UNIVERSITY OF KENTUCKY
Purchasing Division

INVITATION FOR BIDS

CCK-2120-16

ADDENDUM # 4

5-25-16

ATTENTION: This is not an order. Read all instructions, terms and conditions carefully.

IMPORTANT: BID AND ADDENDUM MUST BE RECEIVED BY 6-2-16 @ 3:00 P.M. LEXINGTON, KY TIME

Bidder must acknowledge receipt of this and any addendum as stated in the Invitation for Bids.

Please see the enclosed for additional clarifications to this bid.

OFFICIAL APPROVAL
UNIVERSITY OF KENTUCKY

Jim Sutton

Contracting Officer / (859) 257-5406

SIGNATURE

Typed or Printed Name

University of Kentucky
Purchasing Division
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Member of the Consulting
Engineers Council

CENTRAL HEATING PLANT ADDENDUM 4
May 25, 2016

Underground Storage Tank:

The attached documents cover the removal of the existing tank and purchase and installation of the new tank. The "Underground Storage Tank Upgrade TECHNICAL SPECIFICATIONS" only apply to this work. Where there are duplicate specifications in this document, this document over-rules only outside where it applies to the fuel oil work. Also reference the Attachment A and B.

Asbestos Abatement:

Reference the attached "ASBESTOS-CONTAINING MATERIALS INSPECTION" (Addendum 2) for the report and sampling that was done for the project. See the attached "ASBESTOS ABATEMENT SPECIFICATION" (Addendum 2) for the scope of work and specifications removal and disposal of the asbestos.

End of Addendum 4

University of Kentucky Central Heating Plant
Lexington, Kentucky

UNDERGROUND STORAGE TANK UPGRADE

TECHNICAL SPECIFICATIONS

16-DOC-0323A

Table of Contents

SECTION 02010
SUBSURFACE EXPLORATION

1.0 GENERAL

1.01 WORK INCLUDED

Under this Section, the Contractor is to furnish all labor, equipment and materials required for borings, test trenches and test pits as required for the proper completion of the work under this Contract.

1.02 REFERENCED SECTIONS

A. Section 02140 – Dewatering

B. Section 02200 – Earthwork

C. Section 02226 – Compaction Control and Testing

1.03 EXISTING INFORMATION

Information regarding existing subsurface conditions within the limits of the project site is presented merely for the convenience of the Contractor. The Engineer does not represent that the information on underlying strata, water levels, structures or utilities accurately indicate the conditions at the site at the time the work will be undertaken. The Contractor shall realize that the underlying strata that University of Kentucky has shown for any given boring is indicative only of the underlying strata found at that specific location.

The Contractor shall conduct further subsurface investigations as he may deem necessary and shall rely solely on his own interpretation of his own investigations.

2.0 PRODUCTS

2.01 MATERIALS AND EQUIPMENT

The Contractor shall furnish the necessary materials and equipment required by this Section.

3.0 EXECUTION

3.01 GENERAL

The Contractor is to excavate such test trenches and test pits as may be required to locate existing subsurface structures, utilities or strata. Such test areas are to be of adequate depth and size to provide the required information. Such areas are to be dewatered, if necessary.

The Contractor is advised that the site may have some areas where underground pipes, conduits or structures may exist. Such pipes, conduits or structures may or may not be in active use. In certain instances, they may not even be in the approximate location horizontally or vertically indicated. Every

reasonable attempt has been made to indicate the most accurate location of such possible underground interferences.

The Contractor must exercise caution in his work in order to prevent damage to such unknown structures, wells or utilities. Where such structures, utilities, or wells are in active use and become damaged, every effort must be made to restore them to service, as rapidly as possible.

It is the responsibility of the contractor to locate utilities by use of a locating service or other means. It is the contractor's responsibility to make proper notifications to Kentucky Underground ("Before You Dig") a minimum of 48 hours prior to commencing work. Documentation shall be provided to the Engineer.

The Contractor shall undertake sufficient subsurface exploration to determine potential interferences sufficiently in advance of his operations so as not to cause undue delay in the normal sequence or productivity of his work.

4.0 MEASUREMENT AND PAYMENT

The work under this Section shall not be measured for payment, but shall be paid as a lump sum under bid proposal.

END OF SECTION

SECTION 02050
DEMOLITION / ABANDONMENT

1.0 GENERAL

1.01 STANDARD OF QUALITY

The Contractor is to provide all labor, materials and equipment required to complete demolition work.

All demolition work is to be done in a neat manner, consistent with the best acceptable industry practices and with full protection of adjacent construction or areas during the entire period of demolition.

Demolition work is to include the removal of permanent construction materials and includes, but is not limited to pavement, curbing, sidewalks, fencing, underground utilities or foundations, concrete, metal, masonry, wood, piping, equipment or materials of like intent.

Demolition work is to include the removal of existing materials which may interfere with the proper construction of new work regardless of whether noted on the Drawings, or specified. Demolition work is to also include the reinstallation of any items of work which may have to be removed on a temporary basis, prior to demolition operations, in order to allow for the proper construction of new work.

1.02 WORK INCLUDED UST SYSTEM REMOVAL

The work shall include but not be limited to providing supervision, labor, materials and equipment necessary to perform the following:

A. Neatly cut any pavement prior to excavation;
B. Empty tank contents, purge of vapors, clean, excavate, and remove underground storage tanks and associated piping in accordance with the technical requirements;
C. Furnish, place, and remove any sheeting, bracing, and trench box, as required, shown on the plans or ordered by the Engineer;
D. Dispose of tanks, tank contents, concrete ballast pads, tank hold-downs, piping and other debris;
E. Protect existing pipelines and structures;
F. Stockpile and properly dispose of contaminated soil (Section 02070);
G. Dewater excavation (if necessary) (Section 02140);
H. Backfill excavations with approved material as required; and,
I. Restore the site to its original (or equivalent) condition.

The Contractor must obtain all demolition permits from the Lexington Urban County Government construction code enforcement officials prior to the commencement of work.

1.03 REFERENCED SECTIONS

A. Section 02070 – Management of Contaminated Soil and Groundwater

B. Section 02105 – Environmental Protection

C. Section 02140 – Dewatering

D. Section 02200 – Earthwork

1.04 GOVERNING STANDARDS

All demolition and disposal work shall be in accordance with all rules, regulations and requirements of the Kentucky Department of Environmental Protection (KDEP) and all other state agencies having jurisdiction.

All local ordinances associated with demolition and disposal are to be complied with. Ordinances associated with noise or dust control related to demolition are to be complied with.

Services furnished shall be in accordance with the codes and standards listed below. In addition to these codes and standards, the Contractor shall comply with all applicable State laws and regulations. The Contractor shall be licensed by the Kentucky Fire Marshal's Office to perform tank removals.

A. API - American Petroleum Institute:

1. API Recommended Practice 1604 - Removal and Disposal of Used Underground Petroleum Storage Tanks.

B. OSHA - Occupational Safety and Health Act:

1. 29 CFR 1910.120 Hazardous Waste Operations and Emergency Response.

2. 29CFR 1910.146 Permit Required Confined Spaces.

2.0 PRODUCTS

The Contractor may use cleaning agents to clean inside tank prior to demolition. Any cleaning agent to be used by Contractor must be approved by the Engineer. Contractor must submit product technical data sheet and Safety Data Sheet for approval. Minimization of cleaning materials is considered paramount.

3.0 EXECUTION

3.01 STANDARD REQUIREMENTS

In general, demolition materials are not to be used as backfill, but are to be transported and disposed of in an approved off-site disposal area or facility.

Materials such as concrete or masonry will not be acceptable as backfill.

Burning of demolished and/or removed materials is not permitted.

The Contractor is to conduct demolition work and the disposal of debris in such a manner so as to ensure a minimum interference with streets, walks, and other adjacent occupied structures. Contractor is not to obstruct occupied or used facilities.

Demolition work is to be undertaken to completion, irrespective of whether or not it is precisely defined as to limits and quantities. If such demolition is required in order to complete the intended new construction, it is to be undertaken completely and without dispute.

The Contractor is to review the Drawings and Specifications to determine the extent of the work. The Contractor is specifically alerted to requirements for inspection of existing field conditions. The Contractor is to visit and inspect the project prior to preparing his bid in order to completely familiarize himself with all field conditions; the intent of the design, and the extent of all work. After his review and inspection is complete, and before he submits his bid, if the Contractor has any questions regarding the extent and details of the work under this Section, he is to request, in writing, clarification from the Engineer.

Before proceeding with any work, the Contractor is to confirm methods of construction, obtain all required field measurements, and verify all dimensions on the Drawings as required.

Failure of the Contractor to familiarize himself with all drawings, relating to the work, and conditions existing at the site of construction, will not relieve him of his obligation to furnish all material and labor necessary to carry out the provisions of the Documents and to complete the contemplated work for the consideration set forth in his bid.

The Contractor is alerted to the fact that the University of Kentucky assumes no responsibility for actual conditions of the areas indicated to be demolished and/or abandoned.

Conditions existing at the time of inspection for bidding purposes will be maintained by the Owner in so far as practicable.

All materials demolished, removed and/or discarded are to become the property of the Contractor and are to be removed from the project site to an approved off site location, unless instructions to the contrary are given to the Contractor either by Drawings or by Specifications.

Storage or sale of demolished, removed, and/or discarded materials is not to be permitted on the site.

The Contractor is to promptly repair all damages caused to adjacent existing facilities by demolition operations at no cost to the University of Kentucky. All adjacent areas and existing facilities are to be restored to at least the condition existing prior to the start of the work, unless the Drawings indicate otherwise.

The use of explosives is not to be permitted.

Masonry and concrete, intended to be removed, is to be removed in small sections.

All new openings are to be neatly cut using a carborundum wheel or a saw blade producing clean and sharp edges. All new openings are to have their masonry sides patched, repaired and made ready to a condition proper for the installation of new work.

The Contractor is to provide shoring, bracing or support to prevent movement, settlement or collapse of construction and/or work to be removed and adjacent facilities to remain.

All demolition work is to be done in a neat manner, consistent with the best acceptable industry practices and with full protection of adjacent construction or areas during the period of demolition.

All finish surfaces are to be workmanlike in appearance and uniform in color. Surfaces are to be straight, true and satisfactory to the Engineer.

Upon completion of the demolition work, the Engineer will make an inspection of the work. No new work is to be started until the demolition work has been approved by the Engineer.

All work is to be coordinated so that new work can begin immediately after the demolition work has been completed.

The Contractor is to submit a schedule of proposed dates and proposed methods and operations for demolition and/or removal work to the Engineer for review prior to the start of the work. The method of demolition and/or removal is to be such as not to damage any portion of the work or building to be retained, or damage the structural integrity thereof. Included in this schedule is to be the coordination for shut-off, capping, and the discontinuation or continuation of utility services, and the methods to be used for all aspects of demolition and removal work.

No demolition and/or removal work is to be undertaken until the schedules have been reviewed by the Engineer and the University of Kentucky.

3.02 REMOVAL OF UNDERGROUND STORAGE TANK SYSTEMS AND PIPING

The Contractor's scope of work specified in this document shall be as follows; the sequence of steps shall be as follows unless otherwise directed by the Engineer:

A. The Contractor shall check underground storage tank location prior to commencing work to ensure excavation will not cause damage to any underground utilities. The approximate location of the underground storage tank is shown on the Contract Drawings. (Attachment A)

B. Prior to uncovering the tank, the Contractor shall remove all pumpable contents from the tank via Vac truck or the equivalent. Contents higher than 4" shall be transferred to new storage tank for that respective product. Any substance which can be transported and used as fuel will be recorded on a "Bill of Lading". Any substance which is classified as hazardous and requires disposal will require a "Uniform Hazardous Waste Manifest", to be supplied and completed by the Owner prior to leaving the site. Copies of all Bills of Lading and Manifests shall be submitted to the Engineer.

C. The Contractor shall drain product piping into the tank, and remove or cap the piping.

D. The Contractor shall excavate to the top of the tank and determine the tank orientation.

E. The Contractor shall monitor the percent Lower Explosive Limit (LEL) and the Oxygen content of the tank vapors before proceeding. The Contractor shall furnish a combustible gas indicator and an oxygen meter to assess combustible vapor oxygen concentrations in the tank and work area. The Contractor shall perform purging procedures to remove flammable and hazardous vapors from the tank and continue monitoring until both the percent LEL and the percent oxygen concentrations reach acceptable levels.

F. Purging shall continue until the percent LEL is less than 10%. The Contractor will determine when acceptable levels have been achieved. The Contractor shall comply with OSHA 1910.146 - Permit Required Confined Spaces.

G. After the tank has been purged, the Contractor shall cut a manway (if one does not exist) in the tank using a "spark-free" air chisel in order to provide access to the tank for cleaning. No saws or torches which may cause sparks shall be used, so as to minimize the risk of ignition. If the tank has an existing manway, then the Contractor shall utilize that manway for entry. Two (2) openings are required for entry. Larger openings in top of concrete tank may be made utilizing a water-cooled diamond saw. Continuous ventilation will be placed on the tank.

H. The Contractor shall enter the tank utilizing appropriate Personnel Protective Equipment which shall include, but not be limited to the following:

1. Supplied Breathing Air
2. 5-Minute Emergency Air Supply
3. Tyvek or Saranax Coverall
4. Gloves (Nitrile)
5. Boots (Rubber or Neoprene)

I. The Contractor shall "squeegee" clean the interior of the tank and remove excess tank bottoms/sludges via Vac truck or the equivalent. Any material that cannot be pumped will be placed in a 55-gallon DOT approved drum for disposal. The Contractor shall wipe the interior of the tank with absorbent pads to achieve a level of cleanliness which is satisfactory to the Engineer. All liquids, tank bottoms/sludges that

are removed from the tanks must be manifested, transported and disposed of at a licensed disposal facility.

J. Once the interior of the tank has been cleaned to the Engineer's approval, the Contractor can demolish the concrete including the bottom of the tank pad on all sides of the pad. After completing the excavation, the Contractor shall remove the concrete from the excavation pit.

K. If there has been a discharge and the tank removal operations require dewatering, the Contractor shall dewater the excavation via Vac truck or the equivalent.

L. Upon removal of the tank, the Contractor shall break the tank into pieces in order to render the tank materials suitable for transportation from site.

M. The Contractor shall transport and dispose of the tank concrete at an appropriate facility and provide disposal receipts. Recycling of the concrete is preferred if material has been decontaminated suitably.

N. If contaminated soil is encountered in the excavation, the Contractor shall excavate, remove, and stockpile the soil at the Engineer's direction and in accordance with the appropriate sections of these specifications. The Engineer will provide the Contractor with a designated staging area for the soil. The contaminated soil will be placed on and covered with a minimum 6 mil plastic, to be supplied by the Contractor.

O. Contractor shall provide assistance to the Engineer preparing the site assessment report. Assistance shall include, but not be limited to, providing field notes and quantities of materials to the Engineer and allowing the Engineer to take photographs and collect samples as necessary during the work.

P. The Contractor shall backfill the excavation with approved material to install the new tank in the same location.

3.03 PROTECTION OF ADJACENT FACILITES

All existing and new work is to be completely protected from damage and maintained satisfactorily during the Contractor's operations.

The Contractor is to provide adequate protection of other work during his operations to prevent damage or detrimental effects which may arise from general exposure, adverse weather, adjacent construction operations, or activities at the work location.

The Contractor is to execute demolition work so that adjacent property is protected against damages which might occur from falling debris or other causes. The Contractor is not to interfere with the use of adjacent buildings and is to maintain free and safe passage to and from such buildings.

The Contractor is to take all precautions to guard against the movement, settlement or collapse of any sidewalks or street passages of adjoining property and is liable for any movement, settlement or collapse.

3.04 REPAIR WORK

The Contractor is to promptly repair all damage done to the University of Kentucky property or any other person, or persons on or off the premises by reason of his demolition work.

3.05 CLEANUP

The Contractor is to clean all adjacent structures and improvements of dust, dirt and debris caused by his demolition operations.

The Contractor is not to store, or permit debris to accumulate on the site. If the Contractor fails to remove excess debris after more than 48 hours and after written notification by Engineer to the Contractor for said removal, University of Kentucky reserves the right to cause such debris to be removed at the Contractor's expense. Costs incurred by the University of Kentucky are to be deducted from the payment to be made to the Contractor.

4.0 MEASUREMENT AND PAYMENT

The work under this Section shall not be measured for payment, but shall be paid as a lump sum under bid proposal.

END OF SECTION

SECTION 02070
MANAGEMENT OF CONTAMINATED SOIL AND GROUNDWATER

1.0 GENERAL

1.01 DESCRIPTION:

This Section includes specifications for the Management of Contaminated Soil and Groundwater at the site, including the procedures in which worker's health and safety shall be protected and the proper management of contaminated soil and groundwater.

Given its historic and current uses, the potential exists for soil and/or groundwater contamination. The University of Kentucky does not warrant that the site is free of contamination. In addition to dealing with any known contamination, the Contractor shall be prepared in the event that unsuspected contamination, or other environmental concerns are encountered.

1.02 REFERENCED SECTIONS

A. Section 02140 - Dewatering

B. Section 02200 - Earthwork

C. Section 02226 - Compaction Control and Testing.

1.03 REGULATORY REQUIREMENTS

Services furnished shall be in accordance with the codes and standards listed below.

A. Occupational Safety and Health Administration (OSHA):
   1. 29 CFR 1910.120 - Hazardous Waste Operations and Emergency Response
   2. 29 CFR 1910.146 - Permit Required Confined Spaces
   3. 29 CFR 1926.65 - Subpart P - Excavations

B. Kentucky Department of Environmental Protection (KDEP):
   1. 401 KAR 100:30 - Regulatory Requirements for Site Remediation
   2. 401 KAR Chapter 30-36 – Kentucky Hazardous Waste Regulations
   3. Kentucky Superfund Branch Closure Report for Petroleum Releases and Exempt Petroleum Tank Systems DEP 7097C (heating oil tank).

In addition to the above codes and standards, the Contractor shall comply with any and all applicable Federal, State and Local laws and regulations.

1.04 SUBMITTALS

A. Health and Safety Plan

B. Evidence of current and valid permits, licenses and certifications as required by this Section.

C. Executed non-hazardous waste manifests or bill-of-lading for each load of material removed and transported from the site.

D. Certificate of final disposal (or destruction) for each manifest or bill-of-lading from material removed from the site.

E. Provide any other documentation requested and required by University of Kentucky to conform or comply with all applicable laws, codes, ordinances and regulations.

F. Groundwater Dewatering, Treatment and Discharge Plan (if required).

2.0 PRODUCTS

2.01 MATERIALS AND EQUIPMENT

Provide materials and equipment required to implement this Section.

3.0 EXECUTION

3.01 WORK INCLUDED

The Contractor shall prepare a site specific Health & Safety Plan that will address all conditions expected to be encountered during the excavation of shallow soils that are known from investigation to contain contaminants at levels above KDEP soil remediation standards. **(Note: Superfund Branch of KyDWM has adopted US EPA Regional Screening Levels.)** The potential exists that contaminants previously identified may be present at greater concentrations than documented.

The Contractor shall be responsible, at all times, for protecting the health and safety of his workers, subcontractors, University of Kentucky employees, students, and the public. All Contractors and Subcontractors performing work under the Document must utilize appropriate protective clothing and equipment in accordance with the Contractor's site specific Health and Safety Plan.

If contaminated areas or compounds are encountered or if the Contractor believes that the materials encountered warrant the use of additional personnel protective equipment and clothing, the Contractor shall be prepared to provide additional personnel protective equipment and clothing for the health and safety of their workers and to have available properly trained workers for such occurrences. This additional equipment and/or personnel shall be provided by the Contractor at no additional cost to University of Kentucky.

3.02 HEALTH AND SAFETY PLAN (HASP)

The Contractor shall inform his employees fully of the conditions to be encountered during the excavation of soils.

The Contractor shall be responsible, at all times, for protecting the health and safety of his workers, subcontractors, University of Kentucky employees and the public.

The Contractor shall prepare a site specific Health and Safety Plan (HASP) that includes, but shall not be limited to levels of personal protection, emergency procedures, monitoring requirements, emergency procedures, etc. The Contractor's site specific HASP shall be submitted to the University of Kentucky within 30 days after award of the Contract. No construction activity will be permitted until the HASP is submitted by the Contractor. Any delays to the project schedule occurring as a consequence of the late submittal of the HASP will be attributed solely to the Contractor and no time extensions will be granted for this reason.

Within the site specific HASP, the Contractor shall submit verification that at least one supervisory employee, or the Contractor's agent, involved with any on-site activities has undergone Health and Safety Training as per *OSHA 29 CFR 1910.120(e) Hazardous Waste Operations and Emergency Response* and, if applicable, *29 CFR 1910.146 Permit Required Confined Spaces* and any other appropriate training. In addition, all construction activities shall comply with *OSHA 29 CFR 1926.65 Subpart P - Excavations*.

The Contractor's site specific HASP shall address the excavation and temporary stockpiling of all soil which, for the purposes of this construction project, will be assumed to be contaminated soil as outlined under paragraph 3.03 - Management of Excavated Soils.

A copy of the approved HASP shall be displayed or be readily available for reference at all times.

3.03 MANAGEMENT OF EXCAVATED SOILS

A. General

1. The Contractor shall treat all excavated soil as potentially contaminated but nonhazardous until directed by the Engineer.

2. If the Contractor encounters, exposes, observes or has reason to believe that soil is or may be potentially hazardous (i.e., fuel or product saturated; heavily stained or discolored; strong odors, etc.), the Contractor shall notify the Engineer immediately and take any and all precautions to protect the Contractor's employees, subcontractors, representatives of the University of Kentucky and the public. If warranted, the Engineer will direct the Contractor to excavate and stockpile and/or containerize suspected hazardous soil separately. Stockpiled, potentially hazardous soil will be sampled and analyzed for waste classification by the University of Kentucky.

3. The implementation and scheduling of the management of excavated soil must be incorporated into the overall construction schedule as required in the General

Provisions as provided by the Contractor and approved by the University of Kentucky.

4. Space at the site is extremely limited and the Contractor will not potentially be permitted to stockpile all soil in advance of disposal. Therefore, excess soil from the project site shall be immediately loaded onto trucks for transportation and disposal. As such, it is critical that the Contractor submit to the University of Kentucky all necessary sampling plans and analytical procedures, perform all soil characterization sampling and analyses, obtain disposal facility acceptance, and obtain University of Kentucky review and approval well before any excavation and loading activities are scheduled.

5. Regardless of whether the soil contains contamination above the most restrictive cleanup standards, the University of Kentucky will not permit unrestricted off-site disposal or reuse of the soil. Prior to removing any soil from the site, the Contractor shall submit the name of a recycling and/or disposal facility for University of Kentucky's approval. Acceptance procedures and approvals shall be well documented. Copies of all approvals shall be forwarded to the Engineer. The University of Kentucky reserves the right to select a disposal facility and perform some or all soil disposal independently, and thereby NOT exercise the Contractor's bid item for soil disposal.

B. Excavation and Stockpiling

Due to limitations of available space, stockpiling of material will not be permitted.

C. Transportation and Weighing

1. All trucks utilized for transporting soil for disposal shall have all necessary local, state, and federal permits. Where required, all permit numbers shall be clearly visible on all trucks. All vehicles transporting contaminated soil shall be covered before leaving the project site. The cover shall be adequate to prevent loss of material as fugitive dust or whole soil.

2. The Contractor shall provide the name of hauler(s) and a copy of the hauler(s) license well in advance of construction excavation. All trucks shall conform to all USDOT requirements (i.e., placards).

3. The Contractor shall provide weight tickets received from the approved disposal facility's scale representing both the empty weight (tare weight) and loaded weight for all trucks used to remove soil at the project site. Copies of the weight tickets shall be provided to University of Kentucky. Each weight ticket must clearly show the truck number utilized.

4. It is the Contractor's responsibility to determine when each truck is loaded. The University of Kentucky is not responsible for the Contractor to make his load minimum, nor is it the University of Kentucky's responsibility for the

Contractor overloading the trucks or any penalties or costs due to overloading fines.

D. Disposal

1. All soil shall be disposed of in accordance with all applicable federal, state and local standards and regulations. Should the Contractor be directed to dispose of any contaminated soil deemed to be hazardous, then the Contractor shall fill out and properly process USEPA Uniform Hazardous Waste Manifest forms.

2. Recycling or beneficial reuse methods are encouraged when possible.

E. Backfilling

1. Prior to placing backfill, the Engineer will perform an inspection of the area to be backfilled. Backfilling shall not commence until the Engineer

has completed this assessment and provides the Contractor approval to backfill.

2. Placement of backfill material shall be governed in accordance with Section 02200 – Earthwork.

3. Compaction of backfill material shall be governed in accordance with Section 02226 – Compaction Control and Testing.

4. All imported fill material shall be certified clean, virgin material from a commercial source. The material shall not contain substances at levels that exceed the KDEP's soil remediation standards.

5. Documentation of the source and quality of the fill shall be provided in the form of a certification from the source stating:

a. the name and address (street, block no., lot no., town, and state) of the source; and

b. that the material is from a virgin commercial source and is free of hazardous substances.

Appropriate documentation, such as analytical data, can be provided to verify the absence of contamination. No fill shall be transported to the project site unless proper documentation is provided to, and accepted by, Engineer.

6. In the event that soil from on-site construction locations is deemed suitable with respect to geotechnical properties, it may be re-used as backfill material subject to University of Kentucky approval. This does not apply to any soil confirmed to be grossly contaminated by petroleum products or other hazardous substances.

7. The University of Kentucky reserves the right to perform independent testing of the fill material. If the material does not meet applicable University of Kentucky criteria, the University of Kentucky will have the right to reject the material and require the Contractor to remove and replace the material at the Contractor's expense.

3.04 MANAGEMENT OF GROUNDWATER

All dewatering operations must comply with the Technical Provisions for dewatering and address the quantity and quality of contaminated groundwater that will be generated as part of dewatering operations.

The Contractor shall manage and treat groundwater containing free product, free product sheen, petroleum odors or staining that may be captured by any dewatering operations. If present, petroleum contaminated groundwater shall be treated to remove petroleum product prior to discharge. At a minimum, groundwater treatment must include passing all groundwater through a temporary oil/water separator tank(s) and an activated charcoal filter prior to discharge. The exact and final design of the groundwater treatment system is the responsibility of the contractor and must be submitted for the University of Kentucky's review and approval. Due to the potential for free product petroleum groundwater contamination, the Contractor shall exercise good health and safety procedures when handling dewatering water. It will be the Contractor's responsibility to comply with all applicable regulatory approvals, authorizations and/or permits for the withdrawal, collection and discharge of contaminated groundwater.

Any residual waste product that is collected by the groundwater treatment system will be disposed of in accordance with all applicable federal, state and local standards and regulations.

After appropriate treatment, groundwater generated by dewatering operations must be discharged in accordance with KDEP and Lexington Sewer Department requirements and pursuant to a valid permit. Such discharge of treated dewatering water shall be in accordance with pre-approved procedures, methodology and regulatory requirements. At no time is the Contractor to discharge dewatering water with free product, free product sheen, or free petroleum odors.

A Groundwater Dewatering, Treatment and Discharge Plan shall be prepared by the Contractor or their qualified Subcontractor and submitted to the University of Kentucky for review and approval before the commencement of any dewatering activities.

4.0 MEASUREMENT AND PAYMENT

4.01 HEALTH & SAFETY

The work under this Section will not be measured or paid separately, but shall be included in the Division lump sum bid, 'Division 2 – Site Work (All Remaining Work)'.

4.02 MANAGEMENT OF CONTAMINATED SOILS

Soil Disposal, Non-hazardous, Contaminated Material: For the per ton unit price indicated on the Bid Form, Contaminated Soil Disposal, the Contractor shall include all labor, materials, supplies, tools, equipment and other incidentals necessary to load, transport and dispose of contaminated soil, that is classified as contaminated, non-hazardous waste.

For this Section, the units of measurement for payment shall be "tons" as stipulated in the Bid Form. Payment will be based upon the difference in the gross and tare weights of the trucks used for this item. All truck loads shall exceed the facility's minimum weight charge. The original weight tickets shall be provided to University of Kentucky with invoice or no payment will be made on that load. Payment will not be made until the certificate of recycling or disposal is provided to University of Kentucky by the approved disposal facility(s).

Any required soil sampling and laboratory analyses needed to characterize excess excavated soil for proper disposal will not be measured for payment, but will be included in the lump sum bid, 'Laboratory Testing'.

4.03 MANAGEMENT OF CONTAMINATED GROUNDWATER

Management of Contaminated Groundwater during Dewatering; the lump sum amount for Bid shall include all costs associated with the design and installation of the groundwater dewatering system per the Technical Specifications.

END OF SECTION

SECTION 02105
ENVIRONMENTAL PROTECTION

1.0 GENERAL

1.01 WORK INCLUDED

For the lump sum price bid, the Contractor is to furnish all labor, materials, and equipment necessary and take all measures necessary to preserve and protect the site and environs from environmental impact due to the construction activities either on or off-site during all phases of the project construction.

All environmental protection/restoration measures described in this Section have precedence over other potentially contradictory language contained elsewhere in the design Documents.

The required measures shall include, but are not necessarily limited to: providing erosion and sediment control methods and devices; confining the activities of his and his subcontractor's equipment and workmen to the designated site boundaries, except as may be required for site ingress and egress; taking effective measures to minimize and control noise due to construction operations; complying with all municipal, State and Federal regulations regarding open burning, air pollution and water pollution control; disposing of all surplus, unusable and unsuitable excavated material, brush, piles, trees, debris and rubbish to licensed landfill areas outside the site or to other approved off-site locations; providing approved sanitary facilities in sufficient numbers for all workers and visitors to the site, including the Owner, the Engineer, their representatives, and representatives of all agencies authorized to visit the site; protection of all surface and ground waters at the site and in proximity to the site; clean-up work at the completion of the project; and all other measures as described hereinafter required to fulfill the intent of this Section of the Specifications.

2.0 PRODUCTS (Not Used)

3.0 EXECUTION

3.01 EROSION AND SEDIMENT CONTROL

The Contractor is to comply with all local and State regulations for soil erosion and sediment control. Contractor is to submit plans for soil protection to the proper authorities for approval, and assist if necessary in the obtaining of any permits required. If required, copies of the appropriate authority's approved soil protection plans shall be submitted to the University of Kentucky for proof of compliance and record purposes.

All clearing is to be done in such a manner to provide minimum exposure of soils wherever possible. The Contractor is to take protective measures as required to protect undisturbed, disturbed and new soils from erosion.

All temporary disposal sites and stockpile areas shall be so located to prohibit runoff of silt and soil to natural water courses. Where necessary, the Contractor shall provide temporary ditching and dikes designed to retain all pumpage and runoff from the site for a period of time sufficient to settle out suspended materials before disposal of this water.

Before commencing any construction activities, including clearing, grubbing, and fence erection, the Contractor shall first provide ditching, silt fencing, construct temporary sediment basins and grade the construction area so as to completely prohibit any excavated or fill soils, silts and other materials resulting from construction operations from being carried off and away from the construction area. No other excavation work shall be permitted and no fill shall be brought onto the site until the Engineer has given conditional approval of the Contractor's proposed works for controlling soil erosion and sediment control.

All erosion and sediment control measures shall be in place prior to any grading operations or construction of proposed facilities and shall be maintained until construction is completed. All temporary erosion and sedimentation control devices shall be removed after construction has been completed and the construction area is stabilized (i.e., hay bales shall not be allowed to rot in place).

Disturbed areas that will be exposed in excess of 14 days shall be temporarily seeded and/or mulched until proper weather conditions exist for establishment of a permanent vegetative cover.

Sewer inlets must be provided with perimeter hay baling or a similar erosion control device.

When ordered by the Engineer, all existing temporary work as specified in the preceding paragraph shall be removed and the site restored and brought to the lines and grades shown on the Drawings.

The following Guidelines and Standards shall be construed to be part of these Specifications wherever possible:

A. The United States Department of Environmental Protection - Guidelines for Erosion and Sediment Control Planning and Implementation, (EPA-R2-72-015)

If effective control of erosion and sediment is not accomplished, in the opinion of the Engineer, additional controls shall be proposed by the contractor for the Engineer' approval. Failure of the Contractor to provide adequate erosion and sediment controls shall be just cause for stopping construction operations until satisfactory control measures have been implemented.

3.02 PROTECTION OF TREES AND VEGETATION

The Contractor shall make every effort to avoid destruction of and damage to native trees and shrubs not designated to be removed so as not to unduly disturb the ecological or environmental quality of the area.

Straggling roots shall be pruned. Trees which must be pruned shall be cut cleanly and coated with protective tree paint. If trees are damaged, the wood shall be repaired and painted with approved materials.

Trees and shrubs not to be removed shall be protected in an approved manner from any damage due to construction activities.

3.03 DUST CONTROL

The Contractor shall take effective measures, including the use of sprinklers and covered trucks, to minimize dust production and spreading as a result of construction activities on the site and

hauling operations off the site. The use of calcium chloride, petroleum products, or other chemicals for dust control is prohibited.

As often as required during each working day, and particularly prior to each working day's conclusion, areas under immediate construction (including access roads and other affected areas) will be swept clean and wet down with water sufficiently to lay dust. In addition, these areas will be wet down during non-working hours (including weekends) as often as required to keep the dust under control.

3.04 NOISE CONTROL

The Contractor shall take effective measures to minimize noise produced by all construction operations, including the use of properly maintained and operating exhaust mufflers on his construction vehicles, whether used on-site or off-site.

The Contractor shall limit his construction operations and activities to Monday through Friday between the hours of 7:00 AM to 6:00 PM unless variances to these times are granted in times of emergency. No driving, pulling or other vibratory hammers or compactors shall be permitted, other than between the hours of 8:00 AM and 5:00 PM.

The number of machines in operation at a given time must be limited to the minimum practicable. All engine generators or pumps must have mufflers and be enclosed within a temporary structure.

3.05 AIR AND WATER POLLUTION AND SOLID WASTE CONTROL

The Contractor shall make himself aware of and shall comply with all current local, State and Federal regulations governing air and water pollution control and solid waste control, including especially, regulations prohibiting open burning of trees, logs, stumps, brush, vegetation and construction debris.

The Contractor shall take particular note of protective measures required for construction vehicles leaving site.

Excavated material not approved by the Engineer for fill use is not to be used in backfilling or for any other new fill and must be removed from the site. All such material as well as excess earth or refuse, is to be transported to an approved solid waste disposal areas by certified haulers and placed there. All hauling, dumping and other charges are to be paid by the Contractor. The Contractor may submit a list of his own disposal sites to the Engineer for his approval.

For each load which the Contractor delivers to a particular disposal area, he is to obtain a receipt containing the Name and location of the facility; Date and time of delivery; and number of the delivery vehicle. The receipt is to be delivered to the Engineer.

All registrations, permits, and certifications required by the responsible authorities are to be obtained and paid for by the Contractor.

The discharge of water collected from dewatering operations may fall under this jurisdiction and requirements of governmental agencies. The Contractor must comply with any requirements imposed by such agencies, such as pretreatment of waters before discharge or any other conditions. The Contractor alone is to bear all costs of such compliance.

3.06 PROHIBITED CONSTRUCTION ACTIVITIES

The Contractor shall refrain specifically from the following construction activities, as well as others which may be elsewhere specified in this Section or other Sections of the Specifications:

A. Damaging vegetation adjacent to or outside of the designated construction areas;

B. Open burning of project construction or other debris;

C. The use of asphaltic mulch binders; and

D. The use chemicals for dust control.

E. Washing and cleanup of trucks and other construction vehicles and equipment; and

Truck tires shall be clean when they leave the construction site.

The Contractor shall, upon notification of the Engineer, cease any operation which, in the opinion of the Engineer, are considered to be prohibited construction procedures. The Contractor shall correct, at the direction of the Engineer, any defects of said operations, at no cost to University of Kentucky.

3.07 SPECIAL ENVIRONMENTAL CONDITIONS - SEQUENCE OF EROSION CONTROL MEASURES

The sequence of development for environmental work must be rigidly adhered to for adequate environmental protection during and after construction activities. The sequence shall be as follows:

A. Install silt fence-sediment barrier: The silt fence-sediment barrier delineating the construction site shall be put in place where shown on the Drawings or as directed by the Engineer, prior to any stockpiling or construction activities. The sediment barrier shall remain erect until all construction and environmental restoration measures have been completed.

B. Inlet Protection: All inlets installed prior or during construction shall be protected by straw bales or other suitable means as approved by the Engineer. These sediment barriers shall be left in place until all construction activities have been completed and permanent stabilization has been established.

C. Protection of stockpiled fill from wind and/or water erosion: Any suitable fill to be stockpiled for longer than 14 days shall be protected from wind and/or water erosion by suitable methods delineated in this Section.

D. Restoration of storage and stockpile sites: Restoration of storage and/or stockpile sites shall commence as soon as the sites are no longer needed for storage or stockpiling of construction materials.

3.08 CULTURAL RESOURCES

If, during the course of construction, unexpected archaeological or historic resources are encountered, the Contractor must immediately halt all construction in the vicinity of the discovery and contact University of Kentucky.

When the Contractor contacts University of Kentucky in accordance with the above provisions, University of Kentucky shall then immediately contact State Historical Preservation Office, who will determine the appropriate procedures to be followed, in accordance with Historic Preservation procedures.

3.09 WETLAND AND TRANSITION AREA PROTECTION (Not In Contract)

Boundaries of existing wetland areas will be identified by colored surveyor's ribbon. Contractor shall install temporary silt fencing along all such marked boundaries and maintain same in place until completion of all site work. Care shall be exercised when removing trees, clearing and stripping and excavating, not to encroach upon the wetland areas, which are to remain undisturbed. No machines or vehicles shall be permitted to operate or travel beyond said boundaries.

Work in wetlands and wetland transition areas that will be temporarily disturbed shall conform to requirements imposed through applicable permits and, at a minimum, the following:

A. Before excavation is initiated in wetland transition areas, a line of hay bales or other siltation control barriers shall be staked in place along the edges of the construction area and shall remain in place until restoration is complete.

B. Topsoil shall be stripped and soil layers replaced in the excavated area in the same order that they were removed. Final grade shall match the elevation prior to disturbance.

C. Temporarily disturbed transition areas shall be revegetated with a mix and density of species similar to that which was removed. Material for vegetation can be preserved from the areas cleared and replanted or provided from nursery stock.

D. Anti-seep collars shall be installed as needed in the trench to avoid draining the wetland.

3.10 KDEP REGULATIONS FOR ENVIRONMENTAL PROTECTION

The Contractor shall fully comply with the provision of the "Best Management Practices requirement" as specified in Kentucky Division of Water regulations. The design requirement as specified herein shall have precedence over potentially contradictory language contained elsewhere in the design documents.

4.0 MEASUREMENT AND PAYMENT

The work under this Section shall not be measured for payment, but shall be paid as a lump sum.

END OF SECTION

SECTION 02121
CLEAN FILL

1.0 GENERAL

1.01 WORK INCLUDED

The Contractor is to familiarize themselves thoroughly with the types and nature of the fill materials which are required for the project. This section works in conjunction with the material specification sections in this specification and the plans. This section lists the requirements for clean fill for the site.

1.02 RELATED WORK

- **A.** Section 02200 – Earthwork
- **B.** Section 02225 – Fill and Backfill Materials

1.03 REFERENCES

1.04 DEFINITIONS

Quarry Stone: Any stone that is supplied by a certified quarrying operation obtaining material from a virgin formation.

Quarry Fines: Any fine material of various gradations that is supplied by a certified quarrying operation obtaining material from a virgin formation.

Clean Fill: Fill material from a donor site, which is not a certified quarrying operation, and has had another use prior to acting as a donor site.

Donor Site: Any material obtained from a site which is not a permitted quarrying operation.

Clean Fill Allowance: The allowance item to be used for analytical testing of material to determine if it meets the requirements of *Clean Fill*. The *clean fill allowance* is only to be used for material from *donor sites*.

2.0 PRODUCTS

2.01 QUARRY STONE

The Contractor is to submit their source quarry and the analytical results from the quarry with their bid. The analytical results must be within 365 days of submission.

Stone from a quarry must not contain any elevated natural background contaminants. The Contractor is to provide the analytical results for the material generated at the quarry as part of the stone submission with their bid.

2.02 QUARRY FINES

If the Contractor intends to utilize *quarry fines* as their source of clean material, the source must meet the criteria listed in the Clean Fill.

The Contractor is to submit their source quarry and the analytical results from the quarry with their bid. The analytical results must be within 365 days of submission.

2.03 CLEAN FILL

The Contractor must identify the source and provide documentation (analytical data) the University of Kentucky prior to use.

2.04 PROPERTIES OF SOILS

The Contractor shall identify the source for materials and submit, to the Engineer and Owner, the source and all available information for review of the requirements listed in the applicable specification sections in this contract.

2.05 CLEAN FILL ALLOWANCE

NOT IN CONTRACT

2.06 SUBMITTALS

The Contractor will submit the following items during the course of the project and at the request of the Owner.

- Bills of Lading
- Analytical sample Analysis per material required for the project
- Due Diligence Report, if available for each source of material; inclusive of quarries to be used
- Physical Samples of each type of material required (5 lbs bag)
- Certified weight tickets for material
- Any existing analytical data on the fill source or site

3.0 QUALITY ASSURANCE

3.01 SOIL SAMPLING

NOT IN CONTRACT

3.02 LABORATORY REQUIREMENTS

NOT IN CONTRACT

3.03 TRANSPORTATION

The Contractor shall coordinate with the Owner and the Engineer when the soil is transported after approval.

3.04 CLEAN FILL PROCUREMENT TIME

The Contractor will have 10 calendar days following the notice to proceed to provide an acceptable source of fill.

3.05 REJECTION OF MATERIAL

The Owner or Engineer may reject any material delivered to the receiving site if it does not meet the specifications, at no cost to the Owner.

4.0 MEASUREMENT AND PAYMENT

4.01 GENERAL

No additional payment shall be made for quarry stone. The cost of clean quarry stone to replace contaminated soil will be included in the unit price bid.

END OF SECTION

SECTION 02140
DEWATERING

1.0 GENERAL

1.01 WORK INCLUDED

The dewatering of all areas where work must be performed under this Contract is the responsibility of the Contractor and no additional sum will be allowed for any dewatering operation, overtime, equipment rental or any other expense incurred due to the occurrence of ground water, surface water or water from possible leakage of existing buildings, structures and piping in the vicinity of the Contractor's operations.

1.02 REFERENCED SECTIONS

A. Section 02070 – Management of Contaminated Soil and Groundwater

B. Section 02105 – Environmental Protection

C. Section 02200 – Earthwork

2.0 PRODUCTS

2.01 MATERIALS AND EQUIPMENT

The Contractor shall furnish all materials and equipment necessary to carry out all dewatering required during construction.

3.0 EXECUTION

At all times, the Contractor is to maintain and operate proper and adequate surface and subsurface dewatering in order to keep the construction site dry and in such condition that construction of structures and utilities and placement and compaction of fill and backfill may proceed unhindered by saturation of the area.

The Contractor is to prevent surface water and subsurface or groundwater from flooding or spilling into excavations, and from flooding the project site or surrounding area. He is to remove all water in order to prevent softening of structure or pipe foundation bottoms, undercutting footings, and soil consistency changes detrimental to the stability of subgrades and foundations. Further, the Contractor is to provide and maintain pumps, well points, sumps, suction and discharge lines, or other dewatering system components necessary to convey all water away from excavations.

When dewatering will occur in the vicinity of structures or potable wells, the Contractor shall monitor for adverse effects to structures or wells due to dewatering and shall be responsible to remedy same to the satisfaction of the State. Discharges from dewatering activities which contain silt or hydrogen sulfide are subject to the following controls:

A. All discharges from dewatering activities to surface waters, wetlands or storm sewers shall be free of sediments. Care shall be taken not to damage or kill vegetation by excessive watering or by damaging silt accumulation in the discharge area. If discharges are sediment laden, techniques shall be employed to remove sediment prior to discharge.

B. Storm and Sanitary Sewer inlets within construction areas shall be provided with perimeter hay bales or other appropriate siltation control measures.

All dewatering costs as described herein shall be included in the Contractor's total bid price.

4.0 MEASUREMENT AND PAYMENT

The work under this Section shall not be measured for payment, but shall be paid as a lump sum under Bid.

END OF SECTION

SECTION 02200
EARTHWORK

1.0 GENERAL

1.01 SCOPE OF WORK

The Contractor shall make all excavations of every description for sites, structures, road, and trenches in whatever substance encountered, and shall place and compact backfill to the dimensions and levels shown on the plans or as required by the Engineer. Work under this Section includes earthwork complete, consisting of stripping and stockpiling and protecting of suitable topsoil, excavation of all materials encountered, trenching, sheeting, shoring, dewatering, maintenance of excavation, backfill, fill, compaction, and grading. The Contractor shall perform all layout work. The Contractor shall provide all labor, material, equipment and supervision to execute the work in strict accordance with these specifications and applicable drawings. The Contractor shall have a transit or level on site to verify grades and check elevations.

The Contractor's particular attention is directed to Section 02121 – CLEAN FILL, 02225 - FILL AND BACKFILL MATERIALS, and Section 02226 - COMPACTION CONTROL AND TESTING. Specific information is provided for stockpiling material on-site or off-site and disposal of unsuitable material. Special requirements applicable to excavation to remove soft material and timing of construction are identified.

The Contractor is advised that lines and grades, as shown on plans and profiles, are subject to change. Although it is the intention to adhere to that which is shown on the plans, the Engineer reserves the right to make changes in lines and grades of utilities and locations of manholes when such changes may be necessary or advantageous.

In open trenching on state, county, or local highways, the Contractor shall be governed by the conditions, restrictions and regulations made by the appropriate body. All such regulations shall be in addition to those set down in the Specifications.

The excavation, dewatering, sheeting, and bracing shall be carried out in such a manner as to eliminate any possibility of undermining or disturbing the foundations of any existing structure or any work previously completed under this Contract, or as herein specified.

The Contractor shall fill or backfill all excavations as necessary as indicated on the Drawings and as herein specified.

The Contractor shall coordinate his schedule with the Owner to minimize disruption of the Owner's normal operations.

No construction excavation is to be undertaken until utility companies have been notified and all underground utilities or services are located. Test pitting or trenching shall be undertaken as required at no additional cost to the Owner.

1.02 SUBMITTALS

A. Soil Samples

Thirty-pound bag samples of each material to be used as fill shall be approved by the Engineer thirty days prior to commencing fill operations. This material shall not be used as a compacted fill until approved by the Engineer. By submitting samples of this material, the Contractor agrees and guarantees that the fill material used for construction will conform with the sample(s) supplied. Final acceptance of fill material rests with the Engineer, whose decision shall be final and binding upon the Contractor. However, the acceptance of any material by the Engineer shall not relieve the Contractor of his responsibility to have the fill material used conform to the sample(s) approved by the Engineer.

B. Sheeting and Bracing

Where sheeting is used, the braced sheeting must be designed by a professional with experience in shoring and bracing. Said individual is to provide the Contractor with a certification signed and sealed by him stating that the design of the sheeting and bracing conforms to all applicable requirements of the Occupational Health and Safety Act. Copies of this certification shall be submitted to the Owner's Engineer. The Contractor shall submit a complete sheeting and bracing plan, including supports and bracing for existing pipelines. The Owner's engineer shall have no duty to review the adequacy of the design of the sheeting or trench boxes indicated.

The Contractor must follow the proposed sheeting and bracing plans submitted. No deviations may be made from the procedure without first submitting a revised sheeting and bracing plan.

1.03 REFERENCED SECTIONS

A. Section 02121 – Clean Fill
B. Section 02140 – Dewatering
C. Section 02225 – Fill and Backfill Materials
D. Section 02226 – Compaction Control and Testing

1.04 SITE INFORMATION

Existing grades and other site information shown on the applicable Drawings are approximate. The Owner does not guarantee that the grades shown will not vary from the actual site conditions. The Contractor must make his own field investigations to determine all conditions affecting the work to be done and materials needed and make his bid in sole reliance thereon.

1.05 PROTECTION

A. General

Extreme care shall be exercised to avoid existing trees, shrubs, facilities, construction, utilities, fences, and private property that are to remain and all

necessary precautions taken to preclude damage to these items. Any damages to those items as a result of work performed by the Contractor shall be repaired by the Contractor at his own expense.

The Contractor shall contact utility agencies prior to the start of actual excavation. The Contractor shall obtain information from the proper sources and the authorities concerning locations of all utilities within the scope of this work, in order that there will be no damage done to such utilities.

If and when encountered, utilities shall be supported and protected, and the Engineer shall be notified. Permanent existing utilities near the excavation and/or construction work shall be properly protected during construction work, and any damage to such permanent utilities shall be repaired by the Contractor without expense to Owner or Engineer.
All utility services shall be supported by suitable means so that the services shall not fail when compaction and settling occurs. No separate item is provided for service supports and the Contractor must cover same in the unit price bid for sewer construction.

B. Miscellaneous

Rules and regulations governing the respective utilities shall be observed. Active utilities shall be adequately protected from damage, and shall not be removed or relocated except as indicated or directed. Inactive and abandoned utilities encountered in excavation and grading and operations shall be removed, plugged, or capped, as directed.

All existing pipes, poles, wires, fences, curbing, and other structures which, in the opinion of the Engineer, must be preserved in place without being temporarily or permanently relocated, shall be carefully supported and protected from injury by the Contractor, and in case of injury, the Contractor shall notify the appropriate party so that proper steps may be taken to repair any and all damage done. The Contractor shall, at his own expense, replace, repair or restore the affected facilities to their original condition as or shall reimburse the owner of said facilities for such expenses as the said owner may accrue. When the owners do not wish to make the repairs themselves, all damage shall be repaired by the Contractor, or, if not promptly done by him, the Engineer may have the repairs made at the expense of the Contractor.

C. Preserving Survey Markers

Any existing property boundary markers, control points and datum elevation markers or bench marks shall be preserved, and all such established survey points which are displaced or destroyed by the Contractor shall be replaced by the Engineer with all expenses for such replacement paid by the Contractor.

2.0 PRODUCTS

2.01 SAFETY REQUIREMENTS

The Contractor shall provide and maintain barricades, signs, lights, shelters, etc., required for the protection of personnel, materials and property. Barricades, etc., shall conform with all codes and regulations, and shall be lighted at night with lanterns and reflectorized paint as directed or required for safety, and shall be removed upon completion of the Contract.

All work shall conform to Occupational Safety and Health Administration (OSHA) Requirements.

2.02 SHEETING AND BRACING

The Contractor shall furnish, put in place, and maintain such sheeting, bracing etc., as may be required to support the sides of the excavations and to prevent any movement of earth which could in any way diminish the width of the excavation below that necessary for proper construction or otherwise injure persons in or about the work or endanger adjacent structures or delay the work.

Whenever possible, sheeting shall be driven ahead of the excavation to avoid loss of materials from behind the sheeting. If it is necessary to excavate below the sheeting, care shall be taken to avoid trimming behind the face along which the sheeting will be driven. Care shall be taken to prevent voids outside of the sheeting, but if voids are formed, they shall be filled immediately and compacted.

The materials for steel sheet piling shall conform to the requirement of ASTM-A328. Timber sheet piling shall conform to the requirements of AASHTO M.09.01-1. Materials, other than steel or timber, or a combination of these may be used provided they are properly designed for the purpose intended.

Before beginning operations relating to excavation within a sheeted enclosure, the Contractor shall submit to the Engineer a detailed written description of the equipment and methods he proposes to use and acceptable computations and sketches as prepared by a licensed professional engineer, retained by the Contractor, showing details of the sheeting enclosure. The Contractor shall not proceed with this work until authorized by the Engineer. The furnishing of such plans shall not serve to relieve the Contractor of any part of his responsibility for the safety of the work or the successful completion of the work.

The Engineer may direct the Contractor at any time, in writing, to have sheeting, bracing, etc. in place to be embedded in backfill or concrete for the purpose of preventing subsequent injury to structures or property.

The Engineer may direct the sheeting and bracing to be cut off at any specified elevation, at least three (3) feet below final grade.

All sheeting and bracing not to be left in place shall be carefully removed in such a manner as to not endanger the construction or other structures. All voids left or caused by withdrawal of sheeting shall be backfilled immediately with approved material and compacted (by ramming with tools especially adapted to that purpose, by watering, or by other means as may be approved).

3.0 EXECUTION

3.01 DESCRIPTION

The Contractor shall make excavations in such manner and to such width as will give suitable room for building the structures or laying and joining pipe, but complying with the trench limits shown on the Drawings; shall furnish and place all sheeting, bracing, and supports; shall do all pumping and draining and any other work necessary for dewatering; and shall render the bottom of the excavation firm and dry and in all respects acceptable.

All excavations, except as otherwise specified or permitted, shall be open cut. The Contractor shall not have more than 100 feet of trench open at any one time at the location.

No tunneling will be permitted except as provided elsewhere in these Specifications.

3.02 SEPARATION OF SURFACE MATERIALS

From areas where excavations are to be made, sand, gravel, loam and topsoil shall be carefully removed and separately stored to be used again as directed; or, if the Contractor prefers not to separate surface materials, he shall furnish, as directed and without additional compensation, clean backfill and loam and topsoil at least equal in quantity and quality to that excavated.

When excavations are to be made in paved surfaces, the Contractor shall execute a machined cut of the pavement along the proposed trench lines, in such a manner that the edges of the remaining pavement follow clean, trim, straight lines. If pavement is removed it shall not be mixed with other excavated material, but shall be disposed of away from the site of the work before the remainder of the excavation is made.

3.03 EXCAVATED MATERIAL

Excavated material shall be so placed as not to interfere with travel on the streets and driveways by the occupants of adjoining property or cause undesirable settlement. Excavated material shall not be deposited on private property until written consent of owner or owners, thereof, has been filed with the Engineer. On-site excavated material shall not be deposited in streams or in areas subject to flooding.

It is expressly understood that no excavated materials shall be removed from the site of the work or disposed of by the Contractor except as directed or approved by the Engineer or as noted below. Suitable excavated material may be used for fill and backfill on other parts of the work.

Upon completion of the backfilling, the streets or property shall be cleaned, surplus material removed and the surfaces restored to their original condition. All materials left over in public highways shall become the property of the Contractor. If the Contractor fails to promptly remove such surplus material, the Owner may have the work performed and charge the cost thereof as money paid to the Contractor.

Material excavated from private property shall belong to the property owner or his representative, and shall be disposed of by the Contractor, as required by said Owner or representative. If the Contractor

fails to promptly remove such surplus material, the Engineer may have the same done and charge the cost thereof as money paid to the Contractor.

3.04 DRAINAGE

At all times during construction, the Contractor shall temporarily provide, place and maintain ample means and devices with which to remove promptly, and dispose of properly, all water entering trenches and other excavations, or water that may flow along or across the site of the work and keep said excavations dry until the structures, pipes and appurtenances to be built therein have been completed to such extent that they will not be damaged. At this time, the Contractor shall remove such temporary means and devices.

Every precaution necessary to obtain watertight construction of all joints in pipes must be taken. The same precautions must be taken for all connections with manholes and "Y" branches, extensions of laterals and construction of drop connections.

All groundwater which may be found in trenches and excavations, and any water which may enter excavations from any cause whatsoever, shall be pumped or bailed out, so that the site shall be dry during concrete hold down pad installation, tank placement, pipe laying, backfilling and construction.

All water pumped or drained from the work shall be disposed of in a manner satisfactory to the Engineer, without undue interference with other work or damage to pavements, other surface, or property.

3.05 BUILDING OR STRUCTURE EXCAVATION

The Contractor shall excavate to the elevations shown on the plans, or as directed by the Engineer. If the Contractor excavates below the elevations specified, he shall bring the excavation back to the proper elevation by backfilling with approved aggregate and tamping to provide a compact base. All material must be approved by the Engineer before being placed. If the Engineer directs any changes in elevation or dimension of building, pipe, structure excavations from that shown on the plans, the Contractor shall be paid for work performed under the appropriate bid adjustment items. Any increase in cost resulting from backfilling, or increasing the size of the excavation or foundations because of over-excavation in depth, shall be borne by the Contractor.

Cut slopes shall have a maximum slope of 2:1.

3.06 SLABS ON EARTH

Where slabs on undisturbed earth occur, all loams, organic or other undesirable materials shall be removed as required by the Engineer, and the area grubbed to a depth of at least twelve (12) inches below the finished subgrade elevation or as indicated on the Drawings. Where slabs on fill occur, the fill will also be compacted in accordance with the related section of the Specifications Section 02226 - COMPACTION CONTROL AND TESTING.

3.07 TRENCH EXCAVATION

In general, trenches shall be excavated to such depth as will provide a cover depth as indicated on the Drawings from finished grade to the top of the pipe barrel. Deeper trenches shall be provided where necessary on account of the conformation of the ground and to permit the alignment of the pipe without undue deflection of joints.

Trenches shall be excavated by hand or machinery to the width and depth indicated on the Drawings and specified herein under Paragraph 3.09 - "Trench Limits". All loose material shall be removed from the bottom of the trench so that the bottom will be in an undisturbed condition.

Particular care shall be taken that no stone six (6) inches or larger in any diameter protrudes more than three (3) inches from the bottom or side of the trench.

3.08 TRENCH EXCAVATION IN FILL

If the pipe is to be laid in new embankments or other new fill areas which are more than 12 inches below the invert of the pipe, the fill material shall be placed and properly compacted to final grade or to height of at least three (3) feet above the top elevation of the pipe, whichever is the lesser, before laying pipe. Particular care shall be taken to ensure maximum consolidation of material under the pipe location. The pipe trench then shall be excavated as though in undisturbed material.

3.09 TRENCH LIMITS

The limits of normal trench excavation shall be as shown on the Drawings. Trenches shall be excavated to the required depths, adding, however, to such depths the thickness of the pipe and, where applicable, the thickness of the bedding. If, in the opinion of the Engineer, the material at or below the depth to which excavation for structures and pipes would normally be carried is unsuitable for foundation, it shall be removed to such widths and depths as directed and replaced with suitable material. Such work shall be paid for under appropriate items. The width of the trench at the bottom shall always be wide enough to make the joints properly. When, in the opinion of the Engineer, it is necessary to lay a concrete foundation, the excavation shall be made 1/4 I.D. or (4" min.) deeper, or as ordered by the Engineer.

In earth excavation in sections where bedding is excluded, the bottom of the trench shall be shaped so as to conform to the outside of the pipe, particular care being taken to recess the bottom of the trench in such a manner as to relieve the bell of all loads.

Where the bottom of the trench shall, by mistake of the Contractor, have been taken out to a greater depth than above specified, it shall be refilled to the proper grade depth, using approved aggregate to be placed by the Contractor who shall receive no additional compensation for the backfill.

The Contractor shall at all times exercise care not to excavate outside the trench limiting lines as shown on the Drawings unless authorized by the Engineer.

Bedding for pipe will be as detailed by piping manufacturer.

3.10 TUNNELING

In general, excavation shall be made in open cut from the surface and the Contractor shall not do any tunneling without obtaining permission from the Engineer, and then only according to methods approved by him. This permission will only be given where a line is to be laid to a point behind the curb, across the paved street, or where, in the opinion of the Engineer, it is necessary to tunnel short sections on account of proximity of adjacent wall or structures. Such excavations then can be made in alternate section of open cut and tunnel, the length of the tunnel sections to be specified by the Engineer. These tunnel sections shall be supported by bracing, as necessary, with its edge horizontally across the sewer, and backfilled tightly by ramming and tamping from each end.

3.11 EXCAVATION NEAR EXISTING STRUCTURES

Attention is directed to the fact that there are water pipes, drains, electrical conduits and other utilities in certain locations. Some of these have been made to show all of the lines and services, and the completeness of accuracy of the information given is not guaranteed.

All water, or other utility conduits, shall be located on the ground with pipe finding equipment well ahead of the work at all times. All such locations shall be plainly marked by coded paint symbols on pavement or by marked stakes in the ground. All such location work shall be provided by the Contractor in cooperation with the appropriate utility to the satisfaction of the Engineer at no extra cost.

As the excavation approaches pipes, conduits, or other underground structures, digging by machinery shall be discontinued and the excavation shall be done by means of hand tools, as directed or vacuum excavation techniques. Such manual excavation where incidental to normal trenching excavation shall be done to the satisfaction of the Engineer at no extra cost.

3.12 RELOCATION AND REPLACEMENT OF EXISTING STRUCTURES

Whenever the Contractor encounters certain existing structures as described below and is so ordered in writing, he shall do the whole or such portions of the work as he may be directed, to change the location, or remove and later restore, or replace such structures, or to assist the Owner thereof in so doing. For all such work, the Contractor shall be paid under such items of work as may be applicable, otherwise as extra work.

In removing existing pipes of other structures, the Contractor shall use care to avoid damage to material, and the Engineer shall include for payment only those new materials which, in his judgment, are necessary to replace those unavoidably damaged.

The structures to which the provisions of the preceding two paragraphs shall apply include pipes, wires, and other structures which (1) are not indicated on the Drawings or otherwise provided for, (2) encroach upon or are encountered near and substantially parallel to the edge of the excavation, and (3) in the opinion of the Engineer will impede progress to such an extent that satisfactory construction cannot proceed until they have been changed in location, removed (to be later restored), or replaced.

When fences interfere with the Contractor's operations, Contractor shall remove and (unless otherwise specified) later restore them to original condition all without additional compensation. The restoration of fences shall be done as promptly as possible and not left until the end of the construction period. The construction site and the Owner's property shall be secured at all times.

3.13 CARE AND PREVENTION OF PROPERTY

Excavating machinery and cranes shall be operated with care to prevent damage to trees.

Branches, limbs, and roots shall not be cut except by permission of the Engineer. All cutting shall be smoothly and neatly done without splitting or crushing. In case of cutting or unavoidable damage to branches, limbs, and trunks of trees, the cut or damaged portions shall be neatly trimmed and covered with an application of grafting wax or tree healing paint as directed.

Cultivated hedges, shrubs, and plants which might be injured by the Contractor's operations shall be protected by suitable means or shall be dug up and temporarily replanted and maintained. After the construction operations have been substantially completed, they shall be replanted in their original positions and cared for until growth is re-established. If the cultivated hedges, shrubs, and plants are injured to such a degree as to affect their growth or diminish their beauty or usefulness, they shall be replaced by items of kind and quality at least equal to the kind and quality existing at the start of the work.

On paved surfaces, the Contractor shall not use or operate tractors, bulldozers, or other power-operated equipment, the treads or wheels of which are so shaped as to cut or otherwise damage such surfaces. All surfaces which have been damaged by the Contractor's operations shall be restored to a condition at least equal to that in which they were found immediately prior to the beginning of operation. Suitable materials and methods shall be used for such restoration.

The restoration of existing property or structures shall be done as promptly as practicable and shall not be left until the end of the construction period.

3.14 MISCELLANEOUS EXCAVATION

If the Engineer orders excavation for work not indicated on the Drawings or in the Specifications, the Contractor shall be paid for the work performed in accordance with Section 3 Contract Changes of General Provisions for Construction. This Section of the Specifications does not include the change in excavation involved if the Engineer changes a pipe line grade, structure or the excavation for a structure to remove unsuitable material as given on the Drawings issued to the Bidders.

3.15 DUST CONTROL

During the progress of the work, the Contractor shall conduct his operations and maintain the area of his activities so as to minimize the creation and dispersion of dust.

3.16 BACKFILLING GENERAL

In general, or unless other material is indicated on the Drawings or elsewhere specified, material used for backfilling trenches and excavations for or around structures shall be in conformance with Section 02121 – CLEAN FILL. Backfilling shall be done as promptly as is consistent with non-injury to the pipe or structures. Where the trench is in a paved area or an area to be paved, or in an unpaved vehicular or pedestrian traveled way, or the shoulder of a paved roadway, a suitable pavement base shall be provided.

Suitable backfill material shall be in accordance with Section 02121 – CLEAN FILL and Section 02225 - FILL AND BACKFILL MATERIALS.

Frozen material shall not be placed in the backfill, nor shall backfill be placed upon frozen material. Previously frozen material shall be removed, or shall be otherwise treated as required, before new backfill is placed.

Filling and backfilling is to consist of stripping and excavating existing soils, depositing, spreading, and compacting approved materials to be specified densities; terminating the materials at the elevations shown, and controlling moisture.

No filling or backfilling is to be performed in such a manner as to create unbalanced earth pressures which could damage recently completed work or existing work.

No fill or backfill is to be placed or compacted in a frozen condition, or placed on top or frozen material. Any fill or backfill containing unacceptable material, including organic matter, boggy or peaty humus, peat, rubbish, refuse, stones more than 6" in the largest dimension, frozen earth or any other undesirable substances is to be removed and replaced prior to compaction. No fill material is to be placed where free water is standing on the surface of the areas where the fill is to be placed, and no compaction of fill will be permitted with free water on any point of the surface of the fill to be compacted.

The water content of fills is to be controlled during placement within the range necessary to obtain the compaction specified. In general, the moisture content of fill soils is to be within 3% of the optimum moisture content for compaction as determined by laboratory tests. All laboratory tests necessary to establish that the water content of the fill is suitable for placement will be performed by the testing laboratory. The Contractor is to perform all necessary work to adjust the water content of the fill material to within the range necessary to permit the compaction specified. This is to include but not be limited to spreading, scarifying and mixing to permit drying in order to reduce the natural water content to an acceptable range.
Acceptable fill materials are those soils which consist of predominantly coarse grained sand and gravel particles. Organic materials or fine grained silt and clay soils are unacceptable fill materials.

3.17 BACKFILLING AROUND STRUCTURES

No backfill shall be deposited against concrete until the concrete has obtained sufficient strength to withstand the earth pressure placed upon it and in no case less than seven days, not before carrying out and satisfactorily completing quality control tests. Compaction of backfill against concrete structures shall not be carried out by motorized equipment closer to structure than the depth of structure below grade.

In addition, where pipe is connected to the structure, the backfilling procedure shall be carried out as specified in "Backfilling in Open Trench".

3.18 BACKFILLING IN OPEN TRENCH

As soon as practical after the pipe has been placed in accordance with the appropriate Sections of this Specification and the pipe joints have been properly made, the backfilling shall begin, and shall continue without delay. If a concrete envelope is not used, then the backfill material shall be placed

simultaneously on both sides of the pipe, so that there will be no tendency to displace the pipe alignment. In placing the material, care shall be taken that stones do not strike the pipe. Backfill material shall be placed in accordance with the drawings and General Notes.

Care shall be taken in the use of mechanical or other tampers not to injure or move the pipe or cause the pipe to be supported unevenly.

Large masses of backfilling material shall not be dropped into the trench in such a manner as to endanger the pipe.

Whatever method of compacting backfill is used, care shall be taken that stones and lumps shall not become nested and that all voids between stones shall be completely filled with fine material.

No compacting shall be done when the material is too wet to be compacted properly; at such time the work shall be suspended until the previously placed and new materials have dried out sufficiently to permit proper compacting, or such other precautions shall be taken as may be necessary to obtain proper compacting.

All backfill trenches shall be thoroughly surface tamped with an approved tamping machine.

3.19 MATERIAL FOR NONSTRUCTURAL FILLING AND EMBANKMENTS

Approved selected materials available from the excavations and not required for backfill around pipes and under structure may be used for site preparation except as otherwise specified.

Material needed in addition to that available from construction operations shall be obtained from approved structural fill as specified in Section 02121 – CLEAN FILL and Section 02225 - FILL AND BACKFILL MATERIALS.

All materials, whether from the excavations or off-site, shall be of such nature that, after if has been placed and properly compacted in 12-inch layers, it will make a dense, stable fill. It shall not contain vegetation, roots, stones over 6 inches in diameter, or porous matter.

3.20 PREPARATION OF SUBGRADE FOR FILL AREAS

The Contractor shall remove: loam and topsoil to a depth of approximately one (1) foot; and loose vegetable matter, stumps, large roots, etc., from areas upon which embankments will be built or material will be placed for grading. The subgrade shall be shaped as indicated on the Drawings. Subgrade areas shall be proof-rolled with a minimum of ten passes with a ten-ton (static weight) vibratory roller compactor prior to placement of new fill.

The Contractor shall use a rock toe and construction bonding benches along the existing embankment and hillside to provide stability to the new fill.

3.21 PLACING AND COMPACTING FILL

After the subgrade has been prepared as hereinbefore specified, the material shall be placed thereon and built up in successive layers until it has reached the required elevation.

Fill beneath structures shall conform to Section 02121 – CLEAN FILL and to Section 02225 – Fill and Backfill Materials, Dense Graded Aggregate, and be placed in accordance with the Drawings. Material for fill in nonstructural areas shall conform to 02121 – CLEAN FILL as indicated on the drawings.

Layers shall not exceed 12 inches in thickness before compaction. The layers shall be slightly convex toward the center.

Each layer of material shall be compacted by the use of approved means so as to secure a dense, stable, and thoroughly compacted mass. At such points as cannot be reached by mobile, power-driven vibratory rollers, or where such equipment is not permitted, the materials shall be thoroughly compacted by the use of suitable power-driven tampers.
Previously placed or new materials shall be moistened by sprinkling, if required, to ensure proper bond and compaction. No compacting shall be done when the material is too wet, from either rain or too great an application of water, to compact it properly; at such times the work shall be suspended until the previously placed and new materials have dried out sufficiently to permit proper compaction, or such other precautions shall be taken as may be necessary to obtain proper compaction.

3.22 COMPACTION CONTROL

The Contractor's attention is called to the related section of the Specifications, Section 02226 - COMPACTION CONTROL AND TESTING.

4.0 MEASUREMENT AND PAYMENT

The work under this Section shall not be measured for payment, but shall be paid as a lump sum under Bid except for the sheeting material which shall be paid as a unit price item under Bid.

END OF SECTION

SECTION 02225
FILL AND BACKFILL MATERIALS

1.0 GENERAL

1.01 SCOPE OF WORK

The Contractor shall furnish all fill and backfill material for site preparation and to meet finished contours as shown on the Drawings.

1.02 APPROVAL OF MATERIALS

Any imported fill material shall conform to Section 02121 – CLEAN FILL of this specification. The Contractor shall furnish the Engineer with representative 5-pound-bag samples and a gradation analysis of each type of soil proposed for use on the project. If the source of materials changes significantly or a different source is used, resubmittals and reapprovals must be made.

Documentation of the source and quality of the fill shall be provided in accordance with Section 02121 – CLEAN FILL.

Appropriate documentation, such as analytical data, shall be provided to verify the absence of contamination. No fill shall be transported to the project site unless proper documentation is provided to, and accepted by Engineer.

1.03 REFERENCED SECTIONS

A. Section 02200 – Earthwork
B. Section 02226 – Compaction Control and Testing
C. Section 02121 – Clean Fill

2.0 PRODUCTS

2.01 SELECT EXCAVATED MATERIAL

Select excavated material shall not be used as backfill.

2.02 BROKEN STONE OR SCREENED GRAVEL (DOT 57)

Broken stone or screened gravel (No. 57) shall be clean, hard aggregate, shall be accurately leveled to required grades, and where required shall be compacted by tamping or other approved means. The broken stone or screened gravel (No. 57) shall conform to the following gradation:

Sieve Size	Percentage by Weight Passing Square Mesh Sieves
1-1/2"	100%
1"	95- 100%
1/2"	25- 60%
No. 4	0- 10%
No. 8	0- 5%

2.03 PEA GRAVEL

Screened pea gravel shall be used as backfill around tanks and piping and shall be clean, hard aggregate, shall be accurately leveled to required grades, and where required shall be compacted by tamping or other approved means. The pea gravel shall conform to the following gradation:

Sieve Size	Percentage by Weight Passing Square Mesh Sieves
1-1/2"	- -
1"	100%
3/4”	90 – 100%
1/2"	- -
3/8”	20 – 55%
No. 4	0 - 10%
No. 8	0 - 5%

2.04 DENSE GRADED AGGREGATE

Dense graded aggregate base course material shall consist of the type and class or classes of soil aggregates as directed by the Engineer or as indicated on the Plans or in the Specifications. Each type and class shall conform to the requirements specified therefore in the Kentucky DOT Standard Specifications.

Dense graded aggregate base course shall not be constructed when the subgrade therefore is frozen, or when it is soft or unstable. Dense graded aggregate base course shall not be constructed during freezing weather or with frozen material.

Dense graded aggregate base course of more than eight (8) inches compacted thickness shall be placed and compacted in two or more courses of approximately equal thickness, no course is to be more than eight (8) inches thick. If voids develop at or near the surface of the dense graded aggregate base course, fine material of stone, or of sand or sand and small gravel particles, shall be applied and vibrated, or broomed and rolled, into place so as to fill all such voids and close the surface.

Where soil conditions do not provide a sound and stable subgrade, the unstable and unsuitable subgrade material shall be removed, and the excavation shall be uniformly shaped, and firmly compacted. Approved dense graded aggregate base course material shall be placed in layers of not more than eight (8) inches thick. Each layer shall be compacted, with approved compacting machinery. After the dense graded aggregate base course material is placed to the subgrade level, it shall be rolled until the entire mass is thoroughly and satisfactorily compacted. The finished surface thereof shall conform to the specified grade and cross section of the subgrade.

2.05 SAMPLES

When required by the Engineer or where noted in other Sections of these Specifications, samples of materials shall be submitted for approval.

A 30 pound sample for each proposed source of #57 stone (clean stone) and bank run gravel (imported fill) shall be submitted to the Engineer for approval before any material is trucked to the site. Such samples shall be furnished, taken, stored, packed, and shipped as directed, at the expense of the Contractor. The Engineer reserves the right to have a certified testing laboratory perform sieve analyses on the materials. Except as otherwise noted, the Owner will make arrangements for and pay for all tests.

The Contractor shall submit data and samples, or place his orders, sufficiently early to permit consideration inspection, testing, and approval before the materials are necessary for incorporation in the work. Any delay resulting from his failure to do so shall not be used as the basis of a claim against the Owner or Engineer.

2.06 GEOTEXTILE CONSTRUCTION FABRIC

The construction fabric shall be a woven or nonwoven fabric consisting only of long chain polymeric filaments or yarns such as polypropylene, polyethylene, polyester, polyamide, or polyvinyl-chloride formed into a stable network such that the filaments or yarns retain their relative position to each other. The fabric shall be inert to commonly encountered chemicals and conform to the properties in the following tables:

Resistance to Installation Stresses:

General Drainage Application

Fabric Property	Test Method	Minimum Shipment (Averages)
Grab Tensile Strength, lbs	ASTM-D-4632	120
Grab Tensile Elongation, %	ASTM-D-4632	50
Burst Strength, psi	ASTM-D-3786 (Diaphragm Method)	300
Trapezoid Tear Strength, lbs.	ASTM-D-4533	50

Asphalt Paving Underdraining Fabric:

Grab Tensile Strength, lbs	ASTM-D-4632	185
Grab Tensile Elongation, %	ASTM-D-4632	50
Burst Strength, psi	ASTM-D-3786 (Diaphragm Method)	380
Trapezoid Tear Strength, lbs.	ASTM-D-4633	70

Performance Criteria During Service Life:

Fabric Property	Test Method	Minimum Shipment (Averages)
Equivalent Opening Size, U.S. Standard Sieve	CW 002215	70-100
Water Flow Rate, gal/min/ft^2	H, 20 cm to 10 cm	350
Water Permeability, k, cm/sec	CFMC-FEET-2	0.100

Resistance to Environmental Factors:

Mildew, Rot Resistance, % Strength Retention	AATCC-30	100
Insect, Rodent Resistance, % Strength Retention	AATCC-24	100

General drainage application geotextile fabric shall be Amoco 4545 Soil Filtration fabric, or approved equal. Asphalt paving underdraining geotextile fabric shall be Amoco 4553, or approved equal.

3.0 EXECUTION

3.01 PLACING AND COMPACTING

Fill materials shall be placed as specified in Section 02200 - EARTHWORK.

Fill material shall be compacted as specified in Section 02226 - COMPACTION CONTROL AND TESTING.

4.0 MEASUREMENT AND PAYMENT

The work under this Section shall not be measured for payment, but shall be paid as a lump sum under Bid.

END OF SECTION

SECTION 02226
COMPACTION CONTROL AND TESTING

1.0 GENERAL

1.01 SCOPE OF WORK

The Contractor shall furnish all labor, materials and equipment necessary to place and compact fill or backfill. The Contractor shall furnish all materials necessary to collect soil samples. The samples will be collected and transported to the testing laboratory.

Actual testing of soil samples with the exception of in situ density determinations shall be done by an independent testing laboratory approved by the Engineer. In situ density determinations shall be made by the Engineer or his representative. Certified copies of test results shall be furnished by the testing laboratory directly to the Engineer.

1.02 REFERENCED SECTIONS

A. Section 02200 – Earthwork
B. Section 02225 – Fill and Backfill Materials

2.0 PRODUCTS

2.01 TEST METHODS

The Contractor shall provide heavy duty sample bags for fill or backfill material to be tested. Soils shall be classified as in the related section of the specifications, Section 02225 - FILL AND BACKFILL MATERIALS.

Soil samples shall be prepared for testing according to American Society for Testing and Materials (ASTM) Specification 421, Dry Preparation of Soil Samples for Particle-Size Analysis and Determination of Soil Constants.

Gradation testing shall be performed according to ASTM D-2216, Particle-Size Analysis of Soils and ASTM D-1140, Amount of Material in Soils Finer than the No. 200 Sieve.

Moisture content of soil shall be determined by ASTM D-2216, Laboratory Determination of Moisture Content of Soil.

Liquid Limits and Plasticity Index shall be determined by ASTM D-423, Liquid Limits of Soils, and ASTM D-424, Plastic Limit and Plasticity Index of Soils.

Maximum dry density for each type of fill shall be determined by ASTM D-1557, Method D Moisture-Density Relations of Soils using 10-pound rammer and 18-inch drop.

In-place field unit weight shall be determined by ASTM D-1556, Density of Soils in Place by the Sand-Cone Method, or ASTM 2922, Method B, Density of Soil and Soil Aggregate in Place by Nuclear Methods.

Laboratory density may, at the discretion of the Engineer, be determined in accordance with ASTM D-2049, Relative Density of Cohensionless Soils.

3.0 EXECUTION

3.01 COMPACTION EQUIPMENT

Prior to the commencement of filling and backfilling operations, the Contractor shall submit for approval a detailed list of the type of compacting equipment to be utilized in the work, and the number of each.

No backfilling shall be undertaken until the compacting equipment list has been submitted and approved as conforming to the Contract requirements.

Sufficient compacting equipment shall be available at the work site prior to the commencement of filling operations, and at all times thereafter while backfilling is being conducted.

Each layer of fill shall be inspected prior to compaction. All visible roots, vegetation, or debris shall be removed. Stones shall be removed. The water content for each layer shall be determined to be suitable for compaction or shall be brought to a suitable satisfactory condition.

Material incorporated in the fill which is not in satisfactory condition shall be subject to rejection and removal at the Contractor's expense. Placement of fill on frozen ground or placement of fill material which is frozen will not be permitted.

Previously placed or new materials shall be moistened by sprinkling, if required, to ensure proper bond and compaction. No compacting shall be done when the material is too wet, from either rain or too great an application of water, to compact it properly; at such times the work shall be suspended until the previously placed and new materials have dried out sufficiently to permit proper compaction, or such other precautions shall be taken as may be necessary to obtain proper compaction.

Filling shall begin in the lowest section of the area. Fill shall be spread in layers as specified. The surface of each layer shall be approximately horizontal but will be provided with sufficient longitudinal and transverse slope to provide for runoff of surface water from every point. Filling shall be conducted so that no obstruction to drainage from other sections of the fill area is created at any time. Sumps, if any, shall be continuously maintained in effective operating condition.

Each layer of material shall be compacted by the use of only approved rollers or other approved means so as to secure a dense, stable, and thoroughly compacted mass. At such points as cannot be reached by mobile mechanical equipment, or where such equipment is not permitted, the materials shall be compacted by the use of suitable power-driven tampers.

The compaction equipment shall be operated so as to make a minimum of five passes over each section of each layer of fill unless otherwise specified. Each successive pass shall overlap the adjacent pass by not less than 10 percent. Additional passes shall be made to obtain the required compaction, if necessary.

3.02 COMPACTION REQUIREMENTS

A. Pipe Bedding: Bedding shall be placed uniformly in 6-inch layers and compacted. Compaction shall be accomplished by mechanical tampers.

B. Pipe Sand Bedding: Material shall be placed uniformly in 6-inch layers and compacted to 95 percent of maximum dry density of the sand. Compaction shall be accomplished by mechanical tampers.

C. Pipe Backfill: Material shall be placed uniformly in 6-inch layers and compacted to 95 percent of maximum dry density for the type of material used. Compaction shall be accomplished by mechanical tampers.

D. Structural Fill (Foundation Subgrades, Foundation Underdrainage, Pavement Subgrades, Pavement Subbase): Material for foundation subgrade, pavement subgrade, or structural fills shall be placed in 6-inch layers compacted to 95 percent maximum dry density for a given type of material. Compaction shall be by mechanical power driven vibratory compactors. Pavement subgrade in cut areas shall be rolled and compacted to 95 percent density of the in situ material.

Fill around structures shall be placed in 6-inch layers and compacted to 95 percent maximum dry density. Compaction shall be accomplished by mechanical power driven vibratory compactors. Compaction of backfill against concrete structures shall not be carried out by motorized equipment closer to the structure than the depth of the structure below grades.

E. Nonstructural Fill (Landscaping and other uses as designated by the Engineer): Material shall be placed in 9-inch layers and compacted to 85 percent maximum dry density for the given type of material used. Compaction shall be accomplished by mechanical power-driven vibratory compactors. Fill materials must be approved by the Engineer.

3.03 APPROVAL OF FILL OR BACKFILL MATERIAL

Before placing or compacting any on-site material, the Contractor shall submit a sample of the material for testing. No on-site material shall be placed until approved by the Engineer.

Before placing or compacting any borrow material, the Contractor shall submit a sample for testing from each source. For a given type of fill, only those sources approved by the Engineer will be acceptable.

The Engineer may at any time require additional laboratory testing should he observe any changes in gradation of the material being placed. No additional fill shall be placed or compacted until the material has been approved. If the material does not meet the required gradation and Atterburg limits for a given type of fill, the Contractor shall remove it at his expense. The Contractor may use the material for other types of fill providing it meets the required gradation and properties of that type.

3.04 FREQUENCY OF COMPACTION TESTING

Laboratory compaction testing shall be performed for each distinctive type of material to be incorporated in the fill. In each layer of fill, at least one in-place moisture-density determination shall be made for each 5,000 sq. ft. layer area or as determined by the Engineer. The percent compaction of the fill at the point of the in-place moisture-density test shall be computed as follows:

Percentage compaction = $(D_f / D_l) \times 100$

in which:

D_f = Unit dry weight in lb./cu. ft. of sample used in field moisture- density determination.

D_l = maximum unit dry weight in lb./cu. ft. obtained in a specified laboratory compaction testing on a sample of the same type of material.

3.05 FAILED TESTS

If the percentage compaction at any point is found to be unacceptable, additional compaction with or without modification of the field moisture content as directed by the Engineer shall beperformed and a second moisture-density determination made. This procedure shall be repeated until satisfactory compaction is obtained.

If after five (5) tests any fill or backfill material cannot be compacted to the required density, it shall be removed and disposed of at the Contractor's expense.

4.0 MEASUREMENT AND PAYMENT

The work under this Section shall not be measured for payment, but shall be paid as a lump sum under Bid.

END OF SECTION

SECTION 02500
CLEANUP AND RESTORATION

1.0 GENERAL

1.01 SCOPE OF WORK

For the lump sum price bid, the Contractor shall keep the site, project and work free from accumulations of waste materials, rubbish and other debris resulting from construction operations, and at the completion of all work, he shall remove all waste materials, rubbish and debris from and about the site, project and work as well as remove all tools, construction equipment, machinery and surplus materials, and shall leave the site clean and ready for occupancy and use by the Owner. The Contractor shall also restore to their original condition those portions of the site not designated for improvement or alteration under the various contracts comprising the project.

Final site restoration shall be undertaken as soon as an area is no longer needed for construction, stockpile or access. When access roads are no longer needed, road fill shall be removed and the access area shall be restored to pre-disturbance conditions. Care should be taken to avoid damage to adjacent vegetation and to prevent the formation of depressions that would serve as mosquito pools.

Excavated material unsuitable for backfill and considered to be solid waste shall be removed from the construction site and disposed of at an approved facility.

Work described under this Section shall be in addition to the cleanup and restoration operations described under the various other Sections of these Specifications, which work shall also be completed by the Contractor. All cleanup and restoration work shall be to the satisfaction of the Engineer and Owner.

1.02 HAZARDS AND ENVIRONMENTAL CONTROL

Store volatile wastes in covered metal containers and remove them from the site daily. Prevent accumulation of wastes which create hazardous conditions. Provide adequate ventilation during use of volatile or noxious substances.
Conduct cleaning and disposal operations in compliance with local ordinances and all anti-pollution laws. Do not burn or bury rubbish and waste materials on project site. Do not dispose of volatile wastes such as mineral spirits, oil or paint thinner in storm or sanitary drains. Do not dispose of wastes into streams or waterways.

2.0 PRODUCTS

2.01 PRODUCTS

Use only cleaning materials recommended by manufacturer of surface to be cleaned. Use cleaning materials only on surfaces recommended by cleaning material manufacturer.

3.0 EXECUTION

3.01 CLEANUP OPERATIONS

A. General

1. Execute cleaning to ensure that buildings, structures, grounds and public properties are maintained free of accumulations of waste materials and rubbish.

2. Wet down dry materials and rubbish to lay dust and prevent blowing dust.

3. Provide on-site containers for collection of waste materials, debris and rubbish. At least once a week during progress of the work, clean site and public properties, and dispose of waste materials, debris and rubbish at legal public or private dumping areas off Owner's property.

4. Vacuum clean interior building areas when ready to receive finish painting, and continue vacuum cleaning on an as-needed basis until project completion and acceptance or occupancy by the Owner. Maintain other structures in broom-clean condition.

5. Handle materials in a controlled manner with as few handlings as possible; do not drop or throw materials from heights.

6. Schedule cleaning and painting operations so that dust and other contaminants resulting from cleanup processes will not fall on wet, newly painted surfaces.

B. Site Work

Remove cleared vegetation, stones, excess excavation and the like from the site. Check pavements, curbs and walks for damage and stains and clean and repair as required before final sweeping.

C. Concrete

Remove efflorescence, grease, dirt, fungus and other deleterious materials from concrete which will be exposed or which is to receive applied finishes or painting. Remove all form work from project site after stripping unless it is to be reused.

D. Masonry

Properly paint masonry. Clean exposed surfaces only with specified materials and wash with clean water. Remove all paint spots, asphalt and other foreign matter from exposed surfaces.

E. Metals

Remove all excess sealants, dirt and foreign matter, and restore metal finish. Clean only by methods and with materials non-injurious to the metal. Do not remove any methacrylate coatings.

F. Wood

Remove all scrap and surplus material, including shipping cartons, connected with finish carpentry. Remove all excess adhesives, and clean all hardware and prefinished materials.

G. Roofing, Insulation, Waterproofing and Caulking

Remove all cartons, buckets, scrap wood, loose nails and surplus materials not used in the construction. Clean all building faces and other surfaces from drippage and stains, including surfaces adjoining joints filled with sealants.

H. Doors, Windows and Hardware

1. Remove stains, dust, dirt and paint from all doors, windows, and finish hardware. Remove glazing compound stains from both sides of all glass, and wash and polish all glass outside and inside. Do not disturb glazing material and do not scratch glass.

2. Use no acid solutions or water containing caustics for cleaning glass or frames. Maintain protective maskings in place until painting is complete, following which, properly and completely remove maskings.

I. Wall and Floor Finishes

1. Remove all plaster drippings and surplus materials used in construction, including staging, buckets and ladders. Clear spatter from all surfaces adjoining plaster work.

2. Remove excess surface adhesive daubs from tile work before grouting. Clean tile after grouting and leave free of dirt, stains, and haze left from grout. Use no acids for cleaning tile work. Cover floors with protective paper before other trades have access to area.

3. Clean resilient floor with flooring manufacturer's approved cleaner and leave floor free of soil, dust, scuff marks, scraps, excess adhesive and other blemishes. Wax and buff floor, and cover with protective paper until final acceptance.

J. Equipment

Clean all foreign matter from pipeline and valve interiors and exteriors. Clean all equipment and maintain free of finger prints and other soil marks.

K. Furnishings

Remove all spots and soil from all items of furnishings.

L. Plumbing, Heating and Ventilating:

1. Clean and free strainers and aerators from foreign matter. No faucets shall drip when turned off. All fixtures shall be cleaned prior to final inspection.

2. Clean of dust and debris or replace all air tempering filters. Clean all diffusers and return air grills. If an air tempering system has been used without filters during construction, thoroughly clean ducts, diffusers and fans.

M. Electrical

Clean entire project work of wire cuttings, metal knockouts and packing boxes. Clean all fixtures of fingerprints, stains and paint smears. The interior of all electrical equipment, panels, etc. are to be thoroughly cleaned.

3.02 FINAL CLEANUP AND RESTORATION

Check all sight-exposed interior and exterior surfaces, and remove all remaining grease, dust, dirt, stains, labels, fingerprints and other foreign materials from these surfaces.

Repair, patch and touch up marred surfaces to specified finish to match adjacent surfaces. Broom

clean paved surfaces and sidewalks. Rake clean other surfaces of grounds.

The Owner will assume responsibility for cleanup as of time designated as Final Completion date for entire project, and prior to that time for any portions of the work which he occupies prior to Final Completion.

4.0 MEASUREMENT AND PAYMENT

The work under this Section shall not be measured for payment, but shall be paid as a lump sum under Bid.

END OF SECTION

SECTION 02600
ASPHALT PAVEMENT

1.0 GENERAL

1.01 SCOPE OF WORK

Work under this Section consists of furnishing all labor, materials and equipment required to complete full-depth asphalt paving and surfacing work defined by the Documents.

1.02 REFERENCED SECTIONS

A. Section 02200 – Earthwork
B. Section 02225 – Fill and Backfill Materials

1.03 STANDARDS

Comply with applicable provisions and recommendations of the following except where otherwise shown or specified.

ASTM D1557-78, "Tests for Moisture - Density Relations of Soils and Soil-Aggregate Mixtures Using 10 lb. Rammer and 18 inch Drop." (Modified proctor).

KYDOTSS, "Standard Specifications for Road and Bridge Construction", 2007.

2.0 PRODUCTS

2.01 GENERAL CRITERIA

Before starting any kind of operations at the construction site, the Contractor is to submit to the Engineer all internal routes and roads he intends to use in delivering or removing any of his equipment, materials and supplies to or from the site. The Contractor is to instruct his drivers to utilize only those routes which were reviewed with the Engineer. No other routes are to be used without prior notification to the Engineer.

Complete and unrestricted fire and emergency vehicle access is to be maintained at all times.

Samples and certifications of construction materials are to be submitted for record and approval. No materials are to be delivered or placed without the Engineer's prior approval.

After basic pavement drainage patterns have been established the base course pavement is to be immediately placed so as to provide construction vehicle access.

No course is to be placed on prior pavement unless the substrate surface is cleaned and free of all embedded silt, clay or other debris, and tack coated to insure course adhesion.

No grade cuts are to be made in road bed areas unless base course pavement placement immediately follows, insuring that surface waters will not damage or disturb any possible existing sub-grade native clays.

The Contractor is completely responsible for repairing damage to any site pavement caused by his operations. Permanent repairs are to be made promptly upon notification of damage and conform to criteria contained in this Section of the Specifications.

Should the Contractor fail to repair any damage caused by his operations within two (2) weeks after notification, the Owner may have the repairs made by others, and will deduct the actual cost of such repairs from the Contractor's monthly estimate. Notification of hazardous conditions will require immediate attention of the Contractor, or the Owner will have the condition corrected at the Contractor's sole expense.

No additional or separate payments will be made for pavement restoration by the Contractor.

2.02 MATERIALS

The subgrades under roadways and parking areas are, in general, to consist of a minimum of one (1') foot thickness of Class "G" compacted fills and six (6) inches of compacted quarry process road stone. The subgrades are to be brought to the required finished grades and elevations and compacted to 95% of the maximum density determined in accordance with ASTM D 1557-78, using the particular type fill shown on the Drawings and in accordance with the details specified in other Sections of these Specifications. The Engineer is then to check the subgrade. The Contractor is to place no stone, bituminous materials or concrete on any subgrade until it has been inspected and approved by the Engineer.

The Contractor is to comply with the requirements of applicable concrete sections under other Divisions of these Specifications for all concrete materials, admixtures, bonding materials, curing materials, methods of placing and other requirements.

Asphalt cement is to conform to the requirements of the Kentucky Department of Transportation. The penetration grade shall be 85-100 unless otherwise specified by the Engineer.

Coarse aggregate is to be broken stone conforming to the type and requirements of Kentucky Department of Transportation, and unless otherwise approved by the Engineer, is to meet the gradations specified.

Mineral Filler for bituminous concrete and sheet asphalt is to be dolomite, traprock, blast furnace slag or other inert mineral matter from approved sources, free from lumps and foreign materials and is to be of the following quality and fineness: Not less than 95% is to pass a No. 100 sieve and not less than 85% is to pass a No. 200 sieve.

The gradation of total aggregate (coarse plus fine, plus filler if required) is to be as follows:

Sieve Size	Weight Percent Passing
2 Inch	100
1 1/2 Inch	90-100
1 Inch	80-100
3/4 Inch	65-95
No. 4	25-60
No. 8	20-50
No. 50	8-30
No. 200	4-12

Material passing the No. 200 sieve may consist of fine particles of the aggregate or mineral filler or both. Material passing the No. 40 sieve is to be non-plastic when tested in accordance with the requirements of current AASHTO Designation T90.
The gradation of total aggregate (coarse plus fine, plus filler if required) is to be as follows:

U.S. Sieve Size	Weight Percent Passing
1/2 Inch	100
3/8 Inch	80-100
No. 4	55-75
No. 8	30-60
No. 50	10-30
No. 200	4-8

3.0 EXECUTION

3.01 CARE AND RESTORATION OF PROPERTY

The Contractor's attention is directed to the related section of the Specifications, Section 02200 - EARTHWORK.

All pavements which have been damaged by the Contractor's operations shall be restored to a condition at least equal to that in which they were found immediately prior to the beginning of operations.

Suitable materials and methods shall be used for restoration.

Materials and methods for all restoration shall be subject to approval by the Engineer.

3.02 PREPARATION OF SUBGRADE IN CUT AREAS

If after excavation to the proposed subgrade elevation, the in-situ material is determined by the Engineer to be unsuitable, the Contractor shall excavate an additional 1 foot and backfill with AASHTO #1 compacted to 95 percent of maximum dry density.

The Contractor shall remove loam and topsoil, loose vegetable matter, stumps, large roots, etc. from areas upon which subbase and pavement material will be placed. The subgrade shall be shaped as indicated on the Drawings and shall be compacted to 95 percent of maximum dry density, by proof rolling with a minimum 10-ton steel drum roller prior to placement of any paving base materials.

3.03 PREPARATION OF SUBGRADE IN FILL AREAS

The Contractor shall remove loam and topsoil, loose vegetable matter, stumps, large roots, etc. from areas upon which embankments will be built or material will be placed for grading.
After the area has been stripped and grubbed as herein before specified Structural Fill material, as described in Section 02225 - FILL AND BACKFILL MATERIALS, shall be placed thereon and built up in successive layers until it has reached the required elevation.

Layers shall not exceed nine (9) inches in thickness before compaction. The layers shall be slightly convex toward the center. Layers shall be compacted to 95 percent of the maximum dry density of the particular material used. Compaction shall be by proof rolling with a minimum 10-ton vibratory roller prior to placement of any paving base materials. A minimum of ten passes shall be made. If the proof rolling produces pumping or excessive yielding, corrective action shall be taken.

3.04 PLACING EARTH IN ROADWAY

Earth shall be placed in layers the full width of the roadway, generally parallel to the finished grade.

The layers shall not exceed 9 inches of loose depth unless otherwise directed.

Each layer shall be spread to a uniform thickness and compacted to 95 percent dry density prior to placing the next layer. Continuous grading or shaping shall be carried out concurrently with the compactive effort to insure uniform density throughout each layer of material. Compaction shall be by proof rolling with a minimum 10-ton vibratory roller.

Embankments shall be graded at all times to ensure the runoff of water.

3.05 FINAL SUBGRADE PREPARATION

Subgrades for pavements are not to vary more than 1/4 inch from the specified grade and cross section. Variations within the above specified tolerances are to be compensated so that the average grade and cross sections specified are met.

The subgrade is to be maintained in a satisfactory condition and properly finished to the satisfaction of the Engineer. No material is to be placed upon the prepared subgrade until it has been inspected for proper depth and compaction and has met the approval of the Engineer. No materials are to be placed on the prepared subgrade if the subgrade is wet or frozen.

3.06 PLACEMENT OF BITUMINOUS CONCRETE STABILIZED BASE

The stabilized base is to be placed in the manner described herein. The material is to leave the plant at a temperature sufficient for workability under prevailing conditions. However, the temperature of the mixtures when laid is not to be less than 250^{o}F. The material is to be laid in one lift, using a Jersey Spreader Box or other equipment approved by the Engineer, and the thickness is to be sufficient to obtain a compacted thickness as indicated on the plans. Initial rolling of the base course to be compacted is to be done with at least two rollers, one of which is to be a three-wheel roller of ten tons minimum and the other two or three axle tandem roller of eight tons minimum, operating immediately in back of the spreader. The second, third and final rolling are to be performed with a two or three axle tandem roller until the mixture is thoroughly compacted to the satisfaction of the Engineer.

When the air temperature is below 50^{o}F all trucks transporting Bituminous Concrete Stabilized Base Material are to be covered with canvasses. Also, no stabilized base material is to be laid unless the temperature is above 25^{o}F and rising.

Traffic may be carried on the base course only if absolutely necessary and then only if approved by the Engineer. The Contractor will be responsible for the maintenance of the base course at all times it is exposed to traffic. Immediately prior to construction of subsequent pavement surface thereon, the base course is to be cleaned of all loose and foreign materials and all damaged areas are to be repaired to the satisfaction of the Engineer.

After the Bituminous Concrete Base Course has been placed, all manholes, valve boxes, catch basins, and driveway entrances (where curb exists) are to be ramped with stabilized base in a manner satisfactory to the Engineer.

If, prior to the placing of the surface pavement, material has to be removed because it has broken up, the Contractor is to remove the bad areas to the limits as specified by the Engineer. Once this area has been dug out, the Contractor is to furnish and lay bituminous stabilized base and compact as specified above.

3.07 PERMANENT PAVING

After the Engineer has approved the Base Course, the Surface Coarse of Bituminous Concrete Mix No. I-5 is to be constructed to the thickness shown on the Drawings.

Where the air temperature is below 50^{o}F, all trucks transporting bituminous concrete surface course material are to be covered with canvasses. Also, no surface course material is to be laid unless the temperature is above 40^{o}F and rising.

Shoulders, slopes and ditches shall be shaped with suitable machinery supplemented by hand labor to reasonably smooth surfaces that will be in keeping with the character of the adjacent terrain and merge into it without any noticeable break.

The Contractor shall remove and dispose all temporary pavement. All loose or damaged material in the existing pavement outside of trench pavement shall be removed and a leveling course, as hereinbefore specified, shall be installed. A leveling subbase shall also be installed at depths and locations, as directed by the Engineer, to fill existing holes and depressions, or to improve roadway crowns. Leveling course quantities used to repair trench paving shall not be included for compensation.

Prior to permanent paving, the Contractor shall adjust all existing manholes, catch basins, valve boxes, curb boxes, and utility covers, etc. to conform to the final pavement grade.

The Contractor shall thoroughly clean surfaces of existing pavement, which will be bonded to permanent paving.

All base course paving shall be dry and thoroughly cleaned of foreign or loose material; a prime or tack coat, shall be applied at the rate of 0.05 to 0.15 gallons per square yard of pavement, depending upon the condition of the existing surface. All casting and edgestones will be protected from the tack coat.

Longitudinal and transverse joints in curb-to-curb paving shall be offset a minimum of 6 inches from trench paving of definable previously existing joints. The maximum length of longitudinal joints shall be such that the temperature of the mixture at the joint shall not be less than 150^{o}F, when the abutting mixture is placed.

3.08 MAINTENANCE OF PAVING

The Contractor shall maintain pavement placed under this Contract until the expiration of the one-year guarantee period and shall promptly fill with similar material all depressions and holes that may occur so as to keep the pavement in a safe and satisfactory condition for traffic.

3.09 LIMITATIONS ON PRODUCT USE

No materials are to be placed on frozen or untamped subgrades. No more ground area is to be cut at one time than can be completely paved within an eight (8) hour day.

4.0 MEASUREMENT AND PAYMENT

The work under this Section shall not be measured for payment, but shall be paid as a lump sum under Bid.

END OF SECTION

SECTION 03000
CONCRETE - GENERAL

1.0 GENERAL

1.01 WORK INCLUDED

The Contractor is to furnish all labor, equipment and materials required to comply with the intent of the Drawings pertaining to concrete work. All tests, samples, shop drawings, and certifications are to be provided in a timely manner in order not to delay the review process or the construction schedule.

1.02 REFERENCED SECTIONS

A. Section 03100 – Concrete Formwork

B. Section 03200 – Concrete Reinforcement

C. Section 03300 – Cast-in-Place Concrete

1.03 REFERENCES

All work performed and materials installed by the Contractor are to be in strict accordance with the latest requirements of the following Codes and Standards:

A. American Concrete Institute –

ACI 301-05	"Specifications for Structural Concrete for Buildings"
ACI 304R-00	"Guide for Measuring, Mixing, Transporting and Placing Concrete"
ACI 305R-99	"Hot Weather Concreting"
ACI 306R-88(2002)	"Cold Weather Concreting"
ACI 308R-01	"Guide to Curing Concrete"
ACI 318-05	"Building Code Requirements for Structural Concrete and Commentary"
ACI 347-04	"Guide to Formwork for Concrete"
ACI 350.1R-01	"Tightness Testing of Environmental Engineering Concrete Structures"
ACI SP-66(04)	"ACI Detailing Manual"

American Society for Testing Materials –

ASTM A307-03	"Standard Specification for Carbon Steel Bolts and Studs, 60,000 Tensile Strength"

ASTM A497-01	"Standard Specification for Steel Welded Wire Reinforcement, Deformed, for Concrete"
ASTM A615-04a	"Standard Specification for Deformed and Plain Billet-Steel Bars for Concrete Reinforcement"
ASTM C31-98	"Standard Practice for Making and Curing Concrete Test Specimens in the Field"
ASTM C33-03	"Standard Specification for Concrete Aggregates"
ASTM C39-03	"Standard Test Method for Compressive Strength of Cylindrical Concrete Specimens"
ASTM C94-04	"Standard Specification for Ready-Mixed Concrete"
ASTM C143-05a	"Standard Test Method for Slump of Hydraulic Cement Concrete"
ASTM C150-04	"Standard Specification for Portland Cement"
ASTM C171-03	"Standard Specification for Sheet Materials for Curing Concrete"
ASTM C173-01e1	"Standard Test Method for Air Content of Freshly Mixed Concrete by the Volumetric Method"
ASTM C227-03	"Standard Test Method for Potential Alkali Reactivity of Cement-Aggregate Combinations (Mortar-Bar Method)"
ASTM C231-04	"Standard Test Method for Air Content of Freshly Mixed Concrete by the Pressure Method"
ASTM C233-04	"Standard Test Method for Air-Entraining Admixtures for Concrete"
ASTM C260-01	"Standard Specification for Air-Entraining Admixtures for Concrete"
ASTM C309-06	"Standard Specification for Liquid Membrane-Forming Compounds for Curing Concrete"
ASTM C494-04	"Standard Specification for Chemical Admixtures for Concrete"
ASTM C1202-05	"Standard Test Method for Electrical Indication of Concrete's Ability to Resist Chloride Ion Penetration"
ASTM E329-06a	"Standard Specification for Agencies Engaged in Construction Inspection and/or Testing"

B. Army Corp of Engineers – Permeability Testing CRD C48-92

C. American Welding Society –

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

D. Concrete Reinforcing Steel Institute -
"Manual of Standard Practice"

In the event of a conflict between the above listed references and these Specifications, the one having the more stringent requirement shall govern.

1.04 STANDARD REQUIREMENTS

The Contractor is to furnish all labor, equipment and materials required to comply with the intent of the Drawings pertaining to concrete work. All tests, samples, shop drawings, and certifications are to be provided in a timely manner in order not to delay the review process of the construction schedule.

The work, which is to be undertaken by the Contractor to fulfill the intent of this Section of the Specifications, is to be covered by this, as well as other Sections of the Specifications. The Contractor is to thoroughly familiarize himself with all those portions of the Specifications, which might in any way affect the outcome of the concrete work.

1.05 SUBMITTALS

Prior to the start of any construction at the Project Site or ordering of any materials associated with the concrete construction, the Contractor is to meet with the Engineer and submit, for his review, his proposed construction methods. This is to include, but not necessarily be limited to: form section layout and construction; control of exposed concrete color variation; finishing techniques to be employed; and methods of curing.

All design mixes, tests on reinforcing steel and other aspects of quality control are included in this and other Sections of the Specifications. All shop drawings and material samples required to expedite the work of this Section are to be submitted in sufficient time by the Contractor to allow for the proper review by the Engineer without delaying the progress of the work.

2.0 PRODUCTS (Not Used)

3.0 EXECUTION

3.01 CONCRETE TESTING

All Concrete test cylinders are to be cast by an authorized representative of the Engineer or the Testing Laboratory. All necessary assistance is to be afforded these persons by the Contractor in order to execute this work, at no additional cost to the Owner.

The test cylinders are to be made in accordance with the requirements of ASTM C31-98. Test cylinders for strength of pumped concrete are to be taken at the point of delivery from the pumping line. Other cylinders are to be taken at the point of discharge.

A minimum of five test cylinders are to be made for each 50 cubic yards or portion thereof, of concrete deposited, two of which will be tested at age seven days, the remainder to be tested at age twenty-eight days. The tests are to be performed by the Testing Laboratory in accordance with the requirements of ASTM C39-03. Test cylinders are to be made at intervals spaced to provide a representative sampling of the entire placement.

Concrete test cylinders are to be properly marked, showing the name of the Project, the location of the concrete tested, the design strength, and the identification numbers of the cylinders in numerical sequence.

The Contractor shall provide a curing box, on the Project Site, for the safe storage and proper curing of test cylinders in accordance with ASTM C31-98. The curing box shall be of sufficient size to accommodate the maximum number of test cylinders cast for any daily placement. The curing box shall be insulated, with an insulated hinged cover, and shall store cylinders on Site until transported to the Testing Laboratory. The temperature within the curing box shall be maintained between 60°-80°F, as specified in ASTM 31-98. Heating devices and/or blankets shall be supplied by the Contractor to maintain the temperature limits. If space heaters are used, care shall be taken so that the cylinders are not overheated. In the case where the cylinders are stored indoors, the cylinders shall be covered with plastic bags, in order to retain the moisture in the cylinders. The curing box shall have a high-low thermometer and the maximum and minimum internal temperatures shall be recorded daily. The location of the curing box shall be in an area that is free from disturbance and vibration, such as pile driving and traffic. Failure to maintain these conditions may result in additional testing at the cost of the Contractor. No

concrete shall be delivered to the Site until the curing box, as described, has been provided. The cylinders shall remain in the curing box a minimum of 24 hours or until transported to the approved Testing Laboratory.

The cylinders shall be transported in such a manner that they will not be jarred, rolled, bounced, or dropped.

If any test cylinders fail to attain the required strength, concrete work is to be terminated until the Engineer and the Contractor meet to determine the cause, and steps are taken to assure that all future concrete work will attain the desired strength. In order to determine what steps are to be taken to achieve the specified requirements, the Engineer will direct additional testing of the unsatisfactory concrete, at the Contractor's expense.

Slump tests are to be performed by the Testing Laboratory, or an authorized representative of the Engineer, in accordance with the requirements of ASTM C143-03. Excessive slump will be a cause for rejection of the truckload of concrete.

The Testing Laboratory, or an authorized representative of the Engineer, reserves the right to perform air content tests on concrete delivered to the Project Site. This test will be performed in accordance with ASTM C173-01e1 or ASTM C231-04. The results of the air content test shall be noted on the delivery ticket.

If required by the Engineer, an inspector from the Testing Laboratory will be directed to inspect the concrete at the batching plant. The cost of such inspection will be paid by the Contractor.

The Owner shall reimburse the Contractor through the Contract for the delivery and testing of concrete cylinders, which meet specified criteria. Cylinders, which do not meet such criteria, will have their cost of delivery and testing deducted from the Contract cost.

All test reports are to be submitted to the Engineer on appropriate forms. Not less than five (5) copies are to be submitted.

All test reports are to include the Project name, name of Contractor, name of concrete testing service, name of concrete supplier, placement location and date, date of test, cylinder numbers, and tests results. Test reports are also to indicate whether or not materials are acceptable for their intended use.

3.02 DEFECTIVE WORK

Concrete work which does not conform to the specified requirements, including strength, tolerances and finishes, is to be corrected at the Contractor's expense, without extension of time therefore. The Contractor will also be responsible for the cost of corrections to any other work affected by or resulting from corrections to the concrete work.

3.03 STORAGE OF MATERIALS

Storage facilities are subject to the inspection by the Engineer. Cement is to be stored well off the ground in a dry, weather tight, adequately ventilated structure with provision to prevent the absorption of moisture. Aggregates are to be stored in a manner to assure good drainage, to preclude the inclusion of foreign matter, and to preserve the gradation. Each size group is to be kept separate by means of bulkheads between the piles.

4.0 MEASUREMENT AND PAYMENT

The work under this Section shall not be measured for payment, but shall be paid as a lump sum under Bid.

END OF SECTION

SECTION 03100
CONCRETE FORMWORK

1.0 GENERAL

1.01 STANDARD REQUIREMENTS

The design and engineering of the formwork, as well as its construction, are to be the responsibility of the Contractor. All forms are to be tight, adequately constructed, and securely held in place. All forms are to withstand, without deformation, the load of the fresh concrete and the effects of the vibrating process, as well as prevent the leakage of mortar. The alignment of forms is to be carefully undertaken to ensure that the forms are secured to the lines and elevations required. Forms are to be clean and are to be recleaned and repaired for each use. Form surfaces against which concrete are to be placed are to be coated with a non-staining material to prevent the adhesion of the concrete.

Proper safe shoring, reshoring, and time of stripping of forms, plus number, adequacy, size and location of these shores, reshores and forms shall be in accordance with good construction practice and shall be so designed and constructed that all local Codes are adhered to. It shall be the sole responsibility of the Contractor to provide a safe Structure at all times, and to provide safety to human life and property.

All corners, edges and arises are to be constructed with a 3/4' chamfer, whether or not shown on the Drawings. Larger bevels and bull-noses shall be constructed as shown. The Contractor is to review the Drawings to determine what other special concrete configurations may be required.

Form design, tolerances of finished lines, and camber to compensate for deflections due to the weight of the fresh concrete shall conform to ACI 347-04, or as otherwise required.

The Contractor shall provide all chamfers, bevels, "V" scores, construction and expansion joints, waterstops, recesses, notches, reveals, keyways, reglets, inserts, anchors, depressions, ledges, knock-out panels, and temporary cleanout openings of suitably shaped materials in order to produce the cast-in-place concrete work as indicated on the Drawings.

The Contractor shall build into the formwork all plates including sliding plates, floor drains, sleeves, frames, anchors, anchor bolts, shelf angles, flashing, reglets, hangers, recesses, necessary ties, anchors and inserts required to anchor any brick, masonry, precast concrete or other special items.

All forms shall be arranged with joints either vertical or horizontal and having a uniform spacing. All panel faces shall be as large as possible to reduce the number of form joints. Form ties shall be uniformly spaced. Joints and form ties shall be arranged in a geometric pattern acceptable to the Engineer.

1.02 SUBMITTALS

The Contractor shall submit shop drawings for fabrication and erection of formwork for specific finished concrete surfaces. Shop drawings shall show the general construction of forms including

jointing, special formed joints or reveals, location and pattern of form tie placement, and other items which affect the exposed concrete visually.

Shop drawing review shall be for the general architectural applications and features only. The design of formwork for structural stability and sufficiency shall be the Contractor's responsibility. The submission of shop drawings shall be in accordance with another Section of the Specifications.

2.0 PRODUCTS

2.01 FORMWORK

Formwork is to be made from metal forms, “Exterior” grade waterproof plywood panels, or plastic-coated plywood. All exposed concrete, regardless of specified finish, is to be constructed using plastic-coated plywood panels. Where the use of form lumber is permitted by the Engineer, it is to be dressed on four (4) sides and only selected boards are to be used for form surfaces in contact with concrete.

2.02 FORM FASTENERS

Only approved form ties and form hangers are to be used. They are to be provided with a waterstop washer not less than 3/4" in diameter and be of such a type, that after forms are stripped, the ties can be broken back a minimum of 11/2" from the surface of the concrete or, after bolts are removed, the portion of the tie remaining in the concrete would be no closer than 11/2" to the face of the concrete. Ties are to be fitted with lugs, cones, washers, or other devices within the form which will leave a hole not larger than %" in diameter or deeper than 3/4". That portion of the tie which is removed from the concrete is to be coated to assure a break back of 11/2" with a material which will not impair the concrete strength or prevent bonding between the concrete and the hole mortar patch. The spacing of form ties and form hangers is to conform to the Manufacturer's recommendations and the previously specified criterion for a uniform geometric pattern of form ties.

2.03 FORM RELEASE AGENTS

Form release agent shall have NSF Standard 61 approval. The form release agent shall be “Bio-Guard” as manufactured by Atlas Construction, “Farm Fresh” as manufactured by Unitex, or approved equal.

3.0 EXECUTION

3.01 GENERAL REQUIREMENTS

Forms are to conform to required shapes, lines, surface scorings, and dimensions of the members, as shown on the Drawings. All joints are to be horizontal or vertical, and uniformly spaced. All panel faces are to be as large as possible to reduce the number of form joints.

Shoring is to be designed to support the weight of concrete and the loads incurred during placing, with due regard to the height of shores. Shoring is to be laterally braced at all splice points. Forms and shores are to be braced or tied so that there is no displacement of formwork during casting and hardening of concrete.

The Contractor is to provide cross bracing for shoring to resist lateral wind forces, and especially against braking, turning and acceleration forces due to any mechanical equipment used in placing the concrete. The Contractor is to be fully responsible for the design of forms and their shores.

Where shoring is supported on the ground, temporary footings of timber, steel or concrete are to be provided which will support the wet concrete without settlement. These footings are to be founded on firm soil, sufficiently below the ground surface so that they will not settle when the ground is wet, or when frozen ground is thawing.

Finished concrete surfaces are not to vary from the theoretical horizontal or vertical planes as specified elsewhere in these Specifications. Where it is necessary to maintain the specified tolerances, the formwork is to be cambered so as to compensate for anticipated deflections in the formwork due to the weight and pressure of the fresh concrete and due to construction loads.

Positive adjustment of shores and struts is to be provided by means of wedges or jacks, and all settlement is to be taken up during the concrete placing operation. Adjusting devices are to be securely braced against lateral deflections.

In columns, walls and similar members of small dimensions, the height of the forms for each vertical lift is not to exceed eight (8') feet, unless suitable openings are provided at not more than eight (8') feet vertical intervals to permit the proper placing of concrete.

Earthcuts shall not be used as forms for vertical surfaces, unless otherwise specified and shown on the Drawings as an acceptable alternate detail.

The Contractor is to construct and erect formwork for all exposed interior or exterior concrete surfaces in such a manner that, upon completion, a uniform and truly symmetrical pattern of horizontal and vertical joints will be evident. All form ties are to be uniformly spaced in both horizontal and vertical directions. The Contractor is specifically alerted to the intention of this Section of the Specifications with regard to appearance. It is the intention of this Section of the Specifications to do the minimum amount of concrete finishing work and rely upon form liners, where used, and the uniform geometric pattern of the forms and form ties to create the desired esthetic effect.

The Contractor is to meet with the Engineer prior to constructing forms to plan the form arrangement or form pattern.

3.02 CURVED SURFACES

Forms for any curved surfaces shall be of circular segments constructed to a true radius complying with the dimensions shown on the Drawings, except that the use of flat forms arranged to form a series of chords shall be permitted provided standard width forms, such as those accepted by the Engineer, are used. Chord dimensions shall not exceed 2 feet and rise dimensions shall not exceed 1/4 inch. Form panels and fillers shall be placed so as to present a uniform pattern on both exposed interior and exterior walls.

3.03 ACCESSORIES

All insert items are required to be placed in formwork, for the accommodation of other formwork, are to be as specified in other Sections or Divisions of the Specifications. The Contractor shall place and/or build into the formwork all of these insert items, as required.

3.04 PRE-PLACEMENT INSPECTION

Before placing concrete, the Contractor shall complete and inspect the formwork installation, including forms, form ties, form oil, attached items, etc., reinforcing steel, and items to be embedded or cast in. He shall notify other crafts involved in ample time to permit the installation of their work and cooperate with other trades in setting such work, as required.

The Contractor shall thoroughly wet all wood forms immediately before placing concrete, as required.

The Contractor shall coordinate the installation of all joint materials and moisture barriers with the placement of forms and reinforcement.

3.05 FORM REMOVAL

All forms are to be removed, cleaned, repaired and stored for subsequent use. If an inspection by the Engineer indicates that the form materials are not satisfactory for reuse, they are to be removed from the Project Site.

No forms are to be removed until the concrete work has gained sufficient strength to support its own weight and normal construction loadings without permanent damage. The Contractor is to provide and place all temporary posts, shores, braces or other devices which might be required for the temporary support of the concrete work. No temporary bracing is to be removed until the concrete work achieves its design strength.

The Contractor is to assume full responsibility for the premature removal of concrete forms. Any concrete which is damaged or does not achieve its design strength as a result of early form removal is to be removed and replaced at no cost to the Owner.

In general, form removal shall adhere to the following schedule:

	Atmospheric Temperature	
	Above 50°F	Below 50°F
Bottom Forms of Slabs, Beams and Girders	7 Days	12 Days
Walls and Columns	2 Days	6 Days
Sides of Beams and Girders*	2 Days	6 Days

*Where such forms also support formwork for the bottom of beams, girders and slabs, the longer removal time is to govern.

The intent of the above schedule is to serve as a guide; however, forms shall remain in place for greater periods than indicated above if the removal of such forms would be detrimental to the stability or safety of the structure.

Forms may be removed earlier than indicated above upon receipt of satisfactory evidence that the concrete supported thereon has attained sufficient strength to maintain the stability and safety of the structure. Laboratory test reports of job-cured test specimens shall be considered satisfactory evidence. All test specimens taken for the purpose of establishing justification for early form removal shall be made and tested at the expense of the Contractor.

Forms shall be removed from the bottoms of slabs, beams, and girders in sections and said slabs, beams and girders shall be immediately reposted with shores sufficient in number and strength to safely sustain all live and dead loads until all members have attained their design strength.

Any spalls or cracks, which occur due to premature form removal, are to be repaired by the Contractor, to the satisfaction of the Engineer.

Form ties are to be broken back immediately after removing the forms. All holes left by such ties are to be filled immediately with mortar consisting of one part portland cement and two parts sand, of the same type, manufacture and quality as used in the concrete.

If taper ties or she-bolts are used, the Contractor must submit, for the Engineer's review, method of filling the entire tie hole after removal of forms.

Care is to be taken in removing forms, walers, shorings, supports, and form ties to avoid spalling or marring of the concrete work.

3.06 RE-USE OF FORMS

Lumber, once used in forms, shall have nails withdrawn, and surfaces to be in contact with concrete shall be thoroughly cleaned before being used again. Plastic coated plywood forms, either patented or Job Site fabricated, shall not be used more than ten (10) times. Other plywood forms of "Exterior" grade surface shall not be used more than three (3) times. The reuse of forms shall be permitted only if the forms, in the opinion of the Engineer, are suitable for the intended purpose. Split, frayed, delaminated or otherwise damaged form facing materials shall not be acceptable. "Patched" forms for exposed concrete surfaces shall not be used unless such forms are inspected by the Engineer. The Contractor shall apply new form coating compound materials to form surfaces as specified for new formwork. When forms are extended for successive concrete placement, the Contractor shall thoroughly clean surfaces, remove fins and laitance, and tighten forms to close all joints. He shall align and secure joints to avoid offsets.

4.0 MEASUREMENT AND PAYMENT

The work under this Section shall not be measured for payment, but shall be paid as a lump sum under Bid.

END OF SECTION

SECTION 03200
CONCRETE REINFORCEMENT

1.0 GENERAL

1.01 STANDARD REQUIREMENTS

This Section of the Specifications covers the furnishing, bending and placement of all reinforcing steel, welded wire reinforcement, supports and fastenings used in the concrete work. This Section also includes furnishing placement (shop) drawings covering the layout and bending of all reinforcing. These placement drawings are to be furnished to the Engineer for his review, as per the requirements of another Section of these Specifications, prior to cutting, bending, or placing any reinforcement. No work shall be started until the drawings have been reviewed by the Engineer.

All reinforcing is to be kept clean, free of dirt, oil or other substances which might in any way impair the bond between the reinforcing and concrete. The Contractor is to advise the Engineer as to his readiness to have the reinforcing inspected after it has been installed. No concrete is to be placed unless the reinforcing, which is in place, has been inspected by the Engineer.

1.02 SUBMITTALS

The Contractor is to allow proper time for the review of shop drawings. The Contractor is to allow sufficient time for inspection of reinforcing steel, once placed, before ordering and placing of concrete. Whenever possible, the Engineer will attempt to reduce the amount of time required for the completion of these functions.

The Contractor is to submit rebar shop drawings showing all plans, sections, details, elevations, bar schedules and diagrams of all bars, arrangements and assemblies as required for the fabrication and placement in the concrete formwork. Details are to be included for all special reinforcements at openings, and for all support accessories, which must be adequate in strength to hold applied live and dead loads without excessive or permanent displacement of the reinforcement.

2.0 PRODUCTS

2.01 REINFORCING STEEL AND ACCESSORIES

Reinforcing bars are to be deformed, intermediate grade, 60,000 psi minimum yield strength, new billet steel, manufactured in the United States and conforming to the requirements of ASTM A615-04a, Grade 60. Reinforcing bars used for stirrups and column ties shall conform to ASTM A615-04a, Grade 40.

Reinforcing tie wires are to be No. 16 U.S. steel wire gage, black soft annealed wire, conforming to Federal Specifications FS-QQ-W-461G.

Welded wire reinforcement shall be deformed, delivered in flat sheets, and is to conform to the requirements of ASTM A497-01. All welded wire reinforcement is to have a 70,000 psi

minimum yield strength. Testing as indicated in ASTM A497-01 is to be undertaken and the results are to be given to the Engineer for his review.

2.02 REINFORCING SPLICE SYSTEMS

Where shown on the Drawings or accepted by the Engineer, the Contractor is to furnish and install a dowel bar substitution and reinforcing splice system.

The Contractor is to submit, to the Engineer, the Manufacturer's literature, product samples and certified test reports of the system he proposes to use, for review.

Test reports are to include yield and ultimate tensile strength capacities. The capacity of the system is to be a minimum of 125% of the specified yield strength of the reinforcement being spliced. Tensile failure of the system is to occur in the nominal bar diameter of the reinforcing bar being joined to the splicing system.

3.0 EXECUTION

3.01 REINFORCEMENT TESTS

The Contractor is to fulfill all requirements relative to testing of reinforcing steel as may be specified in this Section of the Specifications.

Where reinforcing material is properly identified, mill reports will be accepted. The Contractor shall submit two (2) copies of the Steel Producer's certificates of the mill tests.

When the Manufacturer's name or the heat identification number of the Manufacturer's chemical analysis is unknown, a Testing Laboratory is to undertake a testing program. At least one tensile and one bending test is to be made on each five (5) tons, or fraction thereof, for each size of reinforcement in each lot. The Testing Laboratory used by the Contractor is to be acceptable to the Engineer. The Contractor is to pay for all such tests and submit at least two (2) copies of each test made to the Engineer.

Reinforcing steel that fails to meet the requirements of the testing program is to be rejected and removed from the Project Site. The Contractor is to submit new steel for testing and continue to do so until the steel passes the tests. No steel is to be used for reinforcing until satisfactory test reports are received by the Engineer.

In the event that the Engineer requires additional testing of reinforcing materials which have been delivered to the Project Site, the Contractor is to make such materials available in the sizes, lengths, and quantities necessary for testing, at no additional cost.

3.02 FABRICATION

All reinforcement is to be fabricated to conform to required shapes and dimensions, with fabrication tolerances complying with CRSI “Manual of Standard Practice”. In case of fabricating errors, the Contractor shall not re-bend or straighten reinforcement in a manner that will injure or weaken the

material. All reinforcing steel is to be pre-cut and pre-bent off site in an approved fabricating shop by an acceptable subcontractor for reinforcing steel fabrication.

All reinforcing is to be correctly rolled to the proper section and shall be free from all defects. Reinforcing shall have raised symbols to identify the Manufacturer, bar size and grade of steel.

Reinforcement with any of the following defects is not to be permitted in the work:

A. Bar lengths, depths, and bends exceeding specified fabrication tolerances.

B. Bends or kinks not indicated on Drawings or final shop drawings.

C. Bars with reduced cross-section due to excessive rusting, surface defects, or other causes.

All bends or hooks, unless otherwise required, are to be cold formed around pins. All hooks are to conform to the typical details on the Drawings.

3.03 DELIVERY, HANDLING, AND STORAGE

All concrete reinforcement is to be delivered to the Project Site bundled, tagged, and marked. Metal tags are to be used to indicate bar size, lengths, and other information corresponding to markings shown on the placement diagrams.

All concrete reinforcing materials are to be stored at the Project Site, to prevent damage and accumulation of dirt or excessive rust.

3.04 INSTALLATION

The Contractor is to comply with the previously specified Codes and Standards and Concrete Reinforcing Steel Institute recommended practice described in “Placing Reinforcing Bars”, latest edition, for details and methods of reinforcement placement and supports, and as herein specified.

All reinforcement shall be cleaned prior to installation to remove loose rust and mill scale, earth, ice, and other materials which reduce or destroy the bond with the concrete.

Bar supports shall be provided for reinforcement in foundation elements, slabs on ground, and all framed beams and slabs. Reinforcement shall be positioned, supported, and secured against displacement by formwork, construction, or concrete placement operations. Reinforcement shall be located and supported by metal chairs, runners, bolsters, spacers, and hangers.

Reinforcing steel shall be supported in a manner that will maintain the clear distances between bars and the face of concrete as indicated on the Drawings or mentioned in the Specifications. Supports are to include slab and beam bolsters, low and high chairs, spacers and other devices suitable for the proper spacing, supporting and fastening of reinforcing bars or welded wire reinforcement in place. Consideration is to be given for all loads applied to the reinforcing. Supports for slabs on grade are to include sand plates, laterally welded braces for high chair legs and specially designed steel framed supports for heavy reinforcing.

In no case will the use of masonry, stone, or wood be permitted for bar supports. Plastic protected or non-staining legs are to be provided in the case of bar supports being in contact with the formwork of concrete surfaces exposed to view after completion.

Minimum wire sizes and spacing for support accessories are to be as follows:

A. Continuous high chairs or individual high chairs are to have legs of not less than #4 wire. Continuous high chair legs are to be spaced not more than eight (8") on center. Continuous longitudinal wires are to be not less than #1 wire. The connection of the legs to the continuous wire is to be strong enough to prevent bending of the legs out of the vertical plane or the breaking off of the legs from the continuous longitudinal wire.

B. Slab and beam bolsters are to be not less than #4 wire. Slab bolster legs are to be spaced not more than five (5") inches on center. Beam bolster legs are to be spaced not more than two (2") inches on center.

C. The Contractor is to vary the support bar diameters and spacing to suit each specific support requirement and detail them to suit the condition of loading.

The Contractor shall not place reinforcing bars more than two (2") inches beyond the last leg of any continuous bar support. The Contractor shall not use supports as bases for runways for concrete conveying equipment and similar construction loads.

All reinforcement shall be secured against displacement by tying with No. 16 gauge, black soft annealed wire at all intersections, and shall be so supported so as to keep all reinforcement away from the exposed surfaces. Whenever the members are reinforced with two curtains of reinforcement, bar spacers securely tied to both curtains shall be provided.

The Contractor shall set all wire ties so that twisted ends are directed away from exposed concrete surfaces.

Tack welding of reinforcement shall not be permitted.

Reinforcement shall be contact lap spliced where practical, with the location of and minimum lap lengths as called for on the Drawings. Where no lap length is noted on plan or section, the minimum lap shall be as per the typical details for tension lap splices. All adjacent splices shall be progressively staggered at 5'-0" on center.

All laps or splices shall be tied with No. 16 gauge black annealed wire and seized tight at both ends. Reinforcement shall not be spliced at points of maximum stress and, where possible, shall have splice locations staggered.

The Contractor shall install welded wire reinforcement in as long lengths as practicable. He shall lap adjoining pieces at least one full mesh and lace splices with 16 gauge wire. He shall not make end laps midway between supporting beams, or directly over beams of continuous members. The Contractor shall offset end laps in adjacent widths to prevent continuous laps. If fabric is ordered in rolls, transverse wires are to be on the inside of the rolls. All such fabric is to be unrolled in the direction of the span.

Where welding is shown on the Drawings or specified, the Contractor shall comply with the requirements of AWS D1.4 for field welding. Prior to field welding, the Contractor shall determine the weldability of reinforcing bars by a laboratory analysis of steel. Only steel conforming to the chemical requirements specified in AWS D1.4 shall be used.

After the reinforcement has been placed, the Contractor shall notify the Engineer as to his readiness to have the reinforcing inspected. Concrete shall not be placed until the reinforcement placement is complete and has been inspected by the Engineer.

4.0 MEASUREMENT AND PAYMENT

The work under this Section shall not be measured for payment, but shall be paid as a lump sum under Bid.

END OF SECTION

SECTION 03300
CAST-IN-PLACE CONCRETE

1.0 GENERAL

1.01 STANDARD REQUIREMENTS

This Section of the Specifications covers the furnishing and placement of all cast-in-place concrete. This Section includes requirements regarding concrete design mixes. The casting and breaking of concrete test cylinders is included in another Section.

All excavation for foundation elements of the various structures must be completed and inspected by the Engineer before concrete foundation work for the Structure is started.

1.02 SUBMITTALS

Prior to the ordering of any concrete, the Contractor shall submit to the Engineer, for review, a design mix indicating the proposed proportioning of materials to be used for each class of concrete, together with a certificate of an approved Testing Laboratory that the proportions proposed shall meet the specified requirements.

The design mix or mixes shall be prepared by the Producer or Contractor's Testing Laboratory and shall be prepared in accordance with ACI 318-05, Section 5.3, "Proportioning on the Basis of Field Experience and/or Trial Mixtures". Each required design mix shall reflect the effects of the addition of all proposed or required admixtures. For the purpose of establishing a design mix containing a set-retarding admixture, the temperature may be assumed at 65ºF.

The design mix submittal shall include, but is not necessarily limited to the following:

A. Names of all Suppliers and/or Manufacturers.

B. Distance, in miles, from the Concrete Plant to the Job Site.

C. Certification of compliance of materials with ASTM Specifications as here-inbefore specified.

D. Proposed proportioning of materials required for each design mix submitted for the various required concrete strengths, w/c ratios, and aggregate sizes.

E. Admixtures required and/or proposed and dosage of each for all temperature ranges proposed.

F. Sieve analyses for each aggregate size.

G. Required cylinder test results and curves.

H. Signed statement that the proposed proportions meet all of the Specification requirements.

All design mixes, of each proposed mix for each strength of concrete and maximum coarse aggregate size, shall be approved by the Engineer at least fifteen (15) days prior to the start of the work. The Contractor shall not begin concrete production until the mixes have been reviewed and accepted by the Engineer.

All concrete to be placed by pumping shall be proportioned in accordance with ACI 304R-00, to meet the minimum strength, slump, and air content requirements as specified herein, except that the volume of coarse aggregate per unit volume of concrete may be reduced by 10%. The use of high range water reducing (HRWR) admixtures in pumped concrete is as specified in another Section of these Specifications.

The cost of preparing the design mixes shall be paid by the Contractor.

2.0 PRODUCTS

2.01 CEMENT

All cement shall be Type II or Type I/II, Portland cement, of domestic manufacture, and conforming to ASTM C150-04. All cement is to be delivered in approved containers and stored as directed and specified. Bagged cement is to be plainly marked with name of Manufacturer, the date of manufacture, the type of cement, and the net weight. All cement is to be the product of one Manufacturer.

Bulk deliveries are to be provided with delivery tickets containing data as to name of Manufacturer, date of manufacture, type of cement, and weight.

2.02 AGGREGATE

All normal weight aggregates, coarse and fine, shall conform to the requirements of ASTM C33-03. All aggregates are to be free from any substance that may be deleteriously reactive with the alkalis in the cement in an amount sufficient to cause excessive expansion of the concrete.

Acceptability of the aggregate is to be based upon satisfactory evidence, furnished by the Contractor, that the aggregate is free from such materials. Such evidence is to include service records of concrete of comparable properties under similar conditions of exposure or certified records of tests by an approved Testing Laboratory. Tests are to conform to ASTM C227-03. Aggregate for exposed construction shall be from one source.

Fine aggregates are to consist of washed sand, leaving sharp, hard, uncoated siliceous grains. The fineness modulus must not vary by more than 0.20 throughout the work. Fine aggregates from different sources of supply are not to be mixed or stored in the same stockpile, nor used alternately in the same concrete mix or the same structure.

Maximum size of coarse aggregate shall be 3/8 inch for placements with a maximum thickness of 4 inches. For all other placements use No. 57 (1” to No. 4) maximum with the exception of columns and piers less than 12 inches. All concrete used in columns and piers less than 12 inches

shall contain No. 67 coarse aggregate. The smallest dimension of the entire concrete placement (slab, beam, wall) shall govern the coarse aggregate size.

The following maximum percentages by weight are also to apply:

MATERIAL	% By WT.
Soft Particles	2.0
Chert, as a Soft Impurity (defined in Table 3, ASTM C33-03)	1.0
Total of Soft Particles and Chert (as soft impurities)	2.0
Flat and Elongated Particles (long dimension more than 5 times the short dimension)	15.0

At least one (1) month before the aggregates are to be used, the Contractor is to submit certified reports of tests indicating that the aggregates comply with the Specifications. If samples are ordered for testing by the Engineer, they are to be submitted at least one (1) month before the aggregates are to be used. Additional samples may be ordered for testing by the Engineer at any time.

2.03 WATER

Water for mixing concrete and mortar shall be taken from an approved source and be clear and free from injurious amounts of oil, acid, alkali, organic matter, or other deleterious substance.

2.04 ADMIXTURES

All admixtures shall be compatible. Admixtures, which are not submitted with the accepted concrete mix design, shall not be used.

Air-entrainment shall be provided for all 4500 psi concrete through the addition of an air-entraining admixture for concrete conforming to ASTM C260-01. The admixture is to be "MB-AE90" as manufactured by Master Builders, or equal. The admixture is to be used in strict accordance with the Manufacturer's recommendations and in such quantity to produce the required air content. All normal weight concrete exposed to the weather shall contain 6% (±1%) entrained air.

All concrete may contain a water-reducing set controlling admixture conforming to ASTM C494-04. The admixtures are to be furnished by the Grace Corp., Master Builders, or Sika Corporation, or equal. The admixtures are to be used in strict accordance with the Manufacturer's written recommendations. Admixtures are to be applied as follows:

Air Temperatures	Admixture	Dosage
32º F. to 49º F.	Plastocrete 161FL	16 fl. oz./100 lbs. of cement
	Pozzutec 20	16 fl. oz./100 lbs. of cement
	Daraset 200	16 fl. oz. /100 lbs. of cement
50º F. to 64º F.	Plastocrete 161	3 fl. oz./100 lbs. of cement
	Pozzolith 200N	3 fl. oz./100 lbs. of cement
	WRDA with Hycol	3 fl. oz./100 lbs. of cement
65º F. to 84º F.	Plastiment	3 fl. oz./100 lbs. of cement
	Pozzolith 100XR	3 fl. oz./100 lbs. of cement
	Daratard 17	3 fl. oz./100 lbs. of cement
85º F. +	Plastiment	4 fl. oz./100 lbs. of cement
	Pozzolith 100XR	4 fl. oz./100 lbs. of cement
	Daratard 17	4 fl. oz./100 lbs. of cement

Pumped concrete shall contain a high range-water reducing (HRWR) admixture conforming to the requirements of ASTM C494-04, Type F. The admixture shall be “Rheobuild 1000” as manufactured by Master Builders, or equal. The admixture shall not contain added chlorides, thiocyanates, (naphthalene or melamine) formaldehydes, or lignins. The admixture shall be used in strict accordance with the Manufacturer's written instructions. Concrete containing an HRWR admixture shall not contain a water-reducing set controlling admixture. The maximum slump for concrete containing an HRWR admixture shall be 8” unless otherwise directed by the Engineer. Water shall not be added after the introduction of a HRWR into the concrete mix. The Contractor shall have on Site additional HRWR, from the same Manufacturer as used at the Plant, for re-dosage no more than twice.

In no case shall the use of calcium chloride in concrete be permitted. Accelerating admixtures are not to be used in any concrete work without the Engineer's review. Frozen materials containing ice or snow are not to be used.

2.05 CONCRETE

All concrete placed on the Project shall be ready-mixed concrete.

Concrete that is to be used for all reinforced concrete work, including equipment bases, pads and cradles, and certain non-reinforced concrete work such as walks, curbs, roof fill or as may otherwise be shown on the Drawings or specified shall have a specified 28-day compressive strength of 4500 pounds per square inch. This concrete shall have a minimum cement content of 640 pounds per cubic yard, an air-entraining agent, and may contain an approved set-controlling admixture. Whenever this concrete is placed in any structure or part thereof used to hold, transport or process any portion of the treatment process, the maximum water content shall not exceed 5 gallons per bag of cement (W/C=0.42).

All normal weight concrete, regardless of the specified compressive strength, shall contain coarse aggregate such that the hardened concrete weight is equal to 145+3% lbs./cu. ft.

The addition of water to the mix for the purposes of increasing the slump shall be permitted only after the Engineer has reviewed the request and if the maximum water cement ratio has not been exceeded. All concrete, regardless of specified compressive strength, shall not exceed the following slumps:

Foundation mats	3" (±1")

2.06 BONDING AGENT

The epoxy bonding agent shall be "Armatec 110" as manufactured by Sika.

The chemical bonding agent shall be "A-H P.V.A. Bonder", as manufactured by ANTI Hydro Company, or equal.

2.07 CURING MATERIALS

The liquid membrane-forming curing compound shall conform to the requirements of ASTM C309-06. The curing compound shall contain a fugitive dye. Curing compounds shall conform with all applicable VOC regulations and shall have NSF Standard 61 approval.

A curing compound shall be used on all interior slabs which will be exposed or which will receive resilient tile or carpet finishes. The curing compound shall be "Quantum Cure" as manufactured by Atlas Corporation, "Unitex 12-34" as manufactured by Unitex, or approved equal.

2.08 PROTECTION MATERIALS

Impervious paper, waterproofing curing paper, and polyethylene film used during curing operations shall conform to ASTM C171-03.

2.09 CONSTRUCTION JOINTS AND EXPANSION JOINTS

Foam filler material shall be Progress Unlimited, Inc., "Resilient White Closed Cell Cross-Linked Polyethylene/Vinyl Foam Joint Filler", Code No. FF-7 with 90% recovery factor and with a density of 2.2 pounds per cubic feet, or equal. Fiber filler material shall be equal to "Fibre Joint" by W.R. Meadows, or "Sonoflex Cane Fiber" by Sonneborn-Contech or equal.

Where a joint sealing compound is required, the sealant shall be a two-component Polyurethane High Performance Gun Grade Sealant equal to "Dualthane" as manufactured by W.R. Meadows, Inc.; "Sikaflex 2C, NS", as manufactured by Sika Corporation, or equal.

Where a one component polyurethane joint sealant is required as noted on the Drawings, it shall be a one-component modified polyurethane sealant, "Sikaflex 1a", as manufactured by Sika Corporation, "Dyne Seal W-100", as manufactured by Williams Products, Inc., or equal.

2.10 GROUT

Pre-mixed non-metallic non-shrink grout for bedding plates and column bases and as otherwise called for on the Drawings shall be as manufactured by the following or equal:

A. Sika Corporation - "SikaGrout 212"

B. Five Star - "Five Star Grout"

In general, cement grout shall be made with one (1) part Portland cement, two (2) parts sand and one-quarter (1/4) part lime, or shall be a pre-mixed grout as reviewed by the Engineer.

3.0 EXECUTION

3.01 INSPECTION

The Contractor shall examine the Construction Site and all substrate and conditions under which the Work shall be performed. In the case that there are unsatisfactory conditions, the Contractor shall notify the Engineer in writing. The Contractor is not to proceed with the Work until unsatisfactory conditions have been corrected to the satisfaction of the Engineer.

3.02 PERMISSIBLE TOLERANCES AND VARIATIONS

This Subsection includes all tolerances or the allowable variations from the dimensions or positions indicated for all concrete work. Formwork is to be constructed so as to ensure that the concrete surfaces will conform to the tolerances of the ACI 347-04.

Tolerances apply to concrete dimensions only and not to the positioning of reinforcing steel, dowels, or embedded items.

The Contractor is to establish and maintain sufficient control points and benchmarks in an undisturbed condition until final completion and acceptance of the Project. Control points and benchmarks are to be used for reference purposes to check tolerances.

No portion of any Structure is to extend beyond the legal boundary of the Project.

3.03 MEASURING, MIXING AND TRANSPORTATION

All concrete shall conform to the requirements of ASTM C94-04 and ACI 304R-00, except as otherwise specified.

All ready-mixed concrete shall be secured from an approved Supplier having adequate equipment for proportioning, mixing, rigidly controlling, and delivering concrete in the quantities required for the work. The Engineer, or his agents, are to have the right to inspect the Plant and processes of the Supplier at all times. Thirty days in advance of the contemplated use of ready-mixed concrete, the Contractor is to submit the name and qualifications of the Supplier from whom he proposes to secure ready-mixed concrete to the Engineer for review.

All dry materials, fine and coarse aggregate and cement, shall be measured by weight.
The Contractor is to provide suitable automatic weighing equipment so that the fine and coarse aggregates for each batch will be weighted separately.

Water shall be weighed in a separate batcher or measured by volume in a calibrated tank or by water meter. Admixtures shall be measured by volume.

Regardless of how the required materials or quantities are measured, they shall be within the following tolerances; cement, 1%; aggregates, 2%; water, 1%; and admixtures, 3%.

Mixers shall be of the rotary batch type and so made and operated as to insure a thorough mix, homogeneous in composition and uniform in color, with all coarse aggregate completely covered with mortar. The volume of the mixed material per batch shall be governed by the size of the mixer and the composition of the concrete, but shall not exceed the Manufacturer's rated capacity of the mixer. Each mixer shall be equipped with a suitable charging hopper, water storage tank and a water measuring device that is capable of being locked and will permit the discharge of water only while the mixer is being rotated. All water, except that used for cleaning purposes, is to be admitted to the mixer through the measuring device. Each mixer is to be so equipped as to lock the discharge lever automatically until the batch has been placed in the mixer. The mixer is to be thoroughly washed and cleaned before and after use and be maintained in effective operating conditions at all times. If the mixer is not used for a period of 30 minutes, it is to be thoroughly cleaned before use.

All materials for each batch of concrete, including the water, are to be mixed for at least 11/2 minutes, while the drum revolves at the speed for which it was designed, preferably between 12 and 20 RPM. In any case, the aggregate has to be completely covered with mortar. Any batch mixed less than 11/2 minutes or not completely discharged within 60 minutes after the addition of water is to be discarded at the Contractor's expense. No materials for a batch of concrete are to be placed in the drum of the mixer until the entire previous batch has been discharged.

The maximum length of time from loading at the ready-mix Supplier's Plant to the discharge of concrete at the Project Site shall not exceed 75 minutes, except that under conditions contributing to quick stiffening of the concrete or when the temperature of the concrete is 85°F or above, this time limit shall be changed to 60 minutes. If retarders are used which have been reviewed by the Engineer, they may increase the time limit to a maximum of 75 minutes. Under very severe conditions, the Engineer may further reduce the time limits or require a reduction of the size of the batches. During these intervals, the concrete shall be agitated continuously.
Each delivery of concrete to the Project Site shall be accompanied by a certificate showing: weights of materials and brand names as applicable, amount of water, type and quantity of admixture, and date and time of loading.

When concrete arrives at the Project Site with slump below that suitable for placing, as indicated above, water may be added only if neither the maximum permissible water-cement ratio nor the maximum slump is exceeded. The water is to be incorporated by additional mixing equal to at least one-half of the total mixing time required. An addition of water above that permitted by the limitation on the water-cement ratio is to be accompanied by a quantity of cement sufficient to maintain the proper water-cement ratio. The addition may only be authorized by the Engineer or his representative, and the cost must be borne by the Contractor.

The use of non-agitating equipment for the transportation of concrete will not be permitted.

3.04 CONCRETE PLACEMENT

Concrete is not to be placed until such time as forms, embedded materials, and reinforcement are securely fastened in position, and these and all other preliminary work have been inspected. Concrete is not to be placed in water. If chutes are used, they are to be of metal or be metal lined with a slope not to exceed one (1) vertical to three (3) horizontal.

The Contractor will be required to cover foundation materials with an impervious lining prior to placing concrete, when such lining is indicated on the Drawings. This lining is to be provided and installed in the widest practical widths and is to be lapped at least 12" along any joining edge. Materials for this liner, as well as the adjacent foundation insulation, are specified in other Divisions of these Specifications.

Concrete is to be handled from the mixer to the forms in such a manner that no segregation of ingredients will take place. Concrete is to be deposited in layers approximately level and not more than 18" in depth.

All concrete is to be placed in such a manner that it will not drop freely more than eight (8') feet and it is to be placed as nearly as practicable in its final position, to minimize segregation of the ingredients. Concrete for use in slabs and foundation elements may be placed by buggy bucket, ready-mix truck, or pumping methods, provided that the method selected will not cause the specified slump to be exceeded. In general, concrete in the walls is to be placed by means of a rectangular metal drop chute with hoppers. Drop chutes are to be provided in several lengths so that the total length of the chute can be adjusted as the concreting operations progress. Under special conditions, such as heavily reinforced thin walls, concrete is to be deposited through temporary openings in the sides of wall forms with the drop chutes positioned outside of the forms. Temporary openings are to be provided and spaced approximately 8' vertically and 8' horizontally.

Concrete is to be compacted while being placed, with the aid of mechanical internal vibrators applied directly to the concrete in a vertical position. The intensity and duration of vibration is to be sufficient to cause the concrete to flow, to compact thoroughly and to completely embed the reinforcement, pipe, conduit, or similar work. Vibration is to be supplemented by hand spading in the corners and angles of forms while the concrete is still plastic and workable. The vibrating equipment is to be of size and type as required. Vibration of forms or reinforcement will not be permitted unless specifically authorized. Under no condition is the vibration process to be continued for such a time period that the aggregate would be segregated from the mix and impair concrete strength. Vibrators are not to be used to work concrete along the forms or otherwise to be used as the prime motive force in handling concrete.

3.05 COLD AND HOT WEATHER CONCRETE OPERATION

In general, concreting during cold and hot weather is to be in accordance with the applicable provisions of ACI 318-05, ACI 306R-88(2002), and ACI 305R-99.

For air temperatures between 40°F and 70°F when it is not anticipated that temperature will drop below 40°F no special protection will be required other than the means of maintaining concrete temperatures of at least 50°F, for a period of five (5) days after placing.

Concrete placement is not to be permitted when, in the opinion of the Engineer, the sun, heat, wind, rain, sleet, snow or humidity would prevent proper placement and curing.

A. Cold Weather

Whenever the temperature is below 40°F, or when it is evident that the temperature will drop below that point, concrete is not to be placed unless the Contractor has submitted, in advance to the Engineer, a detailed plan for taking appropriate precautions during cold weather operations.

When it is necessary to remove the protection temporarily during the process of the work, it is to be done in a manner that causes the least disturbance and allows the protection to be restored as quickly as practicable.

The Contractor is not to place the concrete on frozen subgrade or on sub-grade containing frozen materials. He is to ascertain that forms, reinforcing steel and adjacent concrete surfaces are entirely free of frost, snow and ice before placing concrete.

All methods proposed for heating, and protecting the concrete are to be subject to review by the Engineer. Concrete is never to be heated over 90°F nor is any other overheating that would produce a flash set to be permitted.

B. Hot Weather

Whenever the ambient temperature is above 90°F or when it is evident that the temperature will rise above that point, concrete is not to be placed unless the Contractor has submitted, in advance to the Engineer, a detailed plan for taking appropriate precautions during hot weather operations.

3.06 CONCRETE CURING

Freshly deposited concrete shall be protected from premature drying, excessively hot or cold temperatures or mechanical injury. Protective measures shall conform to ACI 308R-01. The concrete is to be maintained with a minimum moisture loss, at a relatively constant temperature, for the period of time necessary for the hydration of the cement and proper hardening of the concrete. Take extreme caution to prevent moisture loss during the three (3) to ten (10) hour period following placing, as the concrete is particularly vulnerable to shrinkage at this time.

A liquid membrane-forming curing compound shall be applied to all exposed concrete surfaces, immediately after the final finishing operations, by means of power-driven spray equipment in accordance with the Manufacturer's written instructions.

The curing compound shall not be used on any surface against which additional concrete or other cementitious finishing materials are to be bonded, nor on any surface for which the final finishing methods are incompatible with the use of a curing compound, such as structural roof slabs that will be covered with liquid membrane roofing materials. The resultant surface shall be dust free and compatible with all floor adhesives, toppings or other finish materials specified. Where such

incompatibility exists, curing methods and length of curing as described below, as reviewed by the Engineer, shall be used.

All interior slabs which will be exposed or which will receive resilient tile or carpet finishes, shall be cured and sealed. It is recommended that a test section be prepared to ensure compatibility with any adhesive used for any additional finishes.
Where impervious formwork is used, the exposed concrete surfaces shall be kept wet prior to form removal. Wood forms left in place shall be kept moist by sprinkling prior to form removal. After removal of the forms, the concrete surfaces shall receive a coating of a liquid membrane-forming compound or other curing method reviewed by the Engineer prior to the start of the concreting operations.

When reviewed by the Engineer, prior to the start of the concrete operations, or where a liquid membrane-forming curing compound cannot be applied, other curing methods such as ponding, continuous spraying, wet coverings such as wet burlap, impervious paper or plastic polyethylene film may be used as a curing medium. The impervious paper or polyethylene film shall be applied after the concrete has hardened and has been thoroughly wetted. Such curing operations shall be continuous for a minimum of seven (7) days.

3.07 CONSTRUCTION JOINTS AND EXPANSION JOINTS

The Contractor is to furnish, install or otherwise construct all construction joints as indicated or detailed on the Drawings. The use and location of construction joints is to be subject to the prior review by the Engineer. All construction joints are to conform to the details shown on the Drawings.

Joints not indicated on the Drawings are to be so made and located as to least impair the strength of the Structure. Construction joints in columns, walls, slabs, beams and girders are to conform to ACI 318-05.

The Contractor shall submit to the Engineer for review a plan showing the location of his proposed construction joints for each Structure prior to beginning construction of the various Structures.

Construction joints are to consist of keyed joints, except as shown, and are to be installed as specified previously. If the Contractor desires to install additional construction joints, at his own expense, he is to submit working drawings for approval showing the proposed locations and a placement schedule. Waterstops are to be installed in the joints where indicated and in all construction joints, as directed by the Engineer.

3.08 CONCRETE FINISHING

It is the specific intention of this Section of the Specifications to leave all surfaces in a first quality condition, regardless of the method of concrete finishing. Work that does not meet the quality standards implied, or directly specified, or which does not meet with respect to the esthetic quality desired will not be accepted and such work is to be refinished until finally accepted by the Engineer.

Within 24 hours after the removal of forms, all honeycombing, pockets and open spaces are to be thoroughly wetted and scrubbed with a brush and then be compactly filled with mortar consisting of one (1) part of Portland cement and two (2) parts sand, of the same type and quality as used in the concrete. This operation is to be considered patching. This is to be done on all surfaces even though they will be covered with backfill afterward. All surfaces are to be neatly finished at the edges. Sprinkling with dry cement will not be permitted.

Rubbing and finishing, as defined hereinafter, shall begin not more than 48 hours after form removal, while the concrete is green and can have its surface worked without impairing structural quality or risking future delamination of the textured surface finish.

Before starting the concrete construction of any Structure, the Contractor shall submit to the Engineer, for review, a finishing schedule indicating the type or types of finishing operations that the various components of the Structure shall receive based on the Contractor's understanding of the Documents. The Contractor shall not begin this work until he receives the Engineer's concurrence with the Contractor's schedule.

Concrete surface finishing shall consist of the following defined operations:

A. Patching: Filling of holes, honeycombs, air bubbles of all sizes or other voids within 24 hours of form removal.

B. Rubbing: The method employed to remove unwanted concrete projections or other surface imperfections that generally project outward from the normal plane of the concrete. Mechanical or hand rubbing tools of various types used in the construction industry shall be employed. Bagging shall not be considered as part of the rubbing operations.

C. Finishing: The method employed to complete the final surface finish such as wood float, steel trowel, broom, cork board, burlap bag or other means. In some instances one or more of these treatments might be required to leave the concrete surface ready to receive special surface finishes such as tile, slate, paint or other materials. Interior concrete surfaces that remain textured finish developed by stoning, cork board working, and bagging without removing the textured finish. This finish shall be developed by working the green concrete, and shall not delaminate upon drying. Dust shall be removed prior to any painting.

The dusting of surfaces with dry materials other than sand shall not be permitted. All concrete slabs shall be wood floated to a true, even plane with no coarse aggregate visible, all while the concrete is still green but sufficiently hardened to bear a man's weight without deep imprint. Sufficient pressure shall be used on the floats to bring moisture to the surface. Other finishing operations shall be as described hereafter.

During the screening and floating operations, care shall be taken that the surface is free from holes, depressions and high spots. The finished surface shall not fall more than 1/8” from a 10 ft. steel straightedge applied to the surface at any point and shall have no visible unevenness.

The Engineer will make all final decisions with regard to finishes whenever the work to be undertaken may fall into one or more of the categories described above.

In the event that efflorescence, stains, oil, grease, or any unsightly accumulation of foreign materials are visible on the exposed surfaces of finished concrete, the Engineer may require remedial action to remove these blemishes. Such action may cover all exposed concrete, or when irregular lapping can be avoided, only such parts that are affected by the stains or other unsightly appearances shall be cleaned. Cleaning shall proceed as follows:

A. Remove oil and grease with detergents and scrubbing and thoroughly wash with water.

B. Only when directed by the Engineer, "Sack-Rub" concrete surfaces as follows:

1. Mix one-part of Portland cement, adding amounts of white Portland cement necessary to obtain required color, one-part fine industrial sand, an approved bonding agent, and sufficient water to give consistency of heavy cream. After surfaces are prepared and wetted down, rub the mortar thoroughly over the entire surface with clean burlap. After short interval, remove dried grout with dry burlap without removing from pits.

2. Spots or streaks remaining may be honed dry and lightly so as not to change the texture of the concrete.

3.09 CONCRETE PROTECTION

After curing compound application or required curing period, concrete slabs are to be covered with a waterproof curing paper. All seams of such paper are to be overlapped at least four (4”) inches and sealed with tape. Further protection is to be provided when erecting equipment, by means of planking of sufficient size, or such other protection, as is required. The paper is not to be removed prior to the final cleaning, and in any case, not sooner than 28 days after being placed.

3.10 SPECIAL CONCRETE WORK

Concrete areas that are in need of repair are to be surface patched and are to be coated with an epoxy patching compound. The concrete surfaces must be completely cleaned before applying the patching compound. The concrete surface is then to be primed by brush coating the patching compound. After priming, sand is to be added to the compound in a ratio of one part sand to one part compound, by volume. The sand and epoxy mixture are to be applied by trowel methods. The application of the patching compound is to conform to the recommendations of the Manufacturer.

All anchors, bolts and similar items furnished under other Sections of the Specifications shall be built into the work. The Contractor shall bolt all fastenings, through fills, into the structural concrete.

3.12 CLEANING UP

Cleanup shall be undertaken upon completion of the work in this Section. Upon final completion of all work included herein; all surplus and waste materials resulting from the concrete and cement finishing work, including all tools and implements employed therein, shall be removed from the

Project Site. The Structures and all portions of the Project Site affected by work under this Section shall be left in a neat, clean and acceptable condition.

4.0 MEASUREMENT AND PAYMENT

The work under this Section shall not be measured for payment, but shall be paid as a lump sum under Bid Item No. C03-000-001.0.

END OF SECTION

SECTION 05500
METAL FABRICATIONS

1.0 GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Special Provisions, apply to this Section.

1.2 SUMMARY

A. Section Includes:

1. Steel framing and supports for mechanical and electrical equipment.
2. Steel framing and supports for applications where framing and supports are not specified in other Sections.
3. Metal ladders.
4. Structural-steel door frames.
5. Metal bollards.

B. Products furnished, but not installed, under this Section:

1. Anchor bolts, steel pipe sleeves, slotted-channel inserts, and wedge-type inserts indicated to be cast into concrete or built into unit masonry.
2. Steel weld plates and angles for casting into concrete for applications where they are not specified in other Sections.

1.3 PERFORMANCE REQUIREMENTS

A. Delegated Design: Design ladders, including comprehensive engineering analysis by a qualified professional engineer, using performance requirements and design criteria indicated.

B. Thermal Movements: Allow for thermal movements from ambient and surface temperature changes acting on exterior metal fabrications by preventing buckling, opening of joints, overstressing of components, failure of connections, and other detrimental effects.

1.4 SUBMITTALS

A. Product Data: For the following:

1. Nonslip aggregates and nonslip-aggregate surface finishes.
2. Metal nosings and treads.
3. Paint products.
4. Grout.

B. Shop Drawings: Show fabrication and installation details for metal fabrications.

1. Include plans, elevations, sections, and details of metal fabrications and their connections. Show anchorage and accessory items.

C. Samples for Verification: For each type and finish of extruded nosing and tread.

D. Qualification Data: For qualified professional engineer.

E. Mill Certificates: Signed by manufacturers of stainless-steel certifying that products furnished comply with requirements.

F. Welding certificates.

G. Paint Compatibility Certificates: From manufacturers of topcoats applied over shop primers certifying that shop primers are compatible with topcoats.

1.5 QUALITY ASSURANCE

A. Welding Qualifications: Qualify procedures and personnel according to AWS D1.1/D1.1M, "Structural Welding Code - Steel."

B. Welding Qualifications: Qualify procedures and personnel according to the following:

1. AWS D1.1/D1.1M, "Structural Welding Code - Steel."

1.6 PROJECT CONDITIONS

A. Field Measurements: Verify actual locations of walls and other construction contiguous with metal fabrications by field measurements before fabrication.

1.7 COORDINATION

A. Coordinate selection of shop primers with topcoats to be applied over them. Comply with paint and coating manufacturers' written recommendations to ensure that shop primers and topcoats are compatible with one another.

B. Coordinate installation of anchorages and steel weld plates and angles for casting into concrete. Furnish setting drawings, templates, and directions for installing anchorages, including sleeves, concrete inserts, anchor bolts, and items with integral anchors, that are to be embedded in concrete or masonry. Deliver such items to Project site in time for installation.

2.0 PRODUCTS

2.1 METALS, GENERAL

A. Metal Surfaces, General: Provide materials with smooth, flat surfaces unless otherwise indicated. For metal fabrications exposed to view in the completed Work, provide materials without seam marks, roller marks, rolled trade names, or blemishes.

2.2 FERROUS METALS

A. Steel Plates, Shapes, and Bars: ASTM A 36/A 36M.

B. Stainless-Steel Sheet, Strip, and Plate: ASTM A 240/A 240M or ASTM A 666, Type 316L.

C. Stainless-Steel Bars and Shapes: ASTM A 276, Type 316L.

D. Steel Tubing: ASTM A 500, cold-formed steel tubing.

E. Steel Pipe: ASTM A 53/A 53M, standard weight (Schedule 40) unless otherwise indicated.

2.3 FASTENERS

A. General: Unless otherwise indicated, provide Type 316 stainless-steel fasteners for exterior use and zinc-plated fasteners with coating complying with ASTM B 633 or ASTM F 1941, Class Fe/Zn 5, at exterior walls. Select fasteners for type, grade, and class required.

1. Provide stainless-steel fasteners for fastening aluminum.
2. Provide stainless-steel fasteners for fastening stainless steel.

B. Steel Bolts and Nuts: Regular hexagon-head bolts, ASTM A 307, Grade A with hex nuts, ASTM A 563 and, where indicated, flat washers.

C. Steel Bolts and Nuts: Regular hexagon-head bolts, ASTM A 325, Type 3 with hex nuts, ASTM A 563, Grade C3 and, where indicated, flat washers.

D. Stainless-Steel Bolts and Nuts: Regular hexagon-head annealed stainless-steel bolts, ASTM F with hex nuts, ASTM F 594 and, where indicated, flat washers; Alloy Group 1 or Group 2

E. Anchor Bolts: ASTM F 1554, Grade 36, of dimensions indicated; with nuts, ASTM A 563; and, where indicated, flat washers.

1. Hot-dip galvanize or provide mechanically deposited, zinc coating where item being fastened is indicated to be galvanized.

F. Eyebolts: ASTM A 489

G. Machine Screws: ASME B18.6

H. Lag Screws: ASME B18.2

I. Plain Washers: Round, ASME B18.22.1

J. Lock Washers: Helical, spring type, ASME B18.21.1

K. Anchors, General: Anchors capable of sustaining, without failure, a load equal to six times the load imposed when installed in unit masonry and four times the load

imposed when installed in concrete, as determined by testing according to ASTM E 488, conducted by a qualified independent testing agency.

L. Cast-in-Place Anchors in Concrete: Either threaded type or wedge type unless otherwise indicated; galvanized ferrous castings, either ASTM A 47/A 47M malleable iron or ASTM A 27/A 27M cast steel. Provide bolts, washers, and shims as needed, all hot-dip galvanized per ASTM F 2329.

M. Post-Installed Anchors: chemical anchors.

1. Material Where Stainless Steel is Indicated: Alloy stainless-steel bolts, ASTM F 593 and nuts, ASTM F 594.

N. Slotted-Channel Inserts: Cold-formed, hot-dip galvanized-steel box channels (struts) complying with MFMA-4, 1-5/8 by 7/8 inches by length indicated with anchor straps or studs not less than 3 inches long at not more than 8 inches o.c. Provide with temporary filler and tee-head bolts, complete with washers and nuts, all zinc-plated to comply with ASTM B 633, Class Fe/Zn 5, as needed for fastening to inserts.

2.4 MISCELLANEOUS MATERIALS

A. Welding Rods and Bare Electrodes: Select according to AWS specifications for metal alloy welded.

B. Shop Primers: Universal Shop Primer: Fast-curing, lead- and chromate-free, universal modified-alkyd primer complying with MPI#79 and compatible with topcoat.

1. Use primer containing pigments that make it easily distinguishable from zinc-rich primer.

C. Galvanizing Repair Paint: High-zinc-dust-content paint complying with SSPC-Paint 20 and compatible with paints specified to be used over it.

D. Bituminous Paint: Cold-applied asphalt emulsion complying with ASTM D 1187.

E. Nonshrink, Metallic Grout: Factory-packaged, ferrous-aggregate grout complying with ASTM C 1107, specifically recommended by manufacturer for heavy-duty loading applications.

F. Nonshrink, Nonmetallic Grout: Factory-packaged, nonstaining, noncorrosive, nongaseous grout complying with ASTM C 1107. Provide grout specifically recommended by manufacturer for interior and exterior applications.

G. Concrete: Comply with requirements in Division 3 Section "Cast-in-Place Concrete" for normal-weight, air-entrained, concrete with a minimum 28-day compressive strength of 3000 psi.

2.5 FABRICATION, GENERAL

A. Shop Assembly: Preassemble items in the shop to greatest extent possible. Disassemble units only as necessary for shipping and handling limitations. Use connections that maintain structural value of joined pieces. Clearly mark units for reassembly and coordinated installation.

B. Cut, drill, and punch metals cleanly and accurately. Remove burrs and ease edges to a radius of approximately 1/32 inch unless otherwise indicated. Remove sharp or rough areas on exposed surfaces.

C. Form bent-metal corners to smallest radius possible without causing grain separation or otherwise impairing work.

D. Form exposed work with accurate angles and surfaces and straight edges.

E. Weld corners and seams continuously to comply with the following:

1. Use materials and methods that minimize distortion and develop strength and corrosion resistance of base metals.
2. Obtain fusion without undercut or overlap.
3. Remove welding flux immediately.
4. At exposed connections, finish exposed welds and surfaces smooth and blended so no roughness shows after finishing.

F. Form exposed connections with hairline joints, flush and smooth, using concealed fasteners or welds where possible. Where exposed fasteners are required, use Phillips flat-head (countersunk) fasteners unless otherwise indicated. Locate joints where least conspicuous.

G. Fabricate seams and other connections that will be exposed to weather in a manner to exclude water. Provide weep holes where water may accumulate.

H. Cut, reinforce, drill, and tap metal fabrications as indicated to receive finish hardware, screws, and similar items.

I. Provide for anchorage of type indicated; coordinate with supporting structure. Space anchoring devices to secure metal fabrications rigidly in place and to support indicated loads.

1. Where units are indicated to be cast into concrete or built into masonry, equip with integrally welded steel strap anchors, 1/8 by 1-1/2 inches with a minimum 6-inch embedment and 2-inch hook, not less than 8 inches from ends and corners of units and 24 inches o.c., unless otherwise indicated.

2.6 MISCELLANEOUS FRAMING AND SUPPORTS

A. General: Provide steel framing and supports not specified in other Sections as needed to complete the Work.

B. Fabricate units from steel shapes, plates, and bars of welded construction unless otherwise indicated. Fabricate to sizes, shapes, and profiles indicated and as necessary to receive adjacent construction.

1. Fabricate units from slotted channel framing where indicated.
2. Furnish inserts for units installed after concrete is placed.

2.7 METAL LADDERS

A. General:

1. Comply with ANSI A14.3 unless otherwise indicated.
2. For elevator pit ladders, comply with ASME A17.1.

B. Steel Ladders:

1. Space siderails 18 inches apart unless otherwise indicated.
2. Space siderails of elevator pit ladders 12 inches apart.
3. Siderails: Continuous, 1/2-by-2-1/2-inch steel flat bars, with eased edges.
4. Rungs: 3/4-inch diameter steel bars.

5. Fit rungs in centerline of siderails; plug-weld and grind smooth on outer rail faces.
6. Provide nonslip surfaces on top of each rung, either by coating rung with aluminum-oxide granules set in epoxy-resin adhesive or by using a type of manufactured rung filled with aluminum-oxide grout.
7. Provide nonslip surfaces on top of each rung by coating with abrasive material metallically bonded to rung.

a. requirements, available products that may be incorporated into the Work include, but are not limited to, the following:

1) IKG Industries, a division of Harsco Corporation; Mebac.
2) SlipNOT Metal Safety Flooring, a W. S. Molnar company; SlipNOT.

8. Provide platforms as indicated fabricated from welded or pressure-locked steel bar grating, supported by steel angles. Limit openings in gratings to no more than 1/2 inch in least dimension.
9. Support each ladder at top and bottom and not more than 60 inches o.c. with welded or bolted steel brackets.
10. Galvanize ladders, including brackets and fasteners.
11. Prime ladders, including brackets and fasteners, with zinc-rich primer.

2.8 STRUCTURAL-STEEL DOOR FRAMES

NOT APPLICABLE TO CONTRACT

2.9 MISCELLANEOUS STEEL TRIM

A. Unless otherwise indicated, fabricate units from steel shapes, plates, and bars of profiles shown with continuously welded joints and smooth exposed edges. Miter corners and use concealed field splices where possible.

B. Provide cutouts, fittings, and anchorages as needed to coordinate assembly and installation with other work.

1. Provide with integrally welded steel strap anchors for embedding in concrete or masonry construction.

C. Galvanize exterior miscellaneous steel trim.

D. Prime exterior miscellaneous steel trim with zinc-rich primer.

2.10 METAL BOLLARDS

A. Fabricate metal bollards from 12 inch, standard weight steel pipe and concrete filled with f'c = 3000 psig, minimum, concrete conforming to the requirements of Section 3300 of this Specification.

B. Bollards shall be installed in a concrete footing as indicated on the Drawings.

C. Prime bollards with zinc-rich primer compatible with urethane top coat.

D. Provide yellow, weather resistant polyurethane top coat on the exterior of the aboveground exposed bollard steel and the bollard cap formed from the bollard concrete fill.

2.11 LOOSE BEARING AND LEVELING PLATES

A. Provide loose bearing and leveling plates for steel items bearing on masonry or concrete construction. Drill plates to receive anchor bolts and for grouting.

B. Galvanize plates.

C. Prime plates with zinc-rich primer.

2.12 LOOSE STEEL LINTELS

A. Fabricate loose steel lintels from steel angles and shapes of size indicated for openings and recesses in masonry walls and partitions at locations indicated. Fabricate in single lengths for each opening unless otherwise indicated. Weld adjoining members together to form a single unit where indicated.

B. Size loose lintels to provide bearing length at each side of openings equal to 1/12 of clear span but not less than 8 inches unless otherwise indicated.

C. Galvanize loose steel lintels located in exterior walls.

D. Prime loose steel lintels located in exterior walls with zinc-rich primer.

2.13 STEEL WELD PLATES AND ANGLES

A. Provide steel weld plates and angles not specified in other Sections, for items supported from concrete construction as needed to complete the Work. Provide each unit with no fewer than two integrally welded steel strap anchors for embedding in concrete.

2.14 FINISHES, GENERAL

A. Comply with NAAMM's "Metal Finishes Manual for Architectural and Metal Products" for recommendations for applying and designating finishes.

B. Finish metal fabrications after assembly.

C. Finish exposed surfaces to remove tool and die marks and stretch lines, and to blend into surrounding surface.

2.15 STEEL AND IRON FINISHES

A. Galvanizing: Hot-dip galvanize items as indicated to comply with ASTM A 153/A 153M for steel and iron hardware and with ASTM A 123/A 123M for other steel and iron products.

1. Do not quench or apply post galvanizing treatments that might interfere with paint adhesion.

B. Shop prime iron and steel items not indicated to be galvanized unless they are to be embedded in concrete, sprayed-on fireproofing, or masonry, or unless otherwise indicated.

1. Shop prime with universal shop primer unless zinc-rich primer is indicated.

C. Preparation for Shop Priming: Prepare surfaces to comply with requirements indicated below:

1. Exterior Items: SSPC-SP 6/NACE No. 3, "Commercial Blast Cleaning."
2. Items Indicated to Receive Zinc-Rich Primer: SSPC-SP 6/NACE No. 3, "Commercial Blast Cleaning."
3. Items Indicated to Receive Primers Specified in Division 9 Section "High-Performance Coatings": SSPC-SP 6/NACE No. 3, "Commercial Blast Cleaning."
4. Other Items: SSPC-SP 3, "Power Tool Cleaning."

D. Shop Priming: Apply shop primer to comply with SSPC-PA 1, "Paint

Application Specification No. 1: Shop, Field, and Maintenance Painting of Steel," for shop painting.

1. Stripe paint corners, crevices, bolts, welds, and sharp edges.

3.0 EXECUTION

3.1 INSTALLATION, GENERAL

A. Cutting, Fitting, and Placement: Perform cutting, drilling, and fitting required for installing metal fabrications. Set metal fabrications accurately in location, alignment, and elevation; with edges and surfaces level, plumb, true, and free of rack; and measured from established lines and levels.

B. Fit exposed connections accurately together to form hairline joints. Weld connections that are not to be left as exposed joints but cannot be shop welded because of shipping size limitations. Do not weld, cut, or abrade surfaces of exterior units that have been hot-dip galvanized after fabrication and are for bolted or screwed field connections.

C. Field Welding: Comply with the following requirements:

1. Use materials and methods that minimize distortion and develop strength and corrosion resistance of base metals.
2. Obtain fusion without undercut or overlap.
3. Remove welding flux immediately.
4. At exposed connections, finish exposed welds and surfaces smooth and blended so no roughness shows after finishing and contour of welded surface matches that of adjacent surface.

D. Fastening to In-Place Construction: Provide anchorage devices and fasteners where metal fabrications are required to be fastened to in-place construction. Provide threaded fasteners for use with concrete and masonry inserts, toggle bolts, through bolts, lag screws, wood screws, and other connectors.

E. Provide temporary bracing or anchors in formwork for items that are to be built into concrete, masonry, or similar construction.

F. Corrosion Protection: Coat concealed surfaces of aluminum that will come into contact with grout, concrete, masonry, wood, or dissimilar metals with the following:

1. Cast Aluminum: Heavy coat of bituminous paint.
2. Extruded Aluminum: Two coats of clear lacquer.

3.2 INSTALLING MISCELLANEOUS FRAMING AND SUPPORTS

A. General: Install framing and supports to comply with requirements of items being supported, including manufacturers' written instructions and requirements indicated on Shop Drawings.

B. Anchor supports for operable partitions securely to and rigidly brace from building structure.

C. Support steel girders on solid grouted masonry, concrete, or steel pipe columns. Secure girders with anchor bolts embedded in grouted masonry or concrete or with bolts through top plates of pipe columns.

1. Where grout space under bearing plates is indicated for girders supported on concrete or masonry, install as specified in "Installing Bearing and Leveling Plates" Article.

D. Install pipe columns on concrete footings with grouted baseplates. Position and grout column baseplates as specified in "Installing Bearing and Leveling Plates" Article.

1. Grout baseplates of columns supporting steel girders after girders are installed and leveled.

3.3 INSTALLING METAL BOLLARDS

A. Bollards to be filled with concrete and domed at the top to eliminate the entrance of moisture; bollards to be installed and anchored as indicated on the Drawings.

B. Anchor bollards in place with concrete footings. Center and align bollards in holes 3 inches above bottom of excavation. Place concrete and vibrate or tamp for consolidation. Support and brace bollards in position until concrete has cured.

C. Fill bollards solidly with concrete, mounding top surface to shed water.

3.4 INSTALLING BEARING AND LEVELING PLATES

A. Clean concrete and masonry bearing surfaces of bond-reducing materials, and roughen to improve bond to surfaces. Clean bottom surface of plates.

B. Set bearing and leveling plates on wedges, shims, or leveling nuts. After bearing members have been positioned and plumbed, tighten anchor bolts. Do not remove wedges or shims but, if protruding, cut off flush with edge of bearing plate before packing with grout.

1. Use nonshrink grout, either metallic or nonmetallic, in concealed locations where not exposed to moisture; use nonshrink, nonmetallic grout in exposed locations unless otherwise indicated.
2. Pack grout solidly between bearing surfaces and plates to ensure that no voids remain.

3.5 ADJUSTING AND CLEANING

A. Touchup Painting: Immediately after erection, clean field welds, bolted connections, and abraded areas. Paint uncoated and abraded areas with the same material as used for shop painting to comply with SSPC-PA 1 for touching up shop-painted surfaces.

1. Apply by brush or spray to provide a minimum 2.0-mil dry film thickness.

B. Touchup Painting: Cleaning and touchup painting of field welds, bolted connections, and abraded areas of shop paint are specified in Division 9 painting Sections.

C. Galvanized Surfaces: Clean field welds, bolted connections, and abraded areas and repair galvanizing to comply with ASTM A 780.

4.0 MEASUREMENT AND PAYMENT

The work under this Section shall not be measured for payment, but shall be paid as a lump sum under Bid.

END OF SECTION

SECTION 11500
DIESEL FUEL STORAGE AND DISTRIBUTION SYSTEMS

1.0 GENERAL

1.01 SUMMARY

A. Work Included: This section includes requirements for boiler fuel storage and transfer systems in accordance with the Documents. The Documents are as defined in the "AGREEMENT." The "GENERAL CONDITIONS" shall apply to all work under the Contract. The work of this Section shall include but not limited to the following:

1. 30,000 gallon fiberglass double-walled diesel fuel storage tank.
2. Containment sump.
3. Tank accessories.
4. Manhole cover.
5. Leak/level monitoring system.
6. Diesel fuel piping.
7. Removal of one 30,000 gallon underground concrete diesel fuel storage tank and related piping and equipment.

B. Related Sections:

1. Section 02200 - Earthwork: Soils for backfill in trenches
2. Section 02600 - Pavement
3. Section 03300 - Cast-In-Place Concrete: Product requirements for concrete pavement above underground tank.
4. Section 05120 - Structural Steel
5. Section 05500 - Metal Fabrications

1.02 REFERENCES

A. American Association Of State Highway And Transportation Officials
1. AASHTO M288 - Standard Specification for Geotextile Specification for Highway Applications

B. American Society Of Testing And Materials:

1. ASTM D2310 - Machine-Made Reinforced Thermosetting Resin Pipe
2. ASTM D2996 - Filament-Wound Reinforced Thermosetting Resin Pipe
3. ASTM D4355 - Standard Test Method for Deterioration of Geotextiles by Exposure to Light, Moisture and Heat in a Xenon Arc Type Apparatus
4. ASTM D4491 - Standard Test Methods for Water Permeability of Geotextiles by Permittivity
5. ASTM D4533 - Standard Test Method for Trapezoid Tearing Strength of Geotextiles
6. ASTM D4632 - Standard Test Method for Grab Breaking Load and Elongation of Geotextiles

7. ASTM D4751 - Standard Test Method for Determining Apparent Opening Size of a Geotextile
8. ASTM D4833 - Standard Test Method for Index Puncture Resistance of Geotextiles, Geomembranes, and Related Products

C. American Petroleum Institute:

1. API 12P - Fiberglass Reinforced Plastic Tanks.
2. API 1615 - Installation of Underground Petroleum Storage Systems.
3. API 2000 - Venting Atmospheric and Low-Pressure Storage Tanks: Non-refrigerated and Refrigerated.

D. Fiberglass Petroleum Tank & Piping Institute

1. FPTPI-P8/89 - FRP Piping Checklist

E. National Electrical Manufacturers Association:

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

F. National Fire Protection Association:

1. NFPA 30 - Flammable and Combustible Liquids Code.
2. NFPA 30A – Motor Fuel Dispensing Facilities and Repair Garages.

G. Petroleum Equipment Institute:

1. PEI 100 - Recommended Practices for Installation of Underground Liquid Storage Systems.

H. Underwriters Laboratories Inc.:

1. UL 567 - Pipe Connectors for Flammable Liquids and Combustible Liquids and LP-Gas.
2. UL 913 - Intrinsically Safe Apparatus and Associated Apparatus for Use in Class I, II, and III, Division 1, Hazardous Locations.
3. UL 1316 - Glass Fiber Reinforced Plastic Underground Storage Tanks for Petroleum Products, Alcohols, and Alcohol-Gasoline Mixtures.

1.03 SYSTEM DESCRIPTION

A. Provide diesel fuel compatible underground tank and fuel piping system of double wall fiberglass construction.

1. Provide one 30,000 gallon double wall underground diesel fuel tank for boiler backup fuel supply.
2. Provide double wall fiberglass underground fuel transfer piping from the underground diesel fuel storage tank to the interior of the building as indicated on the drawings.
3. Provide Veeder-Root sensors and probes as indicated.

1.04 SUBMITTALS

A. Kentucky Fire Marshal Certificate for installation of fuel storage and distribution piping systems.

B. Shop Drawings:

1. Tank: Indicate for fuel tank dimensions; number, size, and location of openings; number, size, and location of manholes; number and location of hold down straps, and accessories.
2. Piping arrangements for underground piping and piping inside of the maintenance facility building.

C. Product Data:

1. Filter fabric.
2. Tank: Submit manufacturer’s catalog information including capacity.
3. Containment sumps.
4. FRP piping and fittings.
5. Manholes and frames.
6. Tank appurtenances.
7. Tank Leak/Level Monitoring System: Submit manufacturer’s catalog information for controller, alarm unit and cable type.
8. All Veeder-Root sensors and probes.
9. Aboveground steel fuel piping and fittings.

D. Test Reports: Submit written test results for tank and piping pressure tests.

E. Manufacturer's Field Reports: Submit report of each visit of manufacturer’s representative to provide technical assistance during installation.

1.05 CLOSEOUT SUBMITTALS

A. Project Record Documents: Record actual locations of manholes, tank, piping, electrical equipment and conduits and leak detection system.

B. Identify and describe unexpected variations to subsoil conditions or discovery of uncharted utilities.

C. Operation and Maintenance Data: Submit spare parts lists, exploded assembly views for tank, leak detection system.

1. Leak/level monitoring system.

D. Provide two laminated tank strapping charts.

1.06 QUALITY ASSURANCE

A. Perform Work in accordance with the Kentucky Uniform Building Code (UBC), and NFPA 30, NFPA 30A, NFPA 31, as applicable.

B. Pipe installers shall be experienced and skilled in the installation of double walled fiber reinforced plastic (FRP) pipe.

1.07 QUALIFICATIONS

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

B. Underground Fuel Storage Tank: Company specializing in manufacturing products specified in this section with minimum three (3) years documented experience.

C. Level/Leak Monitoring System: Company specializing in manufacturing products specified in this section with minimum three (3) years documented experience.

D. UST Installer and Removal: Company specializing in performing Work of this section with minimum three years documented experience approved by manufacturer and possesses a valid Kentucky Fire Marshal UST installer and remover certification. Proof of certification is required.

1.08 DELIVERY, STORAGE, AND HANDLING

A. Do not store plastic pipe and fittings in direct sunlight.

B. All tanks, piping, valves and pumps shall have all openings plugged using plastic pipe plugs to prevent moisture and foreign objects from entering same.

C. Fuel tank shall be handled and stored in accordance with manufacturer’s requirements.

1.09 ENVIRONMENTAL REQUIREMENTS

A. Related Sections:

1. Section 02200 – Earthwork

B. Do not install underground tank when bedding is wet or frozen.

C. Do not install tank foundations when bedding is wet or frozen.

1.10 FIELD MEASUREMENTS

A. Verify field measurements prior to fabrication.

1.11 COORDINATION

A. Coordinate trenching, excavating including rock excavation, bedding and backfilling of underground tank and tank foundations with requirements of Section 03300 and the Drawings.

1.12 WARRANTY

A. Furnish 30-year manufacturer warranty for tank.

2.0 PRODUCTS

2.01 PERMEABLE FILTER FABRIC LINER

A. See Section 02225 – Fill and Backfill Materials.

2.02 UNDERGROUND FUEL STORAGE TANK

A. Manufacturers: Subject to the requirement of the specification, the following manufacturer's products that may be incorporated into the project:

1. Containment Solutions
2. Xerxes

2.03 FIBERGLASS FUEL STORAGE TANK

A. Features:

1. Single compartment double wall fiberglass reinforced plastic (FRP) underground storage tank with a primary (internal) tank and a secondary (external) tank. (Approximate dimensions; 10 feet diameter by 55 fee long.)
2. Brine dome reservoir and brine solution within the interstitial space allows detection of leaks from the primary tank wall and/or secondary tank wall by a hydrostatic level sensor (by Veeder-Root).
3. NPT openings: 4-inch; Quantity: 8

4. Manway: Diameter 22”

B. Design Criteria:

1. UL labeled for underground service in accordance with UL-1316 Construction Standard for Glass-Fiber-Reinforced Plastic Underground Storage Tanks.
2. Internal Load: Primary tank shall withstand 20 psi and Secondary tank shall withstand 5 psi air pressure test with 5 to 1 safety factor. Maximum test pressure is 5 psi.
3. Mercury vacuum tested and by the tank manufacturer to assure structural integrity.
4. Surface Loads: H-20 axles loads when properly installed according to current manufacturer's installation instructions.
5. External Hydrostatic Pressure: 7 feet of overburden with the hole fully flooded with a 5:1 safety factor against buckling.
6. Tank capable of supporting accessory equipment such as drop tubes and ladders when installed according to tank manufacturer's recommendations and limitations.
7. Vent primary tank to atmospheric pressure. The tank is not designed as pressure vessel.

C. Product Storage:

1. Tank capable of storing diesel fuel at ambient underground temperature.

D. Construction:

1. Materials (Primary and Secondary Tanks): Isophthalic polyester resin and glass fiber reinforcement.
2. Manways:
   a. Above liquid level type, size as specified on the drawings.
   b. Bolted cover with UL listed gasket, and welded threaded openings of number and sizes required. Secure nuts or heads of bolts to underside of flange.
   c. Protect threads on bolts during transit and installation.
      1) Monitor Fittings: 4 inch NPT fitting.
      2) Gage/Deflector Plates (Under Manways and Fitting Openings): Fiberglass.

E. Tank Hold Down Device:

1. Hold-Down Strap (by tank Manufacturer): Fiberglass reinforced plastic, preshaped to fit the tank contour. The quantity and location of hold down straps shall be as recommended by tank manufacturer.
2. Wire Rope: Stainless steel, 6 x 19 strand, fiber core, minimum tensile strength 12500 pounds.
3. Wire Rope Clamps: Stainless steel.

F. Tank Identification: Permanent stencils, labels, or plates mounted on tank and fill ports; and which include the following information:

1. Standard of Design by which tank was manufactured.
2. List of products and additives which may be permanently stored in tank.
3. Year in which tank was manufactured.
4. Unique identification number.
5. Dimensions, design, working capacity, and tank model number.
6. Name of tank manufacturer.
7. Date of tank manufacture (Fill port only).

2.04 TANK CONTAINMENT SUMP

A. Fiberglass Containment Sump by Containment Solutions, or approved equal.

1. Features:
   a. Friction fit top cover.
   b. Bulkhead Fittings: S. Bravo or approved equal.
   c. Double walled sump with brine-filled interstitial space by Containment Solutions.
   d. Magnetrostrictive sensor with sump integrity testing capability by Veeder-Root.
   e. Manhole Frame and Lid: Composite material traffic bearing lid (H-20 loading) by Fibrelite.
   f. Manhole Skirt: Composite material; Model FL100/SK10 by Fibrelite.
   g. Single Point Mini Hydrostatic Sensor by Veeder-Root.

2.05 TANK ACCESSORIES

A. Tank Fill Assembly:

1. Top Seal Fill Pipe Cap: Die-cast zinc body, brass or bronze cam action lever, buna-N gasket, and provisions for locking, (4 inch); OPW 634TT.
2. Top Seal Fill Pipe Adapter: Bronze, female threaded end, buna-N gasket (4 x 4 inch); OPW 633T.
3. Tank Overfill Protection Valve: Cast aluminum vapor-tight shut-off valve with Viton seals; OPW 71SO.
4. Drop Tube: Aluminum, length as required to reach within 6 inches of tank bottom: End cut at 45 degrees angle (3 inch).

B. Spill Containment: Open top stainless steel spill container, five gallon capacity: Fairfield Industries SC-5P.

C. Padlock: Bronze, Series 800 by Yale, Eaton Corp., Charlotte, NC or as ordered by owner.

1. Key all locks alike.

D. Stick Gage: Hardwood, calibrated in inches.

E. Vent Caps:

1. Diesel: Aluminum body, designed to direct vapors upward, 40-mesh brass wire screen; OPW-FC 23-0033.

F. Tank Level Gauge: Tank level gauge with water sensor; Veeder-Root

2.06 FRP PIPING

A. Primary and secondary Pipe and Fittings: Filament-wound reinforced thermosetting resin pipe manufactured according to ASTM D 2996 with integral secondary containment pipe; Ameron Dualoy 3000 / LCX pipe and fittings.

2.07 ABOVEGROUND STEEL PIPE AND FITTINGS

A. Black steel, seamless or electric resistance welded per ASTM A-53, Grade B, Schedule 40.

B. Joining method shall be screwed with National Pipe Thread ends for connections to the underground tank bungs, pumps and within containment sumps. Diesel fuel distribution piping within the building shall have welded pipe joints and welded fittings.

C. Fittings for steel pipe shall be threaded, 150 pound malleable iron, per ASTM A 197 or ASTM A 47, dimensions conforming to ANSI B16.3; unions shall be 300 pound malleable iron, per ASTM A 197 or ASTM A 47, dimensions conforming to ANSI B16.3, brass to iron seat.

D. Thread lubricant for steel pipe shall be a joint compound that is insoluble in fuel oil. Pipe joint compound shall be “GASOILA” pipe compound manufactured by Federal Process Co., Cleveland, Ohio, or approved equal.

2.08 WARNING TAPE

A. Acid- and alkali-resistant polyethylene film warning tape manufactured for marking and identifying underground utilities, minimum 6 inches wide and 4 mils thick, continuously inscribed with a description of utility, with metallic core encased in a protective jacket for corrosion protection, detectable by metal detector when tape is buried up to 30 inches deep; colored as follows:

1. Yellow: Petroleum systems.

3.0 EXECUTION

3.01 EXAMINATION

A. Verify excavations are to required grade, dry, and not over-excavated.

3.02 PREPARATION

A. Testing Prior to Installation: Before placing the tank into the excavation, plug all openings and pressure test in accordance with manufacturer's printed test instructions, unless otherwise specified. Tank should not be pressurized beyond manufacturer's specified limits. The tank must hold the test pressure for 60 minutes. Check fitting connections, and seams in tank by applying a soap suds solution. Reject leaking tank.

3.03 INSTALLATION

A. Install the Work of this section in accordance with the item manufacturer's printed installation instructions, unless otherwise shown or specified.

3.04 FUEL STORAGE TANK

A. Lower tank carefully into the excavation using lifting lugs provided on the tank. Set the tank on a 12 inch layer of select tank manufacturer’s approved pea gravel.

B. Do not use chocks or saddles to support or block the tank in position.

C. Install tank anchoring devices to secure tank firmly in place.

D. Do not place fuel into tank until backfilling is completed.

E. Plug and seal all unused openings in containment chamber.

F. Ballasting the tank with water is not allowed.

3.05 TANK IDENTIFICATION

A. Paint the fill ports with the appropriate API color code and stencil the tank ID on the concrete adjacent to the fill port.

B. Terminate vent lines with vent caps.

C. Install padlocks on all lockable caps on fill piping.

D. Install the following tank accessories: anti-siphon devices, overfill shutoff and alarms, vents, gages, emergency vents and other devices indicated on drawings.

3.06 INSTALLATION - UNDERGROUND TANK

A. Install underground tank in accordance with Kentucky Fire Marshal requirements. API 1615, PEI 100, NFPA 30, NFPA 31 and manufacturer's requirements.

B. Check factory installed equipment and accessories for loosening during transit.

C. Install underground tank with minimum 36 inches cover.

D. Backfill tank in accordance with manufacturer's instructions. Do not bed on timbers, beams, or cradles.

E. Adjust liquid level gages before initial start-up and after filling of tank.

F. Fill tank completely at Project turnover with appropriate fuel.

3.07 INSTALLATION - FRP PIPING

A. Install warning tape directly above piping, 12 inches below finished grade, except 6 inches below subgrade under pavements and slabs.

B. Install FRP secondary containment piping in accordance with the manufacturer's recommendations to provide proper flexibility. Secondary containment piping shall be sealed only after primary piping passes inspection and air testing.

3.08 FIELD QUALITY CONTROL

A. Pressure test tank in accordance with the following:

1. Pressure test the primary and secondary spaces of the underground tank in accordance with the manufacturer's Installation Manual.
2. Repair leaks.
3. Retest until no leaks are detected.

B. Field Testing Leak, Level and Overfill Monitoring System:

1. Conduct field testing as per manufacturer's recommendations.
2. Perform tests to demonstrate ability of system to detect leaks, annunciate alarms including overfill.

C. Testing: After installation of tank and piping, test the system in the presence of Engineer, as follows:

1. Piping: Before final assembly of the secondary containment pipe, a 50 psi air pressure test or hydrostatic test shall be performed on the primary piping to detect any leaks that may exist. Prior to backfilling pipe trench, hydrostatically test primary piping system to either 150% of working pressure

or 50 psig for 60 minutes. All piping found leaking shall be repaired or replaced. After test has been completed, perform air pressure testing on secondary containment piping at 5 psig for 60 minutes. Make repairs as required if pressure loss occurs for either piping system at no additional cost to University of Kentucky. Perform tests on piping in strict accordance with manufacturer's recommendations and other applicable code requirements. After product has been introduced into the piping and the system is operational, a 3rd party 0.1 gph piping tightness test shall be performed by a KDEP certified tank tester.

2. Tank: Before backfilling, pressure test tank in accordance with manufacturer's printed test instructions, unless otherwise specified. Tank should not be pressurized beyond manufacturer's specified limits. The tank must hold the test pressure for 60 minutes. Check fitting connections, and seams in tank by applying a soap suds solution. After backfilling, make measurement of vertical distance from top of 4 inch gage opening to top of impact/deflector plate, and deliver this information to the Engineer. After product has been introduced into the tank and the system is operational, a 3rd party 0.1 gph tank tightness test and a secondary containment vacuum test shall be performed by a Kentucky DEP certified tank tester.

   a. Special Requirements: Perform hydrostatic tests on tank using air.

3. Tank Containment Sumps: Perform hydrostatic test on the tank containment sumps to detect any leaks that may exist. All sumps found leaking shall be repaired or replaced. Perform tests on sumps in strict accordance with manufacturer’s recommendations and other applicable code requirements.

4. After reconnection all piping, fuel pumps and tank, and when directed, perform a system acceptance test in the presence of the Engineer to demonstrate that the fuel transfer system is operating properly. Make required repairs and final adjustments.

3.09 MANUFACTURER'S FIELD SERVICES

Furnish factory trained representative for 8 hours of on-site time during underground tank installation.

Furnish factory trained representative of system supplier for 8 hours of on-site time during testing of leak/level monitoring system for training of facility personnel.

4.0 MEASUREMENT AND PAYMENT

The work under this Section shall not be measured for payment, but shall be paid as a lump sum under Bid.

END OF SECTION

SECTION 15000
GENERAL REQUIREMENTS

1.0 GENERAL

1.01 WORK INCLUDED

The work under this Division of the Specifications shall include all materials, equipment and labor for furnishing, installing and testing the piping work described. The work also includes making all connections to pipelines and appurtenances; furnishing and installing all valves, piping, flexible joints, pipe expansion joints and accessories; installation of concrete thrust blocks; furnishing and installation of pipe insulation where required; furnishing and installation of all hangers and hanger supports; and relocation of existing pipelines and appurtenances, all as specified herein and as shown on the Drawings.

Although certain construction operations described above are a necessary part of the pipe, valve and accessory installation, the materials and installation specifications may not be included in this Division or Section. The Contractor shall refer to the appropriate Sections or Divisions of these Specifications for work other than piping and valves which may be related to the work defined in this Section.

The Contractor is advised that making connections to existing pipelines or relocating existing pipelines or appurtenances requires careful consideration as to the construction techniques employed. The Contractor shall be solely responsible for maintaining existing pipelines in such a manner as to prevent disruption of services or prevent bypassing of untreated or partially treated wastewaters directly or indirectly to any water course or underground aquifer.

The piping work shall include, but not necessarily be limited to the following services and categories: inside; outside; underground or above ground; and on or off-site:

A. Service and Process Piping

1. Diesel Fuel Lines

2. Miscellaneous Equipment Connections

2.0 PRODUCTS

2.01 HANGERS AND SUPPORTS

Hangers and supports for piping, valves and pipeline appurtenances are shown on the drawings only in isolated instances. As a part of the piping work, the Contractor shall securely support all piping, valves and pipelines and shall include the cost of all hangers and supports. Included in this classification are saddle stands, steel and cast iron stanchions, hangers, pipe rolls, bearing plates, fastenings, concrete inserts, or other anchors and appurtenances. Where new supports are to be attached to existing concrete, the Contractor shall modify existing concrete, and furnish and install epoxy type expansion anchors as required and as specified in another Division of these Specifications.

Hangers and supports shall be adequate to maintain the piping, valves and equipment in proper position and alignment, and to prevent sway or movement under all operating conditions. Particular attention is called to discharge lines of pumps, connections to wall pieces, and to restraining of mechanical type joints.

The Contractor shall employ the services of a qualified and approved pipe hanger designer/manufacturer to fabricate and furnish all hangers, supports and anchor and guide devices for all piping, valves and accessories in structures and buildings. All design information, calculations and layout drawings; including details of inserts, hangers, supports, anchors, braces, saddles, stanchions, specials, accessories and the like shall be submitted to the Engineer for his review in advance of installation. Special consideration shall be given in the design of pipe supports to the effects of thermal expansion or contraction and to lateral forces from pipe junctions. All hanger and support systems shall be designed, detailed, dimensioned and certified by a professional engineer licensed in the State of Kentucky, at no additional cost to the Owner.

The design of hangers and support systems shall employ the various attachments to structures and piping as specified herein. The components, as manufactured by Grinnell, Fee & Mason, or equal, may be utilized in various combinations subject to the approval of the Engineer.

All rolled formed metal sections shall not be less than 12 gauge (.105 inches thick) material. All structural steel sections shall not be less than 3/16 inches thick.

Design and installation shall be in accordance with best industry practice and shall be governed by the Petroleum Refinery Piping Code ANSI B3l.3, latest revision, MSS Sp-58 and MSS Sp-69 and other requirements as specified herein. Anchors and restraints shall be designed for the test pressures specified; operating thermal forces to be encountered; and the type of expansion devices and pipe joints utilized for the installation. All structural steel members shall be designed for a maximum tensile capacity of 9,000 psi and shall provide for a minimum factor of safety of five (5) based upon ultimate strength. Maximum deflections shall be limited to 1/360 of the span. The system shall be designed to accommodate the dynamic forces in affect when pumping systems are either started or stopped and shall be such as to insure that no sway, permanent system deformation or chattering shall occur at any time. Pipe supports shall be designed to resist lateral forces in accordance with Section 305 of the International Mechanical Code, 2009.

Structural steel framework for supporting pipes shall be furnished and installed where shown or required, and shall be anchored to walls, floors and ceiling with stainless steel expansion bolts having a maximum working strength load of 25 percent of ultimate load capacity of the entire unit in its application.

Material for hangers and supports shall conform to the requirements of the latest revisions to the following standards:

Cold Work Strip Steel (for metal framing)	- ASTM Designation A569-85
Structural Steel	- ASTM Designation A36/A36M-84a
Threaded Steel Rods	- ASTM Designation A575-81
Steel Castings	- ASTM Designation A27-84a Grade 65-35, Full Annealed

All Other Auxiliary Steel for Pipe Supports	- ASTM Designation A36/A36M-84a
Wrought Steel Pipe	- ASTM Designation A53-84a (Schedule 40)
Iron Castings	- ASTM Designation A48-83 (Class 35)
Cast Iron Pipe Stanchions	- ANSI Standard B31.1, Class 125
Malleable Iron Castings	- ANSI Designation A47
Bolting Materials (Bolts, Stud Bolts, Nuts and Washers)	- ASTM Designation A307-84
Chains	- ASTM Designation A413-80
Bolt Materials - Stainless Steel - Type 304	- ASTM Designation A167-84a
Hot Dipped Galvanizing After Fabrication	- ASTM Designation A123-84
Fittings Material	- ASTM Designation A575-81

In general, pipe supports from the various structures shall be as follows:

A. From Walls or Columns:

1. Welded Steel brackets.

2. Adjustable stands of the roll type.

B. From Floors or Piers:

1. Pipe rolls or chairs with bases.

2. Saddle stands or stanchions.

3. Metal framing system with pipe rolls.

C. From Overhead Slabs or Sides of Beams:

1. Pipe rolls or rings suspended from threaded rod hangers.

2. Metal framing system with pipe rolls.

Bracket shall be made of welded wrought steel and shall be designed for three maximum loads classified as follows:

A.	Light	750 lbs.
B.	Medium	1,500 lbs.
C.	Heavy	3,000 lbs.

When medium or heavy brackets are bolted to walls, backing plates of adequate size and thickness shall be furnished and installed to distribute the load against the wall. Where the use of backing plates is not practical, the brackets shall be fastened to the wall in an approved manner.

Saddle stands shall be of the adjustable type. Each stand shall consist of a length of wrought steel pipe fitted at the base with a standard screw threaded cast iron flange and at the top with an adjustable saddle or roll. The base flange shall be bolted to the floor or foundation, and grouted.

Stanchions shall be of similar construction to the saddle stand. They shall be fitted at the top with a cast iron pipe saddle support or with a pipe stanchion saddle consisting of a yoke and nuts.

Column supports of cast iron or steel pipe type or of an approved design, built-up structural steel type, shall be installed, where required.

Non-shrink grout shall be used under all floor type supports or bedding plates. Grout shall be as specified in Division 3 of the Specifications.

Pipe covering protection saddles shall be used on pipes 3" and larger which are to be covered with insulation. Hangers and supports shall include proper pipe covering protection saddles. Saddles shall be not less than 12" long and shall be made of covered steel plates with the side edges turned up. For pipe 8" and larger, the saddle shall have a welded center plate to provide a

three-point support. The saddles shall be filled with either plastic cement or with sectional covering cut to suit, before being placed.

Anchors shall be furnished and installed when specified, shown or required for holding the pipe and equipment in position or alignment. All anchors shall be designed for rigid fastening to the structures either directly or through brackets. The design of all anchors shall be subject to the Engineer's approval.

Anchors for piping shall be of the cast iron chair type with wrought steel straps, except where anchors form an integral part of pipe fittings, or where an anchor of special design is required.

All individual concrete inserts shall be of malleable iron and shall be installed in the concrete structures where required for fastening the supporting devices. To facilitate installation, nail slots shall be provided in the exposed flanges of the insert. Working loads as recommended by manufacturer shall not be exceeded, regardless of allowable rod load. Concrete inserts shall be "Rocket Type" concrete insert anchor as manufactured by Richmond Screw Anchor Co.; Grinnell Corp.; or equal.

The use of adhesive stud anchors will be permitted only to existing concrete or at locations specifically approved by the Engineer.

2.02 SCHEDULE OF PIPE AND JOINTING

Pipe and fitting materials, jointing and pipe lining shall be in accordance with the following schedule. This schedule is set forth as a guide to illustrate requirements. The lack of the specific mention of any particular pipelines does not relieve the Contractor from the responsibility for furnishing, installing, painting and testing such a pipeline in accordance with the requirements of these Specifications and the following schedule. The term "cast iron" may mean ductile cast iron or

grey cast iron, depending on the size of the piping and whether it is buried or not. The Contractor shall refer to the notes following the schedule:

Service	Pipe Material	Jointing
Sewage Lines; Force Mains and Gravity Sanitary Sewers and clean outs	PVC (SDR 35)	**a)** Flanged/split coupled (inside or exposed) **b)** Mechanical/push-on (buried)
Vents	PVC (SCH 80)	Solvent Welded

General Notes (Apply to all piping schedules)

A. Jointing of buried piping shown as mechanical may be replaced with approved rubber gasketed push-on joint at the Contractor's option, unless otherwise directed by the Engineer.

B. All buried fittings on all piping shall be secured for thrust conditions utilizing concrete thrust blocks, or tie rods and socket clamps as permitted by the Engineer.

C. Joint restraining lengths required at bends and fittings will be based on calculations utilizing the line test pressures or water hammer pressures whichever are larger. Calculations showing the restrained lengths are to be submitted to the Engineer for review.

3.0 EXECUTION

3.01 EXCAVATION AND BACKFILL WORK IN CONNECTION WITH PIPE LAYING

The laying of underground pipe will require trimming and grading of trench bottoms for the pipe, and will require backfilling and tamping around all pipes to an elevation one foot above crown of pipe. Such procedures are to be followed as the pipe laying progresses following the approval of all inspection and testing procedures, to provide protection and stabilization of the pipes, irrespective of the size, type, or number of pipes. See Section 02121 – Clean Fill and 02225 – Fill and Backfill Materials of the specifications.

The width of each pipe trench is to be not less than two (2') feet plus the outside pipe diameter, at the level of twelve (12") inches above the top of the pipe. Pipe laying work is to be conducted so that trenching operations are not advanced too far ahead of the pipe laying operations, resulting in excessive lengths of open trench. In general, open trench ahead of pipe laying should not exceed 50 feet.

Special precautions shall be taken in placing, filling, and compacting multiple pipe systems placed in a common trench or on common fill at the same centerline elevation to ensure that pipe alignments and grades are maintained and that no unbalanced soil loads are imposed. Adequate harnessing or thrust-blocking or both if the situation dictates will be required where pressure pipe systems are involved.

The Contractor is to trim the bottom of all acceptable natural soil trenches to receive pipes. The bottoms of all trenches are to be rounded insofar as practical, so that at least one-third of the circumference of the pipes will rest firmly on undisturbed soil to the proper line and grade. Bell holes are to be dug to insure that the pipe is resting for its entire length upon the bottom of the trench. Acceptable natural soil trenches are not to be excavated below grade by machine.

Pipes are to be bedded as shown on the drawings if the natural soil conditions do not conform to the requirements of Section 02121 – Clean Fill, but in all cases bedding shall consist of a minimum of eight (8") inches of broken stone as specified in Section 02225 – Fill and Backfill Materials.

After the pipes have been tested and approved, trenches are to be backfilled with granular material to a point twelve (12") inches above the crown of the pipe. In areas below existing or future pavements, granular material is to be used up to the point of final subgrade. Backfill is to be carefully deposited in layers not to exceed 6 inches in thickness, on both sides of pipe, and thoroughly and carefully rammed until enough fill has been placed to provide a cover of not less than one foot above top of pipe. If permitted by the Engineer, excavated materials may be used above a plane twelve (12") inches above the pipe crown in areas outside existing or future paved areas.

Non-metallic piping is to be fully bedded and backfilled with a fine granular material so that at least eight (8") inches of bedding and twelve (12") inches of side and crown material surrounds the pipe.

When pipe crossings occur, the lower pipe is to be laid first and all backfill thoroughly compacted to the level of the higher pipe before the higher pipe is laid. At the discretion of the Engineer, backfill material under such conditions may be existing material, broken stone or 2500 psi concrete conforming to the details shown for concrete encasements.

In all excavations for pipelines, unsuitable soil, boulders, rocks, masonry or other similar materials are to be excavated to a level of at least eight (8") inches below the invert of the pipe, and carefully refilled with approved material mechanically compacted to provide a stable subbase. Rocks or boulders are to be removed from sides of trenches to a plane twelve (12") inches outside of the outside wall of the pipe, unless permission to do otherwise is expressly given. Gravel, crushed stone fill bedding is to be provided, placed and compacted to the minimum depths indicated in the Documents.

Prior to backfill, the Contractor shall make "Record Drawings", accurately indicating the line and grade of pipeline, as described in General Requirements of the Specifications.

3.02 TESTING

In general, the Contractor shall test all piping to a pressure equal to l.5 times the maximum working pressure, maximum head of water, or shutoff head for the pumps, whichever is larger. Test pressures shall be held continuously for two (2) hours. The test readings shall be taken at the high point of the line or at a location approved by the Engineer.

Wherever conditions will permit, piping which is to be buried shall be tested before trenches are backfilled. All joints shall be examined during the open trench test and all visible leaks entirely stopped.

The Contractor shall furnish all labor, equipment, gauges, water, air and all else necessary for carrying out the testing of all piping. The Engineer reserves the right to periodically check the Contractors test apparatus for accuracy.

All piping, fittings, caps and plugs shall be adequately braced and anchored to withstand the test pressures. The Contractor shall review the Drawings before starting piping installation and shall take special note of where (a) piping enters or leaves sumps, channels and tanks without valving and where (b) piping begins or terminates with fittings which will be difficult or impractical to seal, plug and anchor. For these cases, the Contractor shall devise and perform such tests as shall be acceptable and approved by the Engineer and as shall demonstrate that the piping meets the test pressures and leakage requirements specified herein.

The Contractor shall be required to provide appropriate drawings detailing the methods which the Contractor intends to use regarding the temporary closure or plugging of pipes terminating as open ends in structures for which testing will be required. These drawings will be reviewed by the Engineer for their applicability and utility before any testing may proceed.

When a section of pipe of a length deemed adequate by the Engineer is ready for testing, the lines designed for carrying liquids shall be thoroughly vented and a leakage test shall be made with the line free of air. Lines designed for carrying air or gas shall be tested with air and the joints brushed with a water and soap solution by the Contractor in the presence of the Engineer to aid in detecting leakage. Leaks at joints or in the pipe and fittings shall be corrected by an approved means, and the piping retested in accordance with this specification until it successfully passes the test.

On PVC piping, no testing shall be done until the last solvent cemented joint made has had 24 hours to set and cure.

Pipelines designed for air and gas service shall show no leakage during the 2-hour test period.

Flanged and welded pipelines, no matter what type of service, shall show no leakage during the 2-hour test period. Plastic (PVC) pipe shall show no leakage during the 2-hour test period.

For pipelines designed for liquid service, leakage for mechanical joints, push-on joints, and leaded joints shall not exceed the allowable leakage computed by the following formulae:

A. For Mechanical Joints and Push-on Joints

$$L = \frac{NDP^{0.5}}{7400}$$

Where L = allowable leakage in gallons per hour
N = number of joints in length of pipeline tested
D = nominal diameter of pipe in inches
P = test pressure in pounds per square inch gauge

When testing against closed metal seated valves, an additional leakage of 0.0078 gal/hr./in. of nominal valve size shall be allowed.

B. For reinforced concrete pipe, the allowable leakage shall not exceed the following criteria:

1. 50 gallons per inch of diameter per mile of pipe per 24-hour period as infiltration.

2. 100 gallons per inch of diameter per mile of pipe per 24-hour period as exfiltration.

C. No exposed piping, regardless of service and type of jointing shall have visible leakage.

3.03 CLEANING AND FLUSHING

On completion, the interior of all piping shall be carefully cleaned and flushed. The Contractor shall carefully clean all air and gas piping, headers and accessories through which air or gas is delivered, so that all dust, dirt, oil, grease, or other foreign material will be effectively removed.

3.04 STERILIZATION

After pressure testing the Contractor shall flush and disinfect all site potable water (city water) lines. Disinfection shall be in accordance with the latest revisions to AWWA C601, American Water Works Association Standard for Disinfecting Water Mains. Contractor shall be responsible for doing all work required to successfully disinfect these water lines to the satisfaction of the Engineer, Owner, and local authorities.

3.05 SHEETING AND BRACING

See Section 02200 – Earthwork of the specifications.

3.06 FLUSH, SAMPLE AND DRAIN CONNECTIONS

The Contractor shall furnish and install, where shown on the Drawings and as required by the Engineer, all flush, sample and drain connections (piping and valving). During the shop drawing and coordination drawing review phase of the project, the Contractor shall carefully review the piping layout and provide all pipeline flush, sample and drain connections required, whether or not shown on the Drawings. Location of all connections shall be as approved by the Engineer. The cost of the connections shall be included in the lump sum price bid.

4.0 MEASUREMENT AND PAYMENT

The work under this Section shall not be measured for payment, but shall be paid as a lump sum under Bid.

END OF SECTION

SECTION 15122
PIPE SLEEVES

1.0 GENERAL

1.01 WORK INCLUDED

Wherever shown on the Drawings, and wherever piping passes through walls or floors, sleeves shall be furnished and installed. All sleeves shall be as detailed in the Drawings and specified herein, and shall have waterstops located mid-length along the sleeve axis.

1.02 REFERENCED SECTIONS

A. Section 15000 - General Requirements

1.03 SUBMITTALS

Shop drawings and schedules completely detailing and locating the pipe sleeves and seals shall be submitted to the Engineer for approval prior to their fabrication and well in advance of concrete work.

2.0 PRODUCTS

2.01 SLEEVES AND PIPE SEAL ASSEMBLIES

A pipe seal assembly shall be comprised of a metal sleeve and an approved modular, mechanical type pipe seal, consisting of interlocking synthetic rubber links shaped to continuously fill the annular space between the penetrating pipe and the inside wall of the pipe sleeve and designed to provide a completely watertight seal against a hydrostatic head of 20 psig.

Sleeves shall be Schedule 40 carbon steel pipe, conforming to ASTM Designation A53 or equal. No sleeve shall be cement lined. All sleeves to be used in exterior walls, and in interior walls having a head of water or other liquid on either or both faces shall be protected inside and out with two (2) coats of an approved coal tar epoxy paint, total 16 mils dry film thickness.

Each seal shall consist of the interlocking synthetic rubber links shaped to continuously fill the annular space between the penetrating pipe and the inside of the sleeve. Links shall be initially loosely assembled with steel bolts to form a continuous rubber belt around the pipe and with a metal or plastic pressure plate under each bolt head and nut.

Wherever pipe seal assemblies are to be located in exterior walls, or in interior walls having a head of water or other liquid on either or both faces, all metal parts of the pipe seal shall be stainless steel.

3.0 EXECUTION

3.01 INSTALLATION

The Contractor shall determine the required inside diameter of each wall sleeve and outside diameter of each penetrating pipe before ordering, fabricating and installing sleeves and seals. Sleeve inside diameters shall be sized in accordance with the recommendations of the seal Manufacturer so as to provide a watertight joint in each case.

All pipe seal assemblies in exterior walls, and in interior walls having a head of water or other liquid on either or both faces, shall include two (2) pipe seals, one at each end of the sleeve and adjacent to the wall faces.

All piping penetrating walls shall be properly supported outside of the pipe seal assembly so that the weight of the pipe and its contents are not supported by the pipe seal or sleeve.

After the seal assembly is positioned around the pipe and in the sleeve, the bolts shall be tightened, which shall cause the rubber sealing elements to expand and provide an absolutely watertight seal between pipe and the inside of the sleeve.

All seals shall be installed, wherever possible, so that they can be adjusted and tightened from the interior of structures, from the dry sides of walls and from the top of slabs.

All installations shall be strictly in accordance with the seal manufacturer's instructions and recommendations. The Contractor shall provide the service of the pipe seal Manufacturer's personnel as required to guide and advise during the installation.

4.0 MEASUREMENT AND PAYMENT

The work under this Section shall not be measured for payment, but shall be paid as a lump sum under Bid.

END OF SECTION

SECTION 16051
COMMON WORK RESULTS FOR ELECTRICAL

1.0 GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Special Provisions, apply to this Section.

1.2 SUMMARY

A. Section Includes:

1. Electrical equipment coordination and installation.
2. Sleeves for raceways and cables.
3. Sleeve seals.
4. Grout.
5. Common electrical installation requirements.

1.3 DEFINITIONS

A. EPDM: Ethylene-propylene-diene terpolymer rubber.

B. NBR: Acrylonitrile-butadiene rubber.

1.4 SUBMITTALS

A. Product Data: For sleeve seals.

1.5 COORDINATION

A. Coordinate arrangement, mounting, and support of electrical equipment:

1. To allow maximum possible headroom unless specific mounting heights that reduce headroom are indicated.
2. To provide for ease of disconnecting the equipment with minimum interference to other installations.
3. To allow right of way for piping and conduit installed at required slope.
4. So connecting raceways, cables, wireways, will be clear of obstructions and of the working and access space of other equipment.

B. Coordinate installation of required supporting devices and set sleeves in, masonry walls, and other structural components as they are constructed.

C. Coordinate sleeve selection and application with selection and application of firestopping.

2.0 PRODUCTS

2.1 SLEEVES FOR RACEWAYS AND CABLES

A. Steel Pipe Sleeves: ASTM A 53/A 53M, Type E, Grade B, Schedule 40, galvanized steel, plain ends.

B. Cast-Iron Pipe Sleeves: Cast or fabricated "wall pipe," equivalent to ductile-iron pressure pipe, with plain ends and integral waterstop, unless otherwise indicated.

C. Sleeves for Rectangular Openings: Galvanized sheet steel.

1. Minimum Metal Thickness:

   a. For sleeve cross-section rectangle perimeter less than 50 inches (1270 mm) and no side more than 16 inches (400 mm), thickness shall be 0.052 inch (1.3 mm).
   b. For sleeve cross-section rectangle perimeter equal to, or more than, 50 inches (1270 mm) and 1 or more sides equal to, or more than, 16 inches (400 mm), thickness shall be 0.138 inch (3.5 mm).

2.2 SLEEVE SEALS

A. Description: Modular sealing device, designed for field assembly, to fill annular space between sleeve and raceway or cable.

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

   a. Advance Products & Systems, Inc.
   b. Calpico, Inc.
   c. Metraflex Co.
   d. Pipeline Seal and Insulator, Inc.

2. Sealing Elements: EPDM interlocking links shaped to fit surface of cable or conduit. Include type and number required for material and size of raceway or cable.
3. Pressure Plates: Stainless steel. Include two for each sealing element.
4. Connecting Bolts and Nuts: Stainless steel of length required to secure pressure plates to sealing elements. Include one for each sealing element.

2.3 GROUT

A. See Section 03300, section 2.10 – GROUT, of the specifications.

3.0 EXECUTION

3.1 COMMON REQUIREMENTS FOR ELECTRICAL INSTALLATION

A. Comply with NECA 1 and NFPA-70.

B. Measure indicated mounting heights to bottom of unit for suspended items and to center of unit for wall-mounting items.

C. Headroom Maintenance: If mounting heights or other location criteria are not indicated, arrange and install components and equipment to provide maximum possible headroom consistent with these requirements.

D. Equipment: Install to facilitate service, maintenance, and repair or replacement of components of both electrical equipment and other nearby installations. Connect in such a way as to facilitate future disconnecting with minimum interference with other items in the vicinity.

E. Right of Way: Give to piping systems installed at a required slope.

3.2 SLEEVE INSTALLATION FOR ELECTRICAL PENETRATIONS

A. Electrical penetrations occur when raceways, penetrate concrete slabs, concrete or masonry walls, or fire-rated floor and wall assemblies.

B. Slabs and Walls: Install sleeves for penetrations unless core-drilled holes or formed openings are used. Install sleeves during erection of slabs and walls.

C. Use pipe sleeves unless penetration arrangement requires rectangular sleeved opening.

D. Fire-Rated Assemblies: Install sleeves for penetrations of fire-rated floor and wall assemblies unless openings compatible with firestop system used are fabricated during construction of floor or wall.

E. Cut sleeves to length for mounting flush with both surfaces of walls.

F. Size pipe sleeves to provide 1/4-inch (6.4-mm) annular clear space between sleeve and raceway or cable, unless indicated otherwise.

G. Seal space outside of sleeves with grout for penetrations of concrete and masonry

1. Promptly pack grout solidly between sleeve and wall so no voids remain. Tool exposed surfaces smooth; protect grout while curing.

H. Interior Penetrations of Non-Fire-Rated Walls and Floors: Seal annular space between sleeve and raceway or cable, using joint sealant appropriate for size, depth, and location of joint. Comply with requirements in other related divisions.

I. Fire-Rated-Assembly Penetrations: Maintain indicated fire rating of walls, partitions, ceilings, and floors at raceway and cable penetrations. Install sleeves and seal raceway and cable penetration sleeves with firestop materials.

J. Aboveground, Exterior-Wall Penetrations: Seal penetrations using steel pipe sleeves and mechanical sleeve seals. Select sleeve size to allow for 1-inch (25-mm) annular clear space between pipe and sleeve for installing mechanical sleeve seals.

3.3 SLEEVE-SEAL INSTALLATION

A. Install to seal exterior wall penetrations.

B. Use type and number of sealing elements recommended by manufacturer for raceway or cable material and size. Position raceway or cable in center of sleeve. Assemble mechanical sleeve seals and install in annular space between raceway or cable and sleeve. Tighten bolts against pressure plates that cause sealing elements to expand and make watertight seal.

3.4 FIRESTOPPING

A. Apply firestopping to penetrations of fire-rated floor and wall assemblies for electrical installations to restore original fire-resistance rating of assembly.

4.0 MEASUREMENT AND PAYMENT

A. The work under this Section shall not be measured for payment, but shall be paid as a lump sum under Bid.

END OF SECTION

SECTION 16060
GROUNDING AND BONDING

1.0 GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Special Provisions, apply to this Section.

1.2 SUMMARY

A. Section Includes: Grounding systems and equipment.

1.3 SUBMITTALS

A. Product Data: For each type of product indicated.

B. Informational Submittals: Plans showing dimensioned as-built locations of grounding features specified in "Field Quality Control" Article:

C. Qualification Data: For qualified testing agency and testing agency's field supervisor.

D. Field quality-control reports.

1.4 QUALITY ASSURANCE

A. Testing Agency Qualifications: Member company of NETA or an NRTL.

1. Testing Agency's Field Supervisor: Currently certified by NETA to supervise on-site testing.

B. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.

C. Comply with UL 467 for grounding and bonding materials and equipment.

2.0 PRODUCTS

2.1 CONDUCTORS

A. Insulated Conductors: Copper wire or cable insulated for 600 V unless otherwise required by applicable Code or authorities having jurisdiction.

B. Bare Copper Conductors:

1. Solid Conductors: ASTM B 3.
2. Stranded Conductors: ASTM B 8.
3. Bonding Cable: 28 kcmil, 14 strands of No. 17 AWG conductor, 1/4 inch in diameter.

4. Bonding Conductor: No. 4 or No. 6 AWG, stranded conductor.
5. Bonding Jumper: Copper tape, braided conductors terminated with copper ferrules; 1-5/8 inches wide and 1/16 inch thick.

C. Grounding Bus: Predrilled rectangular bars of annealed copper, 1/4 by 4 inches in cross section, with 9/32-inch holes spaced 1-1/8 inches apart.

2.2 CONNECTORS

A. Listed and labeled by an NRTL acceptable to authorities having jurisdiction for applications in which used and for specific types, sizes, and combinations of conductors and other items connected.

B. Bolted Connectors for Conductors and Pipes: Copper or copper alloy, pressure type with at least two bolts.

1. Pipe Connectors: Clamp type, sized for pipe.

C. Welded Connectors: Exothermic-welding kits of types recommended by kit manufacturer for materials being joined and installation conditions.

D. Bus-bar Connectors: Mechanical type, cast silicon bronze, solderless compression type wire terminals, and long-barrel, two-bolt connection to ground bus bar.

2.3 GROUNDING ELECTRODES

A. Ground Rods: Copper-clad 3/4 inch by 10 feet.

3.0 EXECUTION

3.1 APPLICATIONS

A. Conductors: Install solid conductor for No. 8 AWG and smaller, and stranded conductors for No. 6 AWG and larger unless otherwise indicated.

B. Conductor Terminations and Connections:

1. Pipe and Equipment Grounding Conductor Terminations: Bolted connectors.
2. Connections to Ground Rods at Test Wells: Bolted connectors.
3. Connections to Structural Steel: Welded connectors.

3.2 EQUIPMENT GROUNDING

A. Install insulated equipment grounding conductors with all feeders and branch circuits.

B. Install insulated equipment grounding conductors with the following items, in addition to those required by NFPA 70:

1. Feeders and branch circuits.
2. Receptacle circuits.

3. Single-phase motor and appliance branch circuits.
4. Three-phase motor and appliance branch circuits.

3.3 INSTALLATION

A. Grounding Conductors: Route along shortest and straightest paths possible unless otherwise indicated or required by Code. Avoid obstructing access or placing conductors where they may be subjected to strain, impact, or damage.

B. Ground Rods: Drive rods until tops are 2 inches below finished floor or final grade unless otherwise indicated.

1. Interconnect ground rods with grounding electrode conductor below grade and as otherwise indicated. Make connections without exposing steel or damaging coating if any.

C. Bonding Straps and Jumpers: Install in locations accessible for inspection and maintenance except where routed through short lengths of conduit.

1. Bonding to Structure: Bond straps directly to basic structure, taking care not to penetrate any adjacent parts.
2. Bonding to Equipment Mounted on Vibration Isolation Hangers and Supports: Install bonding so vibration is not transmitted to rigidly mounted equipment.
3. Use exothermic-welded connectors for outdoor locations; if a disconnect-type connection is required, use a bolted clamp.

3.4 LABELING

A. Comply with requirements in Division 16 Section "Identification for Electrical Systems" Article for instruction signs. The label or its text shall be green.

3.5 FIELD QUALITY CONTROL

A. Perform tests and inspections.

1. Manufacturer's Field Service: Engage a factory-authorized service representative to inspect components, assemblies, and equipment installations, including connections, and to assist in testing.

B. Tests and Inspections:

1. After installing equipment grounding but before permanent electrical circuits have been energized, test for compliance with requirements.
2. Inspect physical and mechanical condition. Verify tightness of accessible, bolted, electrical connections with a calibrated torque wrench according to manufacturer's written instructions.
3. Test completed entire grounding system including existing.

4. Prepare dimensioned Drawings locating each test well, ground rod and ground-rod assembly, and other grounding electrodes. Identify each by letter in alphabetical

order, and key to the record of tests and observations. Include the number of rods driven and their depth at each location, and include observations of weather and other phenomena that may affect test results. Describe measures taken to improve test results.

C. Grounding system will be considered defective if it does not pass tests and inspections.

D. Prepare test and inspection reports.

E. Report measured ground resistances that exceed the following values:

1. Power and Lighting Equipment or System with Capacity of 500 kVA and Less: 10 ohms.

F. Excessive Ground Resistance: If resistance to ground exceeds specified values, notify Engineer promptly and include recommendations to reduce ground resistance.

4.0 MEASUREMENT AND PAYMENT

A. The work under this Section shall not be measured for payment, but shall be paid as a lump sum under Bid

END OF SECTION

SECTION 16073
HANGERS AND SUPPORTS FOR ELECTRICAL SYSTEMS

1.0 GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Special Provisions, apply to this Section.

1.2 SUMMARY

A. This Section includes the following:

1. Hangers and supports for electrical equipment and systems.
2. Construction requirements for concrete bases.

B. Related Sections include the following:

1. Division 16 Section "Raceways and Boxes" for products and installation requirements.

1.3 DEFINITIONS

A. IMC: Intermediate metal conduit.

B. RMC: Rigid metal conduit.

1.4 PERFORMANCE REQUIREMENTS

A. Design supports for multiple raceways capable of supporting combined weight of supported systems and its contents.

B. Design equipment supports capable of supporting combined operating weight of supported equipment and connected systems and components.

C. Rated Strength: Adequate in tension, shear, and pullout force to resist maximum loads calculated or imposed for this Project, with a minimum structural safety factor of five times the applied force.

1.5 SUBMITTALS

A. Product Data: For the following:

1. Steel slotted support systems.
2. Nonmetallic slotted support systems.

B. Shop Drawings: Show fabrication and installation details and include calculations for the following:

1. Trapeze hangers. Include Product Data for components.

2. Steel slotted channel systems. Include Product Data for components.
3. Nonmetallic slotted channel systems. Include Product Data for components.
4. Equipment supports.

C. Welding certificates.

1.6 QUALITY ASSURANCE

A. Welding: Qualify procedures and personnel according to AWS D1.1/D1.1M, "Structural Welding Code - Steel."

B. Comply with NFPA

2.0 PRODUCTS

2.1 SUPPORT, ANCHORAGE, AND ATTACHMENT COMPONENTS

A. Steel Slotted Support Systems: Comply with MFMA-4, factory-fabricated components for field assembly.

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

   a. Allied Tube & Conduit.
   b. Cooper B-Line, Inc.; a division of Cooper Industries.
   c. ERICO International Corporation.
   d. GS Metals Corp.
   e. Thomas & Betts Corporation.
   f. Unistrut; Tyco International, Ltd.
   g. Wesanco, Inc.

2. Metallic Coatings: Hot-dip galvanized after fabrication and applied according to MFMA-4.
3. Nonmetallic Coatings: Manufacturer's standard PVC, polyurethane, or polyester coating applied according to MFMA-4.

4. Painted Coatings: Manufacturer's standard painted coating according to MFMA-4.
5. Channel Dimensions: Selected for applicable load criteria.

B. Nonmetallic Slotted Support Systems: Structural-grade, factory-formed, glass-fiber-resin channels and angles with 9/16-inch- (14-mm-) diameter holes at a maximum of 8 inches (200 mm) o.c., in at least 1 surface.

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

   a. Allied Tube & Conduit.
   b. Cooper B-Line, Inc.; a division of Cooper Industries.
   c. Fabco Plastics Wholesale Limited.
   d. Seasafe, Inc.

2. Fittings and Accessories: Products of channel and angle manufacturer and designed for use with those items.
3. Fitting and Accessory Materials: Same as channels and angles.
4. Rated Strength: Selected to suit applicable load criteria.

C. Raceway and Cable Supports: As described in NECA 1 and NECA 101.

D. Conduit and Cable Support Devices: Steel hangers, clamps, and associated fittings, designed for types and sizes of raceway or cable to be supported.

E. Support for Conductors in Vertical Conduit: Factory-fabricated assembly consisting of threaded body and insulating wedging plug or plugs for non-armored electrical conductors or cables in riser conduits. Plugs shall have number, size, and shape of conductor gripping pieces as required to suit individual conductors or cables supported. Body shall be malleable iron.

F. Structural Steel for Fabricated Supports and Restraints: ASTM A 36/A 36M, steel plates, shapes, and bars; black and galvanized.

G. Mounting, Anchoring, and Attachment Components: Items for fastening electrical items or their supports to building surfaces include the following:

1. Powder-Actuated Fasteners: Threaded-steel stud, for use in hardened portland cement concrete, steel, or wood, with tension, shear, and pullout capacities appropriate for supported loads and building materials where used.
   a. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

      1) Hilti Inc.
      2) ITW Ramset/Red Head; a division of Illinois Tool Works, Inc.
      3) MKT Fastening, LLC.
      4) Simpson Strong-Tie Co., Inc.; Masterset Fastening Systems Unit.

2. Mechanical-Expansion Anchors: Insert-wedge-type, stainless steel, for use in hardened portland cement concrete with tension, shear, and pullout capacities appropriate for supported loads and building materials in which used.
   a. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

      1) Cooper B-Line, Inc.; a division of Cooper Industries.
      2) Empire Tool and Manufacturing Co., Inc.
      3) Hilti Inc.
      4) ITW Ramset/Red Head; a division of Illinois Tool Works, Inc.
      5) MKT Fastening, LLC.

3. Concrete Inserts: Steel or malleable-iron, slotted support system units similar to MSS Type 18; complying with MFMA-4 or MSS SP-58.
4. Clamps for Attachment to Steel Structural Elements: MSS SP-58, type suitable for attached structural element.

5. Through Bolts: Structural type, hex head, and high strength. Comply with ASTM A 325.
6. Toggle Bolts: All-steel springhead type.
7. Hanger Rods: Threaded steel.

3.0 EXECUTION

3.1 APPLICATION

A. Comply with NECA 1 and NECA 101 for application of hangers and supports for electrical equipment and systems except if requirements in this Section are stricter.

B. Maximum Support Spacing and Minimum Hanger Rod Size for Raceway: Space supports for EMT, IMC, and RMC as scheduled in NECA 1, where its Table 1 lists maximum spacings less than stated in NFPA 70. Minimum rod size shall be 1/4 inch (6 mm) in diameter.

C. Spring-steel clamps designed for supporting single conduits without bolts may be used for 1-1/2-inch (38-mm) and smaller raceways serving branch circuits and communication systems above suspended ceilings and for fastening raceways to trapeze supports.

3.2 SUPPORT INSTALLATION

A. Comply with NECA 1 and NECA 101 for installation requirements except as specified in this Article.

B. Raceway Support Methods: In addition to methods described in NECA 1, EMT, IMC, and RMC may be supported by openings through structure members, as permitted in NFPA 70.

C. Strength of Support Assemblies: Where not indicated, select sizes of components so strength will be adequate to carry present and future static loads within specified loading limits. Minimum static design load used for strength determination shall be weight of supported components plus 200 lb (90 kg).

D. Mounting and Anchorage of Surface-Mounted Equipment and Components: Anchor and fasten electrical items and their supports to building structural elements by the following methods unless otherwise indicated by code:

1. To Wood: Fasten with lag screws or through bolts.
2. To New Concrete: Bolt to concrete inserts.
3. To Masonry: Approved toggle-type bolts on hollow masonry units and expansion anchor fasteners on solid masonry units.
4. To Existing Concrete: Expansion anchor fasteners.
5. Instead of expansion anchors, powder-actuated driven threaded studs provided with lock washers and nuts may be used in existing standard-weight concrete 4 inches (100 mm) thick or greater. Do not use for anchorage to lightweight-aggregate concrete or for slabs less than 4 inches (100 mm) thick.

6. To Steel: Beam clamps (MSS Type 19, 21, 23, 25, or 27) complying with MSS SP-69] [Spring-tension clamps.
7. To Light Steel: Sheet metal screws.
8. Items Mounted on Hollow Walls and Nonstructural Building Surfaces: Mount cabinets, panelboards, disconnect switches, control enclosures, pull and junction boxes, and other devices on slotted-channel racks attached to substrate.

E. Drill holes for expansion anchors in concrete at locations and to depths that avoid reinforcing bars.

3.3 PAINTING

A. Touchup: Clean field welds and abraded areas of shop paint. Paint exposed areas immediately after erecting hangers and supports. Use same materials as used for shop painting. Comply with SSPC-PA 1 requirements for touching up field-painted surfaces.

1. Apply paint by brush or spray to provide minimum dry film thickness of 2.0 mils.

B. Galvanized Surfaces: Clean welds, bolted connections, and abraded areas and apply galvanizing-repair paint to comply with ASTM A 780.

4.0 MEASUREMENT AND PAYMENT

The work under this Section shall not be measured for payment, but shall be paid as a lump sum under Bid.

END OF SECTION

SECTION 16075
ELECTRICAL IDENTIFICATION

1.0 GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Special Provisions, apply to this Section.

1.2 SUMMARY

A. Section Includes:

1. Identification for raceways.
2. Identification of power and control cables.
3. Identification for conductors.
4. Warning labels and signs.
5. Instruction signs.
6. Equipment identification labels.
7. Miscellaneous identification products.

1.3 SUBMITTALS

A. Product Data: For each electrical identification product indicated.

B. Samples: For each type of label and sign to illustrate size, colors, lettering style, mounting provisions, and graphic features of identification products.

C. Identification Schedule: An index of nomenclature of electrical equipment and system components used in identification signs and labels.

1.4 QUALITY ASSURANCE

A. Comply with ANSI A13.1

B. Comply with NFPA 70.

C. Comply with 29 CFR 1910.144 and 29 CFR 1910.145.

D. Comply with ANSI Z535.4 for safety signs and labels.

E. Adhesive-attached labeling materials, including label stocks, laminating adhesives, and inks used by label printers, shall comply with UL 969.

1.5 COORDINATION

A. Coordinate identification names, abbreviations, colors, and other features with requirements in other Sections requiring identification applications, Drawings, Shop Drawings, manufacturer's wiring diagrams, and with those required by codes, standards, and 29 CFR 1910.145. Use consistent designations throughout Project.

B. Coordinate installation of identifying devices with completion of covering and painting of surfaces where devices are to be applied.

C. Coordinate installation of identifying devices with location of access panels and doors.

D. Install identifying devices before installing acoustical ceilings and similar concealment.

2.0 PRODUCTS

2.1 POWER RACEWAY IDENTIFICATION MATERIALS

A. Comply with ANSI A13.1 for minimum size of letters for legend and for minimum length of color field for each raceway size.

B. Colors for Raceways Carrying Circuits at 600 V or Less:

1. Black letters on an orange field.
2. Legend: Indicate voltage.

C. Self-Adhesive Vinyl Labels for Raceways Carrying Circuits at 600 V or Less: Preprinted, flexible label laminated with a clear, weather- and chemical-resistant coating and matching wraparound adhesive tape for securing ends of legend label.

D. Snap-Around Labels for Raceways Carrying Circuits at 600 V or Less: Slit, pre tensioned, flexible, preprinted, color-coded acrylic sleeve, with diameter sized to suit diameter of raceway or cable it identifies and to stay in place by gripping action.

E. Snap-Around, Color-Coding Bands for Raceways Carrying Circuits at 600 V or Less: Slit, pre tensioned, flexible, solid-colored acrylic sleeve, 2 inches long, with diameter sized to suit diameter of raceway or cable it identifies and to stay in place by gripping action.

F. Metal Tags: Brass or aluminum, 2 by 2 by 0.05 inch, with stamped legend, punched for use with self-locking cable tie fastener.

G. Write-On Tags: Polyester tag, 0.010 inch thick, with corrosion-resistant grommet and cable tie for attachment to conductor or cable.

1. Marker for Tags: Permanent, waterproof, black ink marker recommended by tag manufacturer.
2. Marker for Tags: Machine-printed, permanent, waterproof, black ink marker recommended by printer manufacturer.

2.2 ARMORED AND METAL-CLAD CABLE IDENTIFICATION MATERIALS

A. Comply with ANSI A13.1 for minimum size of letters for legend and for minimum length of color field for each raceway and cable size.

B. Colors for Raceways Carrying Circuits at 600 V and Less:

1. Black letters on an orange field.
2. Legend: Indicate voltage.

C. Self-Adhesive Vinyl Labels: Preprinted, flexible label laminated with a clear, weather- and chemical-resistant coating and matching wraparound adhesive tape for securing ends of legend label.

D. Self-Adhesive Vinyl Tape: Colored, heavy duty, waterproof, fade resistant; 2 inches wide; compounded for outdoor use.

2.3 POWER AND CONTROL CABLE IDENTIFICATION MATERIALS

A. Comply with ANSI A13.1 for minimum size of letters for legend and for minimum length of color field for each raceway and cable size.

B. Self-Adhesive Vinyl Labels: Preprinted, flexible label laminated with a clear, weather- and chemical-resistant coating and matching wraparound adhesive tape for securing ends of legend label.

C. Metal Tags: Brass or aluminum, 2 by 2 by 0.05 inch, with stamped legend, punched for

D. Write-On Tags: Polyester tag, 0.010 inch thick, with corrosion-resistant grommet and cable tie for attachment to conductor or cable.

1. Marker for Tags: Permanent, waterproof, black ink marker recommended by tag manufacturer.
2. Marker for Tags: Machine-printed, permanent, waterproof, black ink marker recommended by printer manufacturer.

E. Snap-Around Labels: Slit, pre tensioned, flexible, preprinted, color-coded acrylic sleeve, with diameter sized to suit diameter of raceway or cable it identifies and to stay in place by gripping action.

F. Snap-Around, Color-Coding Bands: Slit, pre tensioned, flexible, solid-colored acrylic sleeve, 2 inches (50 mm) long, with diameter sized to suit diameter of raceway or cable it identifies and to stay in place by gripping action.

2.4 CONDUCTOR IDENTIFICATION MATERIALS

A. Color-Coding Conductor Tape: Colored, self-adhesive vinyl tape not less than 3 mils thick by 1 to 2 inches wide.

B. Self-Adhesive Vinyl Labels: Preprinted, flexible label laminated with a clear, weather- and chemical-resistant coating and matching wraparound adhesive tape for securing ends of legend label.

C. Snap-Around Labels: Slit, pre tensioned, flexible, preprinted, color-coded acrylic sleeve, with diameter sized to suit diameter of raceway or cable it identifies and to stay in place by gripping action.

D. Snap-Around, Color-Coding Bands: Slit, pre tensioned, flexible, solid-colored acrylic sleeve, 2 inches long, with diameter sized to suit diameter of raceway or cable it identifies and to stay in place by gripping action.

E. Marker Tapes: Vinyl or vinyl-cloth, self-adhesive wraparound type, with circuit identification legend machine printed by thermal transfer or equivalent process.

F. Write-On Tags: Polyester tag, 0.010 inch thick, with corrosion-resistant grommet and cable tie for attachment to conductor or cable.

1. Marker for Tags: Permanent, waterproof, black ink marker recommended by tag manufacturer.
2. Marker for Tags: Machine-printed, permanent, waterproof, black ink marker recommended by printer manufacturer.

2.5 WARNING LABELS AND SIGNS

A. Comply with NFPA 70 and 29 CFR 1910.145.

B. Self-Adhesive Warning Labels: Factory-printed, multicolor, pressure-sensitive adhesive labels, configured for display on front cover, door, or other access to equipment unless otherwise indicated.

C. Baked-Enamel Warning Signs:

1. Preprinted aluminum signs, punched or drilled for fasteners, with colors, legend, and size required for application.
2. 1/4-inch grommets in corners for mounting.
3. Nominal size, 7 by 10 inches.

D. Metal-Backed, Butyrate Warning Signs:

1. Weather-resistant, nonfading, preprinted, cellulose-acetate butyrate signs with 0.0396-inch galvanized-steel backing; and with colors, legend, and size required for application.
2. 1/4-inch grommets in corners for mounting.
3. Nominal size, 10 by 14 inches.

E. Warning label and sign shall include, but are not limited to, the following legends:

1. Workspace Clearance Warning: "WARNING - OSHA REGULATION - AREA IN FRONT OF ELECTRICAL EQUIPMENT MUST BE KEPT CLEAR FOR 36 INCHES."

2.6 INSTRUCTION SIGNS

A. Engraved, laminated acrylic or melamine plastic, minimum 1/16 inch thick for signs up to 20 sq. inches and 1/8 inch thick for larger sizes.

1. Engraved legend with black letters on white face.
2. Punched or drilled for mechanical fasteners.
3. Framed with mitered acrylic molding and arranged for attachment at applicable equipment.

B. Adhesive Film Label: Machine printed, in black, by thermal transfer or equivalent process. Minimum letter height shall be 3/8 inch.

C. Adhesive Film Label with Clear Protective Overlay: Machine printed, in black, by thermal transfer or equivalent process. Minimum letter height shall be 3/8 inch. Overlay shall provide a weatherproof and UV-resistant seal for label.

2.7 EQUIPMENT IDENTIFICATION LABELS

A. Adhesive Film Label: Machine printed, in black, by thermal transfer or equivalent process. Minimum letter height shall be 3/8 inch.

B. Adhesive Film Label with Clear Protective Overlay: Machine printed, in black, by thermal transfer or equivalent process. Minimum letter height shall be 3/8 inch. Overlay shall provide a weatherproof and UV-resistant seal for label.

C. Self-Adhesive, Engraved, Laminated Acrylic or Melamine Label: Adhesive backed, with white letters on a dark-gray background. Minimum letter height shall be 3/8 inch.

D. Engraved, Laminated Acrylic or Melamine Label: Punched or drilled for screw mounting. White letters on a dark-gray background. Minimum letter height shall be 3/8 inch.

E. Stenciled Legend: In nonfading, waterproof, black ink or paint. Minimum letter height shall be 1 inch.

F. Plenum-Rated Cable Ties: Self extinguishing, UV stabilized, one piece, self locking.

1. Minimum Width: 3/16 inch.
2. Tensile Strength at 73 degree F, According to ASTM D 638: 7000 psi.
3. UL 94 Flame Rating: 94V-0.
4. Temperature Range: Minus 50 to plus 284 degree F.
5. Color: Black.

2.8 MISCELLANEOUS IDENTIFICATION PRODUCTS

A. Paint: Select paint system applicable for surface material and location (exterior or interior).

B. Fasteners for Labels and Signs: Self-tapping, stainless-steel screws or stainless-steel machine screws with nuts and flat and lock washers.

3.0 - EXECUTION

3.1 INSTALLATION

A. Verify identity of each item before installing identification products.

B. Location: Install identification materials and devices at locations for most convenient viewing without interference with operation and maintenance of equipment.

C. Apply identification devices to surfaces that require finish after completing finish work.

D. Self-Adhesive Identification Products: Clean surfaces before application, using materials and methods recommended by manufacturer of identification device.

E. Attach signs and plastic labels that are not self-adhesive type with mechanical fasteners appropriate to the location and substrate.

F. System Identification Color-Coding Bands for Raceways and Cables: Each color-coding band shall completely encircle cable or conduit. Place adjacent bands of two-color markings in contact, side by side. Locate bands at changes in direction, at penetrations of walls and floors, at 50-foot maximum intervals in straight runs, and at 25-foot maximum intervals in congested areas.

G. Aluminum Wraparound Marker Labels and Metal Tags: Secure tight to surface of conductor or cable at a location with high visibility and accessibility.

H. Cable Ties: For attaching tags. Use general-purpose type, except as listed below:

1. Outdoors: UV-stabilized nylon.
2. In Spaces Handling Environmental Air: Plenum rated.

3.2 IDENTIFICATION SCHEDULE

A. Accessible Raceways and Metal-Clad Cables, 600 V or Less, for Service, Feeder, and Branch Circuits More Than 30 A, and 120 V to ground: Identify with self-adhesive vinyl label. Install labels at 30-foot maximum intervals.

B. Accessible Raceways and Cables within Buildings: Identify the covers of each junction and pull box of the following systems with self-adhesive vinyl labels with the wiring system legend and system voltage. System legends shall be as follows:

1. Emergency Power.
2. Power.
3. Control and signal circuits.
4. UPS.

C. Install instructional sign including the color-code for grounded and ungrounded conductors using adhesive-film-type labels.

D. Extended in the Future: Attach [write-on tags] [marker tape] to conductors and list source.

E. Workspace Indication: Install floor marking tape to show working clearances in the direction of access to live parts. Workspace shall be as required by NFPA 70 and 29 CFR 1926.403 unless otherwise indicated. Do not install at flush-mounted panelboards and similar equipment in finished spaces.

F. Operating Instruction Signs: Install instruction signs to facilitate proper operation and maintenance of electrical systems and items to which they connect. Install instruction signs with approved legend where instructions are needed for system or equipment operation.

G. Equipment Identification Labels: On each unit of equipment, install unique designation label that is consistent with wiring diagrams, schedules, and the Operation and Maintenance Manual. Apply labels to disconnect switches and protection equipment, central or master units, control panels, control stations, terminal cabinets, and racks of each system. Systems include power, lighting, control, communication, signal, monitoring, and alarm systems unless equipment is provided with its own identification.

1. Labeling Instructions:

a. Indoor Equipment: Adhesive film label Adhesive film label with clear protective overlay. Unless otherwise indicated, provide a single line of text with 1/2-inch-high letters on 1-1/2-inch-high label; where two lines of text are required, use labels 2 inches high.
b. Outdoor Equipment: Engraved, laminated acrylic or melamine label.

2. Equipment to Be Labeled:

a. Panelboards: Typewritten directory of circuits in the location provided by panelboard manufacturer. Panelboard identification shall be self-adhesive, engraved, laminated acrylic or melamine label.

4.0 MEASUREMENT AND PAYMENT

The work under this Section shall not be measured for payment, but shall be paid as a lump sum under Bid.

END OF SECTION

SECTION 16120
CONDUCTORS AND CABLES

1.0 GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Special Provisions, apply to this Section.

1.2 SUMMARY

A. This Section includes the following:

1. Building wires and cables rated 600 V and less.
2. Connectors, splices, and terminations rated 600 V and less.
3. Sleeves and sleeve seals for cables.

1.3 DEFINITIONS

A. EPDM: Ethylene-propylene-diene terpolymer rubber.

B. NBR: Acrylonitrile-butadiene rubber.

1.4 SUBMITTALS

A. Product Data: For each type of product indicated.

B. Field quality-control test reports.

1.5 QUALITY ASSURANCE

A. Testing Agency Qualifications: An independent agency, with the experience and capability to conduct the testing indicated, that is a member company of the InterNational Electrical Testing Association or is a nationally recognized testing laboratory (NRTL) as defined by OSHA in 29 CFR 1910.7, and that is acceptable to authorities having jurisdiction.

1. Testing Agency's Field Supervisor: Person currently certified by the International Electrical Testing Association or the National Institute for Certification in Engineering Technologies to supervise on-site testing specified in Part 3.

B. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, Article 100, by a testing agency acceptable to authorities having jurisdiction, and marked for intended use.

C. Comply with NFPA 70.

1.6 COORDINATION

A. Set sleeves in cast-in-place concrete, masonry walls, and other structural components as they are constructed.

2.0 PRODUCTS

2.1 CONDUCTORS AND CABLES

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

1. Alcan Products Corporation; Alcan Cable Division.
2. American Insulated Wire Corp.; a Leviton Company.
3. General Cable Corporation.
4. Senator Wire & Cable Company.
5. Southwire Company.

B. Copper Conductors: Comply with NEMA WC 70.

C. Conductor Insulation: Comply with NEMA WC 70 for Types THW THHN-THWN.

2.2 CONNECTORS AND SPLICES

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

1. AFC Cable Systems, Inc.
2. Hubbell Power Systems, Inc.
3. O-Z/Gedney; EGS Electrical Group LLC.
4. 3M; Electrical Products Division.
5. Tyco Electronics Corp.

B. Description: Factory-fabricated connectors and splices of size, ampacity rating, material, type, and class for application and service indicated.

2.3 SLEEVE SEALS

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

1. Advance Products & Systems, Inc.
2. Calpico, Inc.
3. Metraflex Co.
4. Pipeline Seal and Insulator, Inc.

B. Description: Modular sealing device, designed for field assembly, to fill annular space between sleeve and cable.

1. Sealing Elements: EPDM interlocking links shaped to fit surface of cable or conduit. Include type and number required for material and size of raceway or cable.
2. Pressure Plates: Stainless steel. Include two for each sealing element.
3. Connecting Bolts and Nuts: Stainless steel of length required to secure pressure plates to sealing elements. Include one for each sealing element.

3.0 EXECUTION

3.1 CONDUCTOR MATERIAL APPLICATIONS

A. Feeders: Copper Solid for No. 10 AWG and smaller; stranded for No. 8 AWG and larger.

B. Branch Circuits: Copper. Solid for No. 10 AWG and smaller; stranded for No. 8 AWG and larger.

3.2 CONDUCTOR INSULATION AND MULTICONDUCTOR CABLE APPLICATIONS AND WIRING METHODS

A. Exposed Feeders: Type THHN-THWN, single conductors in raceway, Armored cable, Type AC Metal-clad cable, Type MC.

B. Feeders Concealed in Ceilings, Walls, Partitions, and Crawlspaces: Type THHN-THWN, single conductors in raceway Armored cable, Type AC Metal-clad cable, Type MC.

C. Branch Circuits Concealed in Ceilings, Walls, and Partitions: Type THHN-THWN, single conductors in raceway Armored cable, Type AC Metal-clad cable, Type MC.

3.3 INSTALLATION OF CONDUCTORS AND CABLES

A. Conceal cables in finished ceilings, unless otherwise indicated.

B. Use manufacturer-approved pulling compound or lubricant where necessary; compound used must not deteriorate conductor or insulation. Do not exceed manufacturer's recommended maximum pulling tensions and sidewall pressure values.

C. Use pulling means including fish tape, cable, rope, and basket-weave wire/cable grips that will not damage cables or raceway.

D. Install exposed cables parallel and perpendicular to surfaces of exposed structural members, and follow surface contours where possible.

E. Support cables according to Division 16 Section "Hangers and Supports for Electrical Systems."

F. Identify and color-code conductors and cables according to Division 16 Section "Identification for Electrical Systems."

3.4 CONNECTIONS

A. Tighten electrical connectors and terminals according to manufacturer's published torque-tightening values. If manufacturer's torque values are not indicated, use those specified in UL 486A and UL 486B.

B. Make splices and taps that are compatible with conductor material and that possess equivalent or better mechanical strength and insulation ratings than unspliced conductors.

C. Wiring at Outlets: Install conductor at each outlet, with at least 6 inches of slack.

3.5 SLEEVE INSTALLATION FOR ELECTRICAL PENETRATIONS

A. Coordinate sleeve selection and application.

4.0 MEASUREMENT AND PAYMENT

The work under this Section shall not be measured for payment, but shall be paid as a lump sum under Bid Item No. C16-000-001.0.

END OF SECTION

SECTION 16123
CONTROL-VOLTAGE ELECTRICAL POWER CABLES

1.0 GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Special Provisions, apply to this Section.

1.2 SUMMARY

A. Section Includes:

1. UTP cabling.
2. RS-232 cabling.
3. RS-485 cabling.
4. Low-voltage control cabling.
5. Control-circuit conductors.
6. Identification products.

1.3 DEFINITIONS

A. EMI: Electromagnetic interference.

B. IDC: Insulation displacement connector.

C. Low Voltage: As defined in NFPA 70 for circuits and equipment operating at less than 50 V or for remote-control and signaling power-limited circuits.

D. Open Cabling: Passing telecommunications cabling through open space (e.g., between the studs of a wall cavity).

E. UTP: Unshielded twisted pair.

1.4 SUBMITTALS

A. Product Data: For each type of product indicated.

B. Shop Drawings: For pathway or cable layout, showing cable route to scale, with relationship between the pathway and adjacent structural, electrical, and mechanical elements. Include the following:

1. Vertical and horizontal offsets and transitions.
2. Clearances for access above and to side of pathway.
3. Vertical elevation of pathway or cable above the floor or bottom of ceiling structure.

C. Qualification Data: For qualified layout technician, installation supervisor, and

field inspector.

D. Source quality-control reports.

E. Field quality-control reports.

F. Maintenance Data: For wire and cable to include in maintenance manuals.

1.5 QUALITY ASSURANCE

A. Testing Agency Qualifications: Member company of an NRTL.

1. Testing Agency's Field Supervisor: Currently certified by BICSI as an RCDD to supervise on-site testing.

B. Surface-Burning Characteristics: As determined by testing identical products according to ASTM E 84 by a qualified testing agency. Identify products with appropriate markings of applicable testing agency.

1. Flame-Spread Index: 25 or less.
2. Smoke-Developed Index: 50 or less.

C. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.

1.6 DELIVERY, STORAGE, AND HANDLING

A. Test cables upon receipt at Project site.

1. Test each pair of UTP cable for open and short circuits.

2.0 PRODUCTS

2.1 PATHWAYS

A. Support of Open Cabling: NRTL labeled for support of Category 5e cabling, designed to prevent degradation of cable performance and pinch points that could damage cable.

1. Support brackets with cable tie slots for fastening cable ties to brackets.
2. Lacing bars, spools, J-hooks, and D-rings.
3. Straps and other devices.

B. Conduit and Boxes: Comply with requirements in Division 16 Section "Raceway and Boxes for Electrical Systems.

1. Outlet boxes shall be no smaller than 2 inches wide, 3 inches high, and 2-1/2 inches deep.

2.2 UTP CABLE

A. Manufacturers: Subject to compliance with requirements, provide products.

B. Description: 100-ohm, four-pair UTP, formed into 25-pair binder groups covered with a blue thermoplastic jacket.

1. Comply with ICEA S-90-661 for mechanical properties.
2. Comply with TIA/EIA-568-B.1 for performance specifications.
3. Comply with TIA/EIA-568-B.2, Category 6.
4. Listed and labeled by an NRTL acceptable to authorities having jurisdiction as complying with UL 444 and NFPA 70 for the following types:
a. Communications, General Purpose: Type CM or Type CMG.
b. Communications, Plenum Rated: Type CMP, complying with NFPA 262.

2.3 UTP CABLE HARDWARE

A. Manufacturers: Subject to compliance with requirements, provide products.

B. UTP Cable Connecting Hardware: IDC type, using modules designed for punch-down caps or tools. Cables shall be terminated with connecting hardware of the same category or higher.

C. Connecting Blocks: 110 style for Category 6. Provide blocks for the number of cables terminated on the block, plus 25 percent spare; integral with connector bodies, including plugs and jacks where indicated.

2.4 RS-232 CABLE

A. Standard Cable: NFPA 70, Type CM.

1. Paired, two pairs, No. 22 AWG, stranded (7x30) tinned-copper conductors.
2. Polypropylene insulation.
3. Individual aluminum foil-polyester tape shielded pairs with 100 percent shield coverage.
4. PVC jacket.
5. Pairs are cabled on common axis with No. 24 AWG, stranded (7x32) tinned-copper drain wire.
6. Flame Resistance: Comply with UL 1581.

B. Plenum-Rated Cable: NFPA 70, Type CMP.

1. Paired, two pairs, No. 22 AWG, stranded (7x30) tinned-copper conductors.
2. Plastic insulation.
3. Individual aluminum foil-polyester tape shielded pairs with 100 percent shield coverage.
4. Plastic jacket.
5. Pairs are cabled on common axis with No. 24 AWG, stranded (7x32) tinned-copper drain wire.
6. Flame Resistance: Comply with NFPA 262.

2.5 RS-485 CABLE

A. Standard Cable: NFPA 70, Type CM.

1. Paired, two pairs, twisted, No. 22 AWG, stranded (7x30) tinned-copper conductors.
2. PVC insulation.
3. Unshielded.
4. PVC jacket.
5. Flame Resistance: Comply with UL 1581.

B. Plenum-Rated Cable: NFPA 70, Type CMP.

1. Paired, two pairs, No. 22 AWG, stranded (7x30) tinned-copper conductors.
2. Fluorinated ethylene propylene insulation.
3. Unshielded.
4. Fluorinated ethylene propylene jacket.
5. Flame Resistance: NFPA 262, Flame Test.

2.6 LOW-VOLTAGE CONTROL CABLE

A. Multi-Conductor, single pair Cable: NFPA 70, Type CMG.

1. One pair, twisted, No. 18 AWG, stranded (16x30), TC tinned-copper conductors.
2. PE-Polyethylene insulation.
3. Shielded.
4. 20 AWG stranded TC drain wire.
5. PVC jacket.
6. Flame Test: Comply with UL 1685.

B. Plenum-Rated, Paired Cable: NFPA 70, Type CMP.

1. One pair, twisted, No. 18 AWG, stranded (16x30), TC tinned-copper conductors.
2. FEP-Fluorinated ethylene propylene insulation.
3. Shielded.
4. 20 AWG stranded TC drain wire.
5. FEP jacket.
6. Flame Test: NFPA 262, Flame Test.

C. Multi-Conductor, single pair Cable: NFPA 70, Type CMG.

1. Three conductors, No. 18 AWG, stranded (16x30), TC tinned-copper conductors.
2. PE-Polyethylene insulation.
3. Shielded.
4. 20 AWG stranded TC drain wire.
5. PVC jacket.
6. Flame Test: Comply with UL 1685.

D. Plenum-Rated, Paired Cable: NFPA 70, Type CMP.

1. Three conductors, No. 18 AWG, stranded (16x30), TC tinned-copper conductors.
2. FEP-Fluorinated ethylene propylene insulation.
3. Shielded.
4. 20 AWG stranded TC drain wire.
5. FEP jacket.
6. Flame Test: NFPA 262, Flame Test.

2.7 CONTROL-CIRCUIT CONDUCTORS

A. Class 1 Control Circuits: Stranded copper, Type THHN-THWN, in raceway, complying with UL 83.

B. Class 2 Control Circuits: Stranded copper, Type THHN-THWN, in raceway, complying with UL 83.

C. Class 3 Remote-Control and Signal Circuits: Stranded copper, Type TW or Type TF, complying with UL 83.

2.8 IDENTIFICATION PRODUCTS

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

1. Brady Corporation.
2. HellermannTyton.
3. Kroy LLC.
4. Panduit Corp.

B. Comply with UL 969 for a system of labeling materials, including label stocks, laminating adhesives, and inks used by label printers.

C. Comply with requirements in Division 16 Section "Identification for Electrical Systems."

2.9 SOURCE QUALITY CONTROL

A. Testing Agency: Engage a qualified testing agency to evaluate cables.

B. Factory test UTP and optical fiber cables on reels according to TIA/EIA-568-B.1.

C. Factory test UTP cables according to TIA/EIA-568-B.2.

D. Cable will be considered defective if it does not pass tests and inspections.

E. Prepare test and inspection reports.

3.0 EXECUTION

3.1 INSTALLATION OF PATHWAYS

A. Comply with TIA/EIA-569-A for pull-box sizing and length of conduit and number of bends between pull points.

B. Comply with requirements in Division 16 Section "Raceway and Boxes for Electrical Systems" for installation of conduits and wireways.

C. Install manufactured conduit sweeps and long-radius elbows if possible.

3.2 INSTALLATION OF CONDUCTORS AND CABLES

A. Comply with NECA 1.

B. General Requirements for Cabling:

1. Comply with TIA/EIA-568-B.1.
2. Comply with BICSI ITSIM, Ch. 6, "Cable Termination Practices."
3. Terminate all conductors; no cable shall contain unterminated elements. Make terminations only at indicated outlets, terminals, and cross-connect and patch panels.
4. Cables may not be spliced. Secure and support cables at intervals not exceeding 30 inches and not more than 6 inches from cabinets, boxes, fittings, outlets, racks, frames, and terminals.
5. Bundle, lace, and train conductors to terminal points without exceeding manufacturer's limitations on bending radii, but not less than radii specified in BICSI ITSIM, "Cabling Termination Practices" Chapter. Install lacing bars and distribution spools.
6. Do not install bruised, kinked, scored, deformed, or abraded cable. Do not splice cable between termination, tap, or junction points. Remove and discard cable if damaged during installation and replace it with new cable.
7. Cold-Weather Installation: Bring cable to room temperature before dereeling. Heat lamps shall not be used for heating.
8. Pulling Cable: Comply with BICSI ITSIM, Ch. 4, "Pulling Cable." Monitor cable pull tensions.

C. UTP Cable Installation:

1. Comply with TIA/EIA-568-B.2.
2. Install 110-style IDC termination hardware unless otherwise indicated.
3. Do not untwist UTP cables more than 1/2 inch from the point of termination to maintain cable geometry.

D. Installation of Control-Circuit Conductors:

1. Install wiring in raceways. Comply with requirements specified in Division 16 Section "Raceway and Boxes for Electrical Systems."

E. Open-Cable Installation:

1. Install cabling with horizontal and vertical cable guides in telecommunications spaces with terminating hardware and interconnection equipment.
2. Suspend copper cable not in a wireway or pathway a minimum of 8 inches above ceilings by cable supports not more than 60 inches apart.
3. Cable shall not be run through structural members or in contact with pipes, ducts, or other potentially damaging items.

F. Separation from EMI Sources:

1. Comply with BICSI TDMM and TIA/EIA-569-A recommendations for separating unshielded copper voice and data communication cable from potential EMI sources, including electrical power lines and equipment.

2. Separation between communications cables in grounded metallic raceways and unshielded power lines or electrical equipment shall be as follows:

a. Electrical Equipment Rating Less Than 2 kVA: A minimum of 2-1/2 inches.
b. Electrical Equipment Rating between 2 and 5 kVA: A minimum of 6 inches.
c. Electrical Equipment Rating More Than 5 kVA: A minimum of 12 inches.

3. Separation between communications cables in grounded metallic raceways and power lines and electrical equipment located in grounded metallic conduits or enclosures shall be as follows:

a. Electrical Equipment Rating Less Than 2 kVA: No requirement.
b. Electrical Equipment Rating between 2 and 5 kVA: A minimum of 3 inches.
c. Electrical Equipment Rating More Than 5 kVA: A minimum of 6 inches.

4. Separation between Cables and Electrical Motors and Transformers, 5 kVA or HP and Larger: A minimum of 48 inches.
5. Separation between Cables and Fluorescent Fixtures: A minimum of 5 inches.

3.3 REMOVAL OF CONDUCTORS AND CABLES

A. Remove abandoned conductors and cables.

3.4 CONTROL-CIRCUIT CONDUCTORS

A. Minimum Conductor Sizes:

1. Class 1 remote-control and signal circuits, No 14 AWG.
2. Class 2 low-energy, remote-control, and signal circuits, No. 18 AWG.
3. Class 3 low-energy, remote-control, alarm, and signal circuits, No 12 AWG.

3.5 GROUNDING

A. For data communication wiring, comply with ANSI-J-STD-607-A and with BICSI TDMM, "Grounding, Bonding, and Electrical Protection" Chapter.

B. For low-voltage wiring and cabling, comply with requirements in Division 16 Section "Grounding and Bonding for Electrical Systems."

3.6 IDENTIFICATION

A. Identify system components, wiring, and cabling according to TIA/EIA-606-A. Comply with requirements for identification specified in Division 16 Section "Identification for Electrical Systems."

3.7 FIELD QUALITY CONTROL

A. Perform tests and inspections.

B. Tests and Inspections:

1. Visually inspect UTP cable jacket materials for UL or third-party certification markings. Inspect cabling terminations to confirm color-coding for pin assignments, and inspect cabling connections to confirm compliance with TIA/EIA-568-B.1.
2. Visually inspect cable placement, cable termination, grounding and bonding, equipment and patch cords, and labeling of all components.
3. Test UTP cabling for DC loop resistance, shorts, opens, intermittent faults, and polarity between conductors. Test operation of shorting bars in connection blocks. Test cables after termination but not after cross connection.

a. Test instruments shall meet or exceed applicable requirements in TIA/EIA-568-B.2. Perform tests with a tester that complies with performance requirements in "Test Instruments (Normative)" Annex, complying with measurement accuracy specified in "Measurement Accuracy (Informative)" Annex. Use only test cords and adapters that are qualified by test equipment manufacturer for channel or link test configuration.

C. Document data for each measurement. Print data for submittals in a summary report that is formatted using Table 10.1 in BICSI TDMM as a guide, or transfer the data from the instrument to the computer, save as text files, print, and submit.

D. End-to-end cabling will be considered defective if it does not pass tests and inspections.

E. Prepare test and inspection reports.

4.0 MEASUREMENT AND PAYMENT

The work under this Section shall not be measured for payment, but shall be paid as a lump sum under Bid.

END OF SECTION

SECTION 16130
RACEWAY AND BOXES

1.0 GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Special Provisions, apply to this Section.

1.2 SUMMARY

A. This Section includes raceways, fittings, boxes, enclosures, and cabinets for electrical wiring.

1.3 DEFINITIONS

A. EPDM: Ethylene-propylene-diene terpolymer rubber.

B. FMC: Flexible metal conduit.

C. IMC: Intermediate metal conduit.

D. LFMC: Liquidtight flexible metal conduit.

E. NBR: Acrylonitrile-butadiene rubber.

1.4 SUBMITTALS

A. Product Data: For surface raceways, wireways and fittings, boxes, hinged-cover enclosures, and cabinets.

B. Shop Drawings: For the following raceway components. Include plans, elevations, sections, details, and attachments to other work.

C. Coordination Drawings: Conduit routing plans, drawn to scale, on which the following items are shown and coordinated with each other, based on input from installers of the items involved:

1. Structural members in the paths of conduit groups with common supports.
2. HVAC and plumbing items and architectural features in the paths of conduit groups with common supports.

D. Qualification Data: For professional engineer and testing agency.

E. Source quality-control test reports.

1.5 QUALITY ASSURANCE

A. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, Article 100, by a testing agency acceptable to authorities having jurisdiction, and marked for intended use.

B. Comply with NFPA

2.0 PRODUCTS

2.1 METAL CONDUIT AND TUBING

A. Manufacturers: Subject to compliance with requirements, provide products.

B. Rigid Steel Conduit: ANSI C80.1.

C. Fittings for Conduit (Including all Types and Flexible and Liquidtight), and Cable: NEMA FB 1; listed for type and size raceway with which used, and for application and environment in which installed.

D. Joint Compound for Rigid Steel Conduit or IMC: Listed for use in cable connector assemblies, and compounded for use to lubricate and protect threaded raceway joints from corrosion and enhance their conductivity.

2.2 BOXES, ENCLOSURES, AND CABINETS

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

1. Cooper Crouse-Hinds; Div. of Cooper Industries, Inc.
2. EGS/Appleton Electric.
3. Erickson Electrical Equipment Company.
4. Hoffman.
5. Hubbell Incorporated; Killark Electric Manufacturing Co. Division.
6. O-Z/Gedney; a unit of General Signal.
7. RACO; a Hubbell Company.
8. Robroy Industries, Inc.; Enclosure Division.

B. Sheet Metal Outlet and Device Boxes: NEMA OS 1.

C. Cast-Metal Outlet and Device Boxes: NEMA FB 1, ferrous alloy Type FD, with gasketed cover.

D. Cast-Metal Access, Pull, and Junction Boxes: NEMA FB 1, galvanized cast iron with gasketed cover.

E. Hinged-Cover Enclosures: NEMA 250, Type 1, with continuous-hinge cover with flush latch, unless otherwise indicated.

1. Metal Enclosures: Steel, finished inside and out with manufacturer's standard enamel.

2.3 SLEEVES FOR RACEWAYS

A. Steel Pipe Sleeves: ASTM A 53/A 53M, Type E, Grade B, Schedule 40, galvanized steel, plain ends.

B. Cast-Iron Pipe Sleeves: Cast or fabricated "wall pipe," equivalent to ductile-iron pressure pipe, with plain ends and integral waterstop, unless otherwise indicated.

C. Sleeves for Rectangular Openings: Galvanized sheet steel with minimum 0.052-or 0.138-inch thickness as indicated and of length to suit application.

D. Coordinate sleeve selection and application with selection and application of firestopping.

2.4 SLEEVE SEALS

A. Manufacturers: Subject to compliance with requirements, provide products.

B. Description: Modular sealing device, designed for field assembly, to fill annular space between sleeve and cable.

1. Sealing Elements: EPDM interlocking links shaped to fit surface of cable or conduit. Include type and number required for material and size of raceway or cable.
2. Pressure Plates: Stainless steel. Include two for each sealing element.
3. Connecting Bolts and Nuts: Stainless steel of length required to secure pressure plates to sealing elements. Include one for each sealing element.

3.0 EXECUTION

3.1 RACEWAY APPLICATION

A. Outdoors: Apply raceway products as specified below, unless otherwise indicated:

1. Exposed Conduit: Rigid steel conduit.
2. Concealed Conduit, Aboveground: Rigid steel conduit.
3. Connection to Vibrating Equipment LFMC.
4. Boxes, Aboveground: NEMA 250, Type 3R 4.

B. Comply with the following indoor applications, unless otherwise indicated:

1. Exposed, Not Subject to Physical Damage: RNC.
2. Exposed and Subject to Severe Physical Damage: Rigid steel conduit. Includes raceways in the following locations:

a. Fueling Bay
b. Corridors used for traffic of mechanized carts, forklifts, and pallet-handling units.
c. Mechanical rooms.

3. Concealed in Ceilings and Interior Walls and Partitions: Rigid steel conduit
4. Connection to Vibrating Equipment: FMC, except use LFMC in damp or wet locations.
5. Damp or Wet Locations: Rigid steel conduit.
6. Boxes: NEMA 250, Type 1, except use NEMA 250, Type 4, stainless steel in damp or wet locations.

C. Minimum Raceway Size: 3/4-inch trade size.

D. Raceway Fittings: Compatible with raceways and suitable for use and location.

1. Rigid and Intermediate Steel Conduit: Use threaded rigid steel conduit fittings, unless otherwise indicated.

E. Do not install aluminum conduits.

3.2 INSTALLATION

A. Comply with NECA 1 for installation requirements applicable to products specified in Part 2 except where requirements on Drawings or in this Article are stricter.

B. Keep raceways at least 6 inches away from parallel runs of flues and steam or hot-water pipes. Install horizontal raceway runs above water and steam piping.

C. Complete raceway installation before starting conductor installation.

D. Support raceways as specified in Division 16 Section "Hangers and Supports for Electrical Systems."

E. Arrange stub-ups so curved portions of bends are not visible above the finished slab.

F. Install no more than the equivalent of three 90-degree bends in any conduit run except for communications conduits, for which fewer bends are allowed.

G. Conceal conduit and EMT within finished walls, ceilings, and floors, unless otherwise indicated.

H. Threaded Conduit Joints, Exposed to Wet, Damp, Corrosive, or Outdoor Conditions: Apply listed compound to threads of raceway and fittings before making up joints. Follow compound manufacturer's written instructions.

I. Raceway Terminations at Locations Subject to Moisture or Vibration: Use insulating bushings to protect conductors, including conductors smaller than No. 4 AWG.

J. Install pull wires in empty raceways. Use polypropylene or monofilament plastic line with not less than 200-lb tensile strength. Leave at least 12 inches of slack at each end of pull wire.

K. Install raceway sealing fittings at suitable, approved, and accessible locations and fill them with listed sealing compound. For concealed raceways, install each fitting in a

flush steel box with a blank cover plate having a finish similar to that of adjacent plates or surfaces. Install raceway sealing fittings at the following points:

1. Where conduits pass from warm to cold locations, such as boundaries of refrigerated spaces.

L. Expansion-Joint Fittings for RNC: Install in each run of aboveground conduit that is located where environmental temperature change may exceed 30 degree F , and that has straight-run length that exceeds 25 feet.

1. Install expansion-joint fittings for each of the following locations, and provide type and quantity of fittings that accommodate temperature change listed for location:

   a. Outdoor Locations Not Exposed to Direct Sunlight: 125 degree F temperature change.
   b. Outdoor Locations Exposed to Direct Sunlight: 155 degree F temperature change.
   c. Indoor Spaces: Connected with the Outdoors without Physical Separation: 125 degree F temperature change.

2. Install fitting(s) that provide expansion and contraction for at least 0.00041 inch per foot of length of straight run per degree F of temperature change.
3. Install each expansion-joint fitting with position, mounting, and piston setting selected according to manufacturer's written instructions for conditions at specific location at the time of installation.

M. Flexible Conduit Connections: Use maximum of 72 inches of flexible conduit for recessed and semi recessed lighting fixtures, equipment subject to vibration, noise transmission, or movement; and for motors.

1. Use LFMC in damp or wet locations subject to severe physical damage.
2. Use LFMC or LFNC in damp or wet locations not subject to severe physical damage.

3.3 SLEEVE INSTALLATION FOR ELECTRICAL PENETRATIONS

A. Coordinate sleeve selection and application with selection and application of firestopping are as indicated on the Contract Drawings.

3.4 FIRESTOPPING

A. Apply firestopping to electrical penetrations of fire-rated floor and wall assemblies to restore original fire-resistance rating of assembly. Firestopping materials and installation requirements are as indicated on the Contract Drawings.

3.5 PROTECTION

A. Provide final protection and maintain conditions that ensure coatings, finishes, without damage or deterioration at time of Substantial Completion.

1. Repair damage to galvanized finishes with zinc-rich paint recommended by manufacturer.

4.0 MEASUREMENT AND PAYMENT

The work under this Section shall not be measured for payment, but shall be paid as a lump sum under Bid.

END OF SECTION

SECTION 16138
UNDERGROUND RACEWAYS FOR ELECTRICAL SYSTEMS

1.0 GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Special Provisions, apply to this Section.

1.2 SUMMARY

A. Section Includes:

1. Conduit, ducts, and duct accessories for concrete-encased duct banks.
2. Handholes and pull boxes.

1.3 DEFINITION

A. RNC: Rigid nonmetallic conduit.

B. PVC: Polyvinyl chloride

1.4 SUBMITTALS

A. Product Data: For the following:

1. Duct-bank materials, including separators and miscellaneous components.
2. Ducts and conduits and their accessories, including elbows, end bells, bends, fittings, and solvent cement.
3. Accessories for handholes, pull boxes.
4. Warning tape.
5. Warning planks.

B. Duct-Bank Coordination Drawings: Show duct profiles and coordination with other utilities and underground structures.

1. Include plans and sections, drawn to scale, and show bends and locations of expansion fittings.
2. Drawings shall be signed and sealed by a qualified professional engineer.

C. Qualification Data: For qualified professional engineer and testing agency.

D. Source quality-control reports.

E. Field quality-control reports.

1.5 QUALITY ASSURANCE

A. Comply with IEEE C2.

B. Comply with NFPA 70.

1.6 PROJECT CONDITIONS

A. Interruption of Existing Electrical Service: Do not interrupt electrical service to facilities occupied by The University of Kentucky or others unless permitted under the following conditions and then only after arranging to provide temporary electrical service according to requirements indicated:

1. Notify the University of Kentucky no fewer than two days in advance of proposed interruption of electrical service.
2. Do not proceed with interruption of electrical service without the University of Kentucky's written permission.

1.7 COORDINATION

A. Coordinate layout and installation of ducts, manhole, and pull boxes with final arrangement of other utilities, site grading, and surface features as determined in the field.

B. Coordinate elevations of ducts and duct-bank entrances into manhole, and pull boxes with final locations and profiles of ducts and duct banks as determined by coordination with other utilities, underground obstructions, and surface features. Revise locations and elevations from those indicated as required to suit field conditions and to ensure that duct runs drain to manholes, and as approved by the University of Kentucky.

2.0 PRODUCTS

2.1 CONDUIT

A. Rigid Steel Conduit: Galvanized. Comply with ANSI C80.1.

B. RNC: NEMA TC 2, Type EPC-80-PVC, UL 651, with matching fittings by same manufacturer as the conduit, complying with NEMA TC 3 and UL 514B.

2.2 HANDHOLES AND PULL BOXES OTHER THAN PRECAST CONCRETE

A. Description: Comply with SCTE 77.

1. Color: Gray.
2. Configuration: Units shall be designed for flush burial and have integral closed bottom unless otherwise indicated.
3. Cover: Weatherproof, secured by tamper-resistant locking devices and having structural load rating consistent with enclosure.
4. Cover Finish: Nonskid finish shall have a minimum coefficient of friction of 0.50.
5. Cover Legend: Molded lettering,

a. "ELECTRIC."

b. Tier level number, indicating that the unit complies with the structural load test for that tier according to SCTE 77.

6. Duct Entrance Provisions: Duct-terminating fittings shall mate with entering ducts for secure, fixed installation in enclosure wall.

2.3 CAST-IN-PLACE HANDHOLES

A. Description: Underground utility structures, constructed in place, complete with accessories, hardware, and features. Include concrete knockout panels for conduit entrance and sleeve for ground rod.

B. Materials: Comply with ASTM C 858 and with Division 03 Section "Cast-in-Place Concrete."

1. Concrete shall have a minimum compressive strength of 3000 psi.

2.4 UTILITY STRUCTURE ACCESSORIES

A. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work.

B. Ferrous metal hardware, where indicated, shall be hot-dip galvanized complying with ASTM A 153 (A 153M) and A 123 (A 123M).

C. Manhole Frames, Covers, and Chimney Components: Comply with structural design loading specified for manhole.

1. Frame and Cover: Weatherproof, cast aluminum with milled cover-to-frame bearing surfaces; (2) 30 inches x 30 inches.

a. Cover Finish: Nonskid finish shall have a minimum coefficient of friction of 0.50.

b. Special Covers: Recess in face of cover designed to accept finish material in paved areas.

2. Cover Legend: Cast in. Retained to suit system.

a. Legend: "ELECTRIC-LV" for duct systems with power wires and cables for systems operating at 600 V and less.

b. Legend: "ELECTRIC-HV" for duct systems with medium-voltage cables.

D. Bolting Inserts for Concrete Utility Structure Cable Racks and Other Attachments: Flared, threaded inserts of noncorrosive, chemical-resistant, nonconductive thermoplastic material; 1/2-inch ID by 2-3/4 inches deep, flared to 1-1/4 inches minimum at base.

1. Tested Ultimate Pullout Strength: 12,000 lbf minimum.

E. Expansion Anchors for Installation after Concrete Is Cast: Zinc-plated, carbon-steel-wedge type with stainless-steel expander clip with 1/2-inch bolt, 5300-lbf

rated pullout strength, and minimum 6800-lbf rated shear strength.

F. Duct-Sealing Compound: Nonhardening, safe for contact with human skin, not deleterious to cable insulation, and workable at temperatures as low as 35 degrees F. Capable of withstanding temperature of 300 degrees F without slump and adhering to clean surfaces of plastic ducts, metallic conduits, conduit coatings, concrete, masonry, lead, cable sheaths, cable jackets, insulation materials, and common metals.

3.0 EXECUTION

3.1 CORROSION PROTECTION

A. Aluminum shall not be installed in contact with earth or concrete.

3.2 UNDERGROUND DUCT APPLICATION

A. Ducts for Electrical Cables over 600 V: RNC, NEMA Type EPC-80 in concrete-encased duct bank unless otherwise indicated.

B. Ducts for Electrical Feeders 600 V and Less: RNC, NEMA Type EPC-80 in concrete-encased duct bank unless otherwise indicated.

3.3 EARTHWORK

A. Excavation and Backfill: Comply with Section 02200 - Earth Work, but do not use heavy-duty, hydraulic-operated, compaction equipment.

B. Restore areas disturbed by trenching, storing of dirt, cable laying, and other work. Restore vegetation and include necessary topsoiling, fertilizing, liming, seeding, sodding, sprigging, and mulching.

C. Cut and patch existing pavement in the path of underground ducts and utility structures according to General Provisions for Construction.

3.4 DUCT INSTALLATION

A. Slope: Pitch ducts a minimum slope of 1:300 down toward manholes and handholes and away from buildings and equipment. Slope ducts from a high point in runs between two manholes to drain in both directions.

B. Joints: Use solvent-cemented joints in ducts and fittings and make watertight according to manufacturer's written instructions. Stagger couplings so those of adjacent ducts do not lie in same plane.

C. Sealing: Provide temporary closure at terminations of ducts that have cables pulled. Seal spare ducts at terminations. Use sealing compound and plugs to withstand at least 15-psig hydrostatic pressure.

D. Pulling Cord: Install 100-lbf test nylon cord in ducts, including spares.

E. Concrete-Encased Ducts: Support ducts on duct separators.

1. Separator Installation: Space separators close enough to prevent sagging and deforming of ducts, with not less than 4 spacers per 20 feet of duct. Secure separators to earth and to ducts to prevent floating during concreting. Stagger separators approximately 6 inches between tiers. Tie entire assembly together using fabric straps; do not use tie wires or reinforcing steel that may form conductive or magnetic loops around ducts or duct groups.
2. Concreting Sequence: Pour each run of envelope between manholes or other terminations in one continuous operation.

    a. Start at one end and finish at the other, allowing for expansion and contraction of ducts as their temperature changes during and after the pour. Use expansion fittings installed according to manufacturer's written recommendations, or use other specific measures to prevent expansion-contraction damage.
    b. If more than one pour is necessary, terminate each pour in a vertical plane and install 3/4-inch reinforcing rod dowels extending 18 inches into concrete on both sides of joint near corners of envelope.

3. Pouring Concrete: Spade concrete carefully during pours to prevent voids under and between conduits and at exterior surface of envelope. Do not allow a heavy mass of concrete to fall directly onto ducts. Use a plank to direct concrete down sides of bank assembly to trench bottom. Allow concrete to flow to center of bank and rise up in middle, uniformly filling all open spaces. Do not use power-driven agitating equipment unless specifically designed for duct-bank application.
4. Reinforcement: Reinforce concrete-encased duct banks where they cross disturbed earth and where indicated. Arrange reinforcing rods and ties without forming conductive or magnetic loops around ducts or duct groups.
5. Forms: Use walls of trench to form side walls of duct bank where soil is self-supporting and concrete envelope can be poured without soil inclusions; otherwise, use forms.
6. Minimum Space between Ducts: 3 inches between ducts and exterior envelope wall, 2 inches between ducts for like services, and 4 inches between power and signal ducts.
7. Depth: Install top of duct bank at least 24 inches below finished grade in areas not subject to deliberate traffic, and at least 30 inches below finished grade in deliberate traffic paths for vehicles unless otherwise indicated.
8. Stub-Ups: Use manufactured rigid steel conduit elbows for stub-ups at equipment and at building entrances through the floor.

    a. Couple steel conduits to ducts with adapters designed for this purpose, and encase coupling with 3 inches of concrete.
    b. Stub-Ups to Equipment: For equipment mounted on outdoor concrete bases, extend steel conduit horizontally a minimum of 60 inches from edge of base. Install insulated grounding bushings on terminations at equipment.

9. Warning Tape: Bury warning tape approximately 12 inches above all concrete-encased ducts and duct banks. Align tape parallel to and within 3 inches of the centerline of duct bank. Provide an additional warning tape for each 12-inch

increment of duct-bank width over a nominal 18 inches. Space additional tapes 12 inches apart, horizontally.

3.5 INSTALLATION OF HANDHOLES AND PULL BOXES OTHER THAN PRECAST CONCRETE

A. Install handholes and pull boxes level and plumb and with orientation and depth coordinated with connecting ducts to minimize bends and deflections required for proper entrances. Use pull box extension if required to match depths of ducts, and seal joint between box and extension as recommended by the manufacturer.

B. Unless otherwise indicated, support units on a level 6-inch- thick bed of crushed stone or gravel, graded from 1/2-inch sieve to No. 4 sieve and compacted to same density as adjacent undisturbed earth.

C. Elevation: Set so cover surface will be flush with finished grade.

D. Install removable hardware, including pulling eyes, cable stanchions, cable arms, and insulators, as required for installation and support of cables and conductors and as indicated. Retain arm lengths to be long enough to provide spare space for future cables, but short enough to preserve adequate working clearances in the enclosure.

E. Field-cut openings for ducts and conduits according to enclosure manufacturer's written instructions. Cut wall of enclosure with a tool designed for material to be cut. Size holes for terminating fittings to be used, and seal around penetrations after fittings are installed.

3.6 GROUNDING

A. Ground underground ducts and utility structures according to Division 16 Section "Grounding and Bonding."

3.7 FIELD QUALITY CONTROL

A. Perform the following tests and inspections:

1. Demonstrate capability and compliance with requirements on completion of installation of underground ducts and utility structures.

2. Pull aluminum or wood test mandrel through duct to prove joint integrity and test for out-of-round duct. Provide mandrel equal to 80 percent fill of duct. If obstructions are indicated, remove obstructions and retest.

3. Test handhole grounding to ensure electrical continuity of grounding and bonding connections. Measure and report ground resistance as specified in Division 16 Section "Grounding and Bonding."

B. Correct deficiencies and retest as specified above to demonstrate compliance.

C. Prepare test and inspection reports.

3.8 CLEANING

A. Pull leather-washer-type duct cleaner, with graduated washer sizes, through full length of ducts. Follow with rubber duct swab for final cleaning and to assist in spreading lubricant throughout ducts.

B. Clean internal surfaces of handhole. Remove foreign material.

4.0 MEASUREMENT AND PAYMENT

The work under this Section shall not be measured for payment, but shall be paid as a lump sum under Bid.

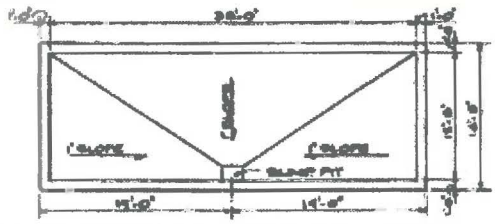
END OF SECTION

Attachment A
Current 30,000 Gallon Concrete Oil Storage Tank Drawings

Attachment B
Tank Upgrade Drawings

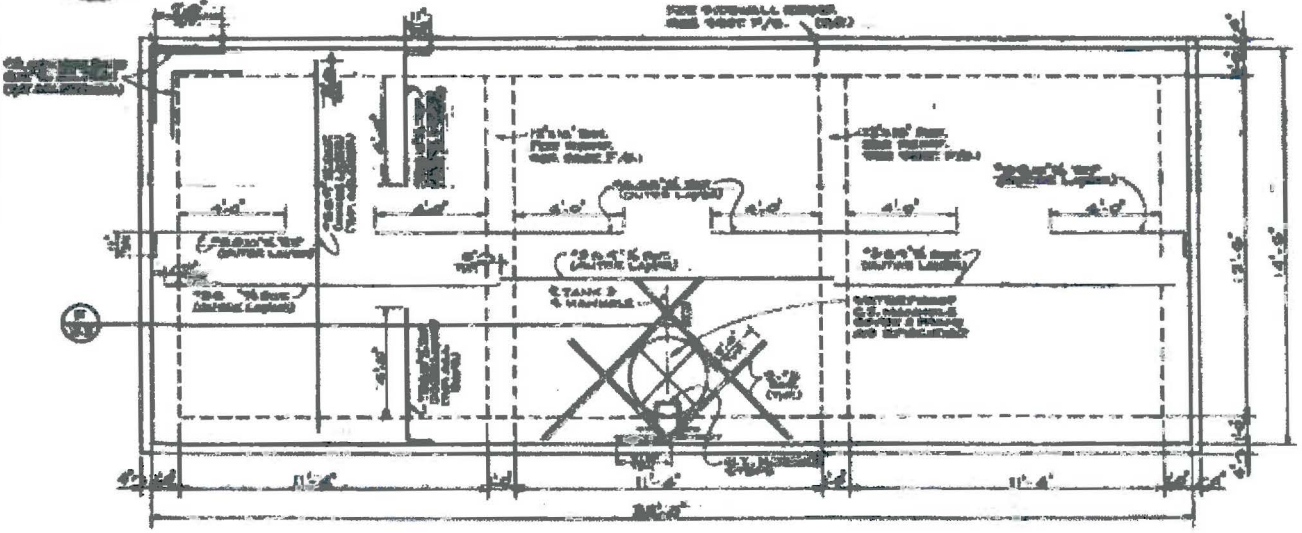
Attachment A
Current 30,000 Gallon Concrete Oil Storage Tank Drawings

DETAIL P/S-5

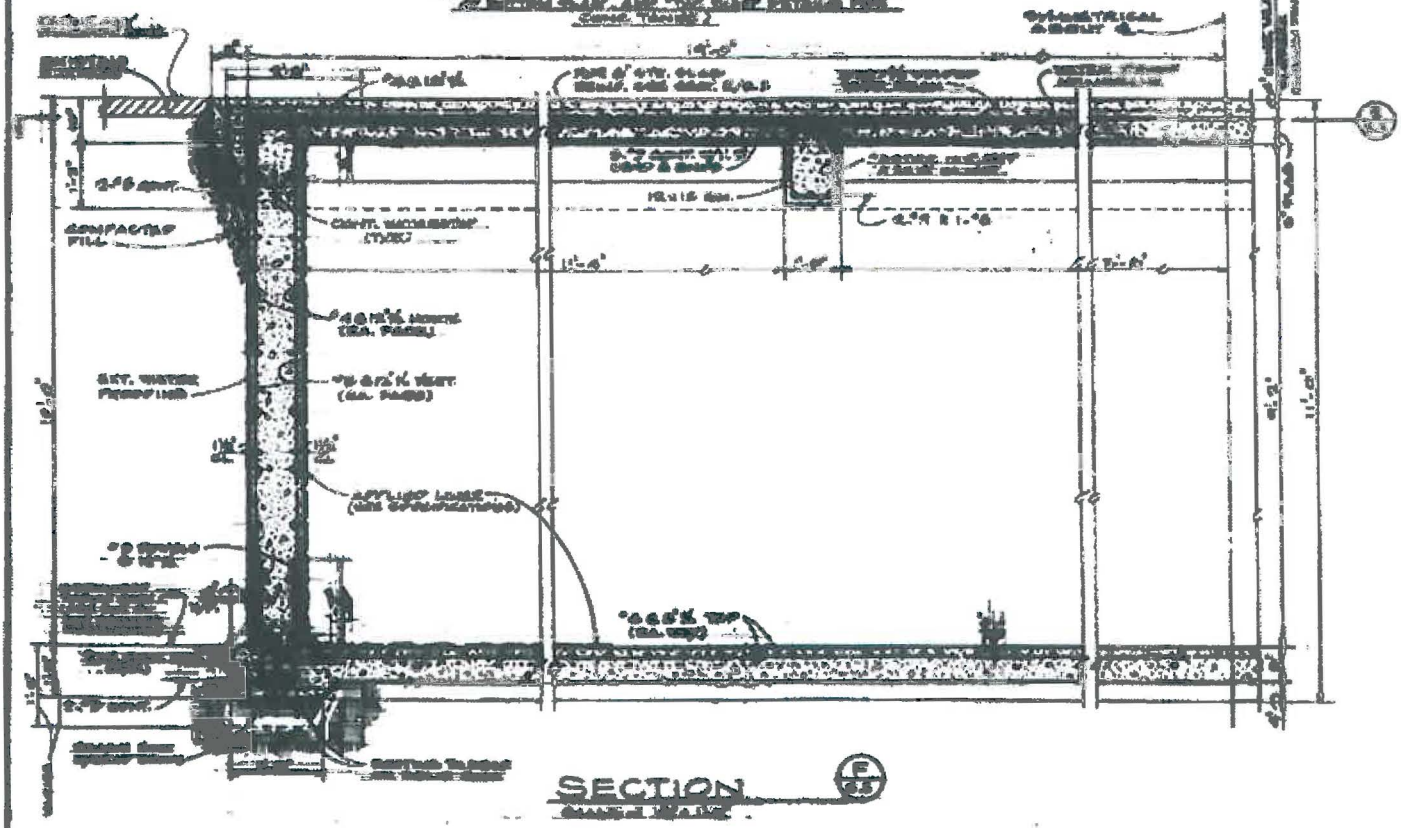


NORTH

PLAN SHOWING SLOPES OF BOTTOM SLAB

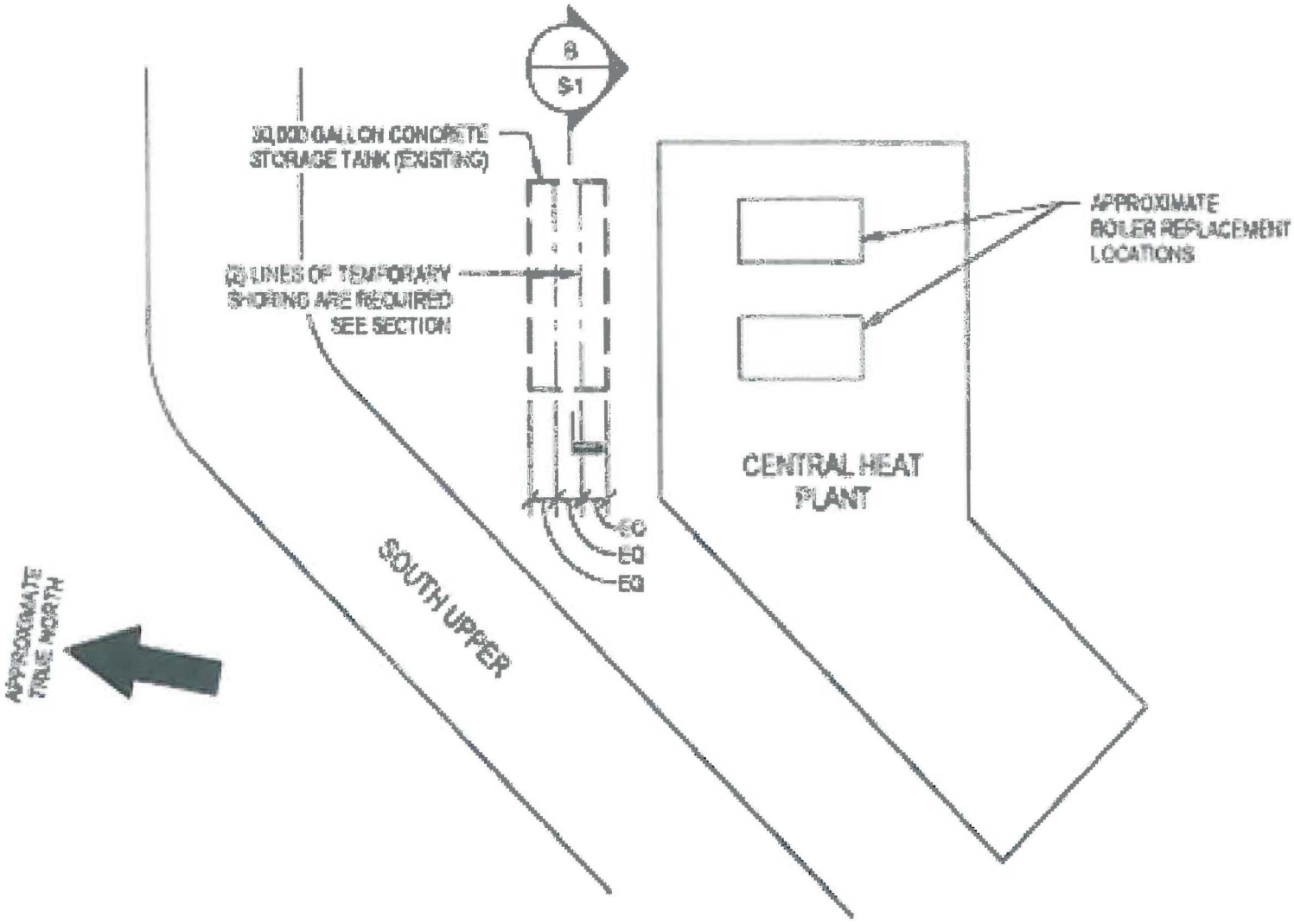


(PLAN) SECTION



SECTION

30,000 GALLON CONCRETE OIL STORAGE TANK

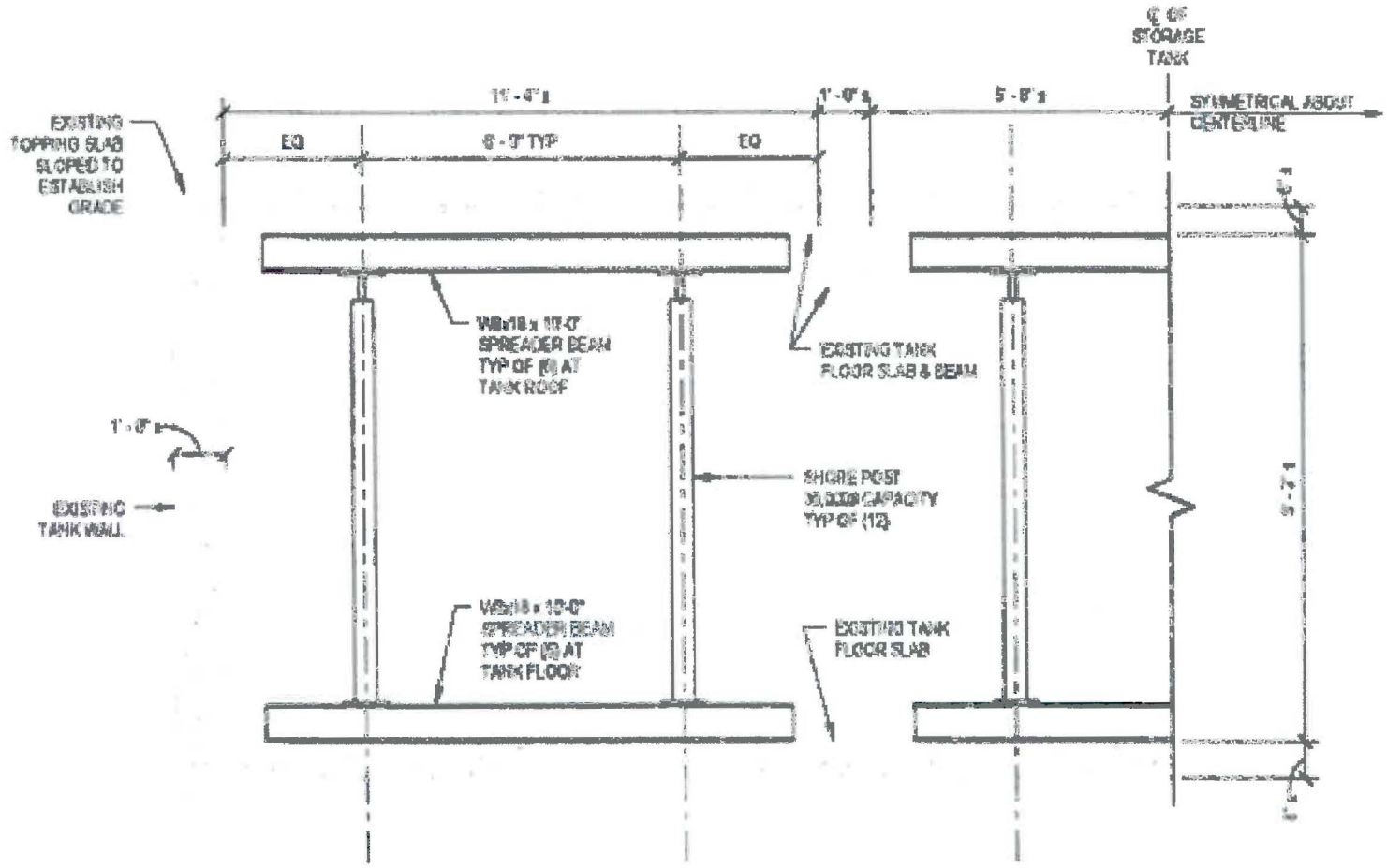


NOTES:

1. NEW CONSTRUCTION WILL REQUIRE HEAVY EQUIPMENT & MECHANICAL COMPONENTS TO TRAVERSE THE GRADE DIRECTLY OVER EXISTING 30,000 GALLON STORAGE TANK.
2. TANK LOCATION SHOWN IN THIS VIEW IS APPROXIMATE. CONTRACTOR SHALL FIELD VERIFY EXACT EXTENT OF TANK PRIOR TO TRANSPORTING HEAVY EQUIPMENT / COMPONENTS IN THIS REGION.
3. CONTRACTOR SHALL ERECT SHORING INSIDE OF TANK PRIOR TO TRANSPORTING HEAVY EQUIPMENT / COMPONENTS IN THIS REGION.

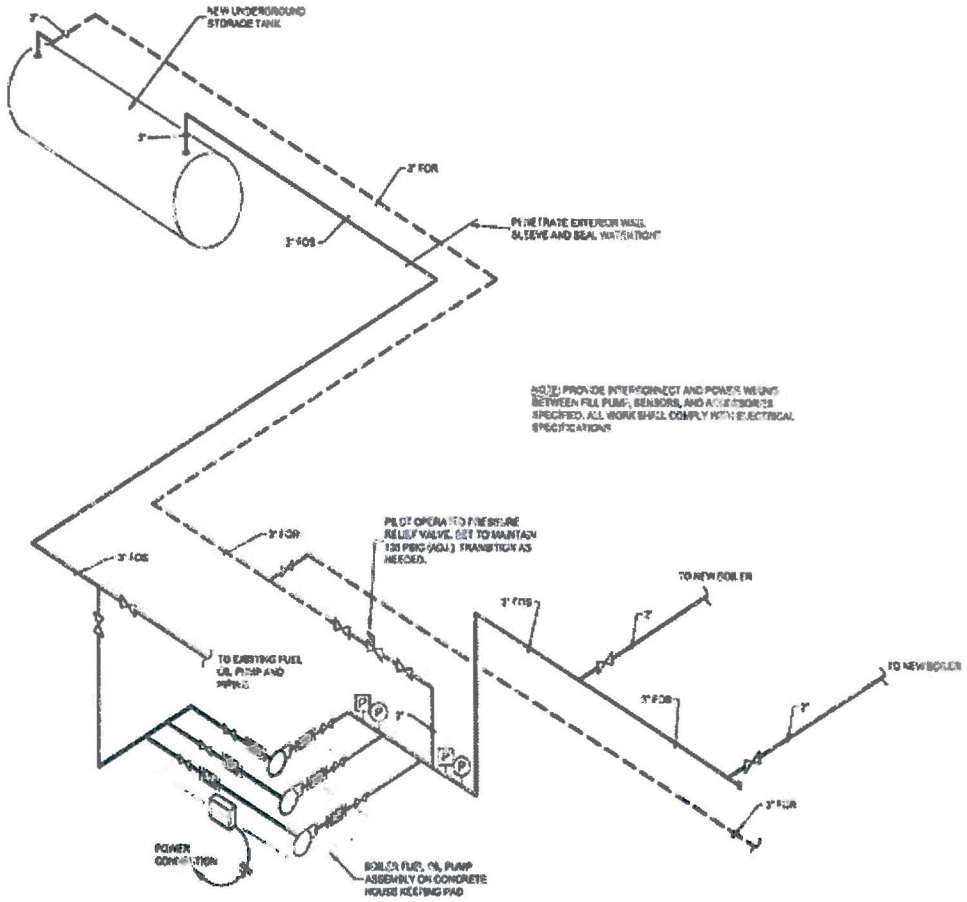
A / S-1 UNDERGROUND STORAGE TANK INFORMATION PLAN

NOT TO SCALE



B / S-1 UNDERGROUND STORAGE TANK - REQUIRED TEMPORARY SHORING DETAIL

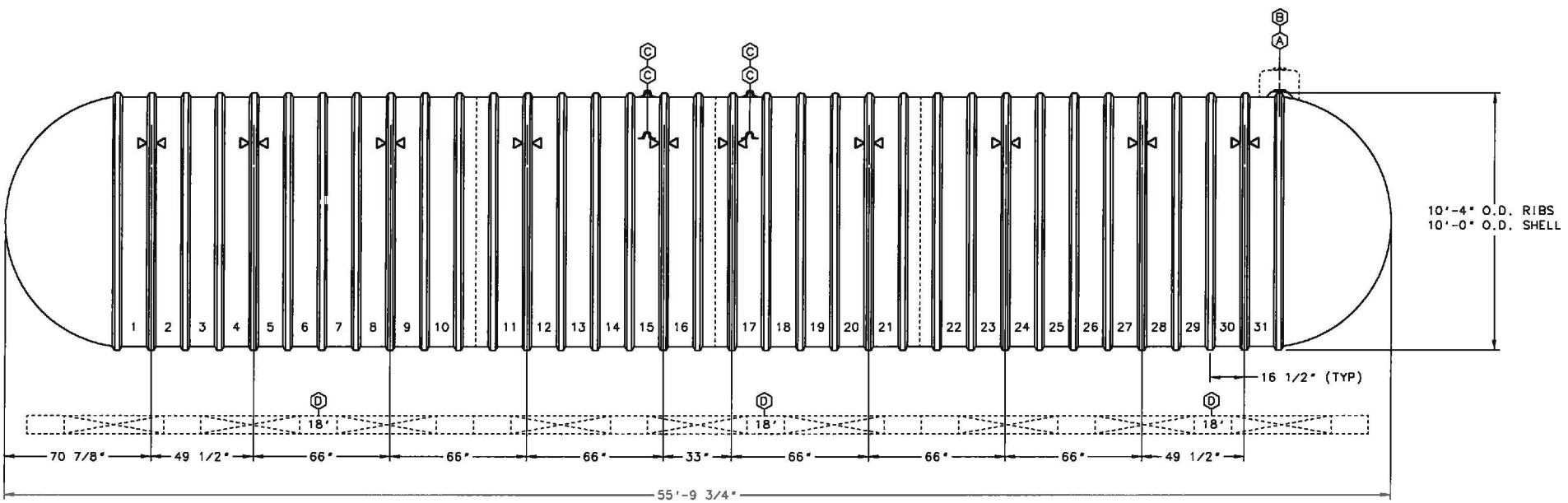
3/8" = 1'-0"



FUEL OIL FLOW DIAGRAM

NO SCALE

Attachment B
Tank Upgrade Drawings



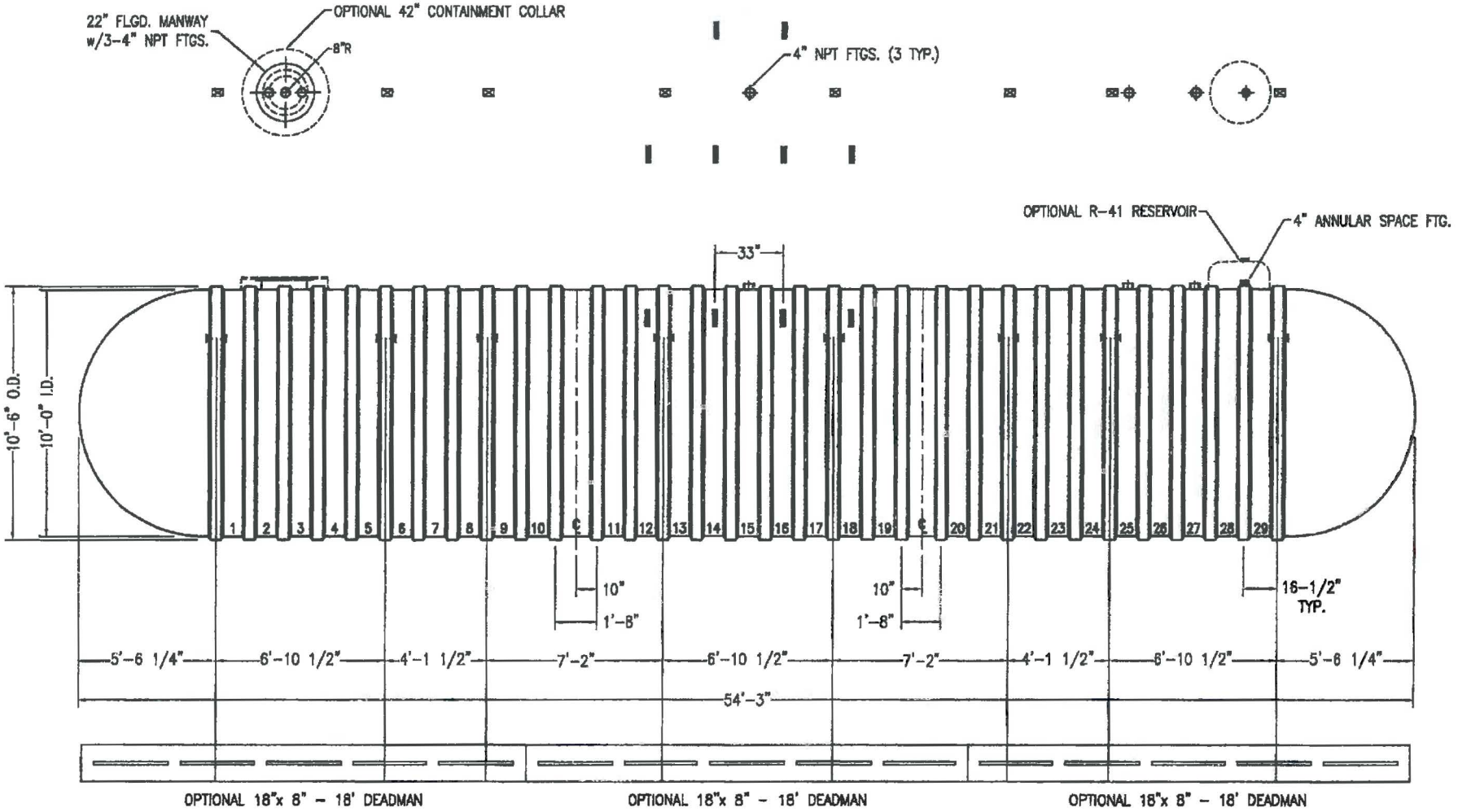
ITEM	QTY	DESCRIPTION
A	1	4" NPT MONITOR FITTING
B	1	OPTIONAL 18" DIA. HYDROSTATIC MONITORING RESERVOIR WITH 4" NPT FITTING
C	4	LIFTING LUG
D	6	OPTIONAL 18' PREFABRICATED CONCRETE DEADMAN
⋈	10	HOLD DOWN STRAP LOCATION

XERXES®
a ZCL company

TITLE 10' DIA. DOUBLE-WALL
CAP. 30,000 GALLONS
MADE-TO-ORDER

DATE 3-14 DR. NO. S11-746.00

SHELL CODES: 2-EXD11SD, 1-OXD10SD



NOTES:

- ⊠ HOLD DOWN STRAP CLIP
- ▶◀ HOLD DOWN STRAP LOCATION
- ▯ TYPE "13" LIFT LUG - SD
- ▮ TYPE "13" LIFT LUG - HD

DWT-6 TYPE II (10')-30000		DATE: 1/1/2014
		DRAWN BY: K.A.SOEDER
CONTAINMENT SOLUTIONS	CAPACITY: 29,816	REVISED:
	WEIGHT: DRY/WET 14500/20400	DWG NUMBER: 1030DW6S