs. Support chairs used in slabs on grade shall be stainless steel or shall be hot-dip galvanized after fabrication or plastic-tipped in such a manner as to provide a minimum 3/4 inch of protection from the subgrade. Nails shall not be used to support reinforcement.
- D. Tie Wire: Tie wire shall conform to Federal Specification QQ-W-461 and shall be of black annealed steel, 16-gauge minimum.
- E. All steel used for reinforcement purposes shall be clean, new stock, and free from defects and bends not specified by the CONTRACTOR or the CONSULTANT/ENGINEER. Only corrugated or deformed bars, of an approved type, shall be used in the Work.
- F. No reinforcing steel shall be welded unless specifically approved by the CONSULTANT/ENGINEER. Welding of reinforcing bars shall be per AWS D 1.4.
- G. All structural steel (sole plates, angle seats, clips) shall be hot dip galvanized when surfaces will be exposed after the concrete is finished.
- H. Deformed steel bar mats shall be per ASTM A184.

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- G. Steel bar dowels in the caisson plug which tie-in with the caisson walls shall be coated with compatible epoxy.

2.02 TESTS

- A. Reinforcement bars and wire mesh shall be inspected and tested at the mill at which they are rolled or fabricated, in accordance with A.S.T.M. Designation: A 615-82 and A 185-79, respectively.
- B. The CONTRACTOR shall provide two (2) certified copies of the reinforcing steel mill test reports to the CONSULTANT/ENGINEER upon request.

PART 3 - EXECUTION

3.01 BENDING

- A. All reinforcement bars shall be cold bent as specified on the approved Shop Drawings.
- B. Bars of a single length shall be used in all cases, except where the length required is such that they cannot be so obtained, or where the CONSULTANT/ENGINEER shall give permission to use shorter lengths or allow lapping. Cold bends shall be made around a pin having a diameter at least six (6) times the least dimension of the reinforcing bar, for No. 3 through No. 8 bars, and around a pin having a diameter at least eight (8) times the least dimension of the reinforcing bar for No. 9 through No. 11 bars.
- C. Reinforcement partially embedded in concrete shall not be field bent without the prior permission of the CONSULTANT/ENGINEER.

3.02 STORAGE AND PROTECTION

- A. All steel for reinforcement shall be delivered to the site of the Work without rust, other than that which may have accumulated in normal transit. It shall be sorted for size and length and shall be properly tagged, with substantial tags securely attached to each bundle properly identifying the bars as to use intended.
- B. Reinforcement shall be protected from the weather and stored at least 12 inches above ground on timber mats or other supports acceptable to the CONSULTANT/ENGINEER. Contact between reinforcement and the ground shall not be permitted during storage. Reinforcement shall be supported so as not to bend or deflect excessively under its own weight.

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- C. All steel shall be kept free from oil, grease, dirt, or other objectionable adhering substances, and it shall be satisfactorily cleaned of scale and heavy or flaky rust before being placed in the Work.
- D. If, after having been placed in the Work, installation of the concrete shall be delayed or interrupted for any considerable number of days, the steel shall be well protected.

3.03 SURFACE PREPARATION

- A. Before placement, all reinforcement shall be thoroughly cleaned of oil, dirt, mill scale, rust scale, and other coatings that would tend to destroy or reduce bond. A thin coating of orange rust resulting from short exposure will not be considered objectionable, but any reinforcement having heavy rust scale or thick rust coating shall be thoroughly cleaned to the satisfaction of the CONSULTANT/ENGINEER or shall be rejected and removed from the job site. When there is a considerable delay between placement of reinforcement and placement of concrete, the reinforcement shall be reinspected prior to placement of concrete and recleaned if necessary.

3.04 PLACEMENT

- A. Reinforcement shall be accurately positioned and tied at intersections with annealed wire or suitable clips approved by the CONSULTANT/ENGINEER. Reinforcement shall be supported by concrete or metal chairs, stays, spacers, hangers, or other supports acceptable to the CONSULTANT/ENGINEER.
- B. Reinforcing bars shall be fastened with wire ties at a minimum of three places per bar. Bars shall be tied at every intersection around the periphery of slabs. Wall steel shall be tied at every fourth intersection as a minimum.
- C. Reinforcement supports shall have sufficient strength and stability to maintain the reinforcement in place throughout placement and concreting operations. Supports and ties shall not be exposed at the face of the concrete nor shall they discolor the surface of the finished concrete.
- D. Movement of steel reinforcement in place during concreting operations shall be prevented. Any reinforcement which is displaced shall be accurately repositioned in the proper place before being completely covered.
- E. Dowels for successive work shall be securely fastened in correct position before placing concrete. The sticking of dowels after placing concrete shall not be permitted.

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- F. Reinforcement which has been exposed for bonding with future work shall be protected from corrosion by heavy wrappings of burlap saturated with a bituminous material.
- G. No bars partially embedded in concrete shall be field-bent unless approved by the CONSULTANT/ENGINEER.
- H. Welding of crossing bars shall not be permitted unless approved by the CONSULTANT/ENGINEER.

3.05 CONCRETE COVER/SPACING

- A. The minimum concrete cover for the protection of embedded steel reinforcement shall be as follows:

Surfaces cast against crushed rock, sand, or earth:

All bar sizes	3 inches
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Surfaces exposed directly to water, backfill, or weather after form removal:

All bar sizes	2 inches
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Surfaces not exposed directly to water, backfill, or weather after form removal:

Elevated slabs	1 inch
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Floors, walkways, pavement	3/4" (Top)
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Walls:

Less than 12 inches thick	1½ inches
12 inches or thicker	2 inches

Beams:

Stirrups	1½ inches
Principal reinforcement	2 inches

- B. The minimum clearance between adjacent parallel bars shall not be less than the nominal diameter of the bars, not less than 1.5 times the maximum coarse aggregate size, and not less than 1 inch in beams, 1½ inches in columns, and 2 inches in other locations.

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3.06 TOLERANCES

- A. Allowable tolerances for fabricating steel reinforcement shall be as follows:

<u>Item</u>	<u>Maximum Tolerance</u>	
Sheared length of bars	+1"	-1"
Depth of truss bars	+0.0"	-1/2"
Outside dimensions of stirrups, ties, and spirals	+1"	-1"
Location of bends	+1"	-1"

- B. Allowable tolerances for placing steel reinforcement shall be as follows:

<u>Item</u>	<u>Maximum Tolerance</u>	
Concrete cover from outside of bar to finished surface	+3/8"	-3/8"
Lateral spacing of bars in plane of reinforcement in beams and joists	+1"	-1"
Lateral spacing of bars in plane of reinforcement in slabs and walls	+3"	-3"
Spacing of stirrups, ties, and spirals along longitudinal axis of member	$\pm 1" \times (\text{depth in inches} / 12)$	
Height of bottom bars in slabs, beams and joists	+3/8"	-3/8"
Height of top bars in slabs, beams and joists		
Depth 8" and less	+3/8"	-3/8"
Depth 9-24"	+1/2"	-1/2"

3.07 SPLICES

- A. Lap splices shall be permitted as specified as specified by the CONTRACTOR or as directed by the CONSULTANT/ENGINEER, or where bar length is not sufficient to permit continuous reinforcing. All lap splices shall be clearly indicated on the Shop Drawings, and are subject to the approval of the CONSULTANT/ENGINEER. All lap splices shall be Class B as per ACI 318-89.

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- B. The following are the minimum tension lap splice lengths that are permitted, unless otherwise specified by the CONTRACTOR or as directed by the CONSULTANT/ENGINEER:

No. 3 Rebar: 24"
No. 4 Rebar: 24"
No. 5 Rebar: 28"
No. 6 Rebar: 34"

- C. The following are the minimum compression lap splice lengths that are permitted, unless otherwise specified by the CONTRACTOR or as directed by the CONSULTANT/ENGINEER.

No. 3 Rebar: 18"
No. 4 Rebar: 18"
No. 5 Rebar: 20"
No. 6 Rebar: 24"

- D. Welded splices are permitted only with the permission of the CONSULTANT/ENGINEER. All welding shall conform to the American Welding Society (AWS) "Structural Welding Code-Reinforcing Steel" (AWS #D1.4).

END OF SECTION

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**SECTION 03300
CAST-IN-PLACE CONCRETE**

PART 1 - GENERAL

1.01 WORK INCLUDED

- A. This specification section covers all materials, equipment, and methods to be used by the CONTRACTOR in mixing, placing, testing, finishing, and curing cast-in-place concrete. The CONTRACTOR shall furnish all cement, aggregate, water, admixtures, and other materials and all labor, equipment, and supplies necessary or convenient to him for properly completing all structures built as part of this Work. This shall include the cast-in-place concrete as shown on the Construction Drawings

1.02 RELATED SECTIONS

- A. Section 01300 - Submittals
- B. Section 03110 - Concrete Formwork
- C. Section 03200 - Concrete Reinforcement.
- D. Section 05510 - Metal Stairs, Grate Platforms, Pump Column Supports, Access Hatches, and Air Inlets.

1.03 SUBMITTALS

- A. The concrete mix design shall be provided by the CONTRACTOR and submitted in the Shop Drawings as indicated in paragraph 1.06 and in Section 01300 (Submittals).

1.04 CLASSIFICATION OF CONCRETE

- A. Concrete shall be either Class A or Class B, as indicated on the Drawings or specified in these Specifications. If the class is not otherwise specified, the CONTRACTOR shall furnish Class A concrete.

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- B. In general, Class A concrete shall be used for reinforced concrete cast-in-place in forms for piers, headwalls, tanks, slabs, floors, walls, columns, footings, foundations, pile caps, manholes, and similar reinforced concrete structures coming under the scope of ACI 318. Class B concrete shall be plain concrete and shall be used for pipe cradles, pipe and conduit encasement, bedding, grade correction, anchors, collars, thrust blocks, massive sections, and other non-reinforced concrete.

1.05 GENERAL REQUIREMENTS

- A. All cast-in-place concrete shall be accurately formed and properly placed and finished as shown on the Drawings and specified herein.
- B. The materials, aggregate grading, cement content, and placement methods specified herein are intended to provide a concrete that satisfies the minimum strength requirements, exhibits sufficient plasticity and cohesiveness to facilitate placement and reduce honeycombing and porosity, and incorporates a minimum water-to-cement ratio to minimize bleeding and shrinkage and to provide maximum water tightness. However, the CONTRACTOR may submit to the CONSULTANT/ENGINEER for review and approval alternate material requirements and placement techniques for achieving the desired results.

1.06 PRELIMINARY MIX DESIGN

- A. Before starting any concreting operations, the CONTRACTOR shall submit to the CONSULTANT/ENGINEER for approval a preliminary mix design for each class of concrete and for each size and gradation of aggregate and each consistency within a given class of concrete intended for use in the work. The preliminary mix design submittals shall contain the following information for each:
 - 1. Fine Aggregate (Sampled per ASTM D 75)
 - a. Source and type
 - b. Sieve analysis per ASTM C 136
 - c. Magnesium sulfate soundness per ASTM C 88
 - d. Deleterious substances per ASTM C 117, C 123, and C 142
 - e. Saturated surface dry weight per cubic yard of concrete
 - f. Bulk specific gravity per ASTM 127
 - g. Fineness modulus as defined in ASTM C 125

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2. Coarse Aggregate (Sampled per ASTM D 75)
 - a. Source and type
 - b. Sieve analysis per ASTM C 136
 - c. Abrasion loss per ASTM C 535
 - d. Magnesium sulfate soundness per ASTM C 88
 - e. Deleterious substances per ASTM C 117, C 123, and C 142
 - f. Saturated surface dry weight per cubic yard of concrete
 - g. Bulk specific gravity per ASTM 128
3. Cement (Sampled per ASTM C 183)
 - a. Manufacturer, type, and ASTM designation
 - b. Sacks per cubic yard of concrete
 - c. Total gallons of water per sack (cf) of cement
 - d. Compressive strength at 7 days per ASTM C 109
 - e. Chemical analysis per ASTM C 114
4. Slump per ASTM C 143
5. Air content per ASTM C 231
6. Unit weight per ASTM C 138
7. Time to initial set at 70EF per ASTM C 403

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8. Compressive strength at 7, 14, and 28 days ages per ASTM C 192 and C 39. A total of 9 standard test cylinders shall be prepared and cured in the laboratory for each preliminary mix design, three of which shall be tested each at 7-, 14-, and 28-day ages.
9. Admixtures
 - a. Manufacturer, type, and ASTM designation
 - b. Dosage and point of introduction into the mix.
- B. A preliminary mix design shall not be considered acceptable if the concrete resulting from that mix design does not produce an average 28-day compressive strength at least 1,200 psi higher than that required, unless a standard deviation for compressive strength testing has been established for the concrete supplier using the methods described in ACI 214. If a standard deviation has been established, the strength used as a basis for selecting concrete proportions shall exceed the required 28-day strength by the amounts given in ACI 318, Section 5.3.2.1, based on the appropriate value of the standard deviation. If a standard deviation is utilized, the CONTRACTOR or concrete supplier shall furnish written evidence to the CONSULTANT/ENGINEER that the standard deviation has been determined in accordance with the methods described in ACI 214. A written statement from an independent testing laboratory may be considered satisfactory evidence of compliance.
- C. Tests for compressive strength and all sampling and testing of aggregate and cement shall be conducted in accordance with the specified ASTM standards by an independent testing laboratory acceptable to the CONSULTANT/ENGINEER. Alternately, when approved by the CONSULTANT/ENGINEER, testing of cement and aggregate may be conducted at the point of manufacture by reputable cement and aggregate suppliers who regularly provide such testing services by experienced, competent personnel. Tests for slump, air content, unit weight, and time to initial set may be conducted by the concrete supplier, providing such tests are performed in accordance with the specified ASTM standards by experienced, competent personnel using proper equipment.
- D. The CONTRACTOR shall submit with each preliminary mix design four (4) copies of certified laboratory or mill test reports on all aggregate and cement incorporated in the preliminary mix design and four (4) copies of certified laboratory test reports on the compressive strength of the resulting concrete. Test reports on aggregate and cement shall contain written evidence that clearly indicates that all cement and aggregate covered by the test reports conform in all respects to the applicable material requirements of this specification section.

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- E. Approval of the preliminary mix designs shall in no way be interpreted to relieve the CONTRACTOR of any responsibilities, duties, or obligations for providing concrete conforming to the requirements of this specification section.
- F. If, during the course of concreting operations, the CONTRACTOR desires to use an alternate mix design differing from the approved mix design in order to obtain a desired workability, density, strength, or uniformity, he shall submit to the CONSULTANT/ENGINEER for approval the information specified herein on the proposed alternate mix design prior to its use.
- G. If, based on the results of laboratory or field tests conducted during concreting operations, concrete prepared according to an approved mix design fails to satisfy the requirements of this specification section, the CONSULTANT/ENGINEER shall have the right to require that the CONTRACTOR develop and submit in the manner specified an alternate mix design that will provide concrete conforming to the requirements of this section. The need for a change in mix design will be based on the CONSULTANT/ENGINEER'S statistical analysis and interpretation of laboratory and field tests conducted during concreting operations. Statistical methods and interpretation of test results will be as described in ACI 214 and ACI 318, latest edition.
- H. Any increased material costs resulting from changes in mix designs during construction shall be paid for by the CONTRACTOR and no separate payment will be made.
- I. The cost of all materials, labor, equipment and all sampling and testing services required for the preliminary mix designs or for alternate mix designs during construction shall be paid for by the CONTRACTOR and no separate payment will be made.

1.07 QUALITY CONTROL DURING CONSTRUCTION

A. Certification of Material Compliance

- 1. During concreting operations, the CONTRACTOR shall furnish the CONSULTANT/ENGINEER written evidence that clearly indicates that the cement and aggregate used in each batch of concrete delivered to or mixed at the job site conforms in all respects to the applicable material requirements of this specification section. Satisfactory certified mill test reports from the cement or aggregate suppliers may be considered as evidence of compliance provided that such testing is performed in accordance with the specified ASTM standards by experienced, competent personnel on a regular basis. In case of doubt as to the adequacy or accuracy of mill tests, the CONSULTANT/ENGINEER may require that the CONTRACTOR furnish, at no additional cost to the

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CONSULTANT/ENGINEER, test reports on the cement and aggregate from an independent testing laboratory acceptable to the CONSULTANT/ENGINEER.

2. Certified reports or certificates indicating compliance of cement and aggregate shall be submitted to the CONSULTANT/ENGINEER before such materials are incorporated into the work. The CONTRACTOR shall be responsible for any delays in the progress of the work due to delays in testing and reporting.
3. Certified reports submitted to the CONSULTANT/ENGINEER for laboratory or mill tests on cement and aggregate shall be based on tests conducted not earlier than 90 days prior to incorporation of these materials into the work.
4. The cost of all sampling and testing of cement and aggregate necessary to furnish satisfactory evidence of compliance shall be borne by the CONTRACTOR and no separate payment will be made.

B. Field Sampling and Testing

1. During concreting operations, the CONSULTANT/ENGINEER will periodically require additional field inspection, sampling, and testing of cement, aggregate, and/or concrete by an independent testing laboratory in order to determine if the requirements of this specification section are being satisfied.
2. Field sampling and testing of cement, aggregate, and concrete will be performed according to the following ASTM standards at a frequency determined by the CONSULTANT/ENGINEER:
 - a. Aggregate
 - (1) Sampling ASTM D 75
 - (2) Testing Any test specified in ASTM C 33
 - b. Cement
 - (1) Sampling ASTM C 183
 - (2) Testing Any test specified in ASTM C 150
 - c. Concrete
 - (1) Sampling ASTM C 172
 - (2) Slump Test ASTM C 143

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- (3) Air Content Test ASTM C 231
- (4) Making and Curing
Test Cylinders ASTM C 31
- (5) Compression
Strength Tests ASTM C 39

3. Compressive strength testing will consist of making, curing, and testing cylinders of concrete. A total of six test cylinders will be prepared from each sample of concrete to be tested. Two test cylinders will be broken at an age of 7 days, three test cylinders will be broken at an age of 28 days, and the remaining test cylinders will be held in reserve. The minimum number of samples and test cylinders to be taken is as follows:

Concrete Class	Total Size of Pour	Number of Samples	Number of Cylinders
Class A	1-4 cy	1	6
Class A or B	4-100 cy	1	6
Class A or B	101-200 cy	2	12
Class A or B	201-300 cy	3	18
Class A or B	Over 300 cy	1/100 cy	6/100 cy

4. Test cylinders will normally be laboratory-cured. However, the CONSULTANT/ENGINEER may require tests on field-cured specimens to check the adequacy of curing operations.
5. A slump test and an air content test will be performed on each sample of concrete tested for compressive strength.
6. Cement and aggregate will be subject to inspection, sampling, and field testing at the batching plant. Concrete will be subject to inspection, sampling, and field testing at the place of concrete placement.
7. All field sampling, field testing, making and curing of field test cylinders, and laboratory testing performed during concreting operations for the purpose of determining if the requirements of this specification section are being satisfied shall be conducted by an independent testing laboratory approved by the CONSULTANT/ENGINEER and paid for directly by the CONTRACTOR as a part of this Contract.
8. The CONTRACTOR shall furnish the testing laboratory representative satisfactory samples of cement, aggregate, and concrete for inspection and testing purposes. The CONTRACTOR shall furnish any barrows, shovels, mixing boards, shaded area for preparing test cylinders, and similar equipment required by the testing laboratory representative for securing

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samples, making test cylinders, and conducting field tests.

9. No materials or concrete which fail to conform to the requirements of this specification section shall be incorporated into the work.

1.08 SHOP DRAWINGS AND CONSULTING DATA

Complete product data shall be submitted to the CONSULTANT/ENGINEER on all admixtures, curing compounds, hardeners, sealers, and waterstops in accordance with the requirements of the Section 01300 (Submittals) of these Specifications.

1.09 GUARANTEE

The CONTRACTOR shall provide a guarantee against defective or deficient workmanship and materials.

PART 2 - PRODUCTS

2.01 GENERAL

- A. Concrete shall be composed of Portland cement, fine aggregate, coarse aggregate, admixtures as specified herein, and water, so proportioned and mixed as to produce a plastic, workable mixture meeting the requirements of this specification section.
- B. Materials and concrete not conforming to the requirements specified herein shall not be incorporated in the work.

2.02 MATERIALS

A. Cement

1. All cement used in cast-in-place concrete shall be Portland cement conforming to the requirements of ASTM C 150, and, unless otherwise approved by the CONSULTANT/ENGINEER, shall be Type 1. No cement of dark color shall be used. No resacked, lumpy or partially set cement shall be used.
2. Each sack of cement shall contain not less than 94 pounds (net) of cement, and each sack of cement shall be deemed to have a volume of 1 cubic foot; and each 94 pounds, if weighed or measured in bulk, shall be deemed to have a volume of 1 cubic foot.

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B. Fine Aggregate

1. Fine aggregate shall be natural siliceous river sand, consisting of hard, clean, sharp, strong, durable and uncoated particles, conforming to the requirements of ASTM C 33. The mortar strength developed in such test shall be 90 percent of that developed by standard Ottawa sand tested under identical conditions.
2. Fine aggregate shall be graded in conformance with the requirements of ASTM C 33, except that it shall have a fineness modulus of 2.40 minimum and 3.00 maximum and the material passing the No. 200 sieve shall not exceed 3.0 percent by weight of the total sample. Coal and lignite shall not exceed 0.5 percent by weight of the total sample for all concrete. The fineness modulus of fine aggregate incorporated in the work shall not vary more than 0.10 plus or minus from the fineness modulus of the fine aggregate in the appropriate preliminary mix design approved by the CONSULTANT/ENGINEER.
3. If the locally available sources of fine aggregate will not yield the required grading, the CONSULTANT/ENGINEER may approve alternate gradations if such deviations do not adversely affect the work. However, the amount retained on any individual sieve size shall not exceed 35 percent of the sample and the amount passing the No. 50 sieve shall not be less than 15 percent of the sample.

C. Coarse Aggregate

1. Coarse aggregate shall consist of clean, natural, washed gravel or crushed stone suitably processed and conforming to the requirements of ASTM C 33, Class Designation 3S.
2. Coarse aggregate as delivered to the mixing plant shall be graded, or individual sizes shall be so combined as to fall within the grading requirements corresponding to the following grading size numbers, as contained in Table 2 of ASTM C 33:

Maximum Aggregate Grading	
Size, Inches	Size No.
3/4	67
1	57
1-1/2	467
2	357

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3. The maximum size of aggregate shall be no larger than one-fifth of the narrowest dimension between sides of forms within which concrete is to be cast nor larger than three-fourths of the minimum clear spacing between reinforcing bars, or between bars and forms. Coarse aggregate shall be limited to 3/4 inch maximum size for pumped concrete.

D. Water

Water used in mixing concrete shall be fresh, clean, potable water free from injurious amount of oil, acid, alkali, vegetable, sewage and/or organic matter. Water shall be considered as weighing 8.33 pounds per gallon.

E. Admixtures

1. All concrete shall contain an air entraining admixture conforming to ASTM C 260 in order to provide an entrained air content of 5 percent by volume. Air entraining admixtures shall be W. R. Grace "Darex AEA," Master Builders "MB-VR," Protex "AES," Sika "AER," or equal.
2. Concrete may contain a chloride-free, water reducing admixture or plasticizer conforming to ASTM C 494, Type A. Water reducing admixtures shall be W. R. Grace "WRDA-HC," Sika "Plastocrete," Gifford-Hill "PSI Normal," Master Builders "Pozzolith Normal," Chem-Masters "WR-77," or equal.
3. Accelerators and retarders may be used under adverse placement conditions when authorized in writing by the CONSULTANT/ENGINEER. Accelerators shall be calcium chloride conforming to ASTM D 98, dispensed as a solution. Calcium chloride content shall not exceed 1 percent of the cement content by weight. Retarders shall be chloride-free water reducing and retarding admixtures conforming to ASTM C494, Type D. Retarders shall be W. R. Grace "Daratard-HC," Sika "Plastiment," Protex "Protard," Gifford-Hill "PSI Retarder," Master Builders "Pozzolith Retarder," or equal.
4. The admixture content, batching method, and time of introduction into the mix shall be in strict accordance with the manufacturer's recommendations.

2.03 MEMBRANE CURING COMPOUND

- A. Membrane curing compound shall have a 100 percent resin base and shall be of the colorless type with a fugitive dye added conforming to ASTM C 309, Type 1, Class B. The membrane curing compound shall contain sufficient dye to produce a definite, distinguishing color. Curing compound shall be compatible with liquid hardeners and epoxy sealers.

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- B. Membrane curing compound shall be Protex "LR-151," Sonneborn "Hydrocide-309," W. R. Grace "Horncrete 30D," Chem-Masters "Kurex 3," or equal.

2.04 POLYETHYLENE FILM

Polyethylene film shall conform to Product Standard PS 17 and, unless otherwise specified or shown on the Construction Drawings, shall have a thickness of 10 mils.

2.05 EPOXY BONDING AGENT

Epoxy bonding agents shall be specially formulated to bond fresh concrete to existing concrete. Epoxy bonding agents shall be two-component polysulfide or polyamide epoxies containing 100 percent solids. Epoxy bonding agents shall be insensitive to moisture during cure. When cured at a temperature of 63EF, neat epoxy bonding agent shall have a one-day compressive strength of not less than 5,000 psi and a 28-day compressive strength of not less than 12,000 psi, when tested in accordance with ASTM D 695, and shall have a 28-day tensile strength of not less than 3,500 psi, when tested in accordance with ASTM D 638.

2.06 WATERSTOPS

Waterstops shall be manufactured of PVC and shall be of the ribbed type with center bulb. Waterstops shall have a nominal width of 6 inches and shall be as manufactured by W. R. Meadows, Vulcan Metal Products, W. R. Grace, or equal. Waterstops placed in concrete shall be continuous. Lapped joints shall not be permitted. Water stops placed against existing or cold construction joints shall be Adeka Ultra Seal MC-2010M expansive rubber or equal.

2.07 CHEMICAL HARDENER

Unless otherwise specified, all interior concrete floors of shops, garages, and vehicle service areas 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 Engineers Specification 204. Liquid hardener shall be Sonneborn "Lapidolith," Protex "Lithoplate," L&M "Fluo Hard," or equal.

2.08 EPOXY FLOOR SEALER

Epoxy floor sealer shall be a two-component, 100 percent solids, epoxy coating that provides a smooth, tough, flexible, wear abrasion, and chemical resistant surface. Sealer shall be USDA approved for use in food processing plants. Epoxy floor sealer shall be

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applied only where indicated on the Drawings. Unless otherwise specified, sealer shall be colored gray. Epoxy sealer shall be Chem-Masters "Durakote," Sonneborn "Sonoplex," L&M "Dynaflor," or equal.

2.09 VAPOR BARRIER

Unless otherwise specified, all interior concrete slabs on grade in buildings shall be furnished with an FHA approved vapor barrier under the concrete slab. Vapor barrier shall be constructed of a multi-ply lamination of polyethylene film and glass scrim reinforced paper to form a moisture, scuff, and puncture resistant membrane. Moisture permeance shall not exceed 0.10 perms in accordance with ASTM E96, Procedure A. Vapor barrier shall be St. Regis Paper Company "Moistop," Glas-Kraft "Plybar," or equal.

2.10 STRENGTH

- A. Concrete ingredients shall be selected, proportioned, and mixed in such a manner as will produce a watertight, durable concrete that will develop the following minimum compressive strengths at an age of 28 days when sampled, cured, and tested in accordance with the procedures specified in ASTM C 31 and C 39:

Class of Concrete	Age	Average of Three Consecutive Specimens	Minimum Any One Specimen
A	28 days	4,500 psi	4,000 psi
B	28 days	2,500 psi	2,000 psi

- B. Should the average compressive strength of three consecutive specimens or the compressive strength of any single specimen fall below the minimum strengths specified above, the CONSULTANT/ENGINEER shall have the right to order a change in the mix design for the remaining portion of the work. The CONSULTANT/ENGINEER shall also have the right to order additional curing of the affected concrete followed by cores taken in accordance with ASTM C 42 and ACI 318, all at the expense of the CONTRACTOR. If the additional curing does not bring the average compressive strength of three cores taken in the affected area to at least the minimum strength specified, the CONSULTANT/ENGINEER may require that the CONTRACTOR strengthen the structure by means of additional concrete and steel or he may require that the CONTRACTOR replace the affected portions. The cost of all such changes in mix designs and any modifications to or replacement of deficient concrete shall be borne by the CONTRACTOR at no additional cost to the CONSULTANT/ENGINEER.

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2.11 CONSISTENCY

- A. Concrete shall be of such consistency and composition that it can be worked readily into the corners and angles of the forms and around the reinforcement without excessive spading and without permitting the materials to segregate or free water to collect on the surface. When dropped from the discharge chute, the concrete mass should flatten out at the center and spread out slowly at the edges.
- B. The proportions shall be adjusted to secure the lowest water-cement ratio which is consistent with good workability, and a plastic cohesive mixture.

PART 3 - EXECUTION

3.01 STORAGE OF MATERIALS

- A. Cement shall be shipped to the site of the mixer plant in bulk or in paper or cloth bags, at the option of the CONTRACTOR. Upon arrival it shall be stored immediately in a thoroughly dry, weathertight and properly ventilated building or enclosure with adequate provisions for the prevention of absorption of moisture. It shall be stored in a manner that will permit easy access for inspection and identification of each shipment. If cement is to be stored at the job site, storage facilities shall be provided by and at the expense of the CONTRACTOR and approved by the CONSULTANT/ENGINEER prior to arrival of the first shipment. Cement which has become caked or lumpy shall not be used.
- B. Sand and coarse aggregates shall be stored in separate stockpiles at points selected to provide maximum drainage and to prevent the inclusion of any foreign material during rehandling. Stockpiles of coarse aggregates shall be built in horizontal layers to avoid segregation and breakage. Where concrete volumes require batching of various aggregate sizes, a separate stockpile for each size shall be maintained. The bottom 6 inches of aggregate piles shall not be used.

3.02 PROPORTIONING

- A. Concrete materials shall be accurately proportioned and mixed to produce a homogeneous and workable mixture having the consistency and minimum compressive strength specified herein.
- B. Concrete materials shall be proportioned by weight. The types of equipment and methods used for measuring ingredients shall be acceptable to the CONSULTANT/ENGINEER.
- C. The amount of water and cement used shall be the minimum amount necessary to produce a concrete mixture of the required strength and consistency, but in no case

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shall the water-to-cement ratio exceed that specified herein nor shall the cement content be less than that specified herein.

- D. Compressive strength may not necessarily be the most critical factor in proportioning concrete mixes since other factors, such as durability and watertightness, may impose lower water-cement ratios than are required to meet strength requirements. In such cases compressive strength will, of necessity, be in excess of that specified.
- E. Minimum cement contents and maximum water-to-cement ratios shall be as follows:

Factor	Class of Concrete	<u>Maximum Aggregate Size</u>			
		2"	1 1/2"	1"	3/4"
Minimum Cement Factor, Sacks/cy	A	5.3	5.8	6.2	6.6
	B	5.0	5.5	5.9	6.3
Maximum Water-to-Cement Ratio, lb./lb.	A	0.49	0.49	0.49	0.49
	B	0.62	0.62	0.62	0.62
Maximum Water-to-Cement Ratio, Gal./Sack	A	5.5	5.5	5.5	5.5
	B	7.0	7.0	7.0	7.0

- F. The water content of the mix shall be based on the total amount of water in the mixture, including any free water in the aggregate or adhering to the surface of the aggregate, but not including water absorbed by the aggregate.
- G. The total volume of aggregate to be used in each cubic yard of concrete shall be determined by recognized standards for designing concrete mixes, utilizing the actual screen analysis of the aggregates.
- H. The proportion of fine and coarse aggregate shall be such that the ratio of the coarse to the fine based on weight shall not be less than 1.0 nor more than 2.0, nor shall the amount of coarse material be such as to produce harshness in placing or honey-combing in the structure.

3.03 MIXING CONCRETE

- A. The mixing equipment used by the CONTRACTOR shall be capable of combining the aggregates, cement, admixtures, and water within the time specified into a thoroughly mixed and uniform mass.
- B. Concrete shall be mixed by one of the three following methods:

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1. By the operation of one or more batch-type mixing plants, each with a rated capacity of 1/2 cubic yard or more, installed at the site of the work;
 2. By the operation of a proportioning plant installed in the vicinity of the work and the use of transit mixers for mixing concrete and transporting it to the forms; or
 3. By the use of ready-mixed concrete from a central mixing and proportioning plant. The method selected by the CONTRACTOR shall be subject to the approval of the CONSULTANT/ENGINEER.
- C. The mixing and proportioning plants shall be provided with adequate equipment and facilities for accurate measurement and control of the quantities of material and water used in the concrete and for readily changing the proportions to conform to the varying conditions and requirements of the work.
1. Stationary Mixed Concrete
 - a. Stationary mixing shall be done in a batch mixer of approved type which will ensure a uniform distribution of the materials throughout the mass. The equipment at the mixing plant shall be so constructed that all materials including the water entering the drum can be accurately proportioned and be under control. The cement and aggregate shall be proportioned by weight. No volumetric batch shall be allowed. The mixer shall be equipped with an automatic timing device made to lock the discharge level before aggregate and cement enter the drum, and to release such level only after the specified mixing time has elapsed. Stationary mixers shall be in accordance with the "Concrete Mixer Standards" adopted by the Mixer Manufacturer's of the Associated General Contractor's of America and shall bear a plate giving the manufacturer's rated capacity of the mixer.
 - b. The entire batch shall be discharged before recharging. The volume of the mixed material per batch shall not exceed the manufacturer's rated capacity of the mixer. Mixing of each batch shall continue for the period indicated herein, during which time the drums shall rotate at a peripheral speed as recommended by the manufacturer.

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- c. The mixing time shall be as follows:

Capacity of Mixer	Mixing Time in Minutes
1/2 cubic yards	1-1/4
3/4 to 1-1/2 cubic yards	1-1/2
Larger than 1-1/2 cubic yards	2

The mixing time shall be measured from the time that all cement and aggregates and most of the water are in the mixer. Excessive overmixing, requiring additional water to preserve the required consistency will not be permitted. All of the mixing water shall be introduced before one-fourth of the total mixing time has elapsed.

2. Transit Mixed Concrete

- a. The type, capacity, and manner of operation of the mixing and transporting equipment for transit ready-mixed concrete shall conform to the current *Standards for Operation of Truck Mixers and Agitators* of the National Ready-Mixed Concrete Association, the *Truck Mixer and Agitator Standards* of the Truck Mixer Manufacturers Bureau, and ASTM C94. Transit mix concrete trucks shall be equipped with an automatic device for recording the number of revolutions of the drum during the mixing period. Each mixer and agitator shall have attached thereto in a prominent place, a metal plate or plates, installed by the manufacturer, on which is plainly marked the capacity of the drum in terms of the volume of mixed concrete and the speed of rotation for the agitating and mixing speeds of the mixing drum or blades. Each mixer shall have an identification number painted on the truck in such a location that it can be easily read from the batching platform.
- b. The total volume of materials introduced into the mixer shall not exceed the manufacturer's guaranteed mixing capacity. If the concrete so mixed does not meet the uniformity requirements of this subsection, the amount of materials charged into the mixer shall be reduced.
- c. The drum of the mixer shall be completely emptied of any previously mixed load. The proper proportions of aggregate, cement, and water for each load of concrete shall be placed in the mixer and shall be mixed therein for not less than 70 nor more than 100 revolutions of the drum or blades at the speed designated by the manufacturer of the equipment as the mixing speed. Additional

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revolutions of the drum shall be at the speed designated by the manufacturer of the equipment as the agitating speed; however, immediately prior to discharging the concrete, the drum shall be revolved at the mixing speed for a minimum of three minutes. The revolving of the drum shall be continuous until the concrete is completely emptied from the drum.

- d. When Class A concrete is being placed, all wash water shall be emptied from the mixer before any portion of the succeeding load is placed therein. For Class B concrete the mixer shall be empty or may carry no more than 10 gallons of water in the drum.
- e. Water added at the point of discharge shall only take place with the approval and in the presence of the CONSULTANT/ENGINEER. Water so added shall be mixed into the load for a minimum mixing time of three minutes. Water shall not be added to the load during transit.
- f. The total elapsed time between the addition of water to the cement and aggregate or the addition of cement to the water and aggregate and the placement of the concrete in the forms shall not exceed 90 minutes. During hot weather or conditions contributing to quick setting, the total elapsed time permitted may be reduced at the direction of the CONSULTANT/ENGINEER to 45 minutes. When the concrete cannot be delivered to the forms within the time period specified, a water-reducing and retarding admixture may be used subject to the approval of the CONSULTANT/ENGINEER. Such use of a water-water-reducing retarder will be permitted only as necessary to supplement (not to replace) other acceptable hot weather procedures. The retarding admixture used shall not interfere with strength development and other properties of the concrete and its use shall be carefully controlled by the concrete supplier. Before any such admixture is permitted it shall be tested with job site materials under job conditions to determine its compatibility with the other materials and its ability under these conditions to produce the desired properties.
- g. Addition of water at the job site to offset evaporation of mixing water shall be done with the CONSULTANT/ENGINEER'S approval and in his presence using water in the form of a cement paste having the same water-to-cement ratio as the batch in the transit mixer. Following addition of the cement paste, the mixer drum or blades shall be rotated a minimum of 70 revolutions. Addition of water during transit to offset evaporation losses shall not be permitted.

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- h. Prolonged mixing, even at agitating speed, shall be avoided where feasible by stopping the mixer and then agitating intermittently.

3. Ready-Mixed Concrete

- a. A legible certified weighmaster's certificate shall be prepared for each load of ready-mixed concrete. A legible copy of the certified weighmaster's certificate shall be submitted to the CONSULTANT/ENGINEER by the truck operator at the time of delivery. The weighmaster's certificate shall contain the following information:

- (1) Name of Vendor
- (2) Name of CONTRACTOR
- (3) Number of cubic yards in the load
- (4) Actual weights of cement and of each size of aggregate in the load
- (5) Amount of water added at the plant
- (6) Amount of free water in the aggregate
- (7) Brand and type of cement
- (8) Brand and amount of admixture
- (9) Time and date of batching

- b. When mix proportions have been approved for a project and are identified by a mix number, the CONSULTANT/ENGINEER may waive the foregoing and accept a legible certified weighmaster's certificate which shall contain the following information:

- (1) Name of Vendor
- (2) Name of CONTRACTOR
- (3) Number of cubic yards in the load
- (4) Mix designation number

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(5) Amount of water added at the plant (including free water in aggregate)

(6) Time and date of batching

c. Space shall be provided on the certificate so that amount of water and cement added on the job may be indicated.

3.04 CONVEYING CONCRETE

A. Concrete shall be conveyed from the mixer to the place of final deposit by methods which will prevent separation or loss of the materials. Equipment for chuting, pumping, and pneumatically conveying concrete shall be of such size and design as to ensure a practically continuous flow of concrete at the delivery end without separation of the materials.

B. If the concrete is to be transported more than fifty feet in carts or buggies, they shall be equipped with pneumatic tires. Concrete delivered to the carts, buggies or conveyors from spouts, troughs, or mixer trucks shall not have a free fall of more than three feet. Separation or loss of ingredients shall be prevented while transporting the concrete. Delivery carts, buggies, conveyor trucks or barrows shall be kept on temporary runways built over the floor system; runway supports shall not bear upon reinforcing steel or fresh concrete.

3.05 PLACING CONCRETE

A. General

1. Prior to placing concrete, the CONTRACTOR shall ensure that all reinforcement is securely and properly fastened in position and protected against displacement, that all items to be embedded in the concrete are in place and securely anchored in position, that all forms have been thoroughly coated or wetted, that all form ties at construction joints have been retightened, that concrete surfaces to be covered have had all free water, form coating, loose concrete, and debris removed, and that all conveyances, buggies, and barrows are clean and wetted.

2. The CONTRACTOR shall inform the CONSULTANT/ENGINEER at least 24 hours in advance of the times and places at which he intends to place concrete. The CONSULTANT/ENGINEER will make a final inspection of forms, reinforcing steel, screeds, construction joints, openings, anchors, pipe sleeves, conduit, and inserts. No concrete pour shall be started until the condition of the forms and place of pouring has been inspected and approved by the CONSULTANT/ENGINEER.

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3. Concrete shall not be placed when the sun, wind, heat or humidity prevents proper placement and consolidation.
4. No water or cement shall be added to the mix without the CONSULTANT/ENGINEER'S approval or in his absence. No partially hardened concrete shall be deposited.

B. Placing Concrete

1. Unless otherwise specified, all concrete shall be placed upon clean, damp surfaces, free from water, and never upon soft mud, dry absorbent earth or rock, or upon fills that have not been subjected to approved tamping to provide ultimate settlement.
2. Groundwater shall be kept below subgrade until the concrete has set. When subgrade is dry earth, it shall be thoroughly dampened with water to ensure that no moisture will be absorbed from fresh concrete.
3. Where concrete is placed against gravel or crushed rock which does not contain at least 25 percent of the material passing a No. 4 sieve or where shown on the Drawings or directed by the CONSULTANT/ENGINEER, surfaces against which concrete is cast shall be covered with polyethylene film to protect the concrete from loss of water. Joints in the film shall be lapped at least 12 inches and taped. The polyethylene film shall be protected against puncture from the underlying crushed rock by a cushion of natural or imported sand meeting the requirements of ASTM D 1073 placed on top of the crushed rock. Where concrete is placed against rock, all loose pieces of rock shall be removed and the exposed surface cleaned with a high pressure hose.
4. Place vapor barrier under designated interior concrete slabs on grade. Sheeting shall extend the full area of the slab and shall be turned up or down to footings as indicated. Lap all seams at least 12 inches and seal per manufacturer's instructions. Install reinforcement with care so as not to puncture vapor barrier. Tape all cuts, tears, punctures, and pipe penetrations before pouring concrete.
5. To prevent segregation of the mix, concrete shall be deposited in its final position in batches without being moved laterally in the forms more than 5 feet. A crane and a bottom dump concrete bucket shall be used wherever possible. Unless authorized by the CONSULTANT/ENGINEER, no concrete shall be dropped freely into place from a height of greater than 5 feet. Concrete shall be deposited in walls by means of prefabricated, rectangular tremies, constructed in short sections and spaced laterally not

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over 5 feet apart. Special care shall be observed to avoid slopping concrete over forms when placing.

6. The limits of each concrete pour shall be predetermined by the CONTRACTOR and shall be acceptable to the CONSULTANT/ENGINEER. All concrete within such limits shall be placed in one continuous operation.
7. After the concrete has been deposited it shall be distributed over the entire area within the forms in approximately horizontal layers of not more than 18 inches in depth and shall be brought up evenly in all parts of the form. Each layer of concrete shall be plastic when covered with the following layer and the forms shall be filled at a rate of vertical rise of not less than 2 feet per hour nor more than 6 feet per hour.
8. Should a layer of concrete reach its initial set before the next lift can be placed, or should more than 60 minutes elapse between placement of successive concrete lifts, the CONTRACTOR shall cease placement of concrete until the surface of the previous lift is prepared in accordance with the procedures specified in Part 3.08, Construction Joints, of this specification section.
9. Workmen shall not walk on concrete during placing or finishing with any earth or foreign matter on footgear. Hand spreading shall be done with forks and shovels, not rakes.
10. Concrete shall be placed and compacted in wall or column forms before any reinforcing steel is placed in the structural system to be supported by such walls or columns. The portion of any wall or column placed monolithically with a floor or roof slab shall not exceed 6 feet of vertical height. Concrete in walls or columns shall have set at least two hours before concrete is placed in the structural systems to be supported by such walls or columns. Brackets, haunches and fillets shall be poured monolithic with the floor or roof slab system.

C. Compaction

1. During and immediately after placement, concrete shall be thoroughly compacted and worked into all corners and angles and around reinforcement and embedded fixtures in a manner to fill all voids, prevent honeycombing against the forms and avoid segregation of coarse aggregate. This operation shall be performed by the use of spades or forks and internal vibrators.
2. Vibration shall be transmitted directly to the concrete and in no case shall it

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be transmitted through the forms. Vibrator driving mechanisms shall revolve at not less than 7,000 rpm. The vibration shall be sufficiently intense to cause the concrete to flow and settle readily into place and to visibly affect the concrete over a radius of at least 18 inches. Vibration shall be supplemented by manual forking or spading adjacent to the forms on exposed faces in order to secure smooth, dense surfaces. Special care shall be taken to ensure consolidation around reinforcement, pipes and other shapes built into the work. Vibrators shall not be used to transport concrete within the forms. Vibrators shall be kept in motion at all times to prevent excessive vibration in one spot. The operation shall be continuous and all concrete shall be in final position before initial set has started.

3. In addition to the vibrators in actual use while concrete is being placed, the CONTRACTOR shall have on hand at least one operable vibrator as a spare in case of equipment failure. No concrete shall be placed until all vibrating equipment, including spares, is at the placement site.
4. Concrete shall be thoroughly compacted prior to top finishing. All laitance, debris, and surplus water shall be removed from concrete surfaces at tops of forms by screeding, scraping, or other effective means. Wherever the top of a wall will be exposed to weathering, the forms shall be overfilled and after the concrete has been compacted, the excess shall be screeded off.

D. Placement Sequence

Unless otherwise indicated on the Drawings or directed by the CONSULTANT/ENGINEER, the following placement sequence shall be followed to reduce the effect of shrinkage in producing cracking:

1. Bottom Slab

A center section shall be placed first. Not less than 72 hours after the center section has been placed, the CONTRACTOR may proceed with the placement of an adjoining section. Sections shall be placed alternately, first on one side and then on the other side of previously placed sections. Pours shall be scheduled so that two adjacent sides of each section are free, except at closures.

2. Walls

Walls shall be divided into sections by construction joints. A section near the center of each wall shall be placed first. Sections shall be placed alternately, first on one side and then on the other side of the previously placed section. Pours shall be scheduled so that one end of each section is free, except at corner closures.

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3. Footings

Footings, except for wall footings, shall be poured in one operation with no joints.

E. Requirements Due to Adverse Weather Conditions

1. No concrete shall be placed during rain. No concrete shall be placed if rain is forecast unless there is sufficient time to complete the placement and finishing. All concrete placed prior to rain shall be protected by whatever means necessary to prevent damage to finish or water entering the mix. Protection equipment and materials shall be on hand prior to placement operations. Freshly placed concrete shall be protected from scour by flowing water and from mud deposits or other injurious conditions.
2. Except as modified herein, cold weather concreting shall comply with ACI 306. The temperature of concrete at the time of placing shall be not less than that shown in the following table for the corresponding ambient outdoor air temperature (in shade) existing at the time of placement:

<u>Ambient Outdoor Air Temperature</u>	<u>Minimum Concrete Temperature</u>
Below 35°F	70°F
Between 35°F and 45°F	60°F
Above 45°F	45°F

3. Placing of concrete when the ambient air temperature at the time of placement is 45°F or less shall be done only when specifically authorized by the CONSULTANT/ENGINEER using concrete heated in a manner acceptable to the CONSULTANT/ENGINEER. If the use of heated concrete is authorized, the temperature of the concrete at the time of placement shall not exceed 80°F.
4. Adequate means shall be provided for maintaining the temperature of the air surrounding the concrete at 70°F for three days, or 50°F for five days, or for as long as is necessary to ensure proper curing of the concrete. Rapid cooling of the concrete shall be prevented. Housing or covering or other protection used in connection with heating shall remain in place and intact at least 24 hours after the artificial heat is discontinued. The use of calcium chloride or other chemicals to prevent freezing shall only be used with the permission of the CONSULTANT/ENGINEER.

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5. Except as modified herein, hot weather concreting shall comply with the requirements of ACI 305. Hot weather precautions shall be taken whenever the maximum ambient outdoor air temperature (in shade) during the day exceeds 85°F. When rapid mixing water evaporation in transit causes the concrete to be delivered in an unworkable condition, initial correction may be made at the job site, provided that water added is in the form of a cement paste having the same water-to-cement ratio as the batch in the truck, and provided that the drum or mixer blades be operated at mixing speed for at least 70 revolutions after the paste addition. Once need for water has been observed, subsequent additions shall be at the batching plant until the need has passed. Correction shall consist of a simultaneous and proportionate increase of water and cement, up to 10 percent of the stated quantity of each material in the batch. Such increases in cement shall not constitute grounds for an increase in the contract price.
6. The temperature of concrete at the time of placement shall not exceed 85°F.
7. During hot weather, extra caution shall be taken to prevent rapid evaporation of water. Forms shall be kept cool by frequent wettings. Flat work shall be protected from drying winds, direct sun, and high temperatures whenever conditions of temperature and humidity are such as to cause plastic shrinkage cracking.
8. In order to prevent plastic shrinkage cracking due to rapid evaporation of moisture, no concrete shall be placed when the rate of evaporation, determined by using Figure 2.1.4 in ACI 305, equals or exceeds 0.2 pound per square foot per hour.

3.06 FINISHING

A. Finishing Formed Surfaces

All permanently exposed surfaces shall be expected to be smooth and of uniform texture and appearance. Surfaces to be rubbed shall include all submerged concrete surfaces that can be seen when water is drained. Rubbing may be omitted for minor blemishes on buried surfaces or on exposed surfaces that cannot normally be seen, such as inside covered tanks. Final determination for which surfaces are to be rubbed is to be the decision of the CONSULTANT/ENGINEER. All holes, pits or imperfections in the surface of the concrete shall be cleaned with a wire brush, thoroughly wetted and completely filled with damp cement mortar composed of 1 part Portland cement to 2 parts fine aggregate. The entire surface shall be left smooth and all lines or markings shall be smoothed over to obtain uniform appearance. In the event the CONTRACTOR fails to obtain a satisfactory appearance of the concrete in the opinion of the CONSULTANT/ENGINEER, the

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entire surface shall be thoroughly wetted down, kept wet continuously and rubbed with a No. 20 carborundum stone until all lines, markings and surplus materials have been removed from the surface and until the surface shows a uniform smooth finish. After rubbing is completed the concrete surface shall be washed clean with water. Rubbing may be done either by hand or with power tools.

B. Finishing Unformed Surfaces

No surface treatment will be required for buried or permanently submerged concrete not forming an integral part of a structure except that required to obtain the surface elevations or contours and surfaces free of laitance. The unformed surfaces of all other concrete shall be screeded and given an initial float finish followed by additional floating followed by troweling where required. Care shall be taken that no excess water is present when the finish is made. No special concrete or cement mortar topping course shall be used unless so shown on the Drawings.

1. Screeding

- a. All slabs shall be screeded to an even surface by the use of a straight edge and screeding strips accurately and securely set to the proper level. Screeds shall be such type and so arranged so as not to interfere with the top bar reinforcement.
- b. Screeding shall provide a concrete surface conforming to the proper elevation and contour with all aggregates completely embedded in mortar. All screeded surfaces shall be free of surface irregularities with a height or depth in excess of 1/4 inch as measured from a 10-foot straight edge.

2. Floating

- a. Screeded surfaces shall be given an initial float finish as soon as the concrete has stiffened sufficiently for proper working. Any piece of coarse aggregate which is disturbed by the float or which causes a surface irregularity shall be removed and replaced with mortar. Initial floating shall produce a surface of uniform texture and appearance with no unnecessary working of the surface.
- b. Initial floating shall be followed by a second floating at the time of initial set. The second floating shall produce a finish of uniform texture and color. Unless additional finishing is specifically required, the completed finish for unformed surfaces shall be the float finish produced by the second floating.

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- c. Floating shall be performed with hand floats or suitable mechanical compactor floats.

3. Brooming

Surfaces of equipment bases and curbs and sidewalks shall be given a light broom finish providing a nonslip surface. Brooming shall be done after the second floating and for traffic areas shall be at right angles to the normal traffic direction.

4. Troweling

Surfaces to be covered with resilient floor coverings and other surfaces designated on the Constructing Drawings to be trowelled shall be steel trowel finished. Trowel finishing will not be required for floors which are normally submerged. Troweling shall be performed after the second floating when the surface has hardened sufficiently to prevent an excess of fines being drawn to the surface. Troweling shall produce a dense, smooth, uniform surface free from blemishes and trowel marks.

5. Edging

All permanently exposed edges of unformed surfaces shall be chamfered with a 3/4 inch approved edging tool unless other edge treatment is indicated on the Construction Drawings.

3.07 CURING

- A. All concrete shall be protected from loss of moisture by curing for at least 14 days following placement. Curing operations shall take place immediately after concrete finishing is complete or forms are removed. Breaking of form ties or otherwise breaking the seal between the concrete surface and the form shall be considered form removal.
- B. Curing shall be accomplished by water curing, membrane curing, film curing, or any other curing method acceptable to the CONSULTANT/ENGINEER which does not injure or discolor exposed surfaces nor destroy the bond on surfaces to receive subsequent concrete pours or protective coatings.
- C. Water Curing
 - 1. Concrete surfaces being water-cured shall be kept constantly and visibly wet for a period of not less than 14 days. Water saturation of concrete surfaces shall begin as quickly as possible after the initial set of the concrete. The rate of water application shall be regulated to provide complete surface

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saturation with a minimum of runoff.

2. Slabs poured on grade and decks may be water-cured by ponding or by covering with wet burlap sacks, sand, or sawdust and keeping this covering continually and visibly wet during this period. Standard canvas seep hose placed in parallel runs on 8-foot centers is recommended for ponding.
3. Walls may be cured by leaving the forms tied in place and keeping the forms and all exposed surfaces of the concrete continually and visibly wet for the duration of the curing period.

D. Membrane Curing

1. Membrane-curing compound may be used in lieu of water curing on Class B concrete and on concrete which will not be covered later with mortar, liquid hardener, or additional concrete. Except as modified herein, membrane-curing compounds shall be applied in strict accordance with the manufacturer's recommendations. Membrane curing compounds shall conform to the requirements of Part 2.03, Membrane Curing Compound, of this specification section.
2. Membrane-curing compound shall be spray applied in two separate coats, each having a surface coverage of not more than 300 square feet per gallon.
3. Unformed surfaces shall be covered with curing compound within 30 minutes after final finishing. If forms are removed before the end of the specified curing period, curing compound shall be immediately applied to the formed surfaces before they dry out.
4. Curing compound shall be suitably protected against abrasion during the curing period. Whenever the membrane will be subject to damage from traffic or other cause, it shall be protected after drying for 24 hours by a layer of sand or fine earth not less than one inch thick or by other means acceptable to the CONSULTANT/ENGINEER.
5. Compound applied improperly or compound applied without sufficient dye to produce a distinguishing color shall be reapplied to the satisfaction of the CONSULTANT/ENGINEER.

E. Film Curing

1. Film curing with polyethylene sheeting may be used in lieu of water curing on concrete which will be covered later with mortar or additional concrete or will otherwise be covered or hidden from view.

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2. Film curing shall begin as quickly as possible after initial set of the concrete. Polyethylene sheeting shall completely cover the surfaces. Sheeting shall overlap the edges sufficiently for proper sealing and anchorage. Joints between sheets shall be overlapped a minimum of 12 inches and sealed. All tears, holes, and other damage shall be promptly repaired. Covering shall be anchored continuously at edges and shall be anchored on the surface as necessary to prevent billowing.

3.08 CONSTRUCTION JOINTS

- A. Construction joints shall be made only at locations indicated on the Drawings or specified herein. Construction joints shall not be made at other locations without the concurrence of the CONSULTANT/ENGINEER. No vertical construction joints shall be used in walls unless specifically approved by the CONSULTANT/ENGINEER. The work shall be laid out and conducted so as to minimize the number of construction joints.
- B. All construction joints shall be keyed. Keys shall be continuous and shall have a width equal to 1/3 of the thickness of the wall and a depth equal to 1/6 of the thickness of the wall. Unless indicated otherwise on the Drawings no keys smaller than 3 inches in width and 1 1/2 inches in depth shall be used.
- C. Waterstops of the type specified shall be installed where indicated on the Drawings and in all construction joints in concrete walls and slabs having one face exposed in a dry pit or room and having the other face in contact with backfill, subgrade, ground water, or other liquid.
- D. Immediately prior to placing the next lift, the horizontal surface shall be thoroughly cleaned using water or air as required. The surface of the concrete shall then be coated by a uniform, evenly distributed thin layer of cement-sand mortar. The cement-sand mortar shall be composed of a mixture of 1.3 parts by volume Portland cement and 1 part by volume fine aggregate and shall have a water-to-cement ratio equal to that of the concrete to follow.

3.09 EXPANSION JOINTS

Expansion joints shall be provided as shown on the Construction Drawings. Details of the expansion joints and materials of construction shall be as shown on the Construction Drawings and specified in these Contract Documents. If not shown on the Construction Drawings, expansion joints shall consist of full-depth, preformed, 1/2-inch asphalt plank material conforming to ASTM D 994.

3.10 BONDING NEW CONCRETE TO EXISTING CONCRETE

- A. Where new concrete is to be cast against and permanently bonded to an existing

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concrete surface, the existing concrete shall be chipped or cut back from the surface a minimum distance of 1/2 inches or as necessary to expose sound concrete, remove loose or weathered concrete and provide a roughened surface for bonding to the new concrete. Edges shall be cut square and feathered edges will not be permitted. All loose material remaining after chipping or cutting operations shall be removed by sandblasting and/or stiff wire brushing.

- B. Where chipping back of existing concrete is not possible and where approved by the CONSULTANT/ENGINEER, the surface of existing concrete may be prepared by sandblasting or acid etching. If sandblasting or etching is used, the surface of the existing concrete shall be bare, clean, dry, and structurally sound. All grease, oil, wax, or other residue shall be removed by scraping followed by washing with a nonionic detergent or a suitable solvent compatible with the epoxy bonding agent to be used. Animal fats may be removed by scrubbing with a 10 percent solution of caustic soda to saponify them.
- C. After all loose material, grease, etc., have been removed, the surface of the existing concrete shall be etched by either sandblasting or scrubbing with a 10-20 percent solution of hydrochloric acid in water applied at a rate of 1 quart per square yard followed by a thorough rinsing with clean water. The surface shall then be allowed to dry completely before application of the epoxy bonding agent. Goggles, rubber boots, and rubber gloves shall be worn by workmen when applying caustic soda or acids.
- D. When the surface is dry and just prior to placing the new concrete, an epoxy bonding agent shall be applied to the surface of the existing concrete with a whitewash brush or stiff broom. The epoxy bonding agent shall be spread evenly over the surface to be bonded, avoiding skips and holidays, to wet film thickness of 40 to 60 mils. The new concrete shall be placed as soon as the epoxy bonding agent becomes tacky. In the event that the epoxy bonding agent is allowed to dry before placement of the new concrete the surface shall be recoated with epoxy.
- E. The epoxy bonding agent shall comply with the material requirements of Part 2.05, Epoxy Bonding Agent, of this specification section and shall be applied in strict conformance to the manufacturer's recommendations. Adequate safety precautions shall be taken during the handling and use of the epoxy bonding agent.

3.11 EMBEDDED ITEMS

- A. Wherever steel, wrought or cast iron piping, fittings, valves, collars, sleeves, structural steel, electrical conduits, appurtenances and fixtures, equipment anchorages or castings are shown for embedment in the concrete, such items must be on hand before concrete is poured. They shall be set in place accurately and firmly braced before concrete is poured around them. No cutouts for future installation of these items shall be permitted.

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- B. Before placing concrete the CONTRACTOR shall see that all embedded parts are accurately positioned and firmly and securely fastened in place. They shall be thoroughly clean and free from any coating, rust, scale, oil or other foreign matter. The embedding of wood in concrete shall be avoided whenever possible. If wood is to be embedded it shall be thoroughly wetted before the concrete is placed. After placement, surfaces not in contact with concrete shall be cleaned of concrete spatter and other foreign substances.
- C. Conduit shall be installed between the reinforcing steel in walls or slabs which have reinforcement in both faces. In slabs which have only a single layer of reinforcing steel, conduit shall be placed under the reinforcement.
- D. Unless installed in pipe sleeves, anchor bolts shall have sufficient threads to permit a nut and washer to be installed on the concrete side of the form or template. A second nut and washer shall be installed on the other side of the form or template and the two nuts shall be adjusted so that the bolt will be held rigidly in proper position.
- E. The CONTRACTOR shall be responsible for coordinating all work and ensuring that all embedded items or openings to be built into the concrete are placed in the forms before concrete is placed. The CONTRACTOR shall be responsible for conferring with his subcontractors and suppliers regarding their requirements for embedments and openings.
- F. Forms, sleeves, and inserts shall be set, and concrete shall be cast to the lines and grades indicated on the Construction Drawings and as detailed in these Contract Documents. The maximum deviation from true line and grade shall not exceed the tolerances listed below. Deviation in alignment of slabs or walls shall not exceed a rate of 1/8 inch in 10 feet within the tolerances specified.

Item	Maximum Tolerance
Sleeves and inserts	+1/8" -1/8"
Projected ends of anchor bolts	+1/4" -0.0"
Anchor bolt setting	+1/16" -1/16"
Concrete forms	+1/8" -1/8"

- G. All slabs shall be carefully finished true to grade such that the surface is free draining and contains no depressions which can hold or collect water.
- H. Regardless of the tolerances listed herein, it shall be the responsibility of the CONTRACTOR to limit deviations in line and grade to tolerances which will permit proper installation and operation of mechanical equipment and piping.

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3.12 WATERTIGHTNESS

- A. It is the intention of this specification section to provide impervious concrete. All pits below groundwater level and all structures for holding or carrying water shall be watertight. A loss of not more than 1/4 inch depth in 24 hours will be permitted when water-holding structures are filled. All exposed surfaces of water-holding structures and interior surfaces of pits below groundwater level shall be free from visible damp spots or seepage before acceptance. Repeated tests and repairs may be required by the CONSULTANT/ENGINEER to obtain watertight structures. All structures shall be drained at the completion of tests unless otherwise directed by the CONSULTANT/ENGINEER. The cost and expense of all testing for watertightness and of providing a watertight structure shall be borne by the CONTRACTOR. Methods of repair shall be acceptable to the CONSULTANT/ENGINEER.
- B. The use of special admixtures or integral waterproofing compounds in concrete required to be watertight is not required but may be permitted, provided the materials and methods are approved in writing by the CONSULTANT/ENGINEER.

3.13 CONCRETE EMBEDMENT AND ENCASEMENT OF PIPE

- A. Concrete for embedment and encasement shall be installed where and as indicated on the Construction Drawings and at such locations where installation conditions require such pipe reinforcement because of unforeseen conditions encountered in the work, as determined by the CONSULTANT/ENGINEER.
- B. Embedment and encasement of pipe shall be preceded by the following preliminary steps:
 - 1. All loose material shall be removed from the trench prior to placing concrete. All concrete shall have a continuous contact with undisturbed soil on sides and bottom of trench.
 - 2. A base course of concrete shall be accurately screeded to such grade and elevation that the pipe will be at specified grade when pipe bells are supported on, and in contact with, the top surface of such base course.
 - 3. Each length of pipe shall be rigidly held in alignment and anchored, to prevent flotation, in a manner acceptable to the CONSULTANT/ENGINEER.

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3.14 PILE DRIVING AND CONCRETE WORK

The CONTRACTOR shall not drive foundation piling which may damage freshly placed or existing concrete structures. Minimum distance between concrete less than seven days old and pile driving operations shall be 100 feet. Any damage made to concrete structures from pile driving operations shall be repaired by the CONTRACTOR at his expense.

3.15 DEFECTIVE WORK AND METHODS OF REPAIR

- A. All defective or damaged work shall be removed and replaced or repaired as directed by the CONSULTANT/ENGINEER. Any work which has not been constructed in accordance with these Contract Documents shall be considered defective. No defective or damaged work shall be patched, repaired or covered without prior inspection and approval of the CONSULTANT/ENGINEER.
- B. Defects in formed concrete surfaces shall be repaired within 24 hours of placement, to the satisfaction of the CONSULTANT/ENGINEER, and defective concrete shall be replaced within 48 hours after the adjacent forms have been removed. All concrete which is honey-combed or otherwise defective shall be cut out and removed to sound concrete, with edges square cut to avoid feathering.
- C. Except as modified herein, concrete repair work shall conform to Chapter 9 of ACI 301 and shall be performed in a manner that will not interfere with thorough curing of surrounding concrete. All repair work shall be adequately cured.
- D. Where authorized by the CONSULTANT/ENGINEER, repair may be accomplished by patching conducted as specified herein. However, permission to patch shall not waive the CONSULTANT/ENGINEER'S right to have the defective work completely removed if the patch or repairs do not, in the CONSULTANT/ENGINEER'S opinion, satisfactorily restore the quality and appearance of the work. Patching shall be conducted as follows:
 - 1. Chip away defective areas at least 1-1/2 inches deep perpendicular to the surface, wet the area and 6 inches around it to prevent absorption of water from patching mortar, and brush a sand-cement grout consisting of one part fine aggregate to one part Portland cement into the surface, following with patching mortar.
 - 2. Patching mortar shall be no richer than one part Portland cement to three parts fine aggregate using white Portland cement to replace a portion of the gray cement as determined by a trial patch and shall contain only the minimum mixing water required for placing. Retemper the mortar if necessary without the addition of water by allowing it to stand for one hour during which time it shall be mixed with a trowel to prevent setting.

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3. Mortar shall be compacted into place and screeded to leave the patch higher than the surrounding surface, then left undisturbed for one or two hours to permit initial shrinkage before being finally finished to match the adjoining surface. Cure patch in accordance with the requirements of Part 3.07, Curing, of this specification section.

3.16 LOADS APPLIED TO NEW CONCRETE

- A. Loads including, but not limited to, earth loads, loads exerted from bracing or shoring, wind loads, hydrostatic or hydraulic loads, equipment or vehicle loads, or loads exerted by stacked materials, shall not be permitted until the concrete has reached 150 percent of the strength required to withstand the imposed load.
- B. Concrete which has cracked due to overloading, loading before required strength has developed, or otherwise damaged shall be repaired or replaced as determined by the CONSULTANT/ENGINEER.

END OF SECTION

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**SECTION 05500
METAL FABRICATIONS**

PART 1 - GENERAL

1.01 SECTION INCLUDES

- A. General standards and specifications related to the manufacture, supply, and installation of various carbon steel equipment and accessories.

1.02 RELATED SECTIONS

- A. Section 01300 - Submittals.
- B. Section 01600 - Material and Equipment.
- C. Section 05510 - Metal Stairs, Grates, Handrails and Hatch, and Safety Accessories.
- D. Section 15000 - Process Piping and Accessories.
- E. Section 15020 - Air Stripping System.
- F. Section 15040 - Vapor treatment Systems.

1.03 REFERENCES

- A. ASTM A36 - Structural Steel.
- B. ASTM A53 - Welded and Seamless Steel Pipe.
- C. ASTM A123 - Zinc (Hot-Galvanized) Coatings on Products Fabricated From Rolled, Pressed, and Forged Steel Shapes, Plates, Bars, and Strips.
- D. ASTM A153 - Zinc Coating (Hot-Dip) on Iron and Steel Hardware.
- E. ASTM A283 - Carbon Steel Plates, Shapes, and Bars.
- F. ASTM A307 - Carbon Steel Externally Threaded Standard Fasteners.
- G. AWS A2.0 - Standard Welding Symbols
- H. AWS D1.1 - Structural Welding Code.

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1.04 SUBMITTALS

- A. The SUPPLIER shall submit information required under provisions of Section 01300 (Submittals).
- B. Shop Drawings: Indicate profiles, sizes, connection attachments, reinforcing, gasket materials, anchorage, size and type of fasteners, and accessories. Include erection drawings and instructions, elevations, and details where applicable.
- C. Indicate welded connections using standard AWS A2.0 welding symbols. Indicate net weld lengths.

1.05 QUALIFICATIONS

- A. The SUPPLIER shall prepare Shop Drawings under direct supervision of a Professional Engineer experienced in design of this work and licensed in the State of New York.
- B. Welders' Certificates: Submit under provisions of Section 01300 certifying welders employed on the Work, verifying AWS qualification within the previous 12 months.

1.06 FIELD MEASUREMENTS

- A. The SUPPLIER shall verify that field measurements are as indicated on the Construction Drawings.

PART 2 - PRODUCTS

2.01 MATERIALS

- A. Steel Sections: ASTM A36.
- B. Plates: ASTM A283.
- C. Pipe: ASTM A53, Grade B, Schedule 40- and 80 Carbon Steel.
- D. Fasteners: Galvanized, slotted strut channels (1 5/8 inch x 13/18 inch) with zinc plated steel pipe clamps from McMaster-Carr or equivalent.

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E. Bolts, Nuts, and Washers: ASTM A325, A307, galvanized to ASTM A153.

F. Welding Materials: AWS D1.1; type required for materials being welded.

2.02 FABRICATION

A. Fit and shop assemble in largest practical sections, for delivery to site.

B. Fabricate items with joints tightly fitted and secured.

C. Continuously seal joined members by continuous welds.

D. Grind exposed joints flush and smooth with adjacent finish surface. Make exposed joints butt tight, flush, and hairline. Ease exposed edges to small uniform radius.

E. Exposed 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.

2.03 FINISHES

A. Shop prime all surfaces with standard coating for corrosion protection, and as shown on the Construction Drawings.

B. Do not prime surfaces in direct contact with concrete or where field welding is required.

C. Apply bitumastic coating to all surfaces in contact with concrete.

PART 3 - EXECUTION

3.01 EXAMINATION

A. The SUPPLIER shall verify that field conditions are acceptable and are ready to receive work.

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3.02 PREPARATION

- A. The SUPPLIER shall clean and strip primed steel items to bare metal where site welding is required.
- B. The SUPPLIER shall supply items required to be cast into concrete with setting templates, to appropriate sections.
- C. The SUPPLIER shall provide anchor bolt kits.

3.03 INSTALLATION

- A. The on-site CONTRACTOR shall be responsible for installing all equipment. The equipment SUPPLIER shall supervise and inspect the equipment installation in accordance with Section 11200 and relevant equipment specifications in Division 15 of these Technical Specifications. The CONTRACTOR shall:
 - 1. Install items plumb and level, accurately fitted, free from distortion and defects.
 - 2. Allow for erection loads, and for sufficient temporary bracing to maintain true alignment until completion of erection and installation of permanent attachment.
 - 3. Field weld components indicated on Construction Drawings.
 - 4. Perform field welding in accordance with AWS D1.1.
 - 5. Obtain the CONSULTANT/ENGINEER'S approval prior to site cutting or making adjustments not scheduled.
 - 6. After erection, prime welds, abrasions, and surfaces not shop primed, except surfaces to be in contact with concrete.
 - 7. Anchor the equipment to the concrete base using 1/2-inch diameter anchor bolts at all corners unless otherwise specified.

3.04 ERECTION TOLERANCES

- A. Maximum offset from true alignment: 1/4-inch.

END OF SECTION

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**SECTION 05510
METAL STAIRS, GRATE PLATFORMS, PUMP COLUMN SUPPORTS,
ACCESS HATCHES, AIR INLETS, AND SAFETY ACCESSORIES**

PART 1 - GENERAL

1.01 WORK INCLUDED

- A. The CONTRACTOR shall furnish and install, complete in every detail, all new metal appurtenances in accordance with these specifications and the Construction Drawings.
- B. In general this work shall include the furnishing and installation of the following:
 - 1. Metal stairs.
 - 2. Grate platforms.
 - 3. Pump column supports.
 - 4. Access hatches.
 - 5. Air inlets
 - 6. Related hardware.
- C. The CONTRACTOR shall furnish and install all items related to the safety accessories in the buildings. The safety accessories as required are as follows:
 - 1. Fire extinguishers.
 - 2. First aid kit.
 - 3. Eye wash station.
 - 4. Air mask and case.

1.02 RELATED SECTIONS

- A. Section 01300 - Submittals.
- B. Section 03300 - Cast-in-Place Concrete.

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1.03 REFERENCES

- A. ASTM A36 - Structural Steel.
- B. ASTM A123 - Zinc (Hot Galvanized) coatings of products fabricated from rolled, pressed, and forged steel shapes, plates, bars and strips.
- C. ASTM A120 - Pipe, steel, black, and hot-dipped zinc-coated (Galvanized) welded and seamless, for ordinary uses.
- D. ASTM B-241 - Aluminum-Alloy Seamless Pipe and Seamless Extruded Tube.
- E. Metal Building Manufacturer's Association - Metal Building Systems Manual.
- F. Aluminum Association - Aluminum Construction Manual.
- G. AWS A2.0 - Standard Welding Symbols.
- H. AWS D1.1 - Structural Welding Code.

1.04 QUALITY ASSURANCE

- A. All equipment and materials furnished under this Section shall be new, suitable for the conditions of service to which they will be subject and equal to the best of their respective classes. Grade and quality shall meet the applicable cited specifications and standards.
- B. Workmanship shall be of the highest quality and shall be carried out by competent and experienced workmen.

1.05 SUBMITTALS

- A. CONTRACTOR shall submit Shop Drawings, design calculations, product data, and installation instructions prior to construction according to Section 01300.
- B. Shop Drawings shall indicate sizes, types, spacing, and materials of components, accessories, fittings, hardware, anchorages, and will include a schedule of components.

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- C. CONTRACTOR shall indicate welded connections using standard AWS A2.0 welding symbols. Indicate net weld lengths.

PART 2 - PRODUCTS

2.01 MATERIALS

- A. The CONTRACTOR shall specify all materials to be used for this portion of the Work. Materials selected shall be corrosion resistant and shall conform to the following (unless otherwise specified or approved by the ENGINEER):
- Zinc-coated steel shall be hot dipped, meeting ASTM specifications A120-83, A128-78 or A153-82, whichever is applicable.
 - Steel Sections: ASTM A36.
 - Fasteners: Galvanized, slotted strut channels (1 5/8 inch x 13/18 inch) with zinc plated steel pipe clamps from McMaster-Carr or equivalent.
 - Bolts, Nuts, and Washers: 304 stainless steel.
 - Welding Materials: AWS D1.1; type required for materials being welded. Field welding of aluminum will not be permitted.
 - Structural aluminum shall be aluminum-alloy 6061-T6 unless otherwise noted. Fabrication and construction shall be in accordance with "Specifications for Aluminum Structures" of the Aluminum Association, Inc.
 - Field welding of aluminum will not be permitted.

2.03 METAL STAIRS

- A. The CONTRACTOR shall furnish and install one (1) pre-fabricated metal stair and railing as indicated on the Construction Drawings. It shall be the CONTRACTOR'S responsibility to assure that the selected stair and railing is capable of supporting the weight of personnel and equipment, and is in accordance with OSHA and any other applicable regulations.
- B. Stair treads shall have an anti-slip pattern and checkered plate nosings

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- C. Portions of the stair and railing to be in contact with concrete shall be coated with bituminous material.

2.04 ACCESS HATCHES

- A. The CONTRACTOR shall specify, furnish, and install access hatches as indicated on the Construction Drawings.
- B. Access hatches located on clearwell No. 1 and clearwell No. 2 shall be provided such that they are completely air-tight.
- C. Access hatches located on clearwell No. 1, clearwell No. 2 and on the treatment building roof shall be able to withstand a live load of 300 pounds per square foot. Access hatches located on recovery well vaults, diffusion well vaults, and flow meter vaults shall be able to withstand a live load rating of H-20.
- D. Cover leafs shall be equipped with heavy brass or bronze hinges, stainless steel pins, spring operators for easy operation and an automatic hold-open arm with release handle. A snap lock with removable trench lift handle shall be provided. Sizes of hatches, number of leaves, and location of hinges shall be specified by the CONTRACTOR in the Shop Drawings.
- E. Hardware shall be cadmium plated and factory finish shall be prime coat of red oxide applied to steel doors and frames. Factory finish shall be mill finish with bituminous coating applied to exterior of frame that will be in contact with concrete.

2.05 AIR INLETS

- A. The CONTRACTOR shall size, furnish, and install one (1) air inlet located on clearwell No. 1 as indicated in the Construction Drawings.
- B. The inlet shall be rectangular with a 2 foot by 6.5 foot base. The inlet opening shall be a screened and louvered 2.25 foot by 6 foot opening that shall be positioned a minimum of 36 inches above the top of the reinforced concrete cap facing the side.
- C. The inlet shall be fitted with a 24-mesh stainless steel screen and expanded metal reinforcing, and the available operating area shall be no less than 40%.

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2.06 FIRE EXTINGUISHERS

- A. One (1) portable tank type fire extinguisher containing fifteen pounds of liquid carbon dioxide, complete with hanger, seat type valve, 3 feet of hose and non-shatterable discharge hose, complete with brackets for wall mounting; as manufactured by Walter Kiddie & Co. Model 15KS, or equal.
- B. Fire extinguisher shall be located where directed by the OWNER.

2.07 FIRST AID KIT

- A. One (1) industrial first aid kit as manufactured by Acme Products, Kit Number 25, or equal.
- B. First aid kit shall be located where directed by the CONSULTANT/ENGINEER.

2.08 EYE WASH

- A. One (1) eye wash station shall be installed in the building.
- B. Eye wash station shall be located where directed by the CONSULTANT/ENGINEER.

2.09 FINISHES

- A. Shop prime all surfaces with standard coating for corrosion protection, where applicable.
- B. Do not prime surfaces in direct contact with concrete or where field welding is required.
- C. Apply bitumastic coating to all surfaces in contact with concrete.

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METAL STAIRS, GRATE PLATFORMS, PUMP COLUMN SUPPORTS,
ACCESS HATCHES, AND AIR INLETS**

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PART 3 - EXECUTION

3.01 EXAMINATION

- A. The CONTRACTOR shall verify that field conditions are acceptable and ready to receive work.

3.02 PREPARATION

- A. The CONTRACTOR shall clean and strip primed steel items to bare metal where site welding is required.
- B. The CONTRACTOR shall supply items required to be cast into concrete with setting templates, to appropriate sections.
- C. The CONTRACTOR shall provide anchor bolt kits.

3.03 INSTALLATION

- A. The CONTRACTOR shall be responsible for installing all items described in this section of the Work. The equipment supplier shall supervise and inspect the equipment installation in accordance with Section 01650 (Starting of Systems) and relevant equipment specifications in Division 15 of these Technical Specifications. The CONTRACTOR shall:
 - 1. Install items plumb and level, accurately fitted, free from distortion and defects.
 - 2. Allow for erection loads, and for sufficient temporary bracing to maintain true alignment until completion of erection and installation of permanent attachment.
 - 3. Perform field welding in accordance with AWS D1.1.
 - 4. Obtain CONSULTANT/ENGINEER'S approval prior to site cutting or making adjustments not scheduled.
 - 5. After erection, prime welds, abrasions, and surfaces not shop primed, except surfaces to be in contact with concrete.

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METAL STAIRS, GRATE PLATFORMS, PUMP COLUMN SUPPORTS,
ACCESS HATCHES, AND AIR INLETS**

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6. Anchor the equipment to the concrete base using ½-inch diameter anchor bolts at all corners unless otherwise specified.
7. Installation shall be in accordance with manufacturer's instructions. manufacturer shall guarantee against defects in material or workmanship for a period of five years.

3.04 ERECTION TOLERANCES

- A. Maximum offset from true alignment: ¼-inch.

END OF SECTION

**05510-7
METAL STAIRS, GRATE PLATFORMS, PUMP COLUMN SUPPORTS,
ACCESS HATCHES, AND AIR INLETS**

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**SECTION 15000
PROCESS PIPING AND ACCESSORIES**

PART 1 - GENERAL

1.01 SECTION INCLUDES

- A. Related Sections.
- B. Work Description.
- C. References.
- D. Acceptable Manufacturers.
- E. Recovery Well Piping.
- F. Treatment System Piping.
- G. Discharge Piping.
- H. Valves.
- I. Flowmeters.
- J. Sample Taps.
- K. Pipe Sleeves.
- L. Hangers, Supports and Anchoring for Piping.
- M. Scheduling of Work.
- N. Protection of Work.
- O. Pipe Preparation.
- P. Pipe Installation.
- Q. Pipe Sleeve Installation.

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- R. Hangers, Supports, and Anchoring Installation.
- S. Identification Marker Installation.
- T. Marker Tape
- U. Testing

1.02 RELATED SECTIONS

- A. Section 01300 - Submittals.
- B. Section 01400 - Quality Control

1.03 WORK DESCRIPTION

- A. The CONTRACTOR is responsible for the installation of all process piping and accessories including, but not limited to, the following items as shown on the Construction Drawings: carbon steel pipe and fittings; Sch. 80 PVC pipe and fittings; valves; pipe sleeves; pipe supports and pipe hangers; fasteners and mounting hardware; and sample taps.
- B. Testing of piping.

1.04 REFERENCES

- A. ASTM D1784 - Standard Specification for Rigid Polyvinyl Chloride (PVC) and Chlorinated Polyvinyl Chloride (CPVC) Compounds.
- B. ASTM D2466 - Standard Specification for Polyvinyl Chloride (PVC) Socket Type Fittings.
- C. ASTM F402 - Standard Practice for Safe Handling of Solvent Cement and Primer Used for Joining Thermoplastic Pipe and Fittings.
- D. BOCA Union Plumbing Code.
- E. ANSI B16.5 - Pipe Flanges and Flanged Fittings.

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- F. ASTM A53 - Pipe, Steel, Black and Hot-Dipped, Zinc-Coated, Welded and Seamless.
- G. ASTM A105 - Carbon Steel Forgings and Fittings.

PART 2 - PRODUCTS

2.01 ACCEPTABLE MANUFACTURERS

- A. Materials and equipment supplied for the work shall conform to the requirements of these technical specifications and Construction Drawings. Suggested suppliers are indicated in some cases, however the CONTRACTOR may offer substitute material and equipment that is equivalent in all respects to that indicated. The CONTRACTOR shall provide technical data that defines the offered substitute and supports the substitution as an equal to the equipment or materials specified. The ENGINEER will review the technical data submittals from the CONTRACTOR and accept or reject the substitution. If the offered substitution is rejected, the CONTRACTOR shall be responsible for compensating the CONSULTANT/ENGINEER's costs to review the offered substitute. All submittals and substitutions shall be handled in accordance with Section 01300 of these Technical Specifications.

2.02 RECOVERY PIPING

- A. Recovery well piping within the below grade vaults to the existing header line shall be carbon steel pipe and installed as shown on the Construction Drawings. The extension of the existing header line to the groundwater treatment system shall be Sch. 80 PVC and installed as shown on the Construction Drawings.

2.03 TREATMENT BUILDING PIPING

- A. All piping located in the treatment building shall be installed as shown on the Construction Drawings and shall conform to applicable standards.

2.04 DISCHARGE PIPING

- A. All discharge piping shall be Sch. 80 PVC and installed as shown on the Construction Drawings.

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2.05 VALVES

- A. Valves for the process piping shall be manufactured by an approved supplier with pressure ratings conforming to those of the piping. The CONTRACTOR shall submit his selection of a MANUFACTURER and technical data to the ENGINEER for approval prior to installation.

- 1. All similar valves shall be purchased from one manufacturer.

2.06 FLOW METERS

- A. All flow meters shall be manufactured by Badger or an approved equivalent as shown on the Construction Drawings.

2.07 SAMPLE TAPS

- A. All sample taps shall include a threaded nipple and isolation valves shown on Construction Drawings.

2.08 PIPE SLEEVES

- A. All pipes passing through walls and roofs of the well vaults and treatment building shall be provided with sleeves. All pipe penetrations shall be made water tight as specified or indicated on the Construction Drawings.

2.09 HANGERS, SUPPORTS AND ANCHORS FOR PIPING

- A. All piping shall be supported by means of an approved combination of hangers, supports, and attachments, assuring that no weight is imposed upon the connected equipment.
- B. All aboveground exterior pipe supports shall be constructed as indicated on the Construction Drawings.

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PART 3 - EXECUTION

3.01 SCHEDULING OF WORK

- A. The CONTRACTOR shall coordinate and schedule mechanical installation with the CONSULTANT/ENGINEER to accommodate the CONSULTANT/ENGINEER'S requirements.

3.02 PROTECTION OF WORK

- A. The CONTRACTOR shall protect all piping from entry of dirt, pipe cuttings, lubricants, debris, stormwater and other foreign material. The CONTRACTOR shall remove any foreign materials and clean piping to the satisfaction of the CONSULTANT/ENGINEER.

3.03 PIPE PREPARATION

- A. The CONTRACTOR shall:
 - 1. Mark pipe sections with required identification prior to assembly.
 - 2. Inspect for defective or damaged spool pieces prior to assembly.
 - 3. Remove scale, dirt, pipe fittings, and lubricants inside and outside, prior to assembly.
 - 4. Complete piping connections to equipment with flanges or unions.

3.04 PIPE INSTALLATION

- A. Carbon steel pipe shall be flanged unless otherwise specified on the Construction Drawings.
- B. The CONTRACTOR shall cut the pipe to exact measurement and install without forcing or springing.
- C. The CONTRACTOR shall install piping to allow for expansion and contraction without stressing pipe, joints, or connected equipment.

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- D. The CONTRACTOR shall provide adequate clearance, install unions, and orient fittings and appurtenances for ease of installation of equipment and access to valves, fittings, and appurtenances.
- E. The CONTRACTOR shall install all piping and equipment as indicated on the Construction Drawings. In the event of an installation requirement that is unclear, the CONTRACTOR shall consult with the CONSULTANT/ENGINEER before proceeding with the work in question.
- F. The CONTRACTOR shall install all couplings, elbows, tees, and valves as shown on the Construction Drawings.

3.05 PIPE SLEEVE INSTALLATION

The CONTRACTOR shall:

- A. Install pipe sleeves around pipes protruding through walls and roofs prior to installing the pipe, as shown on the Construction Drawings.
- B. Seal all pipe sleeve openings with non-shrink caulking.
- C. Rigidly anchor pipe to stable structures where necessary. Provide pipe guides so that movement takes place along the axis of pipe only.

3.06 HANGERS, SUPPORT, AND ANCHORS INSTALLATION

- A. Hangers must be absolutely vertical and are to be secured to supplementary steel, using clamps as attachments, wherever possible. Where necessary to obtain the required vertical alignment, furnish and install angle or channel irons of ample strength and length to bridge between walls and ceilings to receive hanger attachments or supports for piping, ductwork, and equipment. Structural equipment storage container members shall not be drilled, otherwise weakened or overloaded. Hangers shall not be attached to piping, and shall not pierce or be sustained from ductwork. Supplementary steel must be kept as high as possible.
- B. Wire, rope, wood, perforated band iron, tape or other makeshift material shall not be used for hangers or attachments. Threaded hangers shall have lock nuts.
- C. Interior piping shall be supported, guided and anchored to maintain the required alignment and pitch, without sagging or swaying, and to provide controlled

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expansion, using adjustable split clevis or trapeze type hangers. Spacing of hangers and sizes shall be in accordance with ANSI B31.1

- D. A set of piping drawings shall be marked with approximate hanger locations and a standard hanger sheet showing typical random support arrangements shall be furnished for field guidance.
- E. The CONSULTANT/ENGINEER shall have the option to direct the CONTRACTOR to either support piping from above or below at any time at no additional cost to the CONSULTANT/ENGINEER or OWNER.
- F. Fittings with support bases cast with the fitting shall be used to support pipe from floors or walls whenever possible or as directed by the CONSULTANT/ENGINEER. Piping shall be supported from the floor by means of pipe stanchion saddles and U-bolts. Non-insulated copper piping shall be supported with copper hangers or provided with lead shield to separate the dissimilar metals. Maximum spacing of hangers shall comply with ASA B31.3. Arrangements and location of all anchors shall be submitted to the CONSULTANT/ENGINEER for approval before installation.

3.07 IDENTIFICATION MARKER INSTALLATION

The CONTRACTOR shall identify:

- A. Valves: Identify all valves on the system with brass tags with the valve designation permanently stamped on the tag. The CONTRACTOR shall prepare a valve schedule including alpha-numeric designations for each valve and submit the schedule to the CONSULTANT/ENGINEER for approval prior to purchasing and installing the tags. The valve schedule shall include the valve designation, type, and location and shall be submitted in accordance with Section 01300 Submittals.
- B. Piping: Identify piping, concealed or exposed, with plastic pipe markers. Identify service, flow direction, and pressure. Install in clear view and align with axis of piping. Locate identification so as not to exceed 20 feet on straight runs including risers and drops, adjacent to each valve and branch tee and at each point of penetration of enclosures, and at other obstructions to the pipe run.
- C. Insulated sections of piping and valves shall be identified on the pipe and on the exterior of the insulation jacketing.

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3.08 MARKER TAPE

- A. Marker tape installed over all direct burial process piping shall be six (6") inches in width, and shall be Terra Tape "D" detectable as manufactured by Griffolyn, Inc. or approved equal. The tape shall be an inert, bonded layer plastic material with a metallized foil core, so that process piping locations can be determined with a metal detector. The color of the tape shall be blue with the following imprints:

"CAUTION! BURIED PROCESS PIPING LINE BELOW!"

3.09 TESTING

- A. Field inspection and testing shall be performed under provisions of Section 01450. Equipment which is not included in the test shall be disconnected from the piping or isolated by valves.
- B. Leak tests shall be performed on all piping. If tests indicate work does not meet specified requirements, remove work, replace and re-test at CONTRACTOR'S expense.
- C. The tests for piping shall be observed by the CONSULTANT/ENGINEER and written acceptance shall be given to the CONTRACTOR after successful completion of the test.
- D. Any damaged or defective pipe, fittings, valves, or joints that are discovered following the pressure tests shall be repaired or replaced at no cost to the OWNER or CONSULTANT/ENGINEER. The test shall be observed by the CONSULTANT/ENGINEER and written acceptance shall be given to the CONTRACTOR after successful test completion.

END OF SECTION

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**SECTION 15020
AIR STRIPPING SYSTEM**

PART 1 - GENERAL

1.01 WORK INCLUDED

- A. This section includes requirements for coordinating the delivery, installation and functional testing during initial start-up of a complete air stripping system with the CONSULTANT/ENGINEER as specified in these Technical Specifications and as shown on the Construction Drawings. All correspondence between the CONTRACTOR and the VENDOR shall be directed through the CONSULTANT/ENGINEER. The air stripping system will include, but not be limited to: two (2) in-series packed towers complete with internals; packing; attached piping, and duct work; ladder and platform assemblies; and miscellaneous appurtenances; instrumentation and appurtenances.

1.02 RELATED SECTIONS

- A. Section 01090 - Reference Standards.
- B. Section 01300 - Submittals.
- C. Section 01400 - Quality Control.
- D. Section 01600 - Material and Equipment.
- E. Section 01650 - Starting of Systems.
- F. Section 01700 - Contract Closeout.
- G. Section 15000 - Process Piping and Accessories.
- H. Section 15040 - Vapor Treatment System.
- I. Section 16000 - Electrical - General Provisions.

1.03 GENERAL

- A. The CONTRACTOR shall coordinate the delivery and installation of the tower air strippers, its associated blower and ducts, and the duct heater with the CONSULTANT/ENGINEER. The CONSULTANT/ENGINEER's VENDOR will deliver and install two tower air strippers, its associated blower and ducts, and the

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duct heater. CONSULTANT/ENGINEER will be responsible for payment of the above mentioned process equipment to the associated VENDOR. CONTRACTOR shall be responsible for any extra costs incurred by the CONSULTANT/ENGINEER in the event of a rush in the manufacturing, delivery and installation is required to make up for delays in schedule caused by the CONTRACTOR. All correspondence between the CONTRACTOR and the VENDOR shall be directed through the CONSULTANT/ENGINEER. Delivery, storage, and handling of equipment shall conform to the specifications in Section 0-1600, Materials and Equipment.

- B. The CONTRACTOR shall be responsible for obtaining mounting details for air stripper towers, blower, and all penetrating duct work (including intake duct and blower discharge) from the CONSULTANT/ENGINEER and construct the mounting systems in accordance with the VENDOR'S requirements.
- C. The CONSULTANT/ENGINEER shall coordinate the delivery and installation of the tower air strippers and its associated blower with the CONTRACTOR. The CONSULTANT/ENGINEER'S VENDOR will deliver and install two tower air strippers, blower, and associated ducting to the blower and the duct heater.
- D. The CONTRACTOR shall be available to assist in the process equipment installations (i.e.; prepare access, tie in duct supports, break and seal access holes through walls, etc.) and shall provide any miscellaneous materials and labor necessary to complete a workable system in accordance with the Construction Drawings and these Technical Specifications.
- E. The CONTRACTOR shall be responsible to supply and install the influent, interconnecting, and effluent piping for the tower air stripping system.
- F. The CONTRACTOR shall be responsible for all electrical installations associated with the tower air stripping system. This includes but is not limited to electrical supply and controls. The CONTRACTOR shall obtain a list of electrical supply requirements and controls from the CONSULTANT/ENGINEER.
- G. The CONTRACTOR shall provide and install the condensate drain line with an automatic pump/float system as shown on the Construction Drawings.

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1.04 SUBMITTALS

- A. The CONTRACTOR shall submit to the CONSULTANT/ENGINEER for review Shop Drawings and design calculations for formwork the CONTRACTOR intends to use during construction of the clearwells in accordance with Sections 01300 (Submittals) and 03110 (Concrete Formwork).

1.05 PERMITS AND REGULATIONS

- A. The CONTRACTOR shall comply with all Local, State, and Federal regulations.

1.06 DELIVERY, STORAGE, AND HANDLING

- A. All arrangements for delivery and storage of equipment shall conform to the specifications in Section 01600 (Material and Equipment) and shall be the CONSULTANT/ENGINEER responsibility. All correspondence between the CONTRACTOR and the VENDOR shall be directed through the CONSULTANT/ENGINEER.

PART 2 - PRODUCTS

2.01 MANUFACTURER

- A. The air stripping towers will be a Model PC5-76.25.5 SS as manufactured by Hydro Group, Inc., Environmental Products Division, 97 Chimney Rock Road, Bridgewater, NJ 08807 (1-800-524-2725).

2.02 GENERAL DESCRIPTION

- A. An air stripping system will be provided for the treatment of recovered groundwater. The air stripping system will be capable of treating 900 gallons per minute (gpm) of groundwater contaminated with volatile organic compounds (VOCs).
- B. System equipment will be suitable for operation in areas designated as unclassified by the National Electric Code (NEC). The installation of the air stripping system and accessories shall conform to local building and fire requirements.
- C. The tower air stripper system will be operated outdoors and the associated controls and blower will be located indoors.

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2.03 INSTRUMENTATION AND CONTROLS

A. General

1. Instrumentation and controls shall be provided as specified herein and as shown on the Construction Drawings. The air stripping system MANUFACTURER is responsible for providing the necessary fittings and supports for instrumentation attached to the air stripping towers.
2. All instrumentation and controls shall be suitable for operation in areas designated as unclassified per NEC.
3. All instrumentation, controls, and control panels shall be supplied and installed by the CONTRACTOR or electrical subcontractor.
4. A central control panel, located in the treatment building, shall house a programmable logic controller (PLC) to monitor and integrate the operation of the complete IRM system (well pumps, VPGAC system, clear well pumps, and air stripper system). The panel shall be connected to each major component in the Modified IRM groundwater treatment system and will provide an interface for remote access via a telephone line. This panel shall be supplied by the CONTRACTOR or electrical subcontractor.

PART 3 - EXECUTION

3.01 INSTALLATION AND INSPECTION

- A. The CONSULTANT/ENGINEER shall arrange and oversee the VENDOR'S installation of the complete air stripping system and appurtenances at the locations indicated on the Construction Drawings. All arrangements shall be made through the CONSULTANT/ENGINEER. The CONTRACTOR shall provide miscellaneous field labor and equipment during installation of the system (on the CONTRACTOR'S concrete foundation) and shall ensure that the VENDOR has access to all areas of interest. Electrical connections to the blower and any instruments or monitoring devices shall be provided by the CONTRACTOR as specified elsewhere.
- B. A template shall be delivered to the CONTRACTOR by the manufacturer to insure accurate setting of the anchor bolts. The CONSULTANT/ENGINEER will

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arrange the delivery. The CONTRACTOR shall be responsible for the accurate setting of the anchor bolts and torque setting of the anchor bolt nuts (provided by the VENDOR).

- C. The tower manufacturer will provide a field technician as required for installation supervision, and one (1) day of operator training during startup.
- D. The installation shall be in accordance with OSHA specifications.

END OF SECTION

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**SECTION 15040
VAPOR TREATMENT SYSTEM**

PART 1 - GENERAL

1.01 WORK INCLUDED

- A. This section includes requirements for coordinating the delivery, installation and functional testing during initial start-up of a complete vapor treatment system with the CONSULTANT/ENGINEER as specified in these Technical Specifications and as shown on the Construction Drawings. All correspondence between the CONTRACTOR and the VENDOR shall be directed through the CONSULTANT/ENGINEER. The vapor treatment system will include but not be limited to: one (1) vapor phase granular activated carbon (VPGAC) unit, one (1) heat exchanger, associated system supports, ductwork, valves, fittings and appurtenances.

1.02 RELATED SECTIONS

- A. Section 01090 - Reference Standards.
- B. Section 01300 - Submittals.
- C. Section 01400 - Quality Control.
- D. Section 01600 - Material and Equipment.
- E. Section 01650 - Starting of Systems.
- F. Section 01700 - Contract Closeout.
- G. Section 15000 - Process Piping and Accessories.
- H. Section 15020 - Air Stripping System.
- I. Section 15060 - Process Pumps and Appurtenances.
- J. Section 16000 - Electrical - General Provisions.

1.03 GENERAL

- A. The CONTRACTOR shall be responsible for obtaining mounting and equipment details from the CONSULTANT/ENGINEER and construct the mounting pad in accordance with the Construction Drawings.

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- B. The CONTRACTOR shall coordinate the delivery and installation of the vapor treatment system with the CONSULTANT/ENGINEER. The CONSULTANT/ENGINEER'S VENDOR will deliver and install one (1) VPGAC unit. CONSULTANT/ENGINEER will be responsible for payment of the VPGAC unit to the associated VENDOR. All correspondence between the CONTRACTOR and the VENDOR shall be directed through the CONSULTANT/ENGINEER. Delivery, storage, and handling of equipment shall conform to the specifications in Section 01600 (Material and Equipment)
- C. The CONTRACTOR shall be available to assist in the process equipment installations (i.e.; prepare access, construct and tie in duct supports, break and seal access holes through walls, etc.) and shall provide any miscellaneous materials and labor necessary to complete a workable system in accordance with the Construction Drawings and these Technical Specifications.
- D. The CONTRACTOR shall be responsible for all electrical installations associated with the vapor treatment system. This includes but is not limited to electrical supply and controls for the heat exchanger. The CONTRACTOR shall obtain a list of electrical supply requirements and controls from the CONSULTANT/ENGINEER'S VENDOR.

1.04 PERMITS AND REGULATIONS

- A. The CONTRACTOR shall comply with all Local, State, and Federal regulations.

PART 2 - PRODUCTS

2.01 MANUFACTURER

- A. The vapor treatment system will be provided by Westates Carbon (US Filter), 30 Technology Drive, Warren, New Jersey 07059-0928 (908) 668-4719.

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2.02 GENERAL DESCRIPTION

- A. A VPGAC vapor treatment system will be provided for the treatment of volatile organic compounds (VOCs) in air stripper off-gas (vapor). The VPGAC system will be capable of treating 7,225 standard cubic feet per minute (scfm) from the air stripper (as specified in Section 15020). The relative humidity in the vapor from the air stripper will be reduced by the heat exchanger prior to contacting the VPGAC unit. The system shall be configured as shown on the Construction Drawings and as described in these Technical Specifications.

2.03 INSTRUMENTATION AND CONTROLS

A. General

1. Instrumentation and controls shall be provided as specified herein and as shown on the Construction Drawings.
2. All instrumentation and controls shall be suitable for the operation in area designated as unclassified per NEC.
3. All instrumentation, controls, and control panels shall be supplied and installed by the CONTRACTOR or electrical subcontractor.
4. A central control panel, located in the treatment building, shall house a programmable logic controller (PLC) to monitor and integrate the operation of the complete IRM system (well pumps, VPGAC system, clear well pumps, and air stripper system). The panel shall be connected to each major component in the Modified IRM groundwater treatment system and will provide an interface for remote access via a telephone line. This panel shall be supplied by the CONTRACTOR or electrical subcontractor.

PART 3 - EXECUTION

3.01 INSTALLATION AND INSPECTION

- A. The CONSULTANT/ENGINEER shall arrange and oversee the VENDOR'S installation of the complete vapor treatment system and appurtenances at the locations indicated on the Construction Drawings. All arrangements shall be made through the CONSULTANT/ENGINEER. The CONTRACTOR shall provide

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miscellaneous field labor and equipment for installation of the vapor treatment system (on the CONTRACTOR'S concrete foundation) and shall ensure that the VENDOR has access to all areas of interest. Electrical connections to the heat exchanger and any instruments or monitoring devices shall be provided by the CONTRACTOR as specified elsewhere.

- B. The installation shall be in accordance with OSHA specifications.

END OF SECTION

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VAPOR TREATMENT SYSTEM**

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**SECTION 15060
PUMPS AND APPURTENANCES**

PART 1 - GENERAL

1.01 WORK INCLUDED

- A. This specification applies to the installation of pumps and associated drivers. All components necessary for the safe and satisfactory operation of the specified equipment which are not specifically included shall be considered to be a part of this specification. The CONSULTANT/ENGINEER will arrange the supply and delivery of the clearwell pumps and associated drivers.
- B. The CONTRACTOR shall coordinate delivery of two (2) vertical turbine clearwell pumps with the CONSULTANT/ENGINEER. CONSULTANT/ENGINEER will be responsible for payment of the two (2) vertical turbine clearwell pumps to the associated VENDOR. The CONTRACTOR shall furnish all labor, materials, incidentals, supervision, and operations required to complete all work of this section and related work as indicated on the Construction Drawings and specified herein, including, but not necessarily limited to the following:
 - 1. Transfer of the existing pump in Recovery Well RW-1 (stainless steel submersible, 50 horsepower) to Recovery Well RW-1RS, complete and operational with electric motors for constant speed operation, control equipment including motor starters, and accessories as shown on the Construction Drawings and specified herein.
 - 2. Furnish electric motors for constant speed operation, control equipment including motor starters, and accessories as shown on the Construction Drawings and specified herein, for the existing 40 horsepower pump in Recovery Well EW-1.
 - 3. Coordination of the delivery of one (1) new submersible RW-1RD recovery well pump with the CONSULTANT/ENGINEER and furnish all labor and materials required to install and operate the new RW-1RD pump.
 - 4. Installation of a vertical turbine pump, suitable for conveying partially treated groundwater from the first clear-well to the top of the second tower air stripper, complete and operational with electric motors for constant speed

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operation, control equipment including motor starters, and accessories as shown on the Construction Drawings and specified herein.

5. Installation of a vertical turbine pump suitable for conveying treated groundwater from the second clear-well through the discharge piping network. The pump shall be complete and operational with electric motor for constant speed operation, control equipment including motor starter, and accessories as shown on the Construction Drawings and specified herein.
6. Furnishing and installation of pump control panel and control wiring from the pumps to the control panel.
7. Installation, pressure testing, and start-up of the pumps and appurtenances.

C. Design Criteria

	Well Pumps EW-1 Submersible	Well Pump RW-1RS Submersible	Well Pump RW-1RD Submersible	Clear Well P-100 Vertical Turbine Pump	Clear Well P-200 Vertical Turbine Pump
Design Point-GPM	450	450	250	1000	1000
Design Point - TDH - FT	212	193	231	47	38
Minimum Efficiency	80	80	80	80	80
Maximum No. of Stages	1	1	1	1	1
Max HP	40	50	25	20	15
Motor Voltage	460	460	460	460	460
Full Load Power Factor	88%	87%	87%	87%	87%
Discharge Size - Inch	6"	6"	3"	8"	8"
Manufacturer	J-Line	Grundfos	Grundfos	Crown	Crown
Model No. - Bowl Assembly	8MC-3	475S500-5	3005250-6	12CC-1100-A	12CC-1100-B

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1.02 RELATED SECTIONS

- A. Section 03300 - Cast-in-Place Concrete
- B. Section 15000 - Piping and Accessories
- C. Section 16000 - Electrical General Provisions

1.03 QUALITY ASSURANCE/QUALITY CONTROL

- A. Quality assurance/quality control measures shall conform to the requirements of the conditions of the contract, as follows:
 - 2. The CONTRACTOR shall comply with applicable provisions and recommendations of the following standards except as otherwise shown on the Construction Drawings or specified herein:
 - a. AWWA/ANSI E101 Vertical Turbine Pumps - Line Shaft Type.
 - b. American Petroleum Institute Standard for Centrifugal Pumps (API 610 -For pump test tolerances only).
 - c. Hydraulic Institute Standards.
 - d. National Electric Code (NEC).
 - e. National Electrical Manufacturer's Association (NEMA).
 - f. Institute of Electrical and Electronic Engineers (IEEE).
 - g. Anti-Friction Bearing Manufacturer's Association (AFBMA).
 - h. American National Standards Institute (ANSI).
 - i. Steel Structures Paints Council (SSPC).

1.04 PERMITS AND REGULATIONS

- A. The CONTRACTOR, at his expense, shall procure all necessary permits and licenses to conduct the work specified herein.

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- B. If the CONTRACTOR believes that the specifications are at variance with any law or regulation, he shall promptly notify the CONSULTANT/ENGINEER in writing, and any necessary adjustments shall be submitted to the CONSULTANT/ENGINEER for approval.

1.05 SUBMITTALS

- A. The CONTRACTOR shall obtain templates to insure accurate setting of anchor bolts from the CONSULTANT/ENGINEER.

1.06 DELIVERY, STORAGE, AND HANDLING

- A. All arrangements for delivery of equipment will be the CONSULTANT'S responsibility. All arrangements for handling of equipment and materials throughout the execution of the work shall be the CONTRACTOR'S responsibility.
- B. The CONTRACTOR shall store equipment and materials so as to ensure the preservation of their quality and fitness for the work. When considered necessary, they shall be placed on wooden platforms, or other hard, clean surfaces and shall be placed under cover when directed. Stored materials shall be located, so as to facilitate prompt inspection. In the event any material, part, or equipment is damaged during this period, the CONTRACTOR shall notify the CONSULTANT/ENGINEER. The CONTRACTOR shall coordinate the re-delivery of another part/equipment and install it at no additional cost to the CONSULTANT/ENGINEER or the OWNER.

1.08 TECHNICAL INSPECTION

- A. All work shall be subject to inspection by the CONSULTANT/ENGINEER, but such inspection shall not relieve the CONTRACTOR from obligation to perform said work in accordance with these specifications and MANUFACTURER'S requirements, or any modifications thereof, as herein provided, shall be corrected and made good by the CONTRACTOR whenever so ordered by the CONSULTANT/ENGINEER, without reference to any previous oversight or error in inspection.
- B. All directions given to the CONTRACTOR by the CONSULTANT/ENGINEER or MANUFACTURER'S representative, pertaining to the scope of work during routine inspection, shall be binding on the CONTRACTOR.

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PART 2 - PRODUCTS

2.01 MATERIALS

A. Controls

1. The pump controls shall maintain pump operation as described in Section 16910-Electrical Controls.

PART 3 - EXECUTION

3.01 INSTALLATION

- A. Installation shall be completed in the presence of the CONSULTANT/ENGINEER.
- B. All vertical turbine pumping units shall be installed on concrete bases and secured with anchor bolts. The concrete bases shall be poured up to 1 inch below the soleplates. The soleplate with the equipment mounted thereon shall then be accurately shimmed to grade and the spaces between filled with an approved nonshrink grout. After the grout has reached its initial set, exposed edges shall be cut back 1/3 inch and the edges neatly finished with 1 to 2 cement mortar.
- C. Neatly placed 1/2 inch hard copper pipe shall be provided on each pump to convey leakage to designated drainage inlet.
- D. Installation shall include furnishing and applying an initial supply of grease and oil, of a type recommended by the pump and motor manufacturers.

3.02 TESTING

A. Field Tests

1. The CONTRACTOR shall furnish all facilities, certified calibrated instruments, personnel, and the service needed for their preparation and execution.
2. The CONSULTANT/ENGINEER, at his own and exclusive option, may provide substitutes for some or all of the instruments supplied by the CONTRACTOR. Proper calibration of every measuring device shall be

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checked and agreed upon between the CONTRACTOR and the CONSULTANT/ENGINEER before running any test.

3. There shall be one 8-hour witnessed field test under actual operating conditions for each pump and motor. The field testing shall be done in the presence of the CONSULTANT/ENGINEER.
4. The results of the tests will be computed and agreed upon with the pump manufacturer or his representative as acceptable before the test can be considered terminated and the test equipment removed.
5. A preliminary field test shall be made to determine the adequacy of the instruments and apparatus. When conditions do not permit such a preparatory run, operations may be started, and later when conditions are satisfactory, the test shall be made.
6. A careful inspection shall be made before, during and after the field tests to insure the proper operation of each pump. The following items shall be inspected:
 - a. Alignment of pump and driver.
 - b. Direction of rotation.
 - c. Electrical connections.
 - d. Gauge openings.
 - e. Operation of lubricating system.
 - f. Liquid passages.

The liquid passages of the pumps should be inspected before installation to guard against error during the test caused by obstructions clogging the passage. If obstructions are found in the pump, the test shall be re-run.

The actual dimensions of the discharge opening where pressure readings are to be taken shall be determined so that proper velocity head corrections can be made.

7. Complete records shall be kept of all information relevant to all field tests, with test report copies to be submitted to all interested parties.

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PUMPS AND APPURTENANCES**

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3.03 START-UP

- A. CONTRACTOR shall verify that structures, pipes and equipment are compatible.
- B. Make adjustments required to place system in proper operating condition.
- C. A pump MANUFACTURER'S representative or direct employee will check and approve the installation before operation. He/she will observe the test operation of the system in the presence of the CONSULTANT/ENGINEER and verify that the pumps conform to requirements, and instruct plant personnel on care and maintenance of the equipment. He/she will revisit the job site as often as necessary until all trouble is corrected and the installation is entirely satisfactory.

END OF SECTION

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**SECTION 16010
BASIC ELECTRICAL REQUIREMENTS**

PART 1 - GENERAL

1.01 WORK INCLUDED

- A. The work covered by this section consists of furnishing and installing all materials, equipment, labor, supervision and services necessary to complete all electrical work specified herein and shown on Construction Drawings E-1, E-2, E-3, E-4 and E-5.
- B. Principal Features:
1. Provide and install a complete system of conduits, switchgear, cables and conductors for electrical power, control, instrumentation and monitoring of the Modified IRM Groundwater Treatment System.
 2. Provide and install new Motor Control Center (MCC-1) and power distribution network as shown on the Construction Drawings.
 3. Provide and install new Main Control Panel (MCP) as shown on the Construction Drawings and described herein.
 4. Complete the installation of the system in compliance with all New York State, local and federal regulations.
 5. Install all underground raceways, conductors, and remote mounted instrumentation to complete the system as described in these Technical Specifications and in the Construction Drawings.
 6. Provide all labor and materials necessary to complete the installation of the utility connection to the Modified IRM Groundwater Treatment System, including all raceways, vaults, transformer(s), and concrete pads.
 7. Provide labor, equipment and materials to construct the power distribution and control system for recovery well vaults EW-1, RW-1RS and RW-1RD, as shown in the Construction Drawings and described in these Technical Specifications.

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8. Provide appropriate trade labor at startup to assist with any necessary equipment calibration, modification or repairs.

1.02 RELATED DOCUMENTS

- A. General provisions of Contract apply to this and the other sections of Division 16.
- B. The following Drawings apply to this Division:
 1. Drawing E-1, Electrical Legend and Conduit Schedule.
 2. Drawing E-2, Electrical Single Line and Utility Feed Layout.
 3. Drawing E-3, Electrical Layout.
 4. Drawing E-4, MCC Layout and Details.
 5. Drawing E-5, RW-1RS and RW-1RD Vault, Electrical Layout.
- C. General: This Section includes general administrative and procedural requirements for electrical installations. The following administrative and procedural requirements are included in this Section to expand the requirements specified in Division 1:
 1. Submittals.
 2. Coordination drawings.
 3. Record documents.
 4. Maintenance manuals.
 5. Rough-ins.
 6. Electrical installations.
 7. Cutting and patching.
 8. Delivery, Storage, and Handling.

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BASIC ELECTRICAL REQUIREMENTS**

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1.03 REFERENCES

- A. Lake Success Local, New York State, and National Electrical codes.
- B. National Electrical Code (NFPA 70), 1999 Edition.
- C. Life Safety Code 101.
- D. NECA Standards of Installation.
- E. NFPA (National Fire Protection Association)-all applicable codes.

1.04 FEES AND TESTS

- A. CONTRACTOR shall be responsible for all fees for permits, inspections and tests necessary to complete the work described herein. CONTRACTOR shall demonstrate to the CONSULTANT/ENGINEER that all items of equipment installed are completely operational and free of defects in all modes.

1.05 COORDINATION WITH OTHER TRADES

- B. CONTRACTOR shall furnish and locate all anchor bolts, inserts and supports for installation by the other trades as required. CONTRACTOR shall coordinate the location of all fixtures, outlets, equipment and devices with other trades to avoid conflicts.

1.06 INSPECTION OF THE SITE AND EXISTING CONDITIONS

- A. Prior to submitting a bid, CONTRACTOR shall visit the site and determine existing conditions at the site and all existing structures to become familiar with existing conditions and electrical systems which may, in any manner, affect the work required under this Contract.
- B. The CONTRACTOR shall carry out any work involving shutdown of the existing services to any piece of equipment now functioning in existing areas at such time as to provide the least amount of inconvenience to the CONSULTANT/ENGINEER. CONTRACTOR shall do such work when directed by the CONSULTANT/ENGINEER.
- C. After award of the Contract, the CONTRACTOR shall confer with the CONSULTANT/ENGINEER to verify, at each stage of construction activity, the

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location(s) of existing utilities and facilities. CONTRACTOR shall protect all existing underground utilities during construction. The CONTRACTOR shall pay for all required repairs for damage inflicted during construction without increase in Contract cost.

- D. Responsibility: The CONTRACTOR shall be responsible for completing the systems in accordance with the intent of these Contract Documents:
1. Coordination of the details of the facility equipment and construction for all Specification divisions which affect the work covered under Division 16, Electrical.
 2. Furnishing and installing all incidental items not actually shown or specified, but which are required by good trade practice to provide complete, functioning systems.
- E. Departures from the Contract Documents: The CONTRACTOR shall submit to the CONSULTANT/ENGINEER, in writing, details of any necessary, proposed departures from these Contract Documents, and the reasons therefore. Such requests must be submitted as soon as is practically possible, and within 30 days after award of the Contract. No such departures shall be made without the written review of the CONSULTANT/ENGINEER.
- F. Substitution of Materials and Equipment: In accordance with provisions elsewhere in these Contract Documents, manufacturers' names and catalog numbers stated herein are intended to indicate the type and quality of equipment or materials desired. Unless substitution is specifically forbidden, proposed alternatives may be submitted for review.

1.07 SUBITTALS

- A. General: Follow the procedures specified in Division 1 Section "SUBMITTALS."
- B. Additional copies may be required by individual sections of these Specifications.
- C. List of Proposed Materials: The CONTRACTOR shall submit a complete list of the proposed manufacturers for each of the items listed in these electrical specifications. Additional submittal data, sufficient to determine equality, shall be required if the CONTRACTOR proposes to substitute another manufacturer's

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equipment. The opinion of the CONSULTANT/ENGINEER shall be final in the decision to accept or reject proposed manufacturer(s) and substitutions.

1.08 COORDINATION DRAWINGS

- A. Prepare coordination drawings in accordance with Division 1 Section "SUBMITTALS," to a scale of 1/4" = 1'-0" or larger; detailing major elements, components, and systems of electrical equipment and materials in relationship with other systems, installations, and building components. Indicate locations where space is limited for installation and access and where sequencing and coordination of installations are of importance to the efficient flow of the Work, including (but not necessarily limited to) the following:
1. Indicate the proposed locations of major raceway systems, equipment, and materials. Include the following:
 - a. Clearances for servicing equipment, including space for equipment disassembly required for periodic maintenance.
 - b. Exterior wall and foundation penetrations.
 - c. Fire-rated wall and floor penetrations.
 - d. Equipment connections and support details.
 - e. Sizes and location of required concrete pads and bases.
 - f. Service entrance, disconnect and utility metering equipment.
 2. Indicate scheduling, sequencing, movement, and positioning of large equipment into the building during construction.
 3. Prepare floor plans, elevations, and details to indicate penetrations in floors, walls, and ceilings and their relationship to other penetrations and installations.
 4. Prepare schematic, connection, and interconnection wiring diagrams required for installation, checkout, trouble shooting, and maintenance. Interconnection drawings are required for wiring between equipment items which is not covered by connection diagrams supplied by equipment vendors. Interconnection drawings shall use the same terminal numbers

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and device and conductor designations that are used in connection diagrams.

1.09 RECORD DOCUMENTS

- A. Prepare record documents in accordance with the requirements in Division 1 Section "SUBMITTALS." In addition to the requirements specified in Division 1, indicate installed conditions for:
 - 1. Major raceway systems, size and location, for both exterior and interior; locations of control devices; distribution and branch electrical circuitry; and fuse and circuit breaker size and arrangements.
 - 2. Equipment locations (exposed and concealed), dimensioned from prominent building lines.
 - 3. Approved substitutions, Contract Modifications, and actual equipment and materials installed.

1.10 MAINTENANCE MANUALS

- A. Prepare maintenance manuals in accordance with Division 1 Section "SUMMARY OF WORK." In addition to the requirements specified in Division 1, include the following information for equipment items:
 - 1. Description of function, normal operating characteristics and limitations, performance curves, engineering data and tests, and complete nomenclature and commercial numbers of replacement parts.
 - 2. Manufacturer's printed operating procedures to include start-up, break-in, and routine and normal operating instructions; regulation, control, stopping, shutdown, and emergency instructions; and summer and winter operating instructions.
 - 3. Maintenance procedures for routine preventative maintenance and troubleshooting; disassembly, repair, and reassembly; aligning and adjusting instructions.
 - 4. Servicing instructions and lubrication charts and schedules.

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1.11 DELIVERY, STORAGE, AND HANDLING

- A. Deliver products to the project properly identified with names, model numbers, types, grades, compliance labels, and other information needed for identification.

PART 2 - PRODUCTS

2.01 REFERENCE TO DRAWINGS

- A. Reference shall be made to Drawing Schedules, Details, Notes and Specifications for: Manufacturer, model, catalog number, size, capacity, performance, ratings and installation of equipment and material.

2.02 CHOICE OF MATERIALS AND EQUIPMENT

- A. In submitting substitutions, bidders should note the following minimum considerations: (1) capacities shown are absolute minimum and must be equaled, (2) physical size limitations for space allotted, (3) structural properties, (4) noise level, (5) interchangeability, (6) compatibility with other materials and assemblies, (7) similar items shall be same manufacturer and style wherever possible, and; (8) electrical hazardous area classification of equipment shall not be downgraded under any circumstances.
- B. All materials and equipment, for which a UL, ANSI or a NEMA Standard is established, shall be so approved, and will be labeled or stamped as such.
- C. Adhesives are not an acceptable technique for mounting, supporting or assembling any system components or assemblies, unless noted otherwise herein.

2.03 SUBMITTALS DURING CONSTRUCTION

- A. Certified arrangement drawings, outline dimensions and weights for all major (engineered) equipment.
- B. Functional description or logic diagrams for all control systems furnished under Division 16, Electrical, and not listed above.
- C. Characteristic curves for all protective devices.
- D. Schematic (Elementary) drawings for any electrical control, and bills of material for equipment including, but not limited to:

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1. Motor Control Center (MCC-1).
 2. Main Control Panel (MCP).
 3. Remote Pump Control Stations (RCP-1 and RCP-2).
- A. Connection diagrams, showing all internal wiring and all required field connections for the following:
1. Low Voltage Motor Control Center.
 2. Any necessary wiring diagrams for HVAC and lighting equipment.
 3. All controls and instrumentation.
- F. Interconnection elementary diagrams for each of the following conductor types:
1. Service conductors, feeder conductors and any branch circuit conductors which have a connection point between the branch circuit overcurrent protection or motor starter, and the utilization equipment.
 2. Discrete control conductors.
 3. Analog control conductors.

PART 3 - EXECUTION

3.01 ROUGH-INS

- A. CONTRACTOR shall verify final locations for rough-ins with field measurements and with the requirements of the actual equipment to be connected.

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3.02 ELECTRICAL INSTALLATIONS

- A. The CONTRACTOR shall be responsible for all electrical power, control and instrumentation wiring and connections to all equipment requiring electrical power. This responsibility applies to all equipment supplied by the CONTRACTOR, as well as all equipment supplied under this and other Divisions, and/or by the CONSULTANT/ENGINEER.
- B. General: Sequence, coordinate, and integrate the various elements of electrical systems, materials, and equipment. Comply with the following requirements:
 - 1. Coordinate electrical systems, equipment, and materials installation with other building and well installation components.
 - 2. Verify all dimensions by field measurements.
 - 3. Arrange for chases, slots, and openings in other building components during progress of construction, to allow for electrical installations.
 - 4. Coordinate the installation of required supporting devices and sleeves to be set in poured-in-place concrete and other structural components, as they are constructed.
 - 5. Sequence, coordinate, and integrate installations of electrical materials and equipment for efficient flow of the Work.
 - 6. Where mounting heights are not detailed or dimensioned, install systems, materials, and equipment to provide the maximum headroom possible.
 - 7. Coordinate connection of electrical systems with exterior underground and overhead utilities and services. Comply with requirements of governing regulations.
 - 8. Install systems, materials, and equipment to conform with approved submittal data, including coordination drawings, to greatest extent possible. Conform to arrangements indicated by the Contract Documents, recognizing that portions of the Work are shown only in diagrammatic form. Where coordination requirements conflict with individual system requirements, refer conflict to the CONSULTANT/ENGINEER.

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9. Install systems, materials, and equipment level and plumb, parallel and perpendicular to other building systems and components, where installed exposed in finished spaces.
10. Install electrical equipment to facilitate servicing, maintenance, and repair or replacement of equipment components. As much as practical, connect equipment for ease of disconnecting, with minimum of interference with other installations.
11. Install systems, materials, and equipment giving right-of-way priority to systems required to be installed at a specified slope.

3.03 CUTTING AND PATCHING

- A. General: Perform cutting and patching in accordance with the requirements specified below:
 1. Perform cutting, fitting, and patching of electrical equipment and materials required to:
 - a. Uncover Work to provide for installation of ill-timed Work.
 - b. Remove and replace defective Work.
 - c. Remove and replace Work not conforming to requirements of the Contract Documents.
 - d. Remove samples of installed Work as specified for testing.
 - e. Install equipment and materials in existing structures.
 - f. Upon written instructions from the CONSULTANT/ENGINEER, uncover and restore Work to provide for CONSULTANT/ENGINEER observation of concealed Work.
 2. Protection of Installed Work: During cutting and patching operations, protect adjacent installations.

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3.04 RECORD AND AS-BUILT DRAWINGS

- A. CONTRACTOR shall maintain at the job site, a set of Contract Documents kept current by indicating thereon, all changes, revisions and substitutions between work as specified and as installed.
- B. CONTRACTOR shall furnish CONSULTANT/ENGINEER with 1 complete set of reproducible drawings, and 2 complete, clean sets of Specifications, showing installed locations, size, catalog numbers, etc., of all work and material as taken from record documents.
- C. For each piece of equipment, the CONTRACTOR shall provide 4 sets of Manufacturer's printed catalog pages of operating and maintenance instructions and wiring and connection diagrams. This information shall be bound into 8 1/2 x 11 inch notebooks.

3.05 EQUIPMENT OPERATION

- A. This Division is responsible for: (1) proper motor rotation, (2) observing that lubrication has been properly performed, (3) that motors operate within nameplate limits, and (4) adjustment of circuit breaker and motor controller trip settings.

3.06 IDENTIFICATION

- A. CONTRACTOR shall identify all major items of equipment, including: controls, panelboards, switches, contactors, motor starters and enclosures, junction boxes and metering with permanent nameplates, with verbiage approved by the CONSULTANT/ENGINEER. Secure any nameplates using stainless steel screws or rivets. Adhesives are acceptable on components within NEMA 1 enclosures only.
- B. Nameplates, after installation, shall be easily visible and shall bear notations identical to those shown on record drawings. P&ID tag designations shall be utilized wherever they exist.
- C. Each instrument shall be identified with a stamped stainless steel tag system (Brady or approved equal). Instrument tags shall be permanently attached to each individual instrument and stamped with the appropriate tag designation as described in the instrument specification section.

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- D. Each wire and/or cable shall be identified with a permanent labeling system (Brady Catalog Number B-292 with printed legends, or approved equal). Instrumentation cables shall be labeled with the appropriate instrument number of the originating signal (ex: FT-201). Multiplex cables, power and control cables shall be labeled with the appropriate cable number as shown in the conduit and cable schedule.
- E. All MCCs, power panels, lighting panels, control panels, control cabinets and transformers shall be identified with permanently mounted phenolic labels.
- F. All power and lighting panels shall have breaker schedules typed and mounted inside their respective door(s).

3.07 TEST PERIOD

- A. Each piece of equipment shall continue to meet performance specifications throughout the first year of actual operation, beginning with the date of acceptance of completed Work. The CONTRACTOR shall replace or repair any defect due to faulty workmanship or material which shall develop within 1 calendar year from date of acceptance. This warrantee shall cover both material and workmanship.

3.08 ELECTRICAL TESTING AND STARTUP

- A. General:
 - 1. Prior to energizing any equipment, the CONTRACTOR shall thoroughly vacuum clean the equipment with an industrial type vacuum cleaner. Any sheet metal parts shall be thoroughly cleaned with degreaser to remove any oil deposited during fabrication or installation. The outside of all electrical equipment shall be cleaned and touched up with vendor-supplied touch-up paint, in order to leave the equipment in an "as-purchased" condition.
 - 2. During startup of new equipment, the CONTRACTOR shall provide sufficient manpower to aid with the startup of the electrical equipment, to remove any faults, and to make any necessary adjustment for proper operation of electrical equipment.
 - 3. All testing equipment shall be furnished by the CONTRACTOR.

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4. All failures under tests due to defective material or poor workmanship shall be corrected by the CONTRACTOR, at no expense to the CONSULTANT/ENGINEER.
 5. The CONTRACTOR shall not, under any circumstances, energize any electrical equipment covered by these Specifications, without first obtaining the permission of the CONSULTANT/ENGINEER.
- B. All power and replacement fuses, bulbs and spare parts necessary for testing shall be furnished and paid for by the CONTRACTOR under this item. All spare parts and fuses shall be obtained prior to startup.

END OF SECTION

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**SECTION 16050
BASIC ELECTRICAL MATERIALS AND METHODS**

PART 1 - GENERAL

1.01 RELATED DOCUMENTS

- A. Drawings and general provisions of Contract, including General and Supplementary Conditions and Division 1 Specification Sections, apply to this Section.
- B. Requirements specified in Division 16 Section 16010 "Basic Electrical Requirements" apply to this Section.

1.02 SUMMARY

- A. This Section includes limited scope general construction materials and methods for application with electrical installations as follows:
 - 1. Miscellaneous metals for support of electrical materials and equipment.

1.03 SUBMITTALS

- A. Shop drawings detailing fabrication and installation for metal fabrications and anchorage for electrical materials and equipment.
- B. Welder certificates, signed by CONTRACTOR, certifying that welders comply with requirements specified under "Quality Assurance" article of this Section. This shall include performance of "Cadweld".

1.04 QUALITY ASSURANCE

- A. Installer Qualifications: Engage an experienced Installer for the electrical equipment installation and "Cadweld" terminations.

1.05 SEQUENCE AND SCHEDULING

- A. Coordinate the shut-off and disconnection of electrical service with the CONSULTANT/ENGINEER (if necessary).

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BASIC ELECTRICAL MATERIALS AND METHODS**

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PART 2 - PRODUCTS

2.01 MISCELLANEOUS METALS

- A. Steel plates, shapes, bars, and bar grating: ASTM A 36.
- B. Cold-Formed Steel Tubing: ASTM A 500.
- C. Hot-Rolled Steel Tubing: ASTM A 501.
- D. Steel Pipe: ASTM A 53, Schedule 40, welded.
- E. Fasteners: Zinc-coated, type, grade, and class as required.

PART 3 - EXECUTION

3.01 EXAMINATION

- A. Examine substrates, areas, and conditions, with Installer present, for compliance with requirements for installation tolerances and other conditions affecting installation and application of joint sealers and access panels. Do not proceed with installation until unsatisfactory conditions have been corrected.

3.02 ERECTION OF METAL SUPPORTS AND ANCHORAGE

- A. Cut, fit, and place miscellaneous metal fabrications accurately in location, alignment, and elevation to support and anchor electrical materials and equipment.

END OF SECTION

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**SECTION 16110
RACEWAYS**

PART 1 - GENERAL

1.01 RELATD DOCUMENTS

- A. Design Documents.
- B. Requirements of the following Division 16 Sections apply to this Section:
 - 1. Section 16010: "Basic Electrical Requirements."
 - 2. Section 16050: "Basic Electrical Materials and Methods."

1.02 SUMMARY

- A. This Section includes raceways for electrical wiring. Types of raceways in this section include the following:
 - 1. Rigid galvanized steel conduit.
 - 2. Rigid Nonmetallic conduit.
 - 3. Liquidtight flexible conduit.
- B. Related Sections: The following Division 16 Sections contain requirements that relate to this Section:
 - 1. "Wires and Cables" for other wiring methods.
 - 2. "Supporting Devices" for raceway supports.
 - 3. "Cabinets, Boxes, and Fittings" for boxes used with conduit and tubing systems.

1.03 SUBMITTALS

- A. General: Submit the following in accordance with Conditions of Contract and Division 1 Specification Sections.

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B. Product Data for the following products:

1. Rigid galvanized steel conduit.
2. Rigid nonmetallic conduit.
3. Liquidtight flexible conduit.

C. Installation Instructions: Manufacturer's written installation instructions for wireway, galvanized steel raceway products.

1.04 QUALITY ASSURANCE

- A. Electrical Component Standard: Components and installation shall comply with NFPA 70 "National Electrical Code."
- B. NEMA Compliance: Comply with applicable requirements of NEMA standards pertaining to raceways.
- C. UL Compliance and Labeling: Comply with applicable requirements of UL standards pertaining to electrical raceway systems. Provide raceway products and components listed and labeled by UL, ETL, or CSA.

1.05 SEQUENCING AND SCHEDULING

- A. Coordinate with other Work, including metal and concrete deck installation, as necessary to interface installation of electrical raceways and components with other Work.

PART 2 - PRODUCTS

2.01 MANUFACTURERS

- A. Manufacturers: Subject to compliance with requirements, provide products by the following:
1. Rigid galvanized steel conduit:
 - a. Allied Tube and Conduit.

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- b. Wheatland.
 - c. General Electric.
 - d. Approved equivalent.
- 2. Rigid nonmetallic conduit:
 - a. Carlon.
 - b. Borg-Warner.
 - c. Approved equivalent.
- 3. Conduit Bodies:
 - a. Appleton Electric Co.
 - b. Crouse-Hinds Division, Cooper Industries, Inc.
 - c. O-Z/Gedney.
 - d. Spring City Electrical Mfg. Co.
- 4. Conduit Fittings and Bushings:
 - a. O-Z/Gedney, Type B.
 - b. Thomas & Betts Company.
 - c. Panduit Manufacturing.
 - d. Appleton Electric Co.
 - e. Myers Electric Products, Inc.

2.02 CONDUIT BODIES

- A. General: Types, shapes, and sizes as required to suit individual applications and NEC requirements. Provide matching cast gasketed covers secured with corrosion-resistant screws.

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- B. Conduit seals, Class 1, Division 2, Group D (unless more stringently classified): Crouse-Hinds #EYS (with drain: Crouse-Hinds #EYD) or approved equivalent.
- C. Conduit fittings for classified hazardous locations, Class 1, Division 2 Group D (unless more stringently classified): Crouse-Hinds # GUA, GUF, GUJ, EAB, CPS, ESC, OE, ET, LBY, LBH, EKC or approved equivalent

2.03 GALVANIZED STEEL CONDUIT

- A. General: Rigid metal conduit shall be heavy wall, mild steel conduit conforming to ANSI C80.1 and Federal Specification WW-C-581, hot dip galvanized both inside and out. All conduits shall bear the approved stamp of the Underwriters Laboratories.
- B. Rigid Steel Conduit: ANSI C80.1.
- C. Fittings and Conduit Bodies: ANSI/NEMA FB 1; steel and malleable iron fittings.
- D. Conduit (or cable) schedules shown on Drawing 15.

2.04 LIQUIDTIGHT FLEXIBLE METAL CONDUIT

- A. General: Flexible conduit shall have an oil-resistant, liquid-tight jacket, in combination with flexible metal reinforcing tubing and shall be designed for use with waterproof fittings. An integral ground wire shall be included. Only UL Listed fittings shall be used.

2.05 RIGID NONMETALLIC CONDUIT

- A. General: Rigid nonmetallic conduit for voltages 600V and less shall be SCH 80 heavy wall polyvinyl chloride (PVC) electrical conduit rated for 90° C conductors and conforming to NEMA TC-2, Type EPC-80-PVC. It shall be listed by Underwriters Laboratories in conformance with the National Electrical Code. Conduit fittings, elbows, and joint cement shall be produced by the same MANUFACTURER as the conduit.

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2.06 CONDUIT FITTINGS AND BUSHINGS

- A. General: Wherever conduits terminate in sheet steel boxes, cast hubs shall be used to form the conduit connection to the box. All bushings shall be insulated metallic type, equal to O. Z. Electrical Manufacturing Company, Type B; T & B Company, 1200 Series; Appleton Electric Company, Type BU-I; or equal.
- B. All conduits terminating at motor control centers shall be suitably grounded to the motor control center ground bus using grounded type insulated bushings equal to O. Z. Electrical Manufacturing Company, BLB or IGB; Appleton, Type BIB; Thomas and Betts, 3800 Series; or equal.

PART 3 - EXECUTION

3.01 WIRING METHOD

- A. Connection to Vibrating Equipment: Including transformers and hydraulic, pneumatic, or electric solenoid or motor-driven equipment: liquidtight flexible galvanized steel conduit or explosion-proof flexible conduit, as appropriate for the atmospheric classification and code requirements.

3.02 GENERAL

- A. Install electrical raceways in accordance with manufacturer's written installation instructions, applicable requirements of NEC, and as follows:
 - 1. Use galvanized steel conduit for above-grade raceways unless otherwise specified.
 - 2. Use rigid nonmetallic conduit for below-grade raceways, unless otherwise specified.
- B. Expose conduit, unless indicated otherwise, on walls, and ceilings. Keep raceways at least 6 inches away from parallel runs of flues and steam or hot water pipes. Install raceways level and square and at proper elevations. Do not block access to openings, louvers, equipment, etc.

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- C. Elevation of Raceway: Where possible, install horizontal raceway runs above water and steam piping. All conduit runs shall be routed overhead unless explicitly called out otherwise in either the specifications or Drawings.
- D. Installation of all electrical raceways shall be completed prior to starting installation of conductors within raceways.
- E. Supports for raceways shall be provided and installed as specified elsewhere in Division 16.
- F. Prevent foreign matter from entering raceways by using temporary closure protection.
- G. Protect stub-ups from damage and corrosion where conduits rise from floor slabs. Arrange so curved portion of bends is not visible above the finished slab. Provide a pitch pocket to 4" above floor slab where conduits rise from floor slabs.
- H. Make bends and offsets so the inside diameter is not effectively reduced. Unless otherwise indicated, keep the legs of a bend in the same plane and the straight legs of offsets parallel.
- I. Use raceway fittings that are of types compatible with the associated raceway and suitable for the use and location.
- J. Run concealed raceways with a minimum of bends in the shortest practical distance considering the type of building construction and obstructions except as otherwise indicated.
- K. Raceways embedded in slabs: Install in middle third of the slab thickness where practical and leave at least 1 inch concrete cover. Tie raceways to reinforcing rods or otherwise secure them to prevent sagging or shifting during concrete placement. Space raceways laterally to prevent voids in the concrete. Run conduit larger than 1-inch trade size, parallel with or at right angles to the main reinforcement; where at right angles to the reinforcement, the conduit shall be close to one of the supports of the slab.
- L. Install exposed raceways parallel and perpendicular to nearby surfaces or structural members and follow the surface contours as much as practical. Where conduit is run overhead, clearance above floor shall not be less than the vertical opening of the overhead door.

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- M. Run exposed, parallel, or banked raceways together. Make bends in parallel or banked runs from the same center line so that the bends are parallel. Factory elbows may be used in banked runs only where they can be installed parallel. This requires that there be a change in the plane of the run such as from wall to ceiling and that the raceways be of the same size. In other cases provide field bends for parallel raceways.
- N. Join raceways with fittings designed and approved for the purpose and make joints tight. Make raceway terminations watertight. Where terminations are subject to vibration, use flexible liquidtight galvanized steel conduit or explosion-proof flexible conduit, as required by the NEC and atmospheric classification.
- O. Terminations: All conduit terminations in sheet metal enclosures shall utilize O-ring-type oil-tight hub connections, manufactured by Thomas & Betts or equal. Terminations shall be separable and watertight.
- P. Where terminating in threaded hubs, screw the raceway or fitting tight into the hub so the end bears against the wire protection shoulder.
- Q. Install pull wires in empty raceways. Use no. 14 AWG zinc-coated steel or monofilament plastic line having not less than 200-lb. tensile strength. Leave not less than 12 inches of slack at each end of the pull wire.
- R. Telephone and Signal System Raceways 2-Inch Trade Size and Smaller: In addition to the above requirements, install raceways 2-inch and smaller trade size in maximum lengths at 150 feet and with a maximum of two, 90-degree. bends or equivalent. Install pull or junction boxes where necessary to comply with these requirements.
- S. Install raceway sealing fittings in accordance with the Manufacturer's written instructions. Locate fittings at suitable, approved, accessible locations and fill them with UL- listed sealing compound of the same manufacturer as the sealing fitting. For concealed raceways, install each fitting in a flush steel box with a blank cover plate having a finish similar to that of adjacent plates or surfaces. Raceway sealing shall comply with NFPA 70 Section 501-5, "Sealings and Drawings. Install raceway sealing fittings at the following points and elsewhere as indicated:
 - 1. Where conduits pass from indoor to outdoor spaces.
 - 2. Where conduits enter or exit hazardous areas.

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3. Within 18" of entering or exiting any enclosure located in the classified area.
- T. Flexible Connections: Use short lengths (maximum of 2 ft.) of flexible metal conduit for connections to motors, equipment subject to vibration, noise transmission, or movement and shall include a built-in, continuous copper ground conductor and terminating fittings suitable to assure adequate bonding connection to conduit.
- U. Buried Conduits: All buried conduits shall be a minimum of 24" below finished grade. All fill material for first 6" of backfill above buried conduit(s) shall be free of stones, pebbles or other debris larger than 1/4" diameter. Buried conduits shall be vertically separated from process piping by a minimum of 6" of compacted fill material, Provide continuous plastic warning tape 6" above all buried conduits.
- V. Expansion and Deflection Fittings: For long straight conduit runs or at a crossing of expansion joint, expansion and deflection fittings must be utilized.
- W. Conduit Drains: Slope conduits to boxes and drains and provide a drain at a low points in trapped conduit runs.

END OF SECTION

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**SECTION 16120
WIRES AND CABLES**

PART 1 - GENERAL

1.01 WORK INCLUDED

- A. Work covered by this section included furnishing all labor, equipment and materials required to install, connect and test all wire and cable, including splices, terminations, connectors, and accessories for a complete installation as shown on the Drawings and/or specified herein.

1.02 RELATED DOCUMENTS

- A. Design Documents and Drawings.
- B. Requirements of the following Division 16 Sections apply to this section:
 - 1. "Basic Electrical Requirements."

1.03 SUMMARY

- A. This Section includes wires, cables, and connectors for power, lighting, signal, control and related systems rated 600 volts and less.
- B. Related Sections: The following Sections contain requirements that relate to this section:
 - 1. Division 2- "Site Work" for trenching and backfilling.
 - 2. Division 16- Section 16135 "Cabinets, Boxes and Fittings" for connectors for Terminating Cables in boxes and other electrical enclosures.

1.04 SUBMITTALS

- A. Product Data for electrical wires, cables and connectors.

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1.05 QUALITY ASSURANCE

- A. Regulatory Requirements: Comply with provisions of the following code:
- B. NFPA 70 "National Electrical Code."
 - 1. Conform to applicable codes and regulations regarding toxicity of combustion products of insulating materials.
- C. UL Compliance: Provide components which are listed and labeled by UL under the following standards.
 - 1. UL Std. 83 Thermoplastic-Insulated Wires and Cables.
 - 2. UL Std. 486A Wire Connectors and Soldering Lugs for Use with Copper Conductors.
 - 3. UL Std. 854 Service Entrance Cable.
- D. NEMA/ICEA Compliance: Provide components which comply with the following standards:
 - 1. WC-5 Thermoplastic-Insulated Wire and Cable for the Transmission and Distribution of Electrical Energy.
 - 2. WC-7 Cross Linked Thermosetting Polyethylene-Insulated Wire and Cable for the Transmission and Distribution of Electrical Energy.
- E. IEEE Compliance: Provide components which comply with the following standard.
 - 1. Std. 82 Test procedures for Impulse Voltage Tests on Insulated Conductors.

1.06 SIZING OF CONDUCTORS

- A. Unless otherwise required or directed by the CONSULTANT/ENGINEER, conductors shall be furnished in the sizes and types specified on Drawing E-1. No wire for lighting, power or motor control circuits shall be smaller than No. 12 AWG. No wire for instrumentation and low-level signal transmission shall be smaller than No. 18 AWG for single pairs or No. 20 AWG for bundled cable.

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- B. Where the size of the lighting and HVAC wiring is not given on the Drawings, it shall be of such size that the voltage drop on the branch circuit is not more than 2 percent. The voltage drop in motor feeder shall not be more than 3 percent at full load from the motor control center MCC-1 to the motor terminal(s).

PART 2 - PRODUCTS

2.01 MANUFACTURERS

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
1. Wire and Cable:
 - a. American Insulated Wire Corp.
 - b. Carol Cable Co. Inc.
 - c. Senator Wire and Cable Co.
 - d. Southwire Company.
 2. Connectors for Wires and Cable Conductors:
 - a. AMP.
 - b. 3M Company.
 - c. O-Z/Gedney Co.
 - d. Square D Company.

2.02 WIRES AND CABLES

- A. General: Provide wire and cable suitable for the temperature, conditions and location where installed.
- B. Conductors: Provide solid conductors for power and lighting circuits no. 10 AWG and smaller. Provide stranded conductors for sizes no. 8 AWG and larger.

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- C. Conductor Material: copper for all wires and cables.
- D. Insulation: Provide THHN/THWN insulation for all conductors for branch circuit power, lighting, control, signal and alarm wiring, 120 to 480 volts. Where cable is for signal wiring below 120 volts cable shall be #18 twisted pair similar to above with aluminum/polyester shield and PVC jacket. All wire shall have insulation rating of not less than 600 Volts.
- E. Color Coding for phase identification in accordance with Table 1 in Part 3 below.
- F. Flexible power cords shall be moisture-resistant, oil-resistant, neoprene-sheathed service cable designed for extra hard usage, Type SO, rated 600 volts at 90 degrees C continuous conductor temperature. All flexible cords shall be UL Listed.
- G. Instrumentation wiring shall consist of a shielded, twisted pair of conductors, with a minimum conductor size of No. 18 AWG. Shield coverage should be 100 percent. Instrumentation wiring shall be provided by Belden, Inc.

2.03 CONNECTORS FOR CONDUCTORS

- A. Provide UL-listed factory-fabricated, solderless metal connectors of sizes, ampacity ratings, materials, types and classes for applications and for services indicated. Use connectors with temperature ratings equivalent to or greater than those of the wires upon which used.
- B. For wires #10 and smaller in non-hazardous locations, use King watertight twist-on insulation "wire nuts", or equal.

PART 3 - EXECUTION

3.01 WIRING METHOD

- A. Use the following wiring methods as indicated:
 - 1. Wire: install all wire in raceway as indicated.
 - 2. Service Entrance Cable Type USE: for underground service feeders.

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3.02 INSTALLATION OF WIRES AND CABLES

- A. General: Install electrical cables, wires, and connectors in compliance with NEC.
- B. Coordinate cable installation with other Work.
- C. Pull conductors simultaneously where more than one is being installed in same raceway. Use UL listed pulling compound or lubricant, where necessary.
- D. Use pulling means including, fish tape, cable, rope, and basket weave wire/cable grips which will not damage cables or raceways. Do not use rope hitches for pulling attachment to wire or cable.
- E. Install exposed cable parallel and perpendicular to surfaces or exposed structural members, and follow surface contours, where possible.
- F. Keep conductor splices to minimum.
- G. Install splice and tap connectors which possess equivalent or better mechanical strength and insulation rating than conductors being spliced.
- H. Use splice and tap connectors which are compatible with conductor material. Provide appropriate compression connectors, and make watertight with heat shrink tubing.
- I. Provide adequate length of conductors within electrical enclosures and train the conductors to terminal points with no excess. Bundle multiple conductors, with conductors larger than no 10 AWG cabled in individual circuits. Make terminations so there is no bare conductor at the terminal.
- J. Tighten electrical connectors and terminals, including screws and bolts, in accordance with manufacturer's published torque tightening values. Where manufacturer's torquing requirements are not indicated, tighten connectors and terminals to comply with tightening torques specified in UL 486A.
- K. Identification: All conductors, including power, control and instrumentation shall be clearly labeled at each end, using Brady B-500 cloth wire markers, Thomas and Betts "EZ-Code" markers, or approved equal.
- L. Unless otherwise specified, splices shall be made at outlet or conduit boxes, pull or junction boxes, manholes or vaults. No splice shall be drawn into a conduit.

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Splices in wiring rated 600 volts and below shall be made with enough spare wire for 2 splices to be remade with the same wire at the same location.

3.03 FIELD QUALITY CONTROL

- A. Prior to energizing, check installed wires and cables with megohm meter to determine insulation resistance levels to assure requirements are fulfilled.
- B. Prior to energizing, test wires and cables for electrical continuity and for short-circuits.
- C. Subsequent to wire and cable hook-ups, energize circuits and demonstrate proper functioning. Correct malfunctioning units, and retest to demonstrate compliance.
- D. TABLE 1: Color Coding for Phase Identification:

Color code secondary service, feeder, and branch circuit as follows:

<u>240/120 Volts</u>	<u>Phase</u>	<u>480/277 Volts</u>
Black	A	Yellow
Red	B	Brown
Blue	C	Orange
White	Neutral	White
Green	Ground	Green

END OF SECTION

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**SECTION 16135
CABINETS, BOXES, AND FITTINGS**

PART 1 - GENERAL

1.01 WORK INCLUDED

- A. The Work covered by this Section consists of furnishing all materials, tools, equipment and labor necessary to install all electrical cabinets, enclosures, boxes and fittings indicated on the Construction Drawings and in this Specification.
- B. Cabinets and enclosures covered by this section include, but are not limited to: the Main Control panel (MCP), recovery well vault remote pump control panels (RCP-1 and RCP-2), as well as the following:
 - 1. All outlet and device boxes.
 - 2. All pull and junction boxes.
 - 3. All cabinets.
 - 4. All hinged door enclosures.
- C. Conduit-body-type electrical enclosures and wiring fittings are specified in Division 16 Section 16110, "Raceways."

1.02 RELATED DOCUMENTS

- A. Design Documents and Drawings.
- B. Requirements of the following Division 16 Sections apply to this section:
 - 1. Section 16010, "Basic Electrical Requirements."
 - 2. Section 16050, "Basic Electrical Materials and Methods."

1.03 REFERENCES

- A. NEMA 250- Enclosures for Electrical Equipment (1000 Volts Maximum).

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- B. ANSI/NEMA ICS-1- Industrial Controls and Systems.
- C. ANSI/NEMA ICS-4- Terminal Blocks for Industrial Control Equipment and Systems.
- D. ANSI/NEMA ICS-6 - Enclosures for Industrial Control Equipment and Systems.

1.04 SUBMITTALS

- A. General: Submit the following in accordance with Conditions of Contract and Division 1 Specification Sections:
 - 1. Product data for cabinets and enclosures with classification higher than NEMA 1.
 - 2. Shop Drawings for Equipment Panels: Include wiring schematic diagram, wiring diagram, outline drawing and construction diagram as described in ANSI/NEMA ICS-1.

1.05 DEFINITIONS

- A. Cabinets: An enclosure designed either for surface or for flush mounting and having a frame, or trim in which a door or doors may be mounted.
- B. Device Box: An outlet box designed to house a receptacle device or a wiring box designed to house a switch.
- C. Enclosure: A box, case, cabinet, or housing for electrical wiring or components.
- D. Hinged Door Enclosure: An enclosure designed for surface mounting and having swinging doors or covers secured directly to and telescoping with the walls of the box.
- E. Outlet Box: A wiring enclosure where current is taken from a wiring system to supply utilization equipment.
- F. Wiring Box: An enclosure designed to provide access to wiring systems or for the mounting of indicating devices or of switches for controlling electrical circuits.

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1.06 QUALITY ASSURANCE

- A. UL Listing and Labeling: Items provided under this section shall be listed and labeled by UL.
- B. Nationally Recognized Testing Laboratory Listing and Labeling (NRTL): Items provided under this section shall be listed and labeled by a NRTL. The term "NRTL" shall be as defined in OSHA Regulation 1910.7.
- C. National Electrical Code Compliance: Components and installation shall comply with NFPA 70 "National Electrical Code."
- D. NEMA Compliance: Comply with NEMA Standard 250, "Enclosures for Electrical Equipment (1000 Volts Maximum)."

PART 2 - PRODUCTS

2.01 MANUFACTURERS

- A. Manufacturers: Subject to compliance with requirements, provide products by the following:
 - 1. Cabinets, Pull and Junction Boxes:
 - a. Erickson Electrical Equipment Co.
 - b. Hoffman Engineering Co.
 - c. Spring City Electrical Mfg. Co.
 - d. Square D Co.

2.02 CABINETS, BOXES AND FITTINGS, GENERAL

- A. Electrical Cabinets, Boxes, and Fittings: Of indicated types, sizes, and NEMA enclosure classes. Where not indicated, provide units of types, sizes, and classes appropriate for the use and location. Provide all items complete with covers and accessories required for the intended use. Provide gaskets for units in damp or wet locations.

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CABINETS, BOXES, AND FITTINGS**

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2.03 MATERIALS AND FINISHES

- A. Sheet Steel: Flat-rolled, code-gage, galvanized steel.
- B. Fasteners: Stainless steel screws and hardware.
- C. Cast Metal for Boxes, Enclosures, and Covers; Copper-free aluminum except as otherwise specified.
- D. Exterior Finish: Gray baked enamel for items exposed in finished locations except as otherwise indicated.
- E. Painted Interior Finish: Where indicated, white baked enamel.
- F. Fittings for Boxes, Cabinets, and Enclosures: As appropriate for corresponding raceways.

2.04 METAL OUTLET, DEVICE, AND SMALL WIRING BOXES

- A. General: Conform to UL 514A, "Metallic Outlet Boxes, Electrical," and UL 514B, "Fittings for Conduit and Outlet Boxes." Boxes shall be of type, shape, size, and depth to suit each location and application. Boxes shall be type FS or FD, or appropriate to device and wiring.
- B. Steel Boxes: Conform to NEMA OS 1, "Sheet Steel Outlet Boxes, Device Boxes, Covers, and Box Supports." Boxes shall be sheet steel with no knockouts. Threaded screw holes and accessories shall be suitable for each location including mounting brackets and straps, cable clamps, exterior rings and fixture studs. Indoor boxes shall be NEMA 12.

2.05 PULL AND JUNCTION BOXES

- A. General: Comply with UL 50, "Electrical Cabinets and Boxes", for boxes over 100 cubic inches volume. Boxes shall have screwed or bolted on covers of material same as box and shall be of size and shape to suit application.
- B. Hot-Dipped Galvanized Steel Boxes: Sheet steel with welded seams. Where necessary to provide a rigid assembly, construct with internal structural steel bracing. Hot-dip galvanized after fabrication. Cover shall be gasketed.

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- C. Install pull fittings Appleton Model PBFW or approved equivalents for every 100 feet of straight run.

2.06 STEEL ENCLOSURES WITH HINGED DOORS

- A. Comply with UL 50, "Cabinets and Enclosures" and NEMA ICS 6, "Enclosures for Industrial Controls and Systems."
- B. Construction: Sheet steel, 16 gage, minimum, with continuous welded seams. NEMA class as indicated; arranged for surface mounting.
- C. Doors: Hinged directly to cabinet and removable, with approximately 3/4-inch flange around all edges, shaped to cover edge of box. Provide multiple doors where required.
- D. Mounting Panel: Provide painted removable internal mounting panel for component installation as noted.

PART 3 - EXECUTION

3.01 INSTALLATION, GENERAL

- A. Locations: Install items where indicated and where required to suit code requirements and installation conditions. Use appropriate enclosure(s) to meet hazardous area requirements as depicted in Drawings 14, 15 and 16.
- B. Cap unused knockout holes where blanks have been removed and plug unused conduit hubs.
- C. Support and fasten items securely in accordance with Division 16 Section "Supporting Devices."
- D. Sizes shall be adequate to meet NEC volume requirements, but in no case smaller than sizes indicated.
- E. Remove sharp edges where they may come in contact with wiring or personnel.

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3.02 APPLICATIONS

- A. Hinged Door Enclosures: NEMA type 12 enclosure except as indicated.
- B. Hinged Door Enclosures Outdoors, Below Grade or Wet Location: NEMA Type 4 and 4X, of stainless steel or painted carbon steel construction - install drip hood, factory tailored to individual units.

3.03 INSTALLATION OF OUTLET BOXES

- A. Mounting: Mount outlet boxes for switches with the long axis vertical or as indicated. Mount boxes for receptacles either vertically or horizontally but consistently either way. Three or more gang boxes shall be mounted with the long axis horizontal.
- B. Cover Plates for Surface Boxes: Use cast, gasketed plates sized to box front without overlap.

3.04 INSTALLATION OF PULL AND JUNCTION BOXES

- A. Box Selection: For boxes in main feeder conduit runs, use sizes not smaller than 8-inches square by 4-inches deep. Do not exceed 6 entering and 6 leaving raceways in a single box.
- B. Cable Supports: Install clamps, grids, or devices to which cables may be secured. Arrange cables so they may be readily identified. Support cable at least every 30-inches inside boxes.
- C. Size: Provide pull and junction boxes for telephone, signal, and other systems at least 50 percent larger than would be required by Article 370 of NEC, or as indicated. Locate boxes strategically and provide shapes to permit easy pulling of future wires or cables of types normal for such systems.

3.05 INSTALLATION OF CABINETS AND HINGED DOOR ENCLOSURES

- A. Mount with fronts straight and plumb.
- B. Install with bottoms 24 inches above floor or ground level.

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3.06 GROUNDING

- A. Electrically ground metallic cabinets, boxes, and enclosures. All wiring shall include a grounding conductor. Provide a grounding terminal in the interior of each cabinet, box or enclosure.

3.07 CLEANING AND FINISH REPAIR

- A. Upon completion of installation, inspect components. Remove burrs, dirt, and construction debris and repair damaged finish including chips, scratches, abrasions and weld marks.
- B. Galvanized Finish: Repair damage using a zinc-rich paint recommended by the enclosure manufacturer.
- C. Painted Finish: Repair damage using matching corrosion inhibiting touch-up coating.

END OF SECTION

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**SECTION 16170
CIRCUIT AND MOTOR DISCONNECTS**

PART 1 - GENERAL

1.01 RELATED DOCUMENTS

- A. Drawings and general provisions of Contract, including General and Supplementary Conditions and Division 1 Specification Sections, apply to this Section.
- B. Requirements of the following Division 16 Sections apply to this section:
 - 1. Section 16010 - Basic Electrical Requirements.

1.02 SUMMARY

- A. This Section includes circuit and motor disconnects not included as part of the Motor Control Center (MCC-1).
- B. Related Sections: The following sections contain requirements that relate to this section:
 - 1. Division 16 Section 16481- "Motor Control Centers" for combination type starters which incorporate disconnect switches in the same enclosure as the starter and manual motor starters which include the disconnect function as part of the starter switch assembly.

1.03 SUBMITTALS

- A. Product data for each type of product specified.
- B. Maintenance data for circuit and motor disconnects, for inclusion in Operation and Maintenance Manual specified in Division 1 and Division 16 Section "Basic Electrical Requirements."

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1.04 QUALITY ASSURANCE

- A. Electrical Component Standards: Provide components complying with NFPA 70 "National Electrical Code" and which are listed and labeled by UL. Comply with UL Standard 98 and NEMA Standard KS 1.

PART 2 - PRODUCTS

2.01 MANUFACTURERS

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - 1. Appleton Electric Co.
 - 2. Crouse-Hinds Co.
 - 3. Cutler-Hammer Inc.
 - 4. General Electric Co.
 - 5. Square D Company.
 - 6. Allen-Bradley.

2.02 CIRCUIT AND MOTOR DISCONNECT SWITCHES

- A. General: Provide circuit and motor disconnect switches in types, sizes, duties, features ratings, and enclosures as indicated. Provide NEMA 12 enclosure for indoor switches, and other indicated locations provide NEMA 4/4X enclosures with raintight hubs and "O-ring" gasket seal. For motor and motor starter disconnects, provide units with horsepower ratings suitable to the loads. Provide appropriate enclosures for hazardous locations.
- B. Fusible Switches: Heavy duty switches, with fuses of classes and current ratings indicated. See Section "Fuses" for specifications. Where current limiting fuses are indicated, provide switches with non-interchangeable feature suitable only for current limiting type fuses.

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- C. Non-fusible Disconnects: Heavy duty switches of classes and current ratings as indicated.

2.03 ACCESSORIES

- A. Electrical Interlocks: Provide number and arrangement of interlock contacts in switches as indicated.

PART 3 - EXECUTION

3.01 INSTALLATION OF CIRCUIT AND MOTOR DISCONNECTS

- A. General: Provide circuit and motor disconnect switches as indicated and where required by the above Code. Comply with switch manufacturers' printed installation instructions.

3.02 FIELD QUALITY CONTROL

- A. Testing: Subsequent to completion of installation of electrical disconnect switches, energize circuits and demonstrate capability and compliance with requirements. Except as otherwise indicated, do not test switches by operating them under load. However, demonstrate switch operation through six opening/closing cycles with circuit unloaded. Open each switch enclosure for inspection of interior, mechanical and electrical connections, fuse installation, and for verification of type and rating of fuses installed. Correct deficiencies then retest to demonstrate compliance. Remove and replace defective units with new units and retest.

END OF SECTION

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CIRCUIT AND MOTOR DISCONNECTS**

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**SECTION 16350
HEATING AND VENTILATING**

PART 1 - GENERAL

1.01 WORK INCLUDED

- A. The Work covered by this Section includes, but is not limited to, the furnishing and installation of the building electric space heaters and exhaust fans within the treatment system building, including all thermostats, controls, power distribution and miscellaneous equipment.

1.02 RELATED WORK

- A. Section 01300 - Submittals
- B. Section 16010 - "General Electrical Requirements"

PART 2 - PRODUCTS

2.01 BUILDING ELECTRIC SPACE HEATERS

- A. The building space heaters shall be UL listed, and shall be the type and rating shown on the drawings and specified herein.
- B. The building electric space heaters shall be 480 volts, 3 phase, 7.5 kW, for all three units to be deployed in the control room and process room.
- C. The control room shall be equipped with a forced air resistive heater, Q-Mark, Model MUH-07-4, 7.5 kW, 480 V, 3 phase forced air resistive. It shall be equipped with a ceiling mounting bracket.
- D. The process room shall be equipped with two (2) identical forced air resistive heaters, Q-Mark, Model MUH-07-4, 7.5 kW, 480 V, 3 phase forced air resistive. They shall be equipped with ceiling mounting brackets.

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2.02 EXHAUST FANS

- A. The control room exhaust fan shall be a Dayton centrifugal, roof mounted ventilator, Model 4HZ49. This unit is a belt drive model, to be equipped with a 1/3 HP, 460 V three-phase TEFC motor. Mounting curb 4X839 shall be used for roof-mounting of the blower, and shall be equipped with backdraft damper 4XH66. Substitutions: approved equivalent.
- B. The process room exhaust fan shall be a Dayton centrifugal, roof mounted ventilator, Model 4HZ57. This unit is a belt drive model, to be equipped with a 1/2 HP, 460 V three-phase TEFC motor. Mounting curb 4X839 shall be used for roof-mounting of the blower, and shall be equipped with backdraft damper 4XH66. Substitutions: approved equivalent.

2.03 THERMOSTATS AND SWITCHES

- A. Each space heater and ventilator shall be equipped with a wall-mounted thermostat, adjustable from 40-85 degrees F. Each thermostat shall be compatible with the environment in which it is deployed.
- B. Any contactors, relays, enclosures or other accessories required to install the thermostatically controlled heaters and ventilators shall be provided by the CONTRACTOR.
- C. All non-integral thermostats shall be wall-mounted to provide easy access. Locations are shown on Drawing E-3.

2.04 INTAKE LOUVERS AND SHUTTERS

- A. The control room shall be equipped with an electrically-actuated louver/shutter assembly. The unit shall be a model number 4C650, as manufactured by Dayton (Grainger).
- B. The process room shall be equipped with an electrically-actuated louver/shutter assembly. The unit shall be a model number 3C315, as manufactured by Dayton (Grainger).
- C. All louvers shall be equipped with bug screens, with openings no larger than 1/8". The bug screens shall not interfere with the operation of the shutters, and shall be of galvanized or stainless steel construction.

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PART 3 - EXECUTION

3.01 INSTALLATION

- A. The space heaters shall be installed as directed by the manufacturer's instructions, and in accordance with the National Electrical Code (NEC), 1999 Edition.
- B. The louver/shutter assemblies shall be powered by dedicated circuit breakers as shown in Drawing E-2, but shall be actuated simultaneously with each respective ventilator fan, using auxiliary contacts on the appropriate motor controller, located inside the MCC. Louver assemblies shall utilize motorize "open" cycle with spring return for "close" cycle.

END OF SECTION

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**SECTION 16490
MOTOR CONTROL CENTER**

PART 1 - GENERAL

1.01 SCOPE OF WORK

- A. The CONTRACTOR shall provide all materials and labor, tools, plant, and equipment to furnish, install, and test the motor control centers required by the Construction Drawings and Technical Documents and required by the work to be done.

1.02 RELATED WORK

- A. Concrete for equipment pads are included in Division 3.

1.03 SUBMITTALS

- A. Submit shop drawings and product data to the CONSULTANT/ENGINEER in accordance with Section 01300, as follows:
 - 1. Equipment outline drawings showing elevation and plan views, dimensions, weight, shipping splits, and metering layouts. Indicate all options, special features, ratings, and deviations from the Specifications.
 - 2. Conduit entrance drawings.
 - 3. Bus arrangement drawings.
 - 4. Unit summary tables showing detailed functional description and nameplate data for each compartment.
 - 5. Product data sheets and catalog numbers for circuit breakers, solid state and magnetic starters, transformer and miscellaneous items. List all options, trip adjustments, and accessories furnished specifically for this Project.
 - 6. Instruction and renewal parts books.

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7. Itemized list of spare parts furnished specifically for this Project, including quantities, description, prices, and part numbers.
8. Test and inspection reports.
9. Operating and maintenance manuals in accordance with Section 01730.

1.04 REFERENCE STANDARDS

- A. Motor control centers shall be designed, built, and tested in accordance with the latest editions and revisions of NEMA Standard ICS-2 and Underwriters' Laboratories Standard No. UL-845. Equipment shall conform to ANSI C19.3 test standards and the requirements of the National Electrical Code.

1.05 QUALITY ASSURANCE

- A. Motor control centers shall be designed, assembled, and tested by the MANUFACTURER of the motor control equipment included in the control center assembly.
- B. All units and sections shall be U.L. labeled.

1.06 SYSTEM DESCRIPTION

- A. One line and control schematic diagrams are shown on the Construction Drawings.

1.07 MAINTENANCE

- A. Provide the following spare parts in the quantities specified:
 1. One (1) dozen (12) each size of cover bolts, cage nuts, and door fasteners.
 2. Two (2) cans of aerosol touch-up paint.
 3. One hundred (100%) percent replacement fuses, all types and sizes.
 4. Ten (10) dozen (12) replacement lamps for pilot lights.
 5. Ten (10) of each color lens caps for pilot lights.

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6. Two (2), three (3) pole sets of replacement overload heaters of each size range used.
- B. Spare parts shall be boxed or packaged for long term storage. Identify each item with name, description, and part number of the MANUFACTURER on the exterior of the package.

PART 2 - PRODUCTS

2.01 RATING

- A. Service: Two hundred and seventy-seven/four hundred and eighty (277/480) volt, three (3) phase, four (4) wire, sixty (60) hertz.
- B. The overall short circuit withstand rating of the equipment and devices shall be forty-two thousand (42,000) amperes rms symmetrical at four hundred and eighty (480) volts. Main and feeder circuit protective devices shall be fully rated for the specified short circuit duty. Systems employing series connected ratings for main and feeder devices will not be permitted. Motor starter units shall be tested and UL labeled for the specified short circuit duty in combination with the motor branch circuit protective device.
- C. The continuous current rating of the main horizontal bus shall twelve hundred (1200) amperes. Vertical buses shall be sized for the structure load and shall have a minimum rating of three hundred (300) amperes. Bus bracing shall equal or exceed the specified equipment short circuit rating.
- D. Motor control centers, including devices, shall be designed for continuous operation at rated current in a forty (40°C) degree Centigrade ambient temperature.

2.02 CONSTRUCTION

- A. General
 1. The general arrangement of the motor control center is shown on the Drawings. The motor control center shall be Allen-Bradley Co. "Centerline" or Square D "Model 6". Substitutions will not be permitted.

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B. Structure

1. The motor control center shall consist of a series of metal enclosed, free-standing, dead front vertical sections bolted together to form double wall construction between sections. Individual vertical sections shall be nominally ninety (90") inches high, twenty (20") inches wide, and twenty (20") inches deep unless shown otherwise on the Drawings. Removable bottom channel sills shall be mounted front and rear of the vertical sections extending the full width of each shipping split. Top of each section shall have removable plates with lifting angle. Make provisions for field installation of additional sections to either end.
2. Furnish and install continuous top and bottom horizontal wireways extending the full width of the line-up, isolated from the horizontal bus. Furnish and install a four (4") inch wide, full height, vertical wireway in each section, equipped with a hinged door and cable supports. Vertical wireway shall be isolated from the bus and device compartments. Wireways openings shall have rolled edges or protective grommets.
3. Furnish and install individual, flange formed, pan type door with concealed hinges and quarter-turn latches for each device compartment and future space. Doors shall be removable. Door removal shall not be required to withdraw starter units or feeder tap devices.
4. All covers, doors, and openings shall be gasketed to meet UL/NEMA Type 1A requirements, unless shown otherwise on the Construction Drawings.

C. Unit Compartments

1. Furnish and install individual, removable, unit device compartments for each combination starter unit and each feeder tap device. Each vertical section shall accommodate a maximum of six (6) unit compartments. Steel barriers shall isolate the top, bottom, and sides of each unit from adjacent units and wireways. Units shall connect to the vertical bus in each section with tin plated, self aligning, pressure type copper plug connectors. Removable units shall be aligned in the structure on guide rails or shelves and secured with a cam latch mechanism or racking screw.

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2. Furnish and install individual isolated compartments for fixed mounted devices, cable lugs, metering, relaying, and control devices. Main circuit breaker shall be bolted directly to the main horizontal bus. All bus connections shall be fully rated.
3. Furnish and install the following safety interlock features:
 - a. Provision to padlock removable units in a partially withdrawn TEST position, with the bus stabs disengaged.
 - b. Provision to padlock unit disconnect handles in the OFF position with up to three (3) padlocks.
 - c. Mechanical interlock to prevent opening unit door with disconnect in the ON position, or moving disconnect to the ON position while the unit door is open.
 - d. Mechanical split-type terminal blocks for disconnecting external control wiring.

D. Bus Systems

1. Main horizontal bus: Silver plated copper, bolted joints, accessible from the front of the structure, fully rated throughout the lineup.
2. Vertical section bus: Silver plated copper, full height, totally insulated and isolated by glass polyester sandwich type barriers with shutters to cover stab openings when units are withdrawn. Furnish and install fishtape barriers to isolate bottom wireways from lower ends of vertical bus.
3. Horizontal ground bus: Furnish and install one-fourth by two (1/4" x 2") inch uninsulated copper ground bus in each section, equipped with lugs for termination of feeder and branch circuit equipment grounding conductors. Connect to ground bus in adjacent sections with splice plates.
4. Vertical ground bus: Furnish and install one hundred and fifty (150) ampere tin-plated copper vertical ground bus in each section, connected to the horizontal ground bus. Furnish and install ground stabs in all unit compartments.

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E. Wiring

1. Wiring: Stranded copper, minimum size No. 12 AWG, with six hundred (600) volt, ninety (90°C) degree Centigrade, flame retardant, Type MTW thermoplastic insulation, NEMA Class II-S, Type C with top mounted terminal boards. Line side power wiring shall be sized for the full rating or frame size of the connected device.
2. Identification: Sleeve type wire markers at each termination point, color coding per NEMA Standards and NEC. Foreign voltage control wiring shall be yellow.

F. Marking and Identification

1. The motor control center shall be furnished and installed with a sign marked "DANGER - 480 VOLTS - KEEP OUT". Signs shall be attached to the sections of the respective ratings. Letters shall not be less than one (1") inch high, one-fourth (1/4") inch stroke. Signs shall be laminated plastic, engraved white letters with a red background.
2. Compartments with voltages from sources outside of the compartment shall have a sign mounted inside the compartment door marked "CAUTION - THIS UNIT CONTAINS A VOLTAGE FROM AN EXTERNAL SOURCE". Letters shall be black on a high visibility yellow background.
3. Furnish and install a two by six (2" x 6") inch engraved master nameplate reading "MCC", screw fastened to the top wireway of the MCC.
4. Furnish and install a one by three (1" x 3") inch engraved unit nameplates of two (2) ply thermoplastic material, black face, white core, fastened to each door with stainless steel screws. Equipment names shall be as shown on the one-line diagrams (e.g. Pump No. EW-1, etc.).

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2.03 COMPONENTS

A. General

1. The Drawings indicate the approximate horsepower, the estimated NEMA size of the starters, and the intended control scheme of the motor driven equipment. Furnish and install the NEMA size starter, circuit breaker trip ratings, control power transformers, and thermal overload heater element ratings matched to the motors and control equipment actually supplied, in compliance with NEC and the heater selection tables of the MANUFACTURER. All variations necessary to accommodate the motors and controls as actually furnished shall be made at the sole cost and expense of the CONTRACTOR.
2. Circuit breaker frame and trip sizes shown on the Drawings are tentative, and are based on the best information available about the specified equipment load. All variations required to conform to the applicable NEC rules, as may be applied to the equipment actually furnished, shall be made at the sole cost and expense of the CONTRACTOR.
3. The main and all feeder circuit protection devices shall be equipped with properly time-current coordinated ground fault interrupters.

B. Circuit Breakers

1. The main circuit breaker in the motor control center, shall be stationary type, power circuit breaker.
2. All outgoing feeder circuit breakers in the motor control center shall be molded case, thermal magnetic trip, bolt-on type, except where specified otherwise.
3. Power circuit breakers shall be one hundred (100%) percent equipment rated, six hundred (600) volt, insulated case circuit breakers with integral fully adjustable solid state protective trip device. The protective trip device shall be temperature insensitive and shall have the following characteristics and functions:
 - a. Independently adjustable long time pick-up and delay.
 - b. Independently adjustable short time pick-up and delay.

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- c. Adjustable instantaneous.
 - d. Independently adjustable ground fault pick-up and delay suitable for four (4) wire service.
 - e. Trip mode targets for overload, short circuit, and ground fault.
 - f. Long time pick-up light.
4. The power circuit breaker shall be equipped with a neutral current sensor designed to work with the solid state protective device in supplementing ground fault detection required for a four (4) wire service. Controls for "CLOSE" and "TRIP" operations shall be activated by manual operation. Control voltage shall be one hundred and twenty (120) volts, sixty (60) hertz, and shall be derived for a built-in four hundred and eighty/one hundred and twenty (480/120) volt control power transformer.
5. Molded case circuit breakers: Thermal-magnetic trip type, six hundred (600) volt, three (3) pole, labeled in accordance with UL Standard 489. Provide a ground fault interrupter for each feeder circuit breaker.

C. Combination Magnetic Starter Units

- 1. Magnetic starters shall be of NEMA, not IEC design.
- 2. Combination magnetic starters shall include a motor circuit protector (MCP) in series with a motor controller and an overload protective device. The MCP shall have a ground fault interrupter and an adjustable magnetic trip range up to one thousand (1,000%) percent of rated continuous current and a trip test feature. MCPs shall be labeled in accordance with UL489.
- 3. Magnetic motor starters: Three (3) pole, six hundred (600) volt, electrically operated, of the types shown on the Drawings. Furnish and install NEMA sizes as required for the horsepower of the motors actually furnished and installed. Minimum size shall be NEMA Size 1. Fractional size starters shall not be used. Starters shall have one hundred and twenty (120) volt encapsulated operating coils; individual control power transformers with fuses, and silver-to-silver renewable line contacts.

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4. Motor overload protection: Standard adjustable, three (3) pole, thermal bi-metallic type, with push-to-test feature. Overload relays shall be reset manually from outside the enclosure by means of an insulated pushbutton. Furnish and install auxiliary alarm contacts where called for on the Drawings.
5. Auxiliary contacts: Form C, NEMA A600 rating, as required by the control schemes on the Drawings. Furnish and install two (2) normally open and two (2) normally closed spare contacts on each starter. Additional auxiliary contacts shall be furnished and installed as shown on the Drawings or as required by the control scheme. When the number of contacts exceed the starter auxiliary contact capacity, a control relay shall be wired in parallel with the starter coil to derive the additional contacts. The control relay shall be installed within the starter enclosure.
6. Control power transformers: Two (2) winding type, one hundred and twenty (120) volt secondary, fused in accordance with the NEC.
7. Provide power monitor and surge arrester as shown on Drawing E-2

D. Instrumentation and Metering

1. Current and voltage metering: microprocessor-based monitoring and protective device, Bulletin 2190 digital meter (DM), Allen-Bradley or approved equal.
2. Instrumentation transformers: Indoor, six hundred (600) volt, butyl-rubber molded, metering class designed in accordance with ANSI and NEMA standards. Window type current transformers, with burden capacity as low as fifty (50 VA) volt-amperes, may be furnished and installed where such capacity is sufficient. Current transformer accuracy ratings shall be at least equal to NEMA standard requirements for the particular application.
3. Elapsed time hour meters: Five (5) digit, non-reset type, with one hundred and twenty (120) volt synchronous motor.

E. Control and Time Delay Relays

1. Control relays: Heavy duty machine tool type, with ten (10) ampere, six hundred (600) volt convertible contacts, Allen-Bradley; General Electric Co. CR120 Series; or approved equal.

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2. Time delay relays: electro-pneumatic, front connected, suitable for mounting inside or on front surface of control panels or other enclosures, fifteen (15) ampere, one hundred and twenty (120) volt contacts, "on-delay" or "off-delay" type as shown or noted on the Drawings, AGASTAT 7000 series, as manufactured by Amerace Corporation, Control Products Division, Allen-Bradley; or approved equal.

F. Pilot Devices

1. Control operators: Heavy duty, full size, oiltight, with NEMA A600 contact rating.
2. Indicator lights: Full size, oiltight, low voltage, with push-to-test feature.

G. Lighting Transformer

1. Insulation shall be Class H for eighty (80°C) degrees Centigrade rise.
2. Single (1) phase with the ratings shown on the drawings.
3. Tap arrangement shall be two (2) two and one-half (2-1/2%) percent FCAN.

H. Lighting Panel

1. The panel shall be single (1) phase, three (3) wire one hundred and twenty/two hundred forty (120/240) volt with main circuit breaker, copper bus.
2. Branch breakers shall have an interrupting capacity of ten thousand (10,000) amperes symmetrical.
3. All branch breakers shall be bolt-on type.

I. Miscellaneous Units

1. Bus connected surge protection: Six hundred (600) volt, three (3) phase lighting arrestor and surge capacitor, General Electric "Tranquell" Series, or approved equal.

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2.04 SURFACE PREPARATION AND SHOP COATINGS

- A. All non-current carrying metal parts of the motor control center assembly shall be cleaned of all weld spatter and other foreign material and given a heat cured, phosphatized chemical pre-treatment to inhibit rust.
- B. The Motor Control Center shall be finish painted with one (1) coat of standard electrocoated, heat cured enamel of the MANUFACTURER.
- C. Unpainted non-current carrying parts shall receive a protective zinc plating to prevent corrosion. All device contacts shall be gold or silver plated.

2.05 SHOP TESTING

- A. Perform standard production testing and inspection of the MANUFACTURER in accordance with NEMA and ANSI standards. The MANUFACTURER shall submit certified copies of test results to the ENGINEER.

PART 3 - EXECUTION

3.01 INSTALLATION

- A. Motor control center floor sills shall be bolted directly to the equipment pad. Structure shall be leveled and plumb. Anchor bolts shall be one-half (1/2") inch. Furnish and install hardware and shims for installation.
- B. Install the equipment in accordance with the instructions of the MANUFACTURER.
- C. Remove temporary lifting angles, lugs, and shipping braces. Touch-up damaged paint finishes.
- D. Install bus splice plates and torque connections.

3.02 FIELD TESTING

- A. Make the following minimum tests and checks before the representative of the MANUFACTURER is called in for testing and adjustment.

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1. Megger incoming line terminals and buses, phase-to-phase and phase-to-ground, after disconnecting devices sensitive to megger voltage.
 2. Remove current transformer shunts after completing secondary circuit. Check polarity and continuity of metering and relaying circuits.
 3. Check mechanical interlocks for proper operation.
 4. Test ground connections for continuity and resistance.
 5. Adjust unit compartment doors.
 6. Check control circuit interlocking and continuity with starters in the TEST position. Provide external source of control power for this test.
 7. Adjust motor circuit protectors and voltage trip devices to their correct settings.
 8. Adjust overload heaters or relays for actual motor nameplate currents.
- B. In the event of an equipment fault, notify the ENGINEER immediately. After the cause of the fault has been identified and corrected, a joint inspection of the equipment shall be conducted by the CONTRACTOR, the ENGINEER, and the factory service technician of the equipment MANUFACTURER. The CONTRACTOR shall repair or replace the equipment at his sole cost and expense, as directed by the ENGINEER prior to placing the equipment back into service.

3.03 ADJUSTMENT

- A. The motor control center manufacturer shall provide the services of a factory trained service technician for the time period specified in Section 16000. The trip, as specified in Paragraph 1.15 of Section 16000, shall be coordinated with the equipment testing, start-up and to instruct the designated personnel of the ENGINEER. In addition to the time specified in Paragraph 1.15 of Section 16000 for instruction purposes, the CONTRACTOR shall include in his estimate sufficient time to accomplish any necessary follow-up or punch list work. The service technician of the MANUFACTURER shall demonstrate and test all operational features of the installed equipment to the satisfaction of the ENGINEER. Submit a certified copy of the field inspection to the ENGINEER. No equipment shall be energized without the approval of the ENGINEER.

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- B. The factory service technician of the control center MANUFACTURER shall make the following inspection, tests, and adjustments:
1. Calibrate and test main and feeder circuit breaker trip devices and protective relays.
 2. Inspect the installation for compliance with the recommended installation practices of the MANUFACTURER and report all deviations to the ENGINEER.

3.04 CLEANING

- A. Remove all rubbish and debris from inside and around the control center. Remove dirt, dust, or concrete spatter from the interior and exterior of the equipment using brushes, vacuum cleaner, or clean, lint-free rags. Do not use compressed air.

END OF SECTION

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**SECTION 16502
LIGHTNING PROTECTION SYSTEM**

PART 1 - GENERAL

1.01 SCOPE OF WORK

- A. The CONTRACTOR shall furnish all materials and labor, tools, plant, and equipment required to furnish and install a complete system of lightning protection for the air stripper and treatment building as required by the contract documents and required by the work to be done.
- B. Items of work required shall include, but are not necessarily limited to, the following:
 - 1. Air terminals and interconnecting conductors.
 - 2. Grounding and bonding needed for lightning protection.

1.02 SYSTEM DESCRIPTION

- A. The lightning protection system shall be in accordance with the latest edition of Lightning Protection Code (NFPA 78) U.L. 96A, and ANSI/LPI 175 and 176 code requirements, and shall consist of air terminals on roof of the treatment building, bonding of structure, and other metal objects, grounding electrodes, and interconnecting conductors.
- B. The lightning protection system shall be furnished and installed with Class I materials per the provisions of NFPA 78.
- C. Underwriters Laboratories Master Label shall be furnished as evidence that the installation has met with U.L. requirements.

1.03 SUBMITTALS

- A. Complete installation details and product data shall be submitted to the Engineer under the provisions of Section 01300, and shall include, as a minimum, the following:

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1. Shop drawings showing layout of air terminals, grounding electrodes, and bonding connections to structure and other metal objects, including the sizes of all constituent components, and details of connection and termination.
2. Product data complete with material descriptions and physical dimensions of each component, as well as listing of each component per ANSI/UL 96.
3. Installation instructions and guidelines in accordance with Section 01730.

1.04 REFERENCE STANDARDS

- A. American National Standards Institute/Lightning Protection Institute (ANSI/LPI).
 1. ANSI/LPI 175.
 2. ANSI/LPI 176.
- B. National Fire Protection Association (NFPA).
 1. NFPA 78-1986 - Lightning Protection Code.
- C. American National Standards Institute/Underwriters Laboratories, Inc. (ANSI/UL).
 1. ANSI/UL 96-1981 - Safety Standard for Lightning Protection Components.
- D. Underwriters Laboratories, Inc. (UL).
 1. UL 96A - Installation Requirements for Lightning Protection Systems.

1.05 PROJECT RECORD DOCUMENTS

- A. The CONTRACTOR shall submit project record documents under the provisions of Section 01700.
- B. The CONTRACTOR shall prepare and submit "as-built" drawings, showing the actual locations of air terminals, grounding electrodes, bonding connections, and routing of system conductors.

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1.06 QUALITY ASSURANCE

- A. The lightning protection equipment furnished under this Section shall be the product of a Manufacturer who has produced the same type of protective system for a period of at least ten (10) documented consecutive years, and who is a member of the Lightning Protection Institute.
- B. The lightning protection equipment shall be installed by an authorized installer of the Manufacturer, with a minimum of three (3) years documented experience.

1.07 SEQUENCING AND SCHEDULING

- A. The Contractor shall coordinate work in accordance with the provisions of Section 01012.
- B. All work of this Section shall be coordinated with other trades engaged in roofing, and in interior and exterior installations.

1.08 CERTIFIED INSTALLERS

- A. The CONTRACTOR shall engage the services of an experienced firm specializing in this type of work and certified by Underwriters' Laboratories, Inc. Certified installers are Heary Bros. Lightning Protection Co., Inc.; Independent Protection Co., Inc.; Thompson Lightning Protection, Inc.; or other certified approved equals.

PART 2 - PRODUCTS

2.01 MATERIALS

- A. All components of the lightning protection system shall be in accordance with ANSI/UL 96. Air terminals shall be as specified hereinafter. All materials shall be Class I.
- B. Air terminals shall be of material and diameter shown on the contract drawings, and extending not less than twenty-four (24") inches above the object which they protect.

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- C. Lightning grounding rods shall be copper-clad steel electrodes, one (1") inch diameter, ten (10') feet long.
- D. Conductors shall be as shown on the Drawings and described thereon.
- E. Ground plates, if used, shall be copper.
- F. Connectors and splicers shall be standard approved type.
- G. Conductor fasteners shall be an approved type of non-corrosive metal having ample strength to support conductor and shall be spaced on maximum three (3') foot centers.

PART 3 - EXECUTION

3.01 EXAMINATION

- A. Before commencing installation, the CONTRACTOR shall verify the following:
 - 1. Surfaces are ready to receive work..
 - 2. All field dimensions are as shown on the shop drawings.
- B. Commencing installation implies acceptance of existing conditions by the CONTRACTOR.

3.02 PROTECTION OF SURROUNDING ELEMENTS

- A. All elements surrounding the work area specified under this Section shall be effectively protected from damage and/or disfiguration.

3.03 INSTALLATION

- A. All installation shall be in accordance with the instructions of the Manufacturer and in compliance with all applicable rules and provisions of UL 96A and NFPA 78.

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- B. Air terminals shall be furnished and installed with proper base supports for the surface on which they are used, and shall be securely anchored to the protected surface.
- C. Conductors shall be coursed to provide a two (2) way path to ground from each air terminal.
- D. Furnish and install down conductors as evenly distributed as possible on outer walls of building.
- E. Lightning grounding rods shall be driven to a minimum depth of ten (10') feet, and more if necessary, to reach permanent moisture. In case of rock ledge or other conditions making it impossible to comply with the above, trench or other grounding will be permitted, providing it meets U.L. requirements.
- F. Furnish and install necessary common bonding between the lightning protection system, electric grounding system, and underground metallic water piping systems.
- G. All ungrounded sizable metallic objects within six (6') feet of the system, or metal connected to the system, shall be bonded to the system with approved fittings and conductor. Connections between dissimilar metals shall be made with approved bimetallic connectors.

3.04 FIELD QUALITY CONTROL

- A. The complete installation shall be inspected and certified by a representative of the Underwriters' Laboratories under provisions of UL 96A, and after acceptance, a U.L. Master Label shall be issued. The U.L. Master Label shall be attached to the building at the location as directed by the CONSULTANT/ENGINEER.

END OF SECTION

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LIGHTNING PROTECTION SYSTEM**

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**SECTION 16512
LIGHTING FIXTURES**

PART 1 - GENERAL

1.01 RELATED DOCUMENTS

- A. Drawings and general provisions of Contract, including General and Supplementary Conditions apply to work of this section.
- B. Division 16- "Basic Electrical Materials and Methods" applies to work specified in this section.

1.02 SUMMARY

- A. Extent of exterior and interior lighting fixture work is indicated by drawings and schedules.

1.03 SUBMITTALS

- A. Product Data: Submit manufacturer's product data and installation instructions on each type exterior building lighting fixture and component.
- B. Shop Drawings: Submit fixture shop drawings in booklet form with separate sheet for each fixture, assembled in "luminaire type" alphabetical or numerical order, with proposed fixture and accessories clearly indicated on each sheet.
- C. Wiring Diagrams: Submit wiring diagrams for lighting fixtures showing connections to electrical panels, switches, and feeders. Differentiate between portions of wiring which are manufacturer-installed and portions which are field-installed.

1.04 QUALITY ASSURANCE

- A. Manufacturer's Qualifications: Firms regularly engaged in manufacture of building lighting fixtures of types and ratings required, whose products have been in satisfactory use in similar service for not less than 5 years.

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- B. Installer's Qualifications: Firm with at least 3 years of successful installation experience on projects with lighting fixture work similar to that required for project.
- C. Codes and Standards
 - 1. Electrical Code Compliance: Comply with applicable local code requirements of the authority having jurisdiction and NEC Articles 225, 250, 410, and 501 as applicable to installation, and construction of building lighting fixtures.
 - 2. NEMA Compliance: Comply with applicable requirements of NEMA Standards Pub/No. LE 2 pertaining to lighting equipment.
 - 3. UL Compliance: Comply with requirements of UL standards, including Stds 486A and B, pertaining to lighting fixtures. Provide lighting fixtures and components which are UL-listed and labeled.
 - 4. NFPA Compliance: Comply with applicable requirements of NFPA 78, "Lightning Protection Code," pertaining to installation of lighting fixtures.

1.05 DELIVERY, STORAGE, AND HANDLING

- A. Deliver exterior lighting fixtures in factory-fabricated containers or wrappings, which properly protect fixtures from construction debris and physical damage.
- B. Store lighting fixtures in original wrappings in a clean dry space. Protect from weather, dirt, fumes, water, construction debris, and damage.
- C. Handle lighting fixtures carefully to prevent damage, breaking, and scoring. Do not install damaged fixtures or components; remove units from site and replace with new.

1.06 SEQUENCING AND SCHEDULING

- A. Coordinate with other electrical work including wires/cables, electrical boxes and fittings, and raceways, to properly interface installation of exterior lighting fixtures with other work.
- B. Sequence lighting installation with other work to reduce possibility of damage and or soiling of fixtures during remainder of construction period.

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1.07 MAINTENANCE

- A. Maintenance Data: Submit maintenance data and parts list for each lighting fixture and accessory; including "trouble-shooting" maintenance guide. Include that data, product data, and shop drawings in a maintenance manual, in accordance with requirements of Division 1.

PART 2 - PRODUCTS

2.01 MANUFACTURERS

- A. Manufacturers: Subject to compliance with requirements, provide products of one of the following (for each type of exterior lighting fixture):
 - 1. Lighting Fixtures
 - a. Appleton Electric Co.
 - b. Crouse-Hinds Lighting Products Div; Cooper Industries Inc.
 - c. General Electric Co.
 - d. Holophane Div; Johns-Manville Corp.
 - e. Lithonia Lighting Div; National Services Industries, Inc.
 - f. McGraw-Edison Co.
 - g. Wide-Light Corp.
 - h. Lumark
 - i. Metalux
 - 2. High-Intensity Ballasts
 - a. Advance Transformer Co.
 - b. General Electric Co.

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- c. Holophane Div; Johns-Manville Corp.
- d. Jefferson Electric Co.
- e. McGraw-Edison Co.
- f. Sola Electric Div; General Signal Corp.
- g. Wide-Lite Corp.

2.02 LIGHTING FIXTURES

- A. General: Provide lighting fixtures, of sizes, types and ratings indicated on Drawing E-1; complete with, but not limited to, housings, energy efficient ballasts, starters and wiring. Furnish indoor lighting fixtures as specified in the Drawings. All lighting fixtures and peripheral equipment shall be UL Listed for deployment in Class 1, Division 1 Group D hazardous locations.
- B. High-Intensity-Discharge Lamp Ballasts: Provide HID lamp ballasts, of ratings, types and makes as recommended by lamp manufacturer, which properly mates and matches lamps to electrical supply by providing appropriate voltages and impedances for which lamps are designed. Design ballasts to operate lamp within the lamp's power trapezoid requirements.
- C. Lamps:
 - 1. Provide lamps to match fixtures.
- D. Photo Electric Sensors:
 - 1. Photo electric control shall be furnished and installed with time delay for outdoor lighting and shall be completely self-contained and not affected by moisture, vibration, or temperature changes.
 - 2. ON/OFF adjustments shall be made by movement of a light level selector, without the use of tools, in a range from two to fifty (2 to 50) footcandles.
 - 3. Photo electric control device shall be SPST, and shall have two thousand (2,000) watt tungsten capacity.

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E. Specific Exterior Lighting Fixtures and Appurtenances:

1. Floodlights will be mounted on outdoor service areas as shown in the Drawings. See Drawing E-3 for locations. Mounting height for stanchion-mounted fixtures: along top of building wall, below roofline, in locations as indicated.

PART 3 - EXECUTION

3.01 EXAMINATION

- A. Examine areas and conditions under which lighting fixtures are to be installed, and substrate which will support lighting fixtures. Notify Contractor in writing of conditions detrimental to proper completion of the Work. Do not proceed with Work until unsatisfactory conditions have been corrected in a manner acceptable to Installer.

3.02 INSTALLATION OF EXTERIOR LIGHTING FIXTURES

- A. Install exterior lighting fixtures at locations and heights as indicated, in accordance with fixture manufacturer's written instructions, applicable requirements of NEC, NECA's "Standard of Installation", NEMA standards, and with recognized industry practices to ensure that lighting fixtures fulfill requirements.
- B. Tighten connectors and terminals, including screws and bolts, in accordance with equipment manufacturer's published torque tightening values for equipment connectors. Where manufacturer's torquing requirements are not indicated, tighten connectors and terminals to comply with tightening torques specified in UL Stds 486A and B, and the National Electrical Code.
- C. Fasten electrical lighting fixtures and brackets securely to indicated structural supports; and ensure that installed fixtures are plum and level. Conduit for exterior fixtures shall be run on the interior wall, not outside.
- D. Install control circuit for lighting as shown on Drawings E-2 and E-3. Contractor shall provide all necessary enclosures, relays and miscellaneous equipment necessary to utilize a single photocell to operate all for specified metal halide

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floodlights. Mount the photo electric sensor per Manufacturer's recommendations.

3.03 GROUNDING

- A. Provide equipment grounding connections for exterior lighting fixtures as indicated. Tighten connections to comply with tightening torques specified in UL Std 486A to assure permanent and effective grounds.

3.04 FIELD QUALITY CONTROL

- A. At the Date of Substantial Completion, replace lamps in exterior lighting fixtures which are observed to be noticeably dimmed after CONTRACTOR's use and testing, as judged by the ENGINEER.
 - 1. Refer to Division 1 sections for the replacement/restoration of lamps in lighting fixtures, where used for temporary lighting prior to Date of Substantial Completion.

3.05 ADJUSTING AND CLEANING

- A. Aim adjustable lighting fixtures and lamps in night test of system.
- B. Clean lighting fixtures of dirt and debris upon completion of installation.
- C. Protect installed fixtures from damage during construction period.
- D. Calibrate photo electric light control sensor in order to turn on flood lights at dusk, and off at dawn.

3.06 DEMONSTRATION

- A. Upon completion of installation of lighting fixtures and associated electrical supply circuitry, apply electrical energy to circuitry to demonstrate capability and compliance with requirements. Where possible, correct malfunctioning units at site, then retest to demonstrate compliance; otherwise, remove and replace with new units, and proceed with retesting.

END OF SECTION

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LIGHTING FIXTURES**

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**SECTION 16600
UNDERGROUND SYSTEM**

PART 1 - GENERAL

1.01 SCOPE OF WORK

- A. The CONTRACTOR shall furnish all materials and labor, tools, plant, and equipment required to furnish and install a complete underground system of ducts, manholes, and handholes, all as required by the contract documents and required by the work to be done.

1.02 RELATED WORK

- A. Excavation and backfilling, including gravel and sand bedding, is included in Division 2.
- B. All concrete and reinforcing steel is included under Division 3.

1.03 REFERENCE STANDARDS

- A. American Society for Testing and Materials (ASTM):
 - 1. ASTM C478-90b - Standard Specification for Precast Reinforced Concrete Manhole Sections.

PART 2 - PRODUCTS

2.01 MATERIALS

- A. Ducts shall be rigid galvanized steel (RGS) conduit or Schedule 40 polyvinyl chloride (PVC) conduit, and shall be of the types and sizes called for on the Drawings.
- B. Conduits shall be buried below grade at depths not less than twenty-four (24") inches below finished grade, and shall be covered by six (6") inches of sand on all sides.

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- C. Cable racks, supports, standard pulling-in irons (where required), and hardware shall be galvanized steel manufactured by Line Materials Co. or approved equal.
- D. Precast manholes and handholes shall be heavy duty type, designed for a Class H20 wheel load and shall conform to ASTM C478. Precast manholes and handholes shall be as manufactured by John E. Potente & Son Co.; or approved equal, and constructed to dimensions as shown on the Drawings.
- E. Manhole and handhole frames and covers shall be heavy duty type for Class H-20 wheel loading, and shall be of type shown on the drawing and shall have raised letters "ELECTRIC".
- F. Bell ends shall be as manufactured by Carlon or approved equal.
- G. Marker tape installed over all direct burial cables, conduits, and ductbanks shall be six (6") inches in width, and shall be Terra Tape "D" detectable as manufactured by Griffolyn, Inc. or approved equal. The tape shall be an inert, bonded layer plastic material with a metallized foil core, so that cable, conduit, and ductbank locations can be determined with a metal detector. The color of the tape shall be bright red with the following imprints:

"CAUTION! BURIED ELECTRIC LINE BELOW!" (for ductbanks with electric cables)

PART 3 - EXECUTION

3.01 INSTALLATION

- A. Ducts shall be installed to drain away from buildings; ducts between manholes or handholes shall drain toward the manholes or handholes. Ductbank slopes shall be not less than three (3") inches per one hundred (100') feet.
- B. Ductbanks shall be laid in trenches on mats of bank gravel not less than six (6") inches thick and well graded.
- C. All concrete envelopes encasing the ducts shall be steel-reinforced under provision of Section 03800 and as detailed on the Drawings.
- D. Plastic spacers shall be used to hold the ducts in place. Spacers shall provide not less than seven and five-tenths (7.5") inches clearance center-to-center between

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ducts. Spacers shall be installed four (4') feet apart. Tie wires shall be No. 16 black annealed iron wire, of length sufficient to tie the complete ductbank together. Tie wires shall be spaced a maximum of four (4') feet apart along the length of the duct system.

- E. The minimum cover for ductbanks shall be thirty-six (36") inches unless approved otherwise by the OWNER; however, under no circumstance shall the duct structures be so placed as to have their tops above the frostline.
- F. Duct entrances to buildings and vaults shall be made with steel conduit not less than ten (10') feet long. Conduits run below floor slabs in slab-on-grade construction shall be rigid steel.
- G. Duct terminations at manholes shall be with end bells for PVC conduit, and insulated throat grounding bushing for steel conduit.
- H. Where bends in ducts are required, long radius elbows, sweeps and offsets shall be used.
- I. All ducts shall be swabbed clean before cable installation.
- J. Spare or empty ducts and duct stub-ups shall be plugged at all manholes, buildings, and structures.
- K. Ducts in use shall be sealed watertight at all manholes, buildings, and structures.
- L. Pulling-in irons shall be installed opposite all duct entrances to manholes.
- M. Cables shall be trained in manholes and handholes supported on racks and hooks. Furnish inserts on all manhole walls for mounting future racks as well as racks required for present installation.

END OF SECTION

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**SECTION 16660
GROUNDING SYSTEM**

PART 1 - GENERAL

1.01 SCOPE OF WORK

- A. The CONTRACTOR shall furnish all materials and labor, tools, plant, equipment, and incidentals required to furnish and install a complete grounding system in strict accordance with Article 250 of the National Electrical Code (NEC), as required by the contract documents and required by the work to be done.
- B. At the option of the CONSULTANT/ENGINEER, the underground system shall be furnished and installed with a concrete envelope as specified or without a concrete envelope. The CONTRACTOR shall bid alternate prices for the underground system as follows:
 - 1. Furnish and install the underground system as required by the contract documents.
 - 2. Furnish and install the underground system as required by the contract documents with the following exceptions:
 - a. Do not furnish and install a concrete envelope.
 - b. Furnish and install ducts of the types and sizes required by the contract documents with the exception that ducts under roadways shall be rigid galvanized steel (RGS).

1.02 REFERENCES STANDARDS

- A. National Electrical Code (NEC)
- B. Underwriters Laboratory (UL)
 - 1. UL 467

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PART 2 - PRODUCTS

2.01 MATERIALS

- A. Conduit shall be as specified under Section 16110.
- B. Wire shall be as specified under Section 16120.
- C. Ground rods shall be one (1") inch diameter by ten (10') feet copper clad steel and constructed in accordance with UL 467. The minimum copper thickness shall be twenty-five hundredths (0.25 mm) millimeters. Ground rods shall be Copperweld or approved equal.
- D. Grounding conduit hubs shall be malleable iron type similar to Thomas and Betts Co. Cat. No. 3940, three-fourths (3/4") inch conduit size; Burndy; O-Z/Gedney Co.; or approved equal, and of the correct size for the conduit.
- E. Waterpipe ground clamps shall be cast bronze saddle type, similar to Thomas and Betts Co. Cat. No. 2; Burndy; O-Z/Gedney Co.; or approved equal, and of the correct size for the pipe.
- F. The building ground grid shall consist of a buried bare stranded tinned, soft-drawn copper cable of not less than ninety-eight (98%) percent conductivity at twenty (20°C) degrees Centigrade size as shown on drawings.
- G. Buried grounding connections shall be by Cadweld process, or accepted equal exothermic welding system.
- H. Ground wire connections to structural steel columns shall be made with long barrel type one-hole heavy duty copper compression lugs, bolted through one-half (1/2") inch maximum diameter holes drilled in the column web, with stainless steel hex head cap screws and nuts.

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PART 3 - EXECUTION

3.01 INSTALLATION

- A. Grounding electrode conductors shall be buried at a depth of not less than eighteen (30") inches below finished grade. Grounding cables that penetrate equipment slabs and vertical runs on building exteriors, shall be run in Schedule 80 PVC conduits.
- B. Equipment grounding conductors shall be run with all feeders and in all conduits.
- C. All steel building columns shall be bonded together with ground wire in polyvinyl chloride (PVC) conduit and connected to the distribution equipment ground bus. Conductors shall be installed in slabs between columns.
- D. Conduits stubbed into equipment, such as motor control center, shall be fitted with insulated grounding bushings and connected to the equipment ground bus. Boxes mounted below or above motor control center shall be bonded to the equipment ground bus. The grounding wire shall be sized in accordance with Table 250-95 of the NEC, except that a minimum No. 12 AWG shall be used.
- E. Liquid-tight flexible metal conduit in sizes one and one-half (1-1/2") inch and larger shall have bonding jumpers. Bonding jumpers shall be external, run parallel (not spiraled), and fastened with plastic tie wraps.
- F. All transformers not provided with neutral grounding resistors shall have their neutrals grounded to the nearest available grounding electrode with a conductor sized in accordance with Article 250-94 of the NEC.
- G. All equipment enclosures, motor and transformer frames, conduits systems, cable armor, exposed structural steel, and all other equipment and materials required by the NEC to be grounded, shall be grounded and bonded in accordance with the NEC.
- H. Exposed connections between different metals shall be sealed with No-Oxide Paint Grade A or approved equal.
- I. All underground conductors shall be buried not less than eighteen (30") inches below finished grade and laid slack, and where exposed to mechanical injury, shall be protected by pipes or other substantial guards. If guards are iron pipe or

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other magnetic material, conductors shall be electrically connected to both ends of the guard. Connections shall be made as hereinbefore specified.

- J. Care shall be taken to ensure good ground continuity, in particular between the conduit system and equipment frames and enclosures. Where necessary, jumper wires shall be installed. A code sized equipment grounding conductor shall be included in all conduits and bonded to equipment frames at each end.
- K. All grounding type receptacles shall be grounded to the outlet boxes with a #12 THW green conductor connected to the ground terminal of the receptacle, and fastened to the outlet box by means of a grounding screw.

3.02 TESTS

- A. Test the resistance of the ground-grid system of the new facility area. All test equipment shall be provided under this Section and as approved by the OWNER. Dry season ground-grid resistance of the system shall not exceed five (5) ohms. If such resistance - values cannot be obtained with the systems shown, provide additional grounding as approved by the CONSULTANT/ENGINEER, at the sole cost and expense of the CONTRACTOR.

END OF SECTION

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**SECTION 16900
PROCESS CONTROL**

PART 1 - GENERAL

1.1 WORK INCLUDED

- A. Work covered by this Section consists of furnishing all labor, materials and equipment necessary to program and test the process control loops described herein, including hardware and software.
- B. CONTRACTOR shall be responsible for ensuring that all control loops operate properly, regardless of equipment supplier, vendor or subcontractor. The CONTRACTOR shall coordinate repair or replacement of any faulty process equipment, control equipment, wiring, or other system components.
- C. Construction Drawings and Technical Specifications are intended to provide process control requirements only. CONTRACTOR is responsible for determining the configuration, design, layout and details of the control loops.

1.02 RELATED WORK

- A. Division 1- General Requirements.
- B. Division 15- Mechanical.
- C. Division 16- Electrical.

PART 2 - PRODUCTS

2.01 CONTROL WIRING

- A. CONTRACTOR shall provide all necessary hardware, wiring, raceways and ancillary equipment and materials to provide control wiring between process equipment, instrumentation, and logic devices.

2.02 INSTRUMENTATION

- A. Control instruments (i.e. Actuated Valves, Level Switches, Pressure Switches, etc.) as described in this Specification.

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PART 3 - EXECUTION

3.01 SYSTEM LAYOUT

The control system consists of the system's Main Control Panel (MCP) located in the main treatment building, as well as Remote Control Panels (RCPs) 1 and 2, located in the RW-1RS and EW-1 well vaults, respectively. The RCPs shall be networked with the MCP as described in Section 16920, and shall route all interlocks, operators and indicators via the Programmable Logic Controller (PLC) located in the MCP. All operators and indicators located in the main treatment building shall be located on the MCP.

3.02 PROGRAMMING

PLC Programming Contractor is responsible for configuration and programming of the programmable logic controller (PLC), any graphical user interface devices (GUIs), and any communication devices to achieve the process control and monitoring functions described below.

3.03 OPERATION - MOTORS

A. Groundwater Extraction Pump RW-1RS (P-500): The pump is designed to extract groundwater from the RW-1RS well and shall be controlled by the MCP.

1. Control Devices:

- a. HS-500: The pump shall be controlled by a Hand-Off-Auto (H-O-A) selector switch located on Remote Control Panel 1 (RCP-1). When the selector switch is in OFF position, P-500 shall not operate. When the selector switch is in the HAND position, P-500 shall operate regardless of the status of alarms and interlocks. When the selector switch is in the AUTO position, P-500 will be subject to all control devices, alarms, and interlocks described in the interlock section below. The pump is equipped with an alternate Hand-Off-Remote (H-O-R) switch located on the main control panel. When the alternate switch is in the OFF position, the P-500 pump will not operate with the RCP-1 panel switch set in the AUTO position, but will operate with the RCP-1 switch in the HAND position. With the MCP H-O-R switch in the REMOTE position, the P-500 pump will operate as dictated by the position of the RCP-1 hand switch. With the MCP H-O-R switch in the HAND position, the P-500 pump will run regardless of interlock condition or position of the RCP-1 hand switch (HS-500).

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2. Indicating Devices:

- a. YL-500: When the P-500 motor controller (located in Motor Control Center MCC-1) engages, closing its auxiliary contact, the PLC shall illuminate a green YL-500 run indicator, located on the MCP. Simultaneously, a signal is transmitted from the PLC to the RCP-1 control panel, illuminating the green YL-500 indicator on the RCP-1 panel located in the RW-1RS Well vault.
- b. FL-500: When the PLC calls on the P-500 motor controller, and the PLC does not detect a corresponding close of the motor controller auxiliary contact within 3 seconds, the PLC shall simultaneously illuminate the red FL-500 indicator on the MCP and on the RCP-1 panel. The red motor fault FL-500 indicator shall remain illuminated until the RESET pushbutton on the RCP-1 panel or the MCP panel is depressed. When the FL-500 alarm is engaged, the PLC output calling on the P-500 motor controller is disabled.

- A. Groundwater Extraction Pump RW-1RD (P-510): The pump is designed to extract groundwater from the RW-1RD well and shall be controlled by the MCP.

1. Control Devices:

- a. HS-510: The pump shall be controlled by a Hand-Off-Auto (H-O-A) selector switch located on Remote Control Panel 1A (RCP-1A). When the selector switch is in OFF position, P-510 shall not operate. When the selector switch is in the HAND position, P-510 shall operate regardless of the status of alarms and interlocks. When the selector switch is in the AUTO position, P-510 will be subject to all control devices, alarms, and interlocks described in the interlock section below. The pump is equipped with an alternate Hand-Off-Remote (H-O-R) switch located on the main control panel. When the alternate switch is in the OFF position, the P-510 pump will not operate with the RCP-1A panel switch set in the AUTO position, but will operate with the RCP-1A switch in the HAND position. With the MCP H-O-R switch in the REMOTE position, the P-510 pump will operate as dictated by the position of the RCP-1A hand switch. With the MCP H-O-R switch in the HAND position, the P-510 pump will run regardless of

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interlock condition or position of the RCP-1A hand switch (HS-500).

2. Indicating Devices:

- a. YL-510: When the P-510 motor controller (located in Motor Control Center MCC-1) engages, closing its auxiliary contact, the PLC shall illuminate a green YL-510 run indicator, located on the MCP. Simultaneously, a signal is transmitted from the PLC to the RCP-1A control panel, illuminating the green YL-510 indicator on the RCP-1A panel located in the RW-1RD Well vault.
- b. FL-500: When the PLC calls on the P-510 motor controller, and the PLC does not detect a corresponding close of the motor controller auxiliary contact within 3 seconds, the PLC shall simultaneously illuminate the red FL-510 indicator on the MCP and on the RCP-1A panel. The red motor fault FL-510 indicator shall remain illuminated until the RESET pushbutton on the RCP-1A panel or the MCP panel is depressed. When the FL-510 alarm is engaged, the PLC output calling on the P-510 motor controller is disabled.

- B. Groundwater Extraction Pump EW-1 (P-400): The pump is designed to extract groundwater from the EW-1 well, and shall be controlled by the MCP.

1. Control Devices:

- a. HS-400: The pump shall be controlled by a Hand-Off-Auto (H-O-A) selector switch located on Remote Control Panel 2 (RCP-2). When the selector switch is in OFF position, P-400 shall not operate. When the selector switch is in the HAND position, P-400 shall operate regardless of the status of alarms and interlocks. When the selector switch is in the AUTO position, P-400 will be subject to all control devices, alarms, and interlocks described in the interlock section below. The pump is equipped with an alternate Hand-Off-Remote (H-O-R) switch located on the main control panel. When the alternate switch is in the OFF position, the P-400 pump will not operate with the RCP-2 panel switch set in the AUTO position, but will operate with the RCP-2 switch in

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the HAND position. With the MCP H-O-R switch in the REMOTE position, the P-400 pump will operate as dictated by the position of the RCP-2 hand switch. With the MCP H-O-R switch in the HAND position, the P-400 pump will run regardless of interlock condition or position of the RCP-2 hand switch (HS-400).

2. Indicating Devices:

- a. YL-400: When the P-400 motor controller (located in Motor Control Center MCC-1) engages, closing its auxiliary contact, the PLC shall illuminate a green YL-400 run indicator, located on the MCP. Simultaneously, a signal is transmitted from the PLC to the RCP-2 control panel, illuminating the green YL-400 indicator on the RCP-2 panel located in the EW-1 vault.
- b. FL-400: When the PLC calls on the P-400 motor controller, and the PLC does not detect a corresponding close of the motor controller auxiliary contact within 3 seconds, the PLC shall simultaneously illuminate the red FL-400 indicator on the MCP and on the RCP-2 panel. The red motor fault FL-400 indicator shall remain illuminated until the RESET pushbutton on the RCP-2 panel or the RESET pushbutton on the MCP panel is depressed. When the FL-400 alarm is engaged, the PLC output calling on the P-400 motor controller is disabled.
- c. Where a pump is controlled by an "H-O-A" in the RCP and a corresponding "H-O-R" in the MCP, provide an amber indicating with flasher adjacent to each selector switch which will be energized when either selector switch is in the "HAND" position.

- C. Airstripper Blower B-320: The blower is designed to draw air through Airstripper #2 (effluent tower), and discharge into the bottom of Airstripper #1, to supply air for the VOC stripping process.

1. Control Devices:

- a. HS-320: The blower shall be controlled by a H-O-A selector switch located on the Main Control Panel. When the selector switch is in the OFF position, B-320 shall not operate. When the selector switch is in the HAND position, B-320 shall operate regardless of the status of alarms and interlocks. When the selector

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switch is in the AUTO position, B-320 will be subject to the control devices, alarms, and interlocks.

2. Indicating Devices:

- a. YL-320: When the B-320 motor controller (located in Motor Control Center MCC-1) engages, closing its auxiliary contact, the PLC shall illuminate a green YL-320 run indicator, located on the MCP.
- b. FL-320: When the PLC calls on the P-320 motor controller, and the PLC does not detect a corresponding close of the motor controller auxiliary contact within 3 seconds, the PLC shall simultaneously illuminate the red FL-320 indicator on the MCP. The red motor fault FL-320 indicator shall remain illuminated until the RESET pushbutton on the MCP panel is depressed. When the FL-320 alarm is engaged, the PLC output calling on the P-320 motor controller is disabled.

D. Duct Heater DH-600: The duct heater is designed to decrease the relative humidity of the air stream from Airstripper #1 prior to the inlet of the VPGAC unit.

1. Control Devices:

- a. HS-600: The duct heater shall be controlled by a H-O-A selector switch located on the Main Control Panel. When the selector switch is in the OFF position, DH-600 shall not operate. When the selector switch is in the HAND position, DH-600 shall operate regardless of the status of alarms and interlocks. When the selector switch is in the AUTO position, DH-600 will be subject to the control devices, alarms, and interlocks.

2. Indicating Devices:

- a. YL-600: When the DH-600 motor controller (located in Motor Control Center MCC-1) engages, closing its auxiliary contact, the PLC shall illuminate a green YL-600 run indicator, located on the MCP.

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- b. FL-600: When the PLC calls on the DH-600 motor controller, and the PLC does not detect a corresponding close of the motor controller auxiliary contact within 3 seconds, the PLC shall simultaneously illuminate the red FL-600 indicator on the MCP. The red motor fault FL-600 indicator shall remain illuminated until the RESET pushbutton on the MCP panel is depressed. When the FL-600 alarm is engaged, the PLC output calling on the P-600 motor controller is disabled.
- E. Clearwell Pump P-100: P-100 shall transfer partially treated process water from Clear Well #1 into the influent of Airstripper #2.
 - 1. Control Devices:
 - a. HS-100: The P-100 pump shall be controlled by a H-O-A selector switch located on the MCP. When the selector switch is in the OFF position, P-100 shall not operate. When the selector switch is in the HAND position, P-100 shall operate regardless of the status of alarms and interlocks. When the selector switch is in the AUTO position, P-100 will be subject to the control devices, alarms, and interlocks.
 - b. Level Switches LSL/LSH-100: In the AUTO mode, the P-100 pump shall be prohibited from operating unless the water level in Clear Well #1 is between the LSL-100 switch and the LSH-100 switch.
 - 2. Indicating Devices:
 - a. YL-100: When the P-100 motor controller (located in Motor Control Center MCC-1) engages, closing its auxiliary contact, the PLC shall illuminate a green YL-100 run indicator, located on the MCP.
 - b. FL-100: When the PLC calls on the P-100 motor controller, and the PLC does not detect a corresponding close of the motor controller auxiliary contact within 3 seconds, the PLC shall simultaneously illuminate the red FL-100 indicator on the MCP. The red motor fault FL-100 indicator shall remain illuminated until the RESET pushbutton on the MCP panel is depressed. When the

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FL-100 alarm is engaged, the PLC output calling on the P-100 motor controller is disabled.

- F. Clearwell Pump P-200: P-200 shall transfer treated process water from Clear Well #2 into the discharge pipe network.

1. Control Devices:

- a. HS-200: The P-200 pump shall be controlled by a H-O-A selector switch located on the MCP. When the selector switch is in the OFF position, P-200 shall not operate. When the selector switch is in the HAND position, P-200 shall operate regardless of the status of alarms and interlocks. When the selector switch is in the AUTO position, P-200 will be subject to the control devices, alarms, and interlocks.
- b. Level Switches LSL/LSH-200: In the AUTO mode, the P-200 pump shall be prohibited from operating unless the water level in Clear Well #2 is between the LSL-200 switch and the LSH-200 switch.

2. Indicating Devices:

- a. YL-200: When the P-200 motor controller (located in Motor Control Center MCC-1) engages, closing its auxiliary contact, the PLC shall illuminate a green YL-200 run indicator, located on the MCP.
- b. FL-200: When the PLC calls on the P-100 motor controller, and the PLC does not detect a corresponding close of the motor controller auxiliary contact within 3 seconds, the PLC shall simultaneously illuminate the red FL-200 indicator on the MCP. The red motor fault FL-200 indicator shall remain illuminated until the RESET pushbutton on the MCP panel is depressed. When the FL-200 alarm is engaged, the PLC output calling on the P-200 motor controller is disabled.

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3.04 OPERATION – INSTRUMENTS AND ACTUATORS

- A. EW-1 WELL FLOWMETER - FIT-400: The FIT-400 flowmeter shall be located in the EW-1 well vault, and shall transmit its flow rate to the RCP-2 control panel for transmitting to the MCP.
1. Process Devices:
 - a. FIT-400: The EW-1 flowmeter, in addition to displaying its instantaneous flow rate locally, will transmit, via analog signal, its flow rate to the RCP-2 panel for transmittal to the MCP.
 - b. FI-400: The flow rate from the FIT-400 flowmeter shall be displayed continuously on the Graphical User Interface (GUI) located on the MCP.
- B. RW-1RS WELL FLOWMETER - FIT-500: The FIT-500 flowmeter shall be located in the RW-1RS well vault, and shall transmit its flow rate to the RCP-1 control panel for transmitting to the MCP.
1. Process Devices:
 - a. FIT-500: The RW-1RS flowmeter, in addition to displaying its instantaneous flow rate locally, will transmit, via analog signal, its flow rate to the RCP-1 panel for transmittal to the MCP.
 - b. FI-500: The flow rate from the FIT-500 flowmeter shall be displayed continuously on the GUI located on the MCP.
- C. RW-1RD WELL FLOWMETER - FIT-510: The FIT-510 flowmeter shall be located in the RW-1RS well vault, and shall transmit its flow rate to the RCP-1 control panel for transmitting to the MCP.
1. Process Devices:
 - a. FIT-510: The RW-1RD flowmeter, in addition to displaying its instantaneous flow rate locally, will transmit, via analog signal, its flow rate to the RCP-1 panel for transmittal to the MCP.
 - b. FI-510: The flow rate from the FIT-510 flowmeter shall be displayed continuously on the GUI located on the MCP.

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- D. MAIN DISCHARGE FLOWMETER - FIT-100: The FIT-100 flowmeter shall be located in the Pump P-200 discharge, and shall transmit its flow rate to the MCP control panel for display.
1. Process Devices:
- a. FIT-100: The discharge flowmeter, in addition to displaying its instantaneous flow rate locally, will transmit, via analog signal, its flow rate to the MCP.
- b. FI-100: The flow rate from the FIT-400 flowmeter shall be displayed continuously on the GUI located on the MCP.
- E. AIRSTRIPPER BLOWER DISCHARGE PRESSURE - PIT-340: The PIT-340 indicating pressure transmitter shall display static pressure in the Blower B-320 discharge piping.
1. Process Devices:
- a. PIT-340: the indicating pressure transmitter shall transmit the B-320 discharge pressure, in inches of water column, to the MCP.
- b. PI-340: The pressure from the PIT-340 pressure transmitter shall be displayed continuously on the GUI located on the MCP.
- F. DUCT HEATER DOWNSTREAM TEMPERATURE - TIT-600: The TIT-600 indicating temperature transmitter shall display air stream temperature in the duct downstream of the duct heater, DH-600.
1. Process Devices:
- a. TIT-600: The indicating temperature transmitter shall transmit the DH-600 downstream air temperature, in degrees Fahrenheit, to the MCP.
- b. TI-600: The temperature from the TIT-600 temperature transmitter shall be displayed continuously on the GUI located on the MCP.

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- G. CLEAR WELL #1 LEVEL SENSOR - LE/LT/LIC100: Clear Well #1 is equipped with a level transmitter to monitor the level of process water in the sump, and to control the P-100 discharge rate.
1. Process Devices:
- a. LE/LT-100: The level transmitter in Clear Well #1 shall continuously transmit the water level in the clear well to the MCP for control of the P-100 discharge and display on the GUI
- b. LIC-100: The GUI and PLC shall be configured to enable the operator to provide a numeric input of desired level setpoint, and the PLC shall enable an output to control a modulating valve (FCV-100), which will modulate to maintain water level in Clear Well #1 at the specified level. Additionally, the GUI shall graphically depict the level of the process water within Clear Well #1 in inches of water.
- H. CLEAR WELL #2 LEVEL SENSOR - LE/LT/LIC-200: Clear Well #2 is equipped with a level transmitter to monitor the level of process water in the sump, and to control the P-200 discharge rate.
1. Process Devices:
- a. LE/LT-200: The level transmitter in Clear Well #2 shall continuously transmit the water level in the clear well to the MCP for control of the P-200 discharge and display on the GUI.
- b. LIC-200: The GUI and PLC shall be configured to enable the operator to provide a numeric input of desired level setpoint, and the PLC shall enable an output to control a modulating valve (FCV-200), which will modulate to maintain water level in Clear Well #2 at the specified level. Additionally, the GUI shall graphically depict the level of the process water within Clear Well #2 in inches of water.
- I. FLOW CONTROL VALVE - FCV-100: The flow from Clear Well Pump P-100 shall be modulated, using a modulating motorized valve, to maintain a preset water level in Clear Well #1.
1. Process Devices:

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- a. FCV-100: Flow Control Valve FCV-100 shall accommodate an analog signal from the MCP which will modulate the flow from the P-100 clear well pump in order to maintain constant water level in Clear Well #1. The water level setpoint shall be set by the system operator via the GUI.
- J. FLOW CONTROL VALVE - FCV-200: The flow from Clear Well Pump P-200 shall be modulated, using a modulating motorized valve, to maintain a preset water level in Clear Well #2.
 - 1. Process Devices:
 - a. FCV-200: Flow Control Valve FCV-200 shall accommodate an analog signal from the MCP which will modulate the flow from the P-200 clear well pump in order to maintain constant water level in Clear Well #2. The water level setpoint shall be set by the system operator via the GUI.
- K. INTERLOCKS AND ALARMS:
 - 1. Main System Interlock: General alarm condition, complete system shutdown and dialout alarm #1 on autodialer. Unless the airstripper blower (B-320) is the cause of a general alarm condition, the air stripper blower shall run for an additional ½ hour upon a complete system shut down. Also, the solenoid valve on the tower air strippers influent drain line (illustrated on Drawing P-1) shall open when the system is off (for any reason) and close when the system is on. Any alarm condition initiating the main system interlock shall be latched. The system operator must acknowledge the alarm prior to restarting the system. Generated from various non-routine instrumentation events as shown on Drawing P-1, Piping, Process and Instrumentation Diagram. In the event of a Main System Interlock Event, a red "Treatment System Disabled" indicator will illuminate on both RCP panels in the well vaults. The following conditions shall generate a Main System Interlock:
 - a. PAL-340: In the event that the airstripper blower B-320 discharge pressure falls below the operator-specified setpoint, the red PAL-340 Blower Pressure Low indicator will illuminate, and the Main System Interlock will engage.

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- b. PAH-340: In the event that the airstripper blower B-320 discharge pressure rises above the operator-specified setpoint, the red PAL-340 Blower Pressure High indicator will illuminate, and the Main System Interlock will engage.
- c. LALL-100: In the event that the water level in Clear Well #1 falls below the LSSL-100 level switch, a red LALL-100 "Clear Well #1 Level Low" alarm indicator will illuminate, and the Main System Interlock will engage.
- d. LAHH-100: In the event that the water level in Clear Well #1 rises above the LSHH-100 level switch, a red LAHH-100 "Clear Well #1 Level High" alarm indicator will illuminate, and the Main System Interlock will engage.
- e. LALL-200: In the event that the water level in Clear Well #2 falls below the LSSL-200 level switch, a red LALL-100 "Clear Well #2 Level Low" alarm indicator will illuminate, and the Main System Interlock will engage.
- f. LAHH-200: In the event that the water level in Clear Well #2 rises above the LSHH-200 level switch, a red LAHH-200 "Clear Well #2 Level High" alarm indicator will illuminate, and the Main System Interlock will engage.
- g. LAH-400: In the event that a high level condition is detected in the EW-1 vault, a red LAH-400 "EW-1 Vault High Level" alarm indicator will illuminate on both the MCP and the RCP-2 panel. The Main System Interlock will engage in this condition.
- h. LAH-500: In the event that a high level condition is detected in the RW-1RS vault, a red LAH-500 "RW-1RS Vault High Level" alarm indicator will illuminate on both the MCP and the RCP-1 panel. The Main System Interlock will engage in this condition.
- i. FL-320: In the event of a failure of the B-320 blower motor, a red FL-320 "B-320 Blower Motor Failure" alarm indicator will illuminate, and the Main System Interlock alarm will engage.

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- j. FL-100: In the event of a failure of the P-100 clear well pump motor, a red FL-100 "P-100 Pump Failure" alarm indicator will illuminate, and the Main System Interlock alarm will engage.
 - k. FL-200: In the event of a failure of the P-200 clear well pump motor, a red FL-200 "P-200 Pump Failure" alarm indicator will illuminate, and the Main System Interlock alarm will engage.
2. Minor System Interlocks: In the event of any minor system alarm, the MCP shall initiate a dialout of alarm #2 of the autodialer, and initiate the appropriate described interlock responses detailed below:
- a. FAL-400: In the event that the EW-1 recovery well (P-400) fails to maintain a minimum operator-specified flow rate, an amber FAL-400 "Well EW-1 Low Flow" alarm indicator will illuminate on the RCP-2 and MCP control panels, and the Minor System Interlock will engage.
 - b. The MCP and the local RCP shall be equipped with a red indicator which will illuminate when the well pump control valve fails to complete its assigned cycle, either at pump start or pump stop. Each valve is equipped with a microswitch which will communicate to the PLC the position of the valve. Should a control valve cycle failure occur, the red lights on the local RCP and MCP shall illuminate and latch, and the appropriate pump shut down. The rest of the extraction and treatment system shall continue to operate normally. The alarm must be manually cleared with the "reset" button prior to restart of the system.
 - c. FAL-500: In the event that the RW-1RS recovery well (P-500) fails to maintain a minimum operator-specified flow rate, an amber FAL-500 "Well RW-1RS Low Flow" alarm indicator will illuminate on the RCP-1 and MCP control panels, and the Minor System Interlock will engage.
 - d. FAL-510: In the event that the RW-1RD recovery well (P-510) fails to maintain a minimum operator-specified flow rate, an amber FAL-500 "Well RW-1RD Low Flow" alarm indicator will illuminate on the RCP-1A and MCP control panels, and the Minor System Interlock will engage.

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- e. FL-400: In the event of a failure of the P-400 well pump, a red FL-400 "P-400 Pump Failure" alarm indicator will illuminate on the RCP-2 and MCP control panels, and the Minor System Interlock will engage.
- f. FL-500: In the event of a failure of the P-500 well pump, a red FL-500 "P-500 Pump Failure" alarm indicator will illuminate on the RCP-1 and MCP control panels, and the Minor System Interlock will engage.
- g. FL-510: In the event of a failure of the P-510 well pump, a red FL-510 "P-510 Pump Failure" alarm indicator will illuminate on the RCP-1A and MCP control panels, and the Minor System Interlock will engage.
- h. FAL-100: In the event that the Modified IRM Groundwater Treatment System fails to maintain a minimum operator-specified discharge flow rate, an amber FAL-100 "Modified IRM Discharge Low Flow" alarm indicator will illuminate and the Minor System Interlock will engage.
- i. TAL-600: If the temperature in the discharge of the DH-600 duct heater falls below an operator-specified setpoint, a red TAL-600 Offgas Temperature Low indicator will illuminate, and the Minor System Interlock will engage.

3.05 TESTING

- A. All equipment will subjected to simulated functional testing at the vendor's facility. The vendor shall provide all necessary equipment and personnel to perform the test. All system components shall be Y2K compliant. Vendor shall provide the necessary support for any debugging during initial testing.
- B. When vendor (as noted on page 16920-5) is preparing to test any equipment and/or panel furnished under sections 16900, 16910, or 16920 he shall notify the CONSULTANT/ENGINEER at least 5 working days prior to testing so that the CONSULTANT/ENGINEER may have one or more representatives present at the testing.

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3.06 DOCUMENTATION

- A. The contractor shall furnish a complete list and data for all electrical devices that are specified herein. This shall include instrument specifications in ISA format, calibrated ranges, product data sheets, spare parts list, manufacturers' name, location, telephone and fax numbers.
- B. The contractor shall furnish a login diagram, a print out of final working code, and any other data needed to fully document the programming function of the PLC.

END OF SECTION

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**SECTION 16910
CONTROLS AND INSTRUMENTATION**

PART 1 - GENERAL

1.01 SECTION INCLUDES

- A. Flowmeters (Liquid).
- B. Pressure Indicators.
- C. Temperature Indicators.
- D. Flowmeter (Vapor).
- E. Water Level Sensors.
- F. Float Switches.
- G. General.

PART 2 - MATERIALS

2.01 FLOWMETERS (LIQUID)

- A. The flowmeters monitoring groundwater extraction, combined treated, and discharged flow shall be Badger Recordall Turbo Meters with the following model numbers:
 - FIT-400 & FIT-500 – 2000 Meter with 0-500 gpm dial range and totalizer.
 - FI-700, FI-800, and FI-900 (if this discharge option is selected): 5500 Meter with 0-500 gpm dial range and totalizer.
- B. The flowmeter and transmitter, FIT-100 shall be a Badger Recordall Turbo 3500 Meter with a 0-1000 gpm dial range and totalizer.

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2.02 PRESSURE INDICATORS

- A. The pressure indicators shall be Bristol Babcock Helicoid 900 gauges with the following model numbers:
- PI-401, PI-402, PI-403, PI-501, PI-502, PI-503, PI-130, PI-120, and PI-220: Model number N1J3D3A2Y.
 - PI-700, PI-800, and PI-900: Model number N1J3C5A2Y.
 - PI-330 and PI-600: Model number N1J30002Y with 0-30 inches of water column vacuum reading.

2.03 TEMPERATURE INDICATORS

- A. The temperature indicator, TI-330 shall be Bristol Babcock Model number 5L1B2018B0000.

2.04 FLOWMETER (VAPOR)

- A. FI-600 air measuring station shall be a FMS-W Air Sentinel unit, manufactured by Farr Company, Los Angeles, CA. The air measuring station shall be equipped with a dry-type volume meter (magnahelic gauge) calibrated to read air volume in cfm.
- B. The air flow measuring station shall measure airflow by sensing total and static pressure. It shall consist of single or multiple extruded sensors factory positioned and connected, to produce an averaged velocity pressure. The measured velocity pressure converted to airflow (cfm) shall have an accuracy with $\pm 2\%$ of the full scale throughout the velocity range of 700-500+FPM.
- C. The airflow measuring station shall be installed to meet at least the MANUFACTURER's minimum installation recommendations and shall not amplify the sound level within the duct. The airflow measuring station shall be no deeper than 6 inches. The maximum resistance to airflow shall not exceed 12% of the velocity head at any given airflow. The unit shall be suitable to 220°F continuous operation with intermittent exposure to 250°F.
- D. The airflow measuring station shall consist of 16-gauge galvanized steel extruded aluminum sensor(s) for total and static pressure, and copper collectors. All interconnecting tubing shall be internal to the unit with the exception of one total pressure and one static pressure connection. An array of total and static sensing

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ports shall be positioned in the aluminum sensor on an equal area basis, with a maximum of 16 square inches per total pressure port on units smaller than 4 square feet of face area. Units of 4 square feet and larger shall have a maximum of 36 square inches per total sensor port, but need not exceed 64 ports, and a maximum of 144 square inches per static pressure port, but need not exceed 16 ports.

- E. Interconnected extruded sensors and their collectors shall average and relate each type of pressure measurement into one total pressure and one static pressure metering port.
- F. A highly accurate, economical manometer that mounts directly to the FMS-W or at any convenient remote location shall be provided. The gauge shall be logarithmically curved to provide wider increments for ease of reading at lower values, and shall be calibrated to read volume (cfm) and velocity (fpm).

PART 3 - EXECUTION

3.01 GENERAL

- A. The CONTRACTOR shall install control devices and instrumentation in full conformance with the instructions of the respective manufacturers.
- B. All control conduit and conductors shall be installed at the locations shown on the drawings.
- C. All control devices and instruments shall be installed at the locations and in the orientations shown on the drawings.

END OF SECTION

**16910-3
CONTROLS AND INSTRUMENTATION**

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**SECTION 16920
CONTROL PANELS**

PART 1 - GENERAL

1.01 WORK INCLUDED

- A. The work covered by this Specification consists of furnishing all labor, equipment, supplies, and materials to provide a completely integrated operable control system for the Modified IRM Groundwater Treatment System. The system shall be constructed and programmed as shown on the Construction Drawings and specified herein. All controls and associated equipment shall be included.

1.02 QUALITY ASSURANCE

- A. The Control System Supplier shall have in his direct employ a staff of capable personnel for detail engineering, coordination, drafting, procurement, expediting, scheduling, construction inspection, installation start-up service for calibration and commissioning, and service for guarantee compliance.

1.03 REFERENCES

- A. All Work shall conform to applicable standards of ANSI, IEEE, JSA, NEMA, UL, and NEC.
- B. All work shall comply with applicable New York State and Lake Success City electrical codes.
- C. All control components shall be UL Listed.
- D. All assembled control panels shall be UL Listed, and be equipped with a label indicating UL Listing.

1.04 CONTROL LOOP DESCRIPTIONS

- A. The Groundwater Extraction and Treatment Control System shall consist of the Main Control Panel (MCP) and the remote control panels RCP-1 and RCP-2.
 - 1. Main Control Panel (MCP): The MCP shall house the PLC, all alarm indicators, all treatment building local control and instrumentation inputs and outputs, hand switches and push-buttons, power for local analog instrumentation, intrinsically safe relays or barriers (where required), and

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the operator interface terminal. The MCP shall operate on a 15A, 120 volt power feed. No 480 volt power shall be used in, or routed through the MCP.

2. Remote Control Panels (RCP) - (Typical for 2): RCP-1 and RCP-2 shall be deployed in each well vault, as shown on the Drawings. Each RCP shall house all local control inputs and outputs, all operators and indicators, local analog inputs, and communicate with the MCP via network connection.
 3. Remote control panel RCP-1A - This device shall contain the operators and indicators for the operation of the RW-1RD well system, and shall act as the mounting point for all discrete I/O to be routed to the RCP-1 panel located in the RW-1RS vault (located nearby). All connections between the RCP-1A operator terminal and the RCP-1 panel shall be 120V discrete I/O.
- B. All control loop alarms that shut down equipment shall latch, unless noted otherwise, to prevent automatic system restart. Control loops shall be designed such that alarms must be manually reset prior to equipment restart. All alarm lights on the control panels shall be unique to one alarm condition and be clearly and permanently marked to identity the alarm condition. The program of the MCP should be configured such that only the "first in" alarm is displayed prior to acknowledgment. Following acknowledgment/reset, any existing alarms will then be displayed by illuminating the appropriate indicator light.

1.05 SUBMITTALS

- A. The following items shall be submitted for each system as a complete package. NEMA Standard symbols and identification designations shall be used on Shop Drawings. Format for Shop Drawings shall be as follows:
1. Schematic or Elementary Diagrams
 - a. Diagrams shall be drawn between vertical lines which represent the source of power. All coils shall have one side connected to the right line. The diagram shall be complete with all control devices of the system indicated. Devices remote from the control panel shall be indicated by appropriate symbols.
 - b. A cross-reference system shall be used in conjunction with each relay or timer coil to readily locate all contacts on the diagram.

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Each line shall be identified with a line number to facilitate identification and explanation. All wires shall be identified with a wire number.

- c. Where color coded cable is used, the color code shall be included in the diagram.
 - d. Limit, pressure, temperature, floats and similar devices shall be indicated in the turned-off, disconnected or shelf position.
 - e. Selector and other multi-contact switches shall have their contact closure sequence shown on the diagram.
 - f. Descriptions of the functions of valves, starters and indicating lights shall be indicated on the diagram and shall completely describe the sequence of operation, both automatic and manual.
- 2. Interconnection Diagrams: Interconnection diagrams shall indicate all field mounted devices external to panels and cabinets. These devices need not be shown in their relative locations. All field device and control panel terminal numbers shall be indicated. Interconnection diagrams may be incorporated on schematic or elementary diagrams.
 - 3. Dimensions: Shop Drawings shall be drawn to scale and indicate all outline, mounting and clearance dimensions. Relative location and size of panel mounted components shall be indicated. Nameplate legends with exact engraving shall be indicated. Useable spare panel space shall be indicated, identified and dimensioned. The panel space layout drawn to scale together with a complete nameplate schedule including wording shall be submitted for review to the CONSULTANT/ENGINEER prior to fabrication.
 - 4. Operator Interface Layout: The CONTRACTOR shall submit to the CONSULTANT/ENGINEER, printouts or drawings depicting the various screens proposed for the operator interface units. Prior to acceptance of the completed system, the layout requires acceptance by the CONSULTANT/ENGINEER.
 - 5. Data: A bill of materials shall be provided, listing the make, model, type and rating of all components.

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6. As-built documentation: The following documentation will be submitted within 30 calendar days of acceptance of the completed control system:
 - a. All wiring, schematic and interconnecting diagrams originally submitted for CONSULTANT/ENGINEER approval shall be updated to incorporate modifications made to the controls during fabrication, installation and/or startup and shakedown. These updated diagrams shall then be submitted, along with AutoCad files, Version 14, for the project record and operation manual.
 - b. A disk copy of the PLC program.
 - c. A disk copy of the operator interface terminal program/setup.

1.06 PROTECTION OF EQUIPMENT

- A. The CONTRACTOR shall be responsible for all damage to equipment in the factory or during shipment. It shall be the CONTRACTOR's responsibility to protect the equipment fully until it is accepted by the CONSULTANT/ENGINEER.
- B. All damage to the equipment shall be repaired to the satisfaction of the CONSULTANT/ENGINEER. The CONTRACTOR shall pay for all costs of repairing the equipment.

1.07 INSPECTION AND TESTING

- A. The CONTRACTOR shall guarantee that any component or equipment furnished by him which shall fail due to defects in materials or workmanship, within 1 year after acceptance by the CONSULTANT/ENGINEER, shall be replaced or repaired without further cost to the CONSULTANT/ENGINEER for labor, parts or transportation.

PART 2 - PRODUCTS

2.01 SUPPLIERS

- A. All control panels and components shall be provided and programmed by either of the following suppliers:

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- > Eagle Controls
23 Old Dock Road
Yaphank, New York 11980
Phone: 631-924-1315
Atten: Mike Hagan
- > Enterprise Automation, Inc.
P.O. Box 2784
Clifton, New Jersey 07015
Phone: 732-271-1745
Atten: Brian Hawkins

No substitutions are permitted.

2.02 GENERAL

- A. The Main Control Panel (MCP) shall contain indicator lights, indicators, control switches, terminals and wiring as shown on the drawings and described herein.
- B. All wiring shall be minimum AWG #16, run in wireways, clearly marked at all terminations with Brady or equal markers. Field wiring shall terminate on 600V, barrier terminals. All terminals shall be clearly marked. All interior devices and terminals shall be mounted on sub-panels.
- C. Field wiring shall enter the panel through conduit and be attached to specified wiring terminals located on the bottom or sides of the MCP.

2.03 SPECIFIC COMPONENTS

- A. Refer to Drawings and Section 16910 - "Controls and Instrumentation" for additional information pertaining to specific components, in order to obtain the desired operation and monitoring requirements.
- B. Programmable Logic Controller: Programmable controller shall be an Allen-Bradley SLC-500 modular type with I/O provided to meet the requirements of the system as described in the Drawings and Specifications. Provide a minimum of 20 percent spare discrete I/O, and a minimum of 2 unused slots in the SLC modular chassis for future upgrade or expansion. The processor shall be an Allen-Bradley type SLC-5/03 (15K Memory Model, A-B Part # 1747-L532). No substitutions are permitted.

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- C. Control Relays: Logic control relays shall be 2-pole double-throw plug-in type with contacts rated 10 amps. They shall be of the track mounted socket type and have a transparent dust cover. They shall have a visual means of indication when the relay is energized.
- D. Nameplates: Nameplates shall be 1/16-inch laminated plastic. Exterior nameplates shall be white with black core (letters). Interior nameplates shall be black with white core (letters). The lettering shall be arranged in two or three rows. The overall size shall be 1 by 2 1/2 inches, unless mounting space or legend content dictate otherwise.
- E. Fuse Blocks: Fuse blocks and fuses shall be provided for the protection of the instruments. Control fuses shall be rail mounted, with LED "blown" indicator. They shall use 1 1/4" x 1/4" fuses of the type appropriate for the application.
- F. Panel Control Switches: Unless otherwise indicated, control and selector switches shall be of the heavy duty, oil-tight, NEMA-rated rotary type with enclosed contacts. The switches shall have positive, quick acting contacts with contact operation not dependent on springs. Each switch shall be equipped with pistol grip handles and rectangular escutcheon with legends as show on the drawings. Switches shall be manufactured by Allen-Bradley, Square-D, General Electric or approved equal.
- G. Push-Buttons: Push-buttons shall be heavy-duty, oil-tight and NEMA-rated. Manufacturer shall be General Electric, Allen-Bradley, Square D or approved equal.
- H. Indicating Lights: Indicating lamps shall be of the transformer type for 120 volt AC service. The lamp assemblies shall be equipped with lenses of the required color as shown in the P&ID and described herein, and readily removable from the front of the panel. Indicating lights shall be oil-tight, and NEMA rated. Allowable manufacturers include Allen-Bradley, General Electric, Square D or approved equal.
- I. Control Panel Enclosures:
 - 1. Main Control Panel enclosure shall be NEMA-3R/12, and shall be provided with windows, subpanels, dead front kits, and other accessories as required. Control panel door shall be provided with a 3 point latching system with a lockable handle. Main Control Panel Enclosure shall be

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Hoffman or equal, and be of sufficient size to provide at least 30 percent available unused volume for future expansion or upgrade.

2. Smaller Wall or pedestal mounted control panels shall be carbon steel NEMA 12, and shall be provided with windows, subpanels, dead front kits, and other accessories as required. Wall mounted enclosures shall be manufactured by Hoffman Engineering or approved equal.

J. Operator Interface Terminal: The MCP shall be equipped with an Operator Interface Terminal (GUI) enabling the operator to access process parameters and performance data, as well as input digital and numeric process variables into the PLC controller. The terminal shall consist of a PanelView 600, as manufactured by Allen-Bradley, and be configured for RS-485 communication. No substitutions shall be permitted.

K. Communication Equipment: The MCP shall be networked to each of the RCP control panels using Flex I/O communication, as provided by Allen-Bradley. Each RCP shall have the capacity of accepting 16 discrete inputs, 16 discrete outputs, and 2 each analog inputs and analog outputs. Networking between the MCP and RCP-1 and RCP-2 panels shall be done using optical fiber cable and appropriate modems, as supplied by Phoenix Digital, Inc. The specifications for communication components are as follows:

1. Optic Fiber Cable: Cable shall be 62.5/125 micron multi-mode fiber, four (4) conductor glass fiber cable, as manufactured by Corning Glass Works, Inc., Phoenix Digital Part # FOC-EXP-04-062. No substitutions are permitted.
2. Optical Fiber Modems: Model OCM-DPR-85-PDST-ACV as manufactured by Phoenix Digital, Inc. No substitutions are permitted.

L. Terminal Blocks and Accessories

1. Terminal Blocks: ANSI/NEMA ICS 4, UL Listed.
2. Power Terminals: Unit construction type, closed-back type, with tubular pressure screw connectors, rated 600 volts.
3. Signal and Control Terminals: Modular construction type, channel mounted; tubular pressure screw connectors, rated 600 volts.

**Modified IRM Groundwater Treatment System
Former Unisys Facility
Great Neck, New York**

4. 30 percent spare signal and control terminal block points shall be provided for modification or future upgrade.

- M. Reference Section 15952 - "Controls and Instrumentation" for further equipment information.

2.04 CONTROL PANEL FEATURES

- A. Light Test Push-button: The MCP shall be equipped with a momentary push-button which, when pressed, lights all indicator lights for a bulb test.
- B. Emergency Stop Pushbutton(s): The MCP will be equipped with a red, mushroom-type "Emergency Stop" switch, which, once depressed, disconnects power to all MCP components and control outputs. The switch used must require manual reset. The MCP shall be equipped with terminals for the use of up to five (5) external or remote Emergency Stop Pushbuttons.
- C. Main Power "On" Indicator: The MCP shall be equipped with a green indicator which will illuminate whenever power is applied to the MCP. The indicator will not illuminate if (1) the Emergency Stop button is depressed, (2) Power is interrupted to the MCP, or; (3) The main control fuse (F1) has blown.
- D. Duplex Receptacle: The MCP shall be equipped with a GFCI-protected 120 volt duplex receptacle inside the enclosure. The receptacle shall have a minimum circuit rating of 5 amps, and shall not be used for continuous duty. It shall be equipped with a plastic stenciled label reading: "For programming terminal only- Not for use with power tools".
- E. External Programming Port: The MCP shall be equipped with an external programming port for access to serial communication with the PLC and GUI without necessitating the opening of the MCP door. This port shall be clearly marked: "Programming Port".
- F. Autodialer: The MCP shall be equipped with an autodialer, as manufactured by RACO, model # "Chatterbox". Substitutions: approved equivalent.

**Modified IRM Groundwater Treatment System
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Great Neck, New York**

2.05 REMOTE CONTROL PANEL (RCP) FEATURES

- A. The system shall be equipped with two (2) Remote Control Panels (RCPs), one each installed in vaults RW-1RS (RCP-1) and EW-1 (RCP-2). Each shall be identical, and constructed as described herein and in the Drawings.
- B. The system shall be equipped with a remote connection for system control I/O, to interconnect the RCP-1 panel to the remote vault-located RCP-1A panel located in the RW-1RD vault. This panel shall incorporate the following features:
 - 1. Light Test Pushbutton
 - 2. Alarm Reset Pushbutton
 - 3. HS-510 rotating switch
 - 4. YL-510 indicator light
 - 5. FL-510 indicator light
 - 6. Alarms clear/Alarms engaged indicator lights
 - 7. Spare indicator light
 - 8. Cla-Val cycle fault indicator light

PART 3 - EXECUTION

3.01 INSTALLATION

- A. All electrical control equipment shall be installed in a neat and workmanlike manner in complete accordance with the Drawings, approved shop drawings and Manufacturers' printed installation instructions.
- B. All raceways and panel connections shall conform to the guidelines established in Section 16110 - "Raceways".
- C. Ground all devices and shields according to Manufacturers' directions.

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- D. All terminations shall be accessible from the front of the panel.

3.02 FABRICATION/LAYOUT

A. Input/Output Layout

1. All field instrumentation, field control switches, control panel push-buttons and hand switches shall be assigned unique inputs into the PLC. No field devices, instruments or switches shall be permitted to drive indicators, alarms, motor controllers or controls without entering the PLC.
2. All control panel indicators, motor controllers, field devices (ex: solenoids) external alarms or relays shall be driven directly from the PLC output(s).

3.03 PROGRAMMING

- A. The CONTRACTOR shall provide all programming of the PLC as described on the Drawings and described herein. The CONTRACTOR will be responsible for any program modification necessary to reach an acceptable level of system performance, as determined during system startup.
- B. Operator Interface Terminal: The operator interface terminal shall be programmed to provide operator adjustable access to all timers shown on the Drawings, as well as display the status of all scaled 4-20 mA analog input values including:
1. Flow rate for each well (in GPM).
 2. Temperature of VPGAC influent process stream.
 3. Water level in both clear wells.

The default screen shall contain the realtime values for both of the analog values listed above, and shall return to that display when the keypad has been inactive for 60 seconds.

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- C. Analog Process Outputs: The MCP shall contain 4-20 mA outputs to transmit the following signals to analog control equipment:
1. Flow valve control, pump P-100.
 2. Flow valve control, pump P-200.

END OF SECTION

STATE OF NEW YORK: DEPARTMENT OF ENVIRONMENTAL CONSERVATION

In the Matter of the
Development and Implementation
of a Remedial Program for Operable Unit 1 of an
Inactive Hazardous Waste Disposal
Site, Under Article 27, Title 13,
and Article 71, Title 27 of the
Environmental Conservation Law
of the State of New York by

ORDER
ON
CONSENT
INDEX #
W1-0787-96-12

Lockheed Martin,
Respondent

Site Code #1-30-045

WHEREAS,

1. The New York State Department of Environmental Conservation (the "Department") is responsible for enforcement of Article 27, Title 13 of the Environmental Conservation Law of the State of New York ("ECL"), entitled "Inactive Hazardous Waste Disposal Sites." This Order is issued pursuant to the Department's authority under, inter alia, ECL Article 27, Title 13 and ECL 3-0301.
2. Lockheed Martin Corporation ("Respondent"), is a corporation organized and existing under the laws of the State of Maryland and is doing business in the State of New York. The Lockheed Martin Site, which is listed in the New York State Registry of Inactive Hazardous Waste Sites as "Unisys Corporation Site", is located at Marcus Avenue, in the Village of Lake Success, the Town of North Hempstead, State of New York, County of Nassau (the "Site"). Respondent is a successor in interest to the former owners and operators of a facility located at the Site; namely Unisys Corporation, the Loral Corporation, and the Lockheed Martin Tactical Systems, Inc., a formerly owned subsidiary of Lockheed Martin Corporation. A map of the Site is attached to this Order as Appendix A. Because of technical considerations, the Department divided this Site into two operable units. Operable Unit No. 1 ("OU-1") consists of the on-site project area. Operable Unit 2 ("OU-2") includes the off-site area.
3. The Department has determined that the Site is an inactive hazardous waste disposal site, as that term is defined at ECL 27-1301.2. The Site has been listed in the Registry of Inactive Hazardous Waste Disposal Sites in New York State as Site Number 1-30-045. The Department has classified the Site as a Classification "2" pursuant to ECL 27-1305.4.b.
4. A. Pursuant to ECL 27-1313.3.a, whenever the Commissioner of Environmental Conservation (the "Commissioner") "finds that hazardous wastes at an inactive hazardous waste disposal site constitute a significant threat to the environment, he may order the owner

of such site and/or any person responsible for the disposal of hazardous wastes at such site (i) to develop an inactive hazardous waste disposal site remedial program, subject to the approval of the Department, at such site, and (ii) to implement such program within reasonable time limits specified in the order."

B. Any person under order pursuant to ECL 27-1313.3.a has a duty imposed by ECL Article 27, Title 13 to carry out the remedial program committed to under order. ECL 71-2705 provides that any person who fails to perform any duty imposed by ECL Article 27, Title 13 shall be liable for civil, administrative and/or criminal sanctions.

C. The Department also has the power, inter alia, to provide for the prevention and abatement of all water, land, and air pollution. See, e.g., ECL 3-0301.1.i.

5. Following a period of public comment, the Department selected a final remedial alternative for OU-1 in a Record of Decision ("ROD"). The ROD for OU-1 is attached to this Order as Appendix "B," and is incorporated as an enforceable part of this Order.

6. The goals of this Order are for Respondent to (i) develop and implement, in accordance with the ROD for OU-1, an inactive hazardous waste disposal site remedial program ("Remedial Program") for the Site that shall include design and implementation, and operation, maintenance and monitoring of the selected remedial alternative; and (ii) reimburse the State's administrative costs. The Department anticipates issuing a ROD for OU-2, if any. It is expressly agreed by the Department and Respondent that this Order does not cover OU-2.

7. Respondent, without admitting or denying any of the Department's allegations and having waived Respondent's right to a hearing prior to the issuance of this Order as provided by law, and having consented to the issuance and entry of this Order, agrees to be bound by its terms. Respondent consents to and agrees not to contest the authority or jurisdiction of the Department to issue or enforce this Order, and agrees not to contest the validity of this Order or its terms. Nothing contained in this Order shall be construed to prohibit Respondent from defending against an allegation that it violated a specific requirement contained in this Order.

8. Nothing contained in this Order, nor Respondent's consent to the issuance of this Order, nor Respondent's compliance with this Order, shall be construed as an admission by Respondent. Respondent does not admit or deny any of the facts or conclusions of law contained in this Order. Respondent does not admit liability or violation of law to the Department or to any other governmental entity or third parties regarding any fact, responsibility or fault addressed in this Order except that Respondent agrees, in regard to the State, not to challenge data generated during the course of the RI/FS.

NOW, having considered this matter and being duly advised, IT IS ORDERED THAT:

I. Remedial Design Contents

A. Within 180 days after the effective date of this Order, Respondent shall submit to the Department a remedial design to implement the remedial alternative selected by the Department in the ROD for OU-1 (the "Remedial Design"). The Remedial Design shall be prepared by and have the signature and seal of a professional engineer who shall certify that the Remedial Design was prepared in accordance with this Order.

B. The Remedial Design shall include the following:

1. A detailed description of the remedial objectives and the means by which each element of the selected remedial alternative will be implemented to achieve those objectives, including, but not limited to:

- a. the construction and operation of any structures;
- b. the collection, destruction, treatment, and/or disposal of hazardous wastes and substances and their constituents and degradation products, and of any soil or other materials contaminated thereby;
- c. the collection, destruction, treatment, and/or disposal of contaminated groundwater, leachate, and air;
- d. physical security and posting of the Site;
- e. quality control and quality assurance procedures and protocols to be applied during construction of the Department-approved Remedial Design; and
- f. monitoring which integrates needs which are present on-Site and off-Site during implementation of the Department-selected remedial alternative.

2. All documents for the Remedial Design including, but not limited to, plans and specifications, will be prepared, signed, and sealed by a professional engineer. These plans shall satisfy all applicable local, state and federal laws, rules and regulations;

3. A time schedule to implement the Remedial Design;

4. A Performance Analysis and Design Modification Plan to be used to monitor and evaluate the effectiveness of the constructed remedy and make changes, if needed, to improve the ability of the constructed remedy to achieve the remedial goals. The plan shall include the parameters, conditions, procedures, and protocols to determine the effectiveness of the Remedial Design, including a schedule for periodic sampling of groundwater monitoring wells on-Site and off-Site. The Plan shall include specific and

measurable performance criteria and steps to be taken if criteria are not met. This process shall include obtaining Department approval for any physical changes to the design of the remedy. The Performance Analysis and Design Modification Plan shall be implemented in accordance with the time frame provided in the Department-approved plan;

5. A description of operation, maintenance, and monitoring activities to be undertaken after the Department has approved construction of the Remedial Design, including the number of years during which such activities will be performed (where appropriate) and a specific description of the criteria to be used to decide when an operation of the remedy may be discontinued;

6. A contingency plan to be implemented if any element of the Remedial Design fails to achieve any of its objectives or otherwise fails to protect human health or the environment;

7. A health and safety plan for the protection of persons at and in the vicinity of the Site during construction and after completion of construction. This plan shall be prepared in accordance with 29 CFR 1910 by a certified health and safety professional; and

8. A citizen participation plan which incorporates appropriate activities outlined in the Department's publication, "New York State Inactive Hazardous Waste Citizen Participation Plan," dated August 30, 1988, and any subsequent revisions thereto, and 6 NYCRR Part 375.

C. Nothing in this Order shall be construed to require disclosure of any document protected by the attorney-client privilege or the privileges for attorney work product and material prepared in anticipation of litigation. Notwithstanding this provision, there shall be no such attorney work product, material prepared in anticipation of litigation or attorney-client privilege for data generated with respect to the Site. In the event Respondent asserts that any information is privileged, Respondent shall describe the information and the nature of the privilege asserted with sufficient clarity and particularity to place the Department on notice as to the basis of the claim.

II. Remedial Construction

A. Within 90 days after the Department's approval of the Remedial Design, Respondent shall commence construction of the Department-approved Remedial Design.

B. Respondent shall implement the Remedial Design in accordance with the Department-approved Remedial Design.

C. During implementation of all construction activities identified in the Remedial Design, Respondent or its consultant shall have on-Site a full-time representative who is

qualified to supervise the work done.

D. Within 60 days after completion of the construction activities identified in the Department-approved Remedial Design, Respondent shall submit to the Department a detailed post-remedial operation and maintenance plan ("O&M Plan"); "as-built" drawings and a final engineering report (each including all changes made to the Remedial Design during construction); and a certification that the Remedial Design was implemented and that all construction activities were completed in accordance with the Department-approved Remedial Design and were personally witnessed by him or her or by a person under his or her direct supervision. The O&M Plan, "as built" drawings, final engineering report, and certification must be prepared, signed, and sealed by a professional engineer.

E. Upon the Department's approval of the O&M Plan, Respondent shall implement the O&M Plan in accordance with the requirements of the Department-approved O&M Plan.

F. After receipt of the "as-built" drawings, final engineering report, and certification, the Department shall notify Respondent in writing whether the Department is satisfied that all construction activities have been completed in compliance with the Department-approved Remedial Design.

G. 1. If the Department concludes that any element of the Department-approved Remedial Program required to be implemented pursuant to this Order, namely, implementation of the remedial alternative selected in the ROD for OU-1 and implementation of the Department-approved submittals under this Order, fails to achieve its objectives or otherwise fails to protect human health or the environment, Respondent shall take whatever action the Department determines necessary to achieve those objectives or to ensure that the Remedial Program otherwise protects human health and the environment. Respondent can object to the Department's proposal to revise the Remedial Design intended to carry out the Remedial Alternative identified in the ROD for OU-1 pursuant to the dispute resolution procedures set forth in Subparagraph II.G.3. Nothing in this Order shall be construed to allow the consideration or resolution of any dispute regarding the ROD for OU-1 or any of its provisions.

2. During implementation of the Remedial Design, Respondent shall implement the Performance Analysis and Design Modification Plan to monitor and evaluate the effectiveness of the selected remedy. Respondent shall make changes if needed, to improve the ability of the selected remedy to achieve the remedial goals in accordance with the Performance Analysis and Design Modification Plan. Respondent shall obtain Department approval for any physical changes to the Remedial Design.

3. If Respondent disapproves of the Department's proposal to revise the Remedial Design intended to carry out the Remedial Program identified in the ROD for OU-1, Respondent shall within 10 calendar days of the Department's proposal, request to meet

with the Director of the Division of Environmental Remediation ("the Director") in order to discuss Respondent's objections. At this meeting, Respondent shall be given an opportunity to present its objections to the Department's proposals and the Director shall have the authority to modify and/or withdraw such proposal. Respondent shall modify the Remedial Design in accordance with the Director's specific comments, and shall submit a revised Remedial Design. If Respondent fails to modify the Remedial Design in accordance with the Director's specific comments, Respondent shall be in violation of this Order and the ECL.

The invocation of formal dispute resolution procedures under this Subparagraph II.G.3 shall not of itself extend, postpone or modify in any way any of Respondent's obligations under this Order, with respect to matters other than those the Department determines are dependent upon the disputed items, unless and until the Department agrees or a court determines otherwise.

III. Progress Reports

Respondent shall submit to the parties identified in Subparagraph XI.B in the numbers specified therein copies of written monthly progress reports that:

- A. describe the actions which have been taken toward achieving compliance with this Order during the previous month;
- B. include all results of sampling and tests and all other data received or generated by Respondent or Respondent's contractors or agents in the previous month, including quality assurance/quality control information, whether conducted pursuant to this Order or conducted independently by Respondent;
- C. identify all work plans, reports, and other deliverables required by this Order that were completed and submitted during the previous month;
- D. describe all actions, including, but not limited to, data collection and implementation of work plans, that are scheduled for the next month and provide other information relating to the progress at the Site;
- E. include information regarding percentage of completion, unresolved delays encountered or anticipated that may affect the future schedule for implementation of Respondent's obligations under the Order, and efforts made to mitigate those delays or anticipated delays;
- F. include any modifications to any work plans that Respondent has proposed to the Department or that the Department has approved; and
- G. describe all activities undertaken in support of the Citizen Participation Plan during the previous month and those to be undertaken in the next month. Respondent shall

submit these progress reports to the Department by the tenth day of every month following the effective date of this Order.

Respondent also shall allow the Department to attend, and shall provide the Department at least seven days advance notice of, any of the following: prebid meetings, job progress meetings, substantial completion meeting and inspection, and final inspection and meeting.

IV. Review of Submittals

A. 1. The Department shall review each of the submittals Respondent makes pursuant to this Order to determine whether it was prepared, and whether the work done to generate the data and other information in the submittal was done, in accordance with this Order and generally accepted technical and scientific principles. The Department shall notify Respondent in writing of its approval or disapproval of the submittal, except for the submittals discussed in Subparagraph I.B.7 and Paragraph III and shall make good faith efforts to give that notification within a reasonable time period of receipt of the submittal. All Department-approved submittals shall be incorporated into and become an enforceable part of this Order.

2. a. If the Department disapproves a submittal, it shall so notify Respondent in writing and shall specify the reasons for its disapproval. If within 10 days of receiving written notice of the Department's disapproval Respondent so requests, the Department will meet with Respondent to discuss the disapproval. Within 30 days after such meeting or if no meeting is requested within 30 days after receiving written notice that Respondent's submittal has been disapproved, Respondent shall make a revised submittal to the Department that addresses and resolves all of the Department's stated reasons for disapproving the first submittal.

b. After receipt of the revised submittal, the Department shall notify Respondent in writing of its approval or disapproval and shall specify the reasons for its disapproval. If the Department disapproves the revised submittal, unless Respondent requests an opportunity to respond to the Department's objections pursuant to the Dispute Resolution procedure contained in Subparagraph IV.C of this Order, Respondent shall be in violation of this Order and the Department may take any action or pursue whatever rights it has pursuant to any provision of statutory or common law. If the Department approves the revised submittal, it shall be incorporated into and become an enforceable part of this Order. Nothing in this Order shall be construed to allow the consideration or resolution of any dispute regarding the ROD or any of its provisions.

B. Subject to the Dispute Resolution procedure in Subparagraph IV.C, Respondent shall modify and/or amplify and expand a submittal upon the Department's direction to do so if the Department determines, as a result of reviewing data generated by an activity required under this Order or as a result of reviewing any other data or facts, that further work is necessary.

C. If the Department disapproves a revised submittal, Respondent shall be in violation of this Order unless, within 10 business days of receipt of the Department's written notice of disapproval, Respondent serves on the Department a request for an appointment of an Administrative Law Judge ("ALJ"), and a written statement of the issues in dispute, the relevant facts upon which the dispute is based, and factual data, analysis or opinion supporting its position, and all supporting documentation on which Respondent relies (hereinafter called the "Statement of Position"). The Department shall serve its Statement of Position, including supporting documentation no later than ten business (10) days after receipt of Respondent's Statement of Position. Respondent shall have ten (10) business days after receipt of the Department's Statement of Position within which to serve upon the Department a reply to the Department's Statement of position, and in the event Respondent serves such a reply, the Department shall have ten (10) business days after receipt of Respondent's reply to the Department's Statement of Position within which to serve upon Respondent the Department's reply to Respondent's reply to the Department's Statement of Position. In the event that the periods for exchange of Statements of Position and replies may cause a delay in the work being performed under this Order, the time periods may be shortened upon and in accordance with notice by the Department as agreed to by Respondent.

An administrative record of any dispute under this Subparagraph IV.C shall be maintained by the Department. The record shall include the Statement of Position of each party served pursuant to this Subparagraph IV.C, and any relevant information. The record shall be available for review by all parties and the public.

Upon review of the administrative record as developed pursuant to this Subparagraph IV.C, the ALJ shall issue a final decision and order resolving the dispute. Respondent shall revise the submittal in accordance with the Department's specific comments, as may be modified by the ALJ and except for those which have been withdrawn by the ALJ, and shall submit a revised submittal. The period of time within which the submittal must be revised as specified by the Department in its notice of disapproval shall control unless the ALJ revises the time frame in the ALJ's final decision and order resolving the dispute.

After receipt of the revised submittal, the Department shall notify Respondent in writing of its approval or disapproval of the revised submittal.

If the revised submittal fails to address the Department's specific comments, as modified, and the Department disapproves the revised submittal for this reason, Respondent shall be in violation of this Order and the ECL.

In review by the ALJ of any dispute pursued under this Subparagraph, Respondent shall have the burden of proving that the Department's position should not prevail.

With respect to the final determination of the ALJ, Respondent shall have those rights granted pursuant to Article 78 of the Civil Practice law and Rules of New York (CPLR), provided that the petition is filed within thirty (30) calendar days of Respondent's receipt of

the final decision and order issued by the ALJ.

The invocation of the procedures stated in this Subparagraph IV.C shall not extend, postpone, or modify Respondent's obligations under this Order with respect to matters other than those the Department determines are dependent upon the disputed items, unless and until the Department agrees or a court determines otherwise.

V. Compliance

A. Respondent's failure to comply with any term of this Order constitutes a violation of this Order and the ECL, except for matters in dispute and matters the Department determines are dependent upon the disputed item(s) as provided in Subparagraphs IV.C and II.G.3.

B. Respondent shall not suffer any penalty under this Order or be subject to any proceeding or action if it cannot comply with any requirement hereof because of war, riot, strike, Act of God, or an unforeseeable occurrence which the exercise of ordinary human prudence could not have prevented or because of any condition or event beyond the control of Respondent or its agent or agents carrying out Respondent's obligations under this Order. Respondent shall, within five days of when it obtains knowledge of any such condition, notify the Department in writing. Respondent shall include in such notice the measures taken and to be taken by Respondent to prevent or minimize any delays and shall request an appropriate extension or modification of this Order. Failure to give such notice within such five-day period constitutes a waiver of any claim that a delay is not subject to penalties. Respondent shall have the burden of proving that an event is a defense to compliance with this Order pursuant to Subparagraph V.B.

VI. Entry upon Site

Respondent hereby consents to the entry upon the Site or areas in the vicinity of the Site which are under the control of Respondent by any duly designated employee, consultant, contractor, or agent of the Department or any State agency for purposes of inspection, sampling, and testing and to ensure Respondent's compliance with this Order. During Remedial Construction, if available, Respondent shall provide the Department with suitable office space at the Site, including access to a telephone, and shall permit the Department full access to all records, that are not exempted by Subparagraph I.C, relating to matters addressed by this Order and job meetings. Such employee, consultant, contractor, or agent shall comply with all applicable security and health and safety protocols that apply to the Site.

VII. Payment of State Costs

A. Within 30 days after receipt of an itemized invoice from the Department, Respondent shall pay to the Department a sum of money which shall represent reimbursement for the State's expenses including, but not limited to, direct labor, fringe benefits, indirect

costs, travel, analytical costs, and contractor costs incurred by the State of New York for work related to the Site to the effective date of this Order, as well as for reviewing and revising submittals made pursuant to this Order, overseeing activities conducted pursuant to this Order, collecting and analyzing samples, and administrative costs associated with this Order. Such payment shall be made by certified check payable to the Department of Environmental Conservation. Payment shall be sent to:

Bureau of Program Management, Division of Environmental Remediation
New York State Department of Environmental Conservation
50 Wolf Road
Albany, NY 12233-7010

Itemization of the costs shall include an accounting of personal services indicating the employee name, title, biweekly salary, and time spent (in hours) on the project during the billing period, as identified by an assigned time and activity code. This information shall be documented by reports of Direct Personal Service. Approved agency fringe benefit and indirect cost rates shall be applied. Non-personal service costs shall be summarized by category of expense (e.g., supplies, materials, travel, contractual) and shall be documented by expenditure reports.

B. If Respondent disapproves an invoice, Respondent shall within 10 days of receipt of the Department's invoice request to meet with the Director of the Division of Environmental Remediation ("the Director") in order to discuss the Respondent's objections. At this meeting, Respondent shall be given an opportunity to present its objections to the Department's invoices, and the Director shall have the authority to modify and/or withdraw such invoices. Respondent shall pay the invoice in accordance with the Director's specific comments, as modified, except for those invoices which have been withdrawn by the Director, and the Department shall submit a revised invoice. After receipt of the revised invoice, Respondent shall pay the revised invoice. If Respondent fails to pay the revised invoice, Respondent shall be in violation of this Order and the ECL.

C. The invocation of formal dispute resolution procedures under this Paragraph shall not itself extend, postpone or affect in any way any of Respondent's obligations under this Order.

VIII. Department Reservation of Rights

A. Nothing contained in this Order shall be construed as barring, diminishing, adjudicating, or in any way affecting any of the Department's civil, criminal, or administrative rights or authorities.

B. Nothing contained in this Order shall be construed to prohibit the Commissioner or his duly authorized representative from exercising any summary abatement powers.

IX. Indemnification

Respondent shall indemnify and hold the Department, the State of New York, and their representatives and employees harmless for all claims, suits, actions, damages, and costs of every name and description arising out of or resulting from the fulfillment or attempted fulfillment of this Order by Respondent and/or any of Respondent's directors, officers, employees, servants, agents, successors, and assigns. However, Respondent shall not be required to indemnify the Department, the State of New York, or their representatives and employees regarding any liability arising from willful, wanton or malicious acts or acts constituting gross negligence by the Department, the State of New York, or their representatives and employees during the course of any activities conducted pursuant to this Order.

X. Public Notice

A. Within 30 days after the effective date of this Order, Respondent shall file a Declaration of Covenants and Restrictions with the Clerk of the County wherein the Site is located to give all parties who may acquire any interest in the Site notice of this Order.

B. If Respondent proposes to convey the whole or any part of Respondent's ownership interest in the Site, Respondent shall, not fewer than 60 days before the date of conveyance, notify the Department in writing of the identity of the transferee and of the nature and proposed date of the conveyance and shall notify the transferee in writing, with a copy to the Department, of the applicability of this Order.

XI. Communications

A. All written communications required by this Order shall be transmitted by United States Postal Service, by private courier service, or hand delivered as follows:

Communication from Respondent shall be sent to:

Jeanna E. Hussey, Esq.
Division of Environmental Enforcement
New York State Department of Environmental Conservation
200 White Plains Rd., 5th Floor
Tarrytown, N.Y. 10591

and to:

Girish Desai
Division of Environmental Remediation
New York State Department of Environmental Conservation
Region 1

SUNY-Building 40
Stony Brook, New York 11794

with copies to:

G. Anders Carlson, Ph.D.
Director, Bureau of Environmental Exposure Investigation
New York State Department of Health
2 University Place
Albany, New York 12203

Raymond E. Cowen, Director
Region 1
New York State Department of Environmental Conservation
SUNY Bldg. 40
Stony Brook, New York 11794

2. Communication to be made from the Department to Respondent shall be effective upon receipt or refusal to receive and shall be sent to:

Ron Helgersen
Lockheed Martin Corporation
Burbank Program Office
2550 North Hollywood Way #305
Burbank, CA 91505

Dominic J. Hanket, Esq.
Assistant General counsel
Lockheed Martin Corporation
Burbank Program Office
2550 North Hollywood Way #305
Burbank, CA 91505

B. Copies of work plans and reports shall be submitted as follows:

Four copies (one unbound) to:

Robert Becherer, P.E.
Bureau Chief
Division of Environmental Remediation
New York State Department of Environmental Conservation
SUNY Bldg. 40
Stony Brook, New York 11794

Two copies to:

G. Anders Carlson, Ph.D.
Director, Bureau of Environmental Exposure Investigation

One copy to:

Jeanna E. Hussey, Esq.
Division of Environmental Enforcement

1. Within 30 days of the Department's approval of any report submitted pursuant to this Order, Respondent shall submit to Director, Division of Environmental Remediation, a computer readable magnetic media copy of the approved report in American Standard Code for Information Interchange (ASCII) format.

2. Within 30 days after its approval of the drawings and submittals described in Subparagraph II.D of this Order, Respondent shall submit one microfilm copy (16 millimeter roll film M type cartridge) of such Department-approved drawings and submittals, as well as all other Department-approved submittals. Respondent shall submit same to:

Director, Division of Environmental Remediation
New York State Department of Environmental Conservation
50 Wolf Road
Albany, New York 12233-7010

D. The Department and Respondent reserve the right to designate additional or different addressees for communication or written notice to the other.

XII. Miscellaneous

A. 1. All activities and submittals required by this Order shall address the remedies outlined in the ROD for OU-1 covering on-Site contamination. The Department anticipates issuing a ROD for OU-2 covering off-Site remediation, if any, to address off-Site contamination from the Site. It is expressly agreed by the Department and Respondent that this Order does not cover OU-2 for off-Site remedial action.

B. Respondent shall retain or has retained professional consultants, contractors, laboratories, quality assurance/quality control personnel, and third party data validators acceptable to the Department to perform the technical, engineering, and analytical obligations required by this Order. The experience, capabilities, and qualifications of the firms or individuals selected by Respondent shall be submitted to the Department within 15 days after the effective date of this Order. The Department's approval of these firms or individuals shall be obtained before the start of any activities for which Respondent and such firms or

individuals will be responsible. The responsibility for the performance of the professionals retained by Respondent shall rest solely with Respondent. Subject to the requirements of this Subparagraph XII.B, Respondent retains the right to select or change firms or individuals in its sole discretion.

C. The Department shall have the right to obtain split samples, duplicate samples, or both, of all substances and materials sampled by Respondent, and the Department also shall have the right to take its own samples. Respondent and the Department shall make available to each other the results of all sampling and/or tests or other data generated by Respondent or the Department with respect to implementation of this Order and shall submit these results in the progress reports required by this Order.

D. Respondent shall notify the Department at least 10 working days in advance of any field activities to be conducted pursuant to this Order.

E. Unless exempted by 6 NYCRR 375-1.7, Respondent shall use best efforts to obtain all permits, easements, rights-of-way, rights-of-entry, approvals, or authorizations necessary to perform Respondent's obligations under this Order. For purposes of this Subparagraph XII.E, "best efforts" includes the payment of reasonable sums of money in consideration but shall not include the purchase of real property. If any access required to perform this Order is not obtained despite best efforts within 45 days of the effective date of this Order, or within 45 days of the date the Department notifies Respondent in writing that additional access beyond that previously secured is necessary, Respondent shall promptly notify the Department, and shall include in that notification a summary of the steps Respondent has taken to attempt to obtain access. The Department may, as it deems appropriate, assist Respondent in obtaining access. Respondent shall reimburse the Department, in accordance with the procedures in Paragraph VII, Payment of State Costs, for all costs incurred by the Department in obtaining access, including, but not limited to, attorneys fees.

F. Respondent and its successors and assigns shall be bound by this Order. Respondent shall cause its officers, directors, agents, servants, employees, successors, and assigns to comply with the relevant portions hereof in performance of their designated duties. Any change in ownership or corporate status of Respondent including, but not limited to, any transfer of assets or real or personal property shall in no way alter Respondent's responsibilities under this Order. Respondent's officers, directors, employees, servants, and agents shall be obliged by Respondent to comply with the relevant provisions of this Order in the performance of their designated duties on behalf of Respondent.

G. Respondent shall provide a copy of this Order to each contractor hired to perform work required by this Order and to each person representing Respondent with respect to the Site and shall condition all contracts entered into in order to carry out the obligations identified in this Order upon performance in conformity with the terms of this Order. Respondent or Respondent's contractors shall provide written notice of this Order to all

subcontractors hired to perform any portion of the work required by this Order. Respondent shall nonetheless be responsible for ensuring that Respondent's contractors and subcontractors perform the work in satisfaction of the requirements of this Order.

H. All references to "professional engineer" in this Order are to an individual registered as a professional engineer in accordance with Article 145 of the New York State Education Law. If such individual is a member of a firm, that firm must be authorized to offer professional engineering services in the State of New York in accordance with Article 145 of the New York State Education Law.

I. All references to "days" in this Order are to calendar days unless otherwise specified.

J. The paragraph headings set forth in this Order are included for convenience of reference only and shall be disregarded in the construction and interpretation of any of the provisions of this Order.

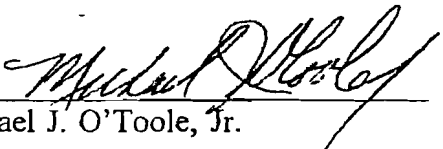
K. 1. The terms of this Order constitute the complete and entire Order concerning the implementation of the ROD for OU-1. No term, condition, understanding, or agreement purporting to modify or vary any term of this Order shall be binding unless made in writing and subscribed by the party to be bound. No informal advice, guidance, suggestion, or comment by the Department regarding any report, proposal, plan, specification, schedule, or any other submittal shall be construed as relieving Respondent of Respondent's obligation to obtain such formal approvals as may be required by this Order.

2. If Respondent desires that any provision of this Order be changed, Respondent shall make timely written application, signed by Respondent, to the Commissioner setting forth reasonable grounds for the relief sought. Copies of such written application shall be delivered or mailed to Jeanna E. Hussey, Esq. and to Garish Desai.

L. The effective date of this Order is the date the Commissioner or his designee signs it.

DATED: 10/29/97

John P. Cahill, Commissioner
New York State Department
of Environmental Conservation

BY: 
Michael J. O'Toole, Jr.

CONSENT BY RESPONDENT
Lockheed Martin Corporation

Respondent hereby consents to the issuing and entering of this Order, waives Respondent's right to a hearing herein as provided by law, and agrees to be bound by this Order.

Lockheed Martin Corporation

By: William R. Sorenson

Title: Vice President

Date: September 26, 1997

Colorado
STATE OF CALIFORNIA)

COUNTY Arapahoe) s.s.:

On this 26th day of September, 1997, before me personally came William R. Sorenson, to me known, who being duly sworn, did depose and say that he resides in Littleton, Colorado; that he is the Vice President of Lockheed Martin Corp., the corporation described in and which executed the foregoing instrument; and that he is duly authorized to execute the foregoing instrument on behalf of said corporation.

Kathleen S. Marshall
Notary Public

My Commission expires 5/7/2001