

ARTICLE 10
TECHNICAL SPECIFICATIONS
for

SECTION 10 WRP
CLARIFIER 3 & RAS/WAS PUMP STATION
IMPROVEMENTS
CITY OF BULLHEAD CITY, ARIZONA
UTILITIES DEPARTMENT

Project No. 26-U-004

August 2025

Volume 2 of 3



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PROJECT NO: 8519.021 00

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PART 1 GENERAL**1.01 GENERAL**

- A. This section describes the project and the work to be performed under this Contract in a general summary. Detailed requirements and extent of work are stated in applicable Specification sections and are shown on the Drawings.
- B. These requirements supplement and are in addition to the requirements in Volume 1 Article 8.43 and 8.50.

1.02 ORGANIZATION AND INTERPRETATION OF CONTRACT DOCUMENTS

- A. Specifications and Drawings included in these Contract Documents establish the performance, quality requirements, location and general arrangement of materials and equipment, and establish the minimum standards for quality of workmanship and appearance.
- B. Specification sections have not been divided into groups for work of subcontractors or various trades. Should there be questions concerning the applicability or interpretation of a particular section or part of a section or Drawing, direct questions to the Engineer.
- C. Piping work and electrical work shown on the Drawings is intended to be depictive and may not be an exact and complete representation of the actual finished work. Include fittings, joints, supports, nuts, bolts, and other accessories required to provide complete and satisfactory piping and electrical systems, as specified even though some items may not be specifically shown on the Drawings.
- D. Any part of the work that is necessary or required to make each installation satisfactory and operable for its intended purpose, even though it is not specifically included in the Specifications or on the Drawings, shall be performed as incidental work as if it were described in the Specifications and shown on the Drawings.

1.03 STANDARD SPECIFICATIONS

- A. The Uniform Standard Specifications and Details for Public Works Construction, Maricopa Association of Governments (MAG), 2023 Revision to the 2020 Edition, January 2023, are referred to elsewhere in this document as MAG Standard Specifications.
- B. Where a specification section from MAG Standard Specifications is referenced, it shall be understood that the section is thereby made a part of these Contract Documents even though the section is not printed in this

Project Manual. Special provisions or technical specification provisions that supplement or supersede referenced MAG Standard Specifications sections are included within this Project Manual and take precedence over any conflicts with the MAG Standard Specifications.

1.04 WORK BY OTHERS

- A. Normal wastewater system operations by Owner's personnel. Also see Section 01 14 16, COORDINATION AND SITE CONDITIONS. Coordinate Work with utilities of the Owner and other pertinent public or private agencies.
- B. Construction of Aeration Basin 2 (AB2) is in progress under a separate contract and is anticipated to be on-going during the project. When construction of the clarifier commences, work of the two project must be coordinated for site access, Owner's preferences, use of staging areas, hours of work, and potential interference with wastewater reclamation plant (WRP) operations. There may be times when work at AB2 takes priority over work on this project. It is not anticipated to occur a lot but may occur.

1.05 DESCRIPTION OF PROJECT

- A. The Contractor shall, except as otherwise specifically stated in applicable parts of these Contract Documents, provide and pay for all labor, materials, equipment, tools, construction equipment, bypass equipment, temporary equipment, facilities, and services necessary for the proper execution, testing, and completion of the work.
- B. This project will provide the Owner with one new clarifier tank equipped with Owner-furnished clarifier equipment. The project also includes replacement of existing RAS pumps and piping systems, yard piping improvements, electrical power and controls, room ventilation and HVAC, alum mixer, and generally consists of the following major items of work:
 - 1. Construction of one new clarifier consisting of site excavation, construction of prestressed concrete clarifier, installation of owner-furnished clarifier equipment, installation of new yard piping providing connections to existing systems, and all associated electrical and controls.
 - 2. Construction of new clarifier splitter box and installation of new yard piping.
 - 3. Contractor procured and installed electrical conduit, wiring, and equipment for power and control.

4. Replacement of two existing RAS pumps and installation of a third and provisions for a fourth RAS pump, including all associated piping, fittings, valves, instrumentation, electrical, and controls.
5. Upsizing of a portion of the existing 24" secondary effluent (SE) pipe to 42" pipe.
6. Grading and site work associated with the improvements in and around the new clarifier.
7. Replacement of the existing ventilation system in the RAS room with new equipment and addition of HVAC equipment.
8. Installation of a mixer in either a new manhole or the clarifier splitter box.
9. Coordinate with the City's SCADA provider for SCADA programming
10. Additive Alternate 1: Replacement of a portion of the existing 24" SE pipe with 42" pipe and installation of a new manhole.
11. Other miscellaneous work as shown on the Drawings.

1.06 OWNER-FURNISHED PRODUCTS

- A. The following major equipment has been procured by the Owner and shall be installed by the Contractor as shown on the Drawings and as specified further in these Contract Documents:
 1. WesTech Clarifier Model COPC1G
 2. Owner's responsibilities include:
 - a. Arrange for and deliver Owner-reviewed shop drawings, product data to Contractor.
 - b. Arrange for manufacturer's warranties, inspections, and service.
 3. Contractor's responsibilities include:
 - a. Review Owner-supplied shop drawings and product data.
 - b. Take delivery of the equipment.
 - c. Inspect the equipment for completeness and any damage jointly with the Owner.
 - d. Handle, store, install and finish products as specified in other sections of these Contract Documents.
 - e. Repair or replace items damaged after moving the equipment to its new location.

1.07 PROVISIONS FOR FUTURE CONSTRUCTION

- A. The work shall make provisions for future construction as shown on the Drawings. Coordinate this work as specified on the Drawings and/or in Section 01 14 16, COORDINATION AND SITE CONDITIONS.
- B. Installation of provisions for adding a fourth RAS/WAS pump in the RAS/WAS room.
- C. Additive Alternate 1 – SE Manhole will serve as bypass pump location for future upsizing of the remaining SE piping to the filter splitter box.

1.08 LOCATION AND INSPECTION OF SITE

- A. The work shall occur in the areas as shown on the Drawings which are within the site of the Section 10 Water Reclamation Plant (WRP). The plant is located west of Highway 95, at the end of Richardo Avenue in Bullhead City, Arizona.

1.09 TIME FOR COMPLETION AND LIQUIDATED DAMAGES

- A. Time for completion shall be as specified in Volume 1.
- B. Liquidated damages shall be as specified in Volume 1.
- C. Milestone: Excavation and installation of piping below the clarifier complete by December 19, 2025.

1.10 ENGINEERING SERVICES

- A. The Owner has established control points for horizontal and vertical control. Existing facilities are located with respect to this control. The Contractor shall be responsible for maintaining the established control points. The Contractor shall be responsible to provide all other horizontal and vertical control to complete the work.
- B. The control points have been established at the project site. The cost of replacing survey stakes, markers, etc. damaged or destroyed after the initial staking will be done by the Contractor at his own expense.
- C. The Owner or Engineer may perform independent and separate compaction density tests, concrete sampling and testing, bacteriological testing, or other testing as he (they) may decide.

1.11 BOUNDARIES OF WORK

- A. The Owner shall make suitable provisions for ingress and egress, and the Owner shall not cause the Contractor to enter or occupy with workers, tools,

equipment or material, any ground outside the property of the Owner without the written consent of the owner of such ground. The final location and extent of the areas to be used shall be coordinated with the Owner. Other contractors and employees or agents of the Owner may for all necessary purposes enter upon the premise used by the Contractor, providing the operations of other contractors do not interfere with the actual scheduled operations. The Contractor shall conduct his work so as not to impede unnecessarily any work being done by others on or adjacent to the site.

- B. It shall be understood that the responsibility for protection and safekeeping of equipment and materials on or near the site will be entirely that of the Contractor and that no claim shall be made against the Owner or the Engineer by reason of any act of an employee or trespasser. It shall be further understood that should any occasion arise necessitating access by the Owner to the sites occupied by these stored materials and equipment, the Contractor owning or responsible for the stored materials or equipment shall immediately remove same. No materials or equipment may be placed upon the property of the Owner until the Owner has agreed to the location contemplated by the Contractor to be used for storage.
- C. The Contractor shall be solely responsible for obtaining and shall pay all costs in connection with any additional work area, storage sites, access to the site, or temporary right-of-way, which may be required for proper completion of the work.

1.12 PROTECTION OF SITE

- A. Except as otherwise provided herein, the Contractor shall take all necessary precautions and provide all material and equipment to protect, shore, brace, support and maintain all public and private property in the proximity or otherwise affected by the construction work performed by him. The Contractor shall remove from the site all unused materials.
- B. Existing underground installations such as WRP yard piping, water mains, gas mains, sewers, telephone lines, power lines, and buried structures in the vicinity of the Work to be done hereunder are indicated on the Drawings only to the extent such information has been made available to or discovered by the Engineer in preparing the Drawings. There is no guarantee as to the accuracy or completeness of such information, and all responsibility for the accuracy and completeness thereof is expressly disclaimed.
- C. The Contractor shall be solely responsible for locating all existing underground installations, including service connections, in advance of excavating or trenching, by contracting the owners thereof and prospecting. The Contractor shall use his own information and shall not rely solely upon

information shown on the Drawings concerning existing underground installations.

- D. The Contractor shall protect yard piping and utilities during excavation that are to remain in place. Contractor shall repair all damage to existing utilities or property to the satisfaction of the utility owner or property owner at his own expense.
- E. Should uncharted, or incorrectly charted, piping or other utilities be encountered during excavation, consult utility owner immediately for directions. If any existing underground utility or facility not shown on the Drawings is located so that it interferes with the Work in either alignment or grade and has to be moved or otherwise modified, such work shall be done by the Contractor, and adjustment in payment will be made according to the General Conditions. Except as stated above, any delay, additional work or extra cost to the Contractor caused by existing underground installation shall not constitute a claim for extra work, additional payment, or damages.
- F. Privately owned utilities, such as gas mains, underground electrical and telephone cables, telephone poles, light poles, etc., required to be moved to make way for new construction will be moved by others unless designated otherwise on the Drawings. However, the Contractor shall be responsible for contacting all utility companies associated with this project to determine additional costs that may be associated with these utilities. These costs shall be incidental to the bid price.
- G. Temporary service shall be provided by the Contractor during any period when utility lines are disturbed unless the Contractor makes other arrangements with the utility users. Existing utility lines, if interrupted, shall be restored as quickly as possible. Do not interrupt existing utility services without written permission from Engineer and Owner and utility service owner. Planned interruptions must be scheduled with the Owner and utility service owner a minimum of 7 calendar days prior to the interruption, and as further specified in Section 01 14 16, COORDINATION AND SITE CONDITIONS.
- H. Contractor shall exercise special care to maintain all existing surroundings in an undamaged condition, such as buildings, fences, structures, etc., unless noted to be removed on the Drawings. Contractor shall not use the existing features as anchors to fasten ropes, chains, or guys without written approval. All damages to existing structures and features shall be restored to the original condition, or better condition, at no additional expense to the Owner.
- I. Where excavation will be required adjacent to existing structures, utilities, sidewalks, pavements or other facilities, the Contractor shall be solely responsible to protect and maintain the structural integrity of the existing

structures. The Contractor shall take whatever means necessary to ensure that the existing structure is not damaged by settlement, lateral movement, undermining, washout and other hazards created by earthwork operations. Any delay, additional work, or extra cost to the Contractor caused by existing underground installations shall not constitute a claim for extra work, additional payment or damages.

- J. Any fences destroyed during construction shall be repaired to the original condition, or better condition, than the condition prior to construction. Unless otherwise noted on the Drawings, all existing ditches and drainage swales disturbed by construction shall be restored to their original size, alignment, and grade.
- K. The dimensions and elevations of existing structures and locations of existing fences, pipelines, conduits, cables, and equipment shown on the Drawings were taken for the most part from available records and survey data and are not guaranteed for accuracy. It shall be the responsibility of the Contractor to check all dimensions and elevations of existing structures, pipelines, conduits, cables, equipment, or other existing items, both above and below ground, affected by or affecting the Work under this contract, prior to the start of construction or ordering materials and equipment affected thereby. The Contractor's attention is directed to the additional bidding information which encourages that each bidder visits the site of the Work to become familiar with the arrangement and condition of existing construction that is to be connected to or that is to remain in place.
- L. Also see Section 01 14 16, COORDINATION AND SITE CONDITIONS.

1.13 TEMPORARY FACILITIES

- A. The Contractor shall be responsible for supplying his own office, toilet and storage facilities at the site. The Contractor shall also be responsible for providing potable water and water needed for construction and testing purposes. All expenses for connection of electrical service, telephone or other temporary services shall be the responsibility of the Contractor. The Contractor shall remove all traces of these facilities prior to completion of the project.
- B. Also see Volume 1 for additional temporary facility requirements.

1.14 SUBSURFACE CONDITIONS AND SITE DRAINAGE

- A. The Contractor shall satisfy himself as to the groundwater and subsurface conditions at the site of the Work. Soil moisture contents and groundwater levels will fluctuate due to seasonal changes, weather, irrigation, and other variations in conditions. Soils with natural moisture contents in excess of optimum are anticipated at some locations on this project. The bidders shall

make independent investigations as they believe are necessary to prepare their bid. The Contractor is responsible to determine construction methods and include these costs in the bid price. Methods and procedures related to wet soils could include adjusting the moisture of the material or removal of the wet material and replacement with another suitable material.

- B. The Contractor is advised that groundwater may be present at the project site. The Contractor is responsible for providing dewatering equipment and methods for this project. Groundwater shall be removed from the project area to satisfactorily prevent the rising of water into or around the new or any existing piping and/or structures that may be exposed during the Work. The Contractor shall be responsible for arrangements of permits and obtaining of sites for groundwater discharge or flushing discharge. This shall include all cleanup, restoration, etc., of any discharge areas. The above-related Work shall be included as part of the total bid price. No separate measurement or payment will be made for dewatering.
- C. Water from such sources as surface runoff, dewatering, and flushing of pipelines during project construction shall not be allowed to enter into drainage ways or open areas that will cause flooding of existing structures, roads, equipment storage areas, agricultural areas, or lawn areas.
- D. Also Volume 1 for environmental quality control requirements.

1.15 SITE ACCESS

- A. The Contractor shall be responsible for determining the adequacy of all roads and bridges used in moving equipment and materials to the construction site. The Contractor shall provide alternative methods of access, such as temporary crossings, for any equipment that exceeds the capacity of existing access facilities.

1.16 SAFETY

- A. The Contractor shall be solely responsible for all project personnel on the jobsite. No acts or comments by the Engineer or Owner shall be interpreted as a transfer of responsibility for safety.
- B. See Volume 1 for additional jobsite safety requirements.

1.17 WORK SEQUENCE

- A. Construct Work in phases to accommodate Owner's operation of the Section 10 WRP during construction. Coordinate construction schedule with Engineer, Owner and also see Section 01 14 16, COORDINATION AND SITE CONDITIONS.

PART 2 PRODUCTS (NOT USED)

PART 3 EXECUTION (NOT USED)

END OF SECTION 01 11 00

DIVISION 01 00 00 - GENERAL REQUIREMENTS

PART 1 GENERAL

1.01 SECTION INCLUDES

- A. Requirements for coordinating and sequencing the work under the Contract, and requirements regarding existing site conditions. These requirements supplement and are in addition to requirements in Article 8 and Article 9 of Volume 1.
- B. Requirements for cutting and patching of new and existing work.
- C. Specific requirements regarding coordination of mechanical equipment and electrical work are specified in Division 23, Division 26, and Divisions 46.

1.02 RELATED SECTIONS

- A. Volume 1 temporary construction facilities.
- B. Section 02 01 90, MOVE IN AND SITE PREPARATION.

1.03 JOBSITE COORDINATION

- A. Project Site Coordination: All project site coordination (i.e. equipment staging, storage, site access, wastewater reclamation plant (WRP) operation, etc.) should be discussed and coordinated with Tim Fontenot, Utility Manager, 901 Richardo Avenue, (928) 763-7299.
- B. Owner may perform additional work related to this project himself, or he may let other direct contracts therefore which shall contain General Conditions and General Requirements similar to these. Contractor shall afford the other contractors who are parties to such direct contracts, (or Owner if he is performing the additional work himself), reasonable opportunity for the introduction and storage of materials and equipment and execution of work and shall properly connect and coordinate his work with theirs.
- C. If any part of Contractor's work depends on proper execution or results from the work of any such other contractor (or Owner), Contractor shall inspect and promptly report to Owner and Engineer in writing any defects or deficiencies in such work that renders it unsuitable for such proper execution and results. Contractor's failure to so report shall constitute an acceptance of the other work as fit and proper for the relationship of his work except as to defects and deficiencies which may appear in the other work after the execution of his work.

DIVISION 01 00 00 - GENERAL REQUIREMENTS

- D. Contractor shall do all cutting, fitting, and patching of their work that may be required to make its several parts come together properly and fit it to receive or be received by such other work. Contractor shall not endanger any work of others by cutting, excavating, or otherwise altering their work and will only cut or alter their work with the written consent of the Engineer and of the other contractors whose work will be affected.
- E. If the performance of additional work by other contractors or Owner is not noted in the Contract Documents prior to the execution of the Contract, written notice thereof shall be given to Contractor prior to starting any such additional work. If Contractor believes that the performance of such additional work by Owner or others involves them in additional expense or entitles them to an extension of the contract time, Contractor may make a claim therefore.
- F. Contractor shall be responsible for all areas of the site used by them and all Subcontractors in performance of the work. Contractor shall exert full control over the actions of all employees and other persons with respect to the use and preservation of property and existing facilities, except such controls as may be specifically reserved to Owner or others.
- G. Contractor and all Subcontractors shall cooperate in the coordination of their separate activities in a manner that will provide the least interference with the Owner's operations and utility companies working in the area, and in the interfacing and connection of the separate elements of the overall project work. If any difficulty or dispute should arise in the accomplishment of the above, the problem shall be brought immediately to the attention of the Owner and Engineer. All Contractors working on this site are subject to this requirement for cooperation, and all shall abide by the Engineer's decision in resolving project coordination problems without additional cost to the Owner.

1.04 SUBMITTALS

- A. Contractor shall submit the following information as applicable to coordination activities:
 - 1. Subsurface Information and Utilities:
 - a. Records or logs of borings or test holes made by Contractor, if any.
 - b. Results of exploratory excavations made to verify locations and nature, shape, dimensions, etc., of existing utilities and facilities; where possible, indicate this information on clean copy of Contract Drawings.

DIVISION 01 00 00 - GENERAL REQUIREMENTS

2. Field Relocation: Clearly show proposed relocations of new or existing facilities, or related work affected by the relocation, on clean copy of the Contract Drawings submitted prior to performing the relocation.
3. Easements: Copy of easements and other agreements obtained from utilities and property owners as required to carry out the work.
4. Connecting Work: Proposed methods of connecting new work to existing facilities, where not shown or specified.
5. Cutting and Patching:
 - a. Written notice requesting consent to perform cutting which may affect structural safety or normal functioning of existing facilities.
 - b. Recommendations indicating changed conditions, alternative materials or methods, time when uncovered work may be observed, and other information necessary to evaluate substitutions when work conditions necessitate change of materials or methods.
6. Detailed schedule of proposed sequence of work meeting the requirements of this section and Section 01 33 00, SUBMITTALS. Schedule shall clearly identify all interfacing work and dates that existing facilities must be modified, connected to, and/or taken out of service.

1.05 SITE CONDITIONS

A. Information on Site Conditions:

1. General: Information obtained by the Owner regarding site conditions, topography, subsurface information, groundwater elevations, existing construction of site facilities as applicable, and similar data is included in the Contract Documents or will be available for inspection at the office of the Engineer or Owner upon request. Such information is offered as supplementary information only. Neither the Engineer nor the Owner assumes any responsibility for its accuracy or completeness or for the Contractor's interpretation of such information.
2. Subsurface Information: Subsurface investigations at the site have been performed. However, it shall be the responsibility of the Contractor to verify subsurface conditions prior to bidding on the work. This information is not part of this Contract and is offered as

DIVISION 01 00 00 - GENERAL REQUIREMENTS

“Technical Data” information only. Neither the Engineer nor the Owner assumes any responsibility for its accuracy or completeness or for the Contractor’s interpretation of such information, as specified in the Standard General Conditions.

3. Control Points: Contractor shall check existing and establish new (if desired) vertical and horizontal survey control points on structures and improvements located in the vicinity of the work prior to beginning work. Preference shall be given to using existing control points established by Morrison-Maierle. Contractor shall check the points for movements when directed by the Engineer. Furnish Engineer with copies of survey notes for each survey and a copy of the layout of survey control points.

B. Existing Utilities:

1. Location:

- a. Known utilities and facilities adjacent to or within the work area are shown on the Drawings. The locations shown are taken from existing records and the best information available from existing utility plans; however, it is expected that there may be some discrepancies and omissions in the locations and quantities shown. Contractor's request for additional compensation or Contract time resulting from encountering utilities not shown will be considered as set forth in the General Conditions.
- b. Contractor shall exercise reasonable care to verify locations of utilities and facilities shown on the Drawings and to determine the presence of those not shown. Immediate and adjacent areas where excavations are to be made shall be thoroughly checked by visual examination for indications of underground facilities and also checked with electronic metal and pipe detection equipment. Where there is reasonable cause to verify the presence or absence of an underground facility, make exploratory excavations prior to proceeding with major excavation in the area. Where information on buried facilities is required to verify their nature, shape, configuration, dimensions, materials, or other properties, make exploratory excavations as acceptable to the Owner and Engineer.
- c. The Contractor is advised that there is a one-call utility locate number in use for utility location requests within the State of Arizona.

DIVISION 01 00 00 - GENERAL REQUIREMENTS

2. Contractor's Responsibilities:

- a. Where Contractor's operations could cause damage or inconvenience to telephone, television, power, oil, gas, water, sewer, irrigation systems, or other similar utilities, the Contractor shall make arrangements necessary for the protection of these utilities and services. Replace existing utilities removed or damaged during construction with equal or better materials, unless otherwise provided for in these Contract Documents.
- b. Notify utility offices that are affected by construction operations at least 48 hours in advance. Under no circumstances shall Contractor expose any utility without first obtaining permission from the appropriate agency and utility owner. Once permission has been granted, locate, expose, and provide temporary support for the utilities.
- c. Protect all utility poles from damage. If interfering utility poles will be encountered, notify the utility company at least 3 days in advance of construction operations to permit necessary arrangements with the utility company for protection. If relocation of the interfering pole is needed, this must be coordinated with the utility company such that the schedule allows the utility company to perform this work.
- d. Contractor shall be solely and directly responsible to owner and operator of such properties for damage, injury, expense, loss, inconvenience, delay, suits, actions, or claims of any character brought because of injuries or damage which may result from construction operations under this Contract.
- e. Neither Owner nor its officers or agents shall be responsible to Contractor for damages as a result of Contractor's failure to protect utilities or associated facilities encountered in the work.
- f. In event of interruption to domestic water, sewer, storm drain, or other utility services as a result of accidental damage due to construction operations, promptly notify the Owner and/or proper authority. Cooperate with Owner and said authority in restoration as promptly as possible and pay for repair. Prevent interruption of utility service unless granted by the utility owner.
- g. Drainage culverts removed by the Contractor during the course of the Work shall be replaced in kind.

DIVISION 01 00 00 - GENERAL REQUIREMENTS

C. Interfering Structures:

1. Take necessary precautions to prevent damage to existing structures whether on the surface, above ground, or underground. An attempt has been made to show major structures on the Drawings. While the information has been compiled from the best available sources, its completeness and accuracy cannot be guaranteed.
2. Protect existing structures from damage, whether or not they lie within limits of easements obtained by the Owner. Where existing fences, gates, sheds, buildings, or other structures must be removed to properly carry out work, or are damaged during work, restore them to original, or better, condition than present prior to construction.
3. Contractor may remove and replace in equal or better than original condition, small structures such as fences, mailboxes, and signposts that interfere with Contractor's operations.

D. Field Relocation:

1. During construction, it is expected that relocations of proposed facilities will be necessary. Make such relocations only by direction of the Owner or Engineer. If existing structures are encountered that prevent construction as shown, notify the Engineer before continuing with work so Engineer may make necessary field revisions.
2. Where shown or directed by and acceptable to the Engineer and Owner, provide relocation of existing facilities to include piping, utilities, equipment, structures, electrical conduit wiring, electrical duct bank, and other miscellaneous items. Use only new materials for relocation of existing facilities. Match materials of existing facilities unless otherwise shown or specified. Perform relocations to minimize downtime of existing facilities. Install new portions of existing facilities in their relocated position prior to removing existing facilities, unless otherwise accepted by Engineer.

E. Monuments and Markers:

1. Preserve and protect survey monuments and markers throughout construction. If damage occurs or removal becomes necessary, immediately notify Engineer and restore monument or marker to original condition.
2. Preserve private and public monuments that are found. If monument must be removed, replace at original locations using registered land

surveyor. Notify Engineer when monuments are encountered. If government monuments are encountered, reference the monument for later replacement and provide 10-day advance notification to Engineer who will notify the proper authority.

- F. Connecting to Existing Facilities: Unless otherwise shown or specified, determine methods of connecting new work to existing facilities, and obtain Engineer's review and acceptance of connections:
1. Determine location, elevation, nature, materials, dimensions, and configurations of existing facilities where necessary for connecting new work.
 - a. Where location, size, or elevations of existing facilities differ from the Drawings, notify Engineer for coordination of connections.
 2. Inspect existing record drawings and shop drawings, conduct exploratory excavations and field inspections, and conduct similar activities as needed.
 3. Shutdown of Owner's existing facility prior to connection, if necessary, shall be by Owner as specified hereinafter. Provide notice to Owner of a planned shutdown as specified hereinafter.
- G. Erosion and Dust Control On-Site:
1. The Contractor shall be responsible for reducing soil erosion and dust due to wind or water to a level meeting federal, state, and local regulations at the construction site. Control measures that may be required include, but may not be necessarily limited to, the following:
 - a. Suspending excavation during high winds or rain.
 - b. Minimizing land exposure in area and time.
 - c. Covering erodible areas as quickly as possible with gravel landscaping or by compaction.
 - d. Retaining existing vegetation where possible.
 - e. Prohibiting clearing or grubbing until a firm construction schedule is known.
 - f. Stabilizing construction site soils.
 - g. Controlling dust during construction by use of water spray.
 2. Also see Volume 1.

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H. Salvage of Materials:

1. Contractor shall salvage materials for Owner's and/or Contractor's use where shown on the Drawings. Store salvaged materials for Owner where instructed by Owner on the jobsite.

1.06 PROJECT MEETINGS OR REPORTS

- A. Preconstruction Conference: A preconstruction conference will be scheduled after the Notice of Award. The Contractor and their major Subcontractors shall attend the meeting.
- B. Progress Meetings: The Owner or Engineer may schedule regular progress meetings approximately every two (2) weeks to review work progress, schedules, and other matters needing discussion and resolution.
- C. Progress Reports: A monthly progress report shall be provided with an updated schedule by the Contractor prior to the submission of the application for progress payment. If the work falls behind schedule, Contractor shall submit progress reports at such intervals as the Owner or Engineer may request. Each progress report shall include sufficient narrative to describe current and anticipated delaying factors, their effect on the construction schedule, and proposed corrective actions. Any work reported complete, but which is not readily apparent to the Engineer must be substantiated with satisfactory evidence.
- D. Purpose of Meetings and Reports: The purpose of the meetings or reports will be to review the general progress of work, maintain coordination of efforts, discuss changes in scheduling, and resolve other problems which develop. At a minimum, each meeting must be attended by the Contractor's Project Manager, Resident Project Superintendent and representatives of major Subcontractors.

1.07 SEQUENCE OF WORK

- A. Operation and Shutdown of Existing Facilities:
 1. Continuous operation of Owner's facilities is of critical importance. Schedule and conduct activities to enable existing facilities to operate continuously, unless otherwise specified. Conduct work outside normal working hours as may be necessary to meet project schedule and avoid undesirable conditions within limits specified in the Owner's contract documents.
 2. Provide at least 21 days advance notice to Owner of need to shut down a process, pipeline, or facility unless specified otherwise

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hereinafter. Do not proceed with work affecting a facility's operation without obtaining Owner's advance approval of the need for, and duration of, such work.

3. It must be stressed that wastewater must continue to flow throughout the treatment plant and must and shall continue to receive treatment in accordance with the State of Arizona Aquifer Protection Permit (APP) and/or the AZPDES permit and/or reclaimed water requirements. At no time shall non-compliant wastewater be allowed to be discharged. The Contractor will be afforded the opportunity to select the appropriate means and methods of construction to accomplish the construction and continue providing treatment, within the specific constraints specified hereinafter.
4. Provide temporary devices, pumps, piping, equipment, electric service, and other similar items as may be required to accomplish the work and maintain continuous and efficient plant operation.

B. Modifications to Existing Facilities:

1. Where existing facilities are to be modified during the course of work, obtain Owner's and Engineer's review and acceptance of submittals for temporary shutdown, demolition, modification, connections between new and existing work, and other related work. Conform to other sections as applicable.
2. Connections to existing services or utilities, or other work that requires the temporary shutdown of any existing operations of utilities shall be planned in detail with appropriate scheduling of the work and coordinated with the Owner and Engineer. The schedule for shutdown or restart shall be given by written advance notice in order that the Owner or Engineer may witness the shutdown, tie-in, and startup.
3. All materials and equipment (including emergency equipment) necessary to expedite the tie-in shall be on hand prior to the shutdown of existing services or utilities. Where bypass pumping is required, the Contractor shall have equipment of adequate capacity to meet maximum anticipated flow rates with one "unit" in standby mode.
4. Unless otherwise specified or indicated, Contractor shall make all necessary connections to existing facilities including structures, pipelines, and utilities such as water, telephone, gas, and electric. In each case, Contractor shall obtain permission from the Owner or the

DIVISION 01 00 00 - GENERAL REQUIREMENTS

owning utility prior to undertaking connections. Contractor shall protect facilities against deleterious substances and damage.

5. Connections to existing facilities which are in service shall be thoroughly planned in advance, and all required equipment, materials, and labor shall be on hand at the time of undertaking the connections. All equipment, materials, and labor that the Contractor plans to have available shall be coordinated with the Owner and Engineer in order to ensure the work is done in the minimum amount of time.
 6. Work shall proceed continuously (around the clock) if necessary to complete connections in the minimum time. Operation of valves or other appurtenances on existing facilities, when required, shall be by or under the direct supervision of the Owner.
 7. Existing valves or gates used to isolate certain structures may not be watertight and some leakage may occur. The Contractor shall provide the necessary temporary plugs and/or pumping facilities to handle any leakage.
 8. Temporary dams, stop logs, stop gates, valves, wall or other devices shall be designed and installed by the Contractor as needed for installation of the work.
 9. The Contractor shall design and install shoring and support of existing and new structures and piping to prevent damage during the work and to maintain functional use of the Owner's facilities.
- C. The following major existing facilities will need to be modified as part of the work, as shown on the Drawings and as necessary to accomplish the work. This work must be carefully planned and coordinated with the Owner and Engineer as specified herein. This work shall also be performed as specified in other appropriate detail specifications.
1. New Splitter Box and Piping: Connections from the new splitter box to the existing process piping will be necessary. This will require coordination with City staff on bypass pumping and potential downtime for the existing clarifiers. At least one clarifier must remain in service at all times. Downtime of one clarifier must be limited to regular work days and shall not exceed five days in duration to allow staff to manage operation of a single clarifier to minimize upsets in the treatment processes. In general, the Contractor shall work to make these connections and construct all necessary thrust restraints in the minimum time. Temporary thrust restraints shall be provided

DIVISION 01 00 00 - GENERAL REQUIREMENTS

by the Contractor for all connections required by the Owner to be placed back into service immediately.

2. New Clarifier Tank, Equipment, and Associated Piping, Electrical, and Controls: The excavation and site work for the clarifier tank must occur in an expedited manner so that by December 19, 2025, the prestressed tank builder can mobilize on site and begin construction of the clarifier tank. During connection of new piping to new or existing structures, bypass pumping may be required.
3. New RAS/WAS Pumps: Existing RAS/WAS pumps in the RAS/WAS room will be replaced. Bypass pumping will be required to provide continued return activated sludge pumping to the treatment process. Downtime of RAS pumping shall not exceed 4 hours. Coordinate any downtime or reduced pumping capacity with Owner at least 21 days in advance of process interruptions.
4. Electrical and Control: The Owner will be providing SCADA programming services to modify the existing SCADA system to operate the new headworks equipment. Contractor shall coordinate with Owner at the beginning of the project for scheduling of startup to allow Owner ample time for SCADA programming.
5. RAS Room HVAC: This work can occur at any time.
6. Additive Alternate 1: This work shall be coordinated with all Work, including bypass pumping required for replacement of the SE piping between Clarifier 1 and Clarifier 2.

D. Sequence of Major Activities: To meet the overall objectives of the project, certain elements of work must be accomplished within the following sequence and/or constraints. The following is meant to be a guideline for the Contractor which presents one method of accomplishing the desired results and includes major items of work. Exact means and methods of accomplishing the Work within these constraints is the responsibility of the Contractor. It is the responsibility of the Contractor to review these items and the work to be done and determine the methods that will be used to accomplish the tasks. The Contractor shall also submit proposed methods to the Owner and Engineer for review prior to commencing work. The Contractor is still responsible for the methods used to accomplish the project objectives and all safety requirements.

1. The Owner does not have a preference for a construction sequence but recognizes that the clarifier tank site must be excavated,

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prepared and ready by the prime contractor early in the project in order to meet completion of the entire project by June 30, 2026.

- E. Miscellaneous Piping Connections: All piping connection work shall be planned and coordinated with the Owner and Engineer as specified hereinbefore and shall be performed during a time of the day when influent wastewater flows are expected to be at a minimum. In general, the Contractor shall work continuously to make these connections and construct all necessary thrust blocks in the minimum time. Temporary thrust restraints shall be provided by the Contractor and high early strength concrete shall be used for all connections required by the Owner to be placed back in service immediately. The temporary thrust restraints shall be left in place until the thrust block concrete has reached its design strength.
- F. Time of Work:
 - 1. All provisions of the Contract shall remain in effect except Article 8.62 shall allow for the maintenance or emergency work may be done without prior permission.

1.08 BYPASS PUMPING

- A. Bypass pumping of the plant flow is required as part of the modification to the existing facilities as discussed elsewhere in this specification.
 - 1. Bypass pumping will be required for RAS/WAS for the duration of construction in the RAS/WAS room.
 - 2. Bypass pumping will be required for mixed liquor (ML) and secondary effluent (SE) as needed to connect new and existing piping and structures.
- B. The Contractor shall supply bypass pumping equipment, piping and fittings capable of pumping at the following rates:
 - 1. RAS: 900 gpm
 - 2. ML from the oxidation ditch to the splitter box and to the clarifiers:
 - a. Minimum: 2,290 gpm
 - b. Average: 3,050 gpm
 - c. Peak Hour: 5,070 gpm
 - 3. SE from the clarifiers to the filter splitter box:
 - a. Minimum: 2.0 mgd (1,390 gpm)
 - b. Average : 3.1 mgd (2,150 gpm)

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- c. Peak Hour: 6.0 mgd (4,170 gpm)
- C. All bypass pump stations shall include a spare pump capable of replacing the largest pump used. Bypass pumping operations shall be conducted continuously for the duration of any construction activities necessitating bypass pumping.
- D. The Contractor shall submit a Bypass Pumping Plan for each flow stream no later than 21 days prior to bypass pumping operations. Bypass pumping shall not be performed without approval of the Plan by the Owner and Engineer. The Plan shall include, at a minimum, the following information:
 - 1. Pump manufacturer, pump type, and motor horsepower of bypass pumps to be used, including spare pump.
 - 2. Type of temporary piping and fittings to be used.
 - 3. Pump suction and discharge locations, temporary pipe routing through construction area, existing plant facilities, and adjacent properties as required. Include pipe supports required to span structures and provisions for allowing flow of traffic as required to maintain WRP operations.
 - 4. Mode of inlet and outlet piping support within existing structures.
 - 5. Anticipated number of days, hours of operation and number of personnel dedicated to bypass pumping operations.
 - 6. Plan for onsite and remote monitoring of bypass pumping equipment and plan for responding to pump or other system failures.
 - 7. A detailed description of Contractor tasks required to install bypass pumping pipe and equipment prior to initiating pumping and to remove equipment and piping after bypass pumping operations are concluded.
 - 8. Construction sequencing as it applies to bypass pumping.
- E. Diesel Bypass Pumping Equipment:
 - 1. Bypass pumping equipment for the full bypass capacity as specified above shall be housed in sound attenuated enclosures. Sound levels from the pumping equipment shall be no more than 69 dBA at 30 feet. The spare bypass pump does not require a sound attenuated enclosure.
- F. Electric Bypass Pumping Equipment:

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1. Contractor has the option of using electric pumping equipment. Contractor is responsible for providing temporary power for the pumps. Existing power at the site may not be used to power the pumps. See Section 01 50 00, CONSTRUCTION FACILITIES AND TEMPORARY CONTROLS for temporary power requirements.
2. Electric bypass pumping equipment must be backed up by a generator sized to provide sufficient power to pump the flows specified above. An automatic transfer switch shall be included in order to automatically startup the generator and switch to the standby generator during loss of utility power. Use of a diesel or other gas engine generator shall have sound levels no more than 69 dBA at 30 feet.

1.09 REQUESTS FOR INTERPRETATIONS (RFI)

- A. Procedure: Immediately on discovery of the need for interpretation of the Contract Documents, and if not possible to request interpretation at a Project meeting, prepare and submit an RFI in the form specified.
 1. RFIs shall originate with Contractor. RFIs submitted by entities other than Contractor will be returned with no response.
 2. Coordinate and submit RFIs in a prompt manner so as to avoid delays in Contractor's work or work of subcontractors.
- B. Content of the RFI: Include a detailed, legible description of item needing interpretation and the following:
 1. Project name.
 2. Date.
 3. Name of Contractor.
 4. Name of Engineer.
 5. RFI number, numbered sequentially.
 6. Specification Section number and title and related paragraphs, as appropriate.
 7. Drawing number and detail references, as appropriate.
 8. Field dimensions and conditions, as appropriate.

DIVISION 01 00 00 - GENERAL REQUIREMENTS

9. Contractor's suggested solution(s). If Contractor's solution(s) impact the Contract Time or the Contract Sum, Contractor shall state impact in the RFI.
 10. Contractor's signature.
 11. Attachments: Include drawings, descriptions, measurements, photos, Product Data, Shop Drawings, and other information necessary to fully describe items needing interpretation.
 - a. Supplementary drawings prepared by Contractor shall include dimensions, thicknesses, structural grid references, and details of affected materials, assemblies, and attachments.
- C. Engineer's Action: Engineer will review each RFI, determine action required, and return it. Allow seven working days for Engineer's response for each RFI. RFIs received after 1:00 p.m. will be considered as received the following working day.
1. The following RFIs will be returned without action:
 - a. Requests for approval of submittals.
 - b. Requests for approval of substitutions not provided within the normal submittal process.
 - c. Requests for coordination information already indicated in the Contract Documents.
 - d. Requests for adjustments in the Contract Time or the Contract Sum.
 - e. Requests for interpretation of Engineer's actions or submittals.
 - f. Incomplete RFIs or RFIs with numerous errors.
 2. Engineer's action may include a request for additional information, in which case Engineer's time for response will start again.
 3. Engineer's action on RFIs that may result in a change to the Contract Time or the Contract Sum may be eligible for Contractor to submit Change Proposal according to the General Conditions.
 - a. If Contractor believes the RFI response warrants change in the Contract Time or the Contract Sum, notify Engineer in writing within seven working days of receipt of the RFI response.

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- D. On receipt of Engineer's action, update the RFI log and immediately distribute the RFI response to affected parties. Review response and notify Engineer within seven working days if Contractor disagrees with response.
- E. RFI Log: Prepare, maintain, and submit a tabular log of RFIs organized by the RFI number. Submit log monthly, include the following:
 - 1. Project name.
 - 2. Name and address of Contractor.
 - 3. Name and address of Engineer.
 - 4. RFI number including RFIs that were dropped and not submitted.
 - 5. RFI description.
 - 6. Date the RFI was submitted.
 - 7. Date Engineer's response was received.
 - 8. Identification of related Minor Change in the Work, Construction Change Directive, and Proposal Request, as appropriate.
 - 9. Identification of related Field Order, Work Change Directive, and Proposal Request, as appropriate.

PART 2 PRODUCTS (NOT USED)

PART 3 EXECUTION

3.01 CUTTING AND PATCHING

- A. General:
 - 1. Execute cutting (including excavating), fitting, or patching of work, required to:
 - a. Make the several parts fit properly.
 - b. Uncover work to provide for installation of specified work.
 - c. Remove and replace defective work or work not conforming to requirements of Contract Documents.
 - d. Install specified work in existing construction.
 - 2. Perform the following upon written instruction of Engineer:

DIVISION 01 00 00 - GENERAL REQUIREMENTS

- a. Uncover work to provide for Engineer's observation of covered work.
 - b. Remove work to provide for alteration of existing work.
 3. Contractor shall not, without written consent of Owner or Engineer:
 - a. Cut or alter work of another contractor.
 - b. Cut structural or reinforcing steel.
 - c. Endanger existing or new structures or facilities.
 - d. Shut down or disrupt existing operations.
 4. Materials for replacement of work removed shall comply with applicable sections of these Specifications for corresponding type of work to be done.
 5. Provide all tools and equipment required to accomplish cutting and patching.
- B. Inspection and Preparation:
1. Inspect existing conditions of work, including elements subject to movement or damage during cutting, patching, excavating, and backfilling.
 2. After uncovering work, inspect conditions affecting installation of new products.
 3. Prior to cutting, provide safety protection.
- C. Procedures:
1. Execute fitting and adjustment of products to provide finished installation to comply with specified tolerances and finishes.
 2. Execute excavating and backfilling as specified in Section 31 23 33, TRENCH EXCAVATION AND BACKFILL FOR PIPELINES AND APPURTENANT STRUCTURES.
 3. Restore work which has been cut or removed; install new products and provide completed work in accordance with specified requirements.
 4. Restore structures and surfaces damaged that are to remain in the completed work including concrete- embedded piping, conduit, and other utilities.

DIVISION 01 00 00 - GENERAL REQUIREMENTS

5. Make restorations with new materials and appropriate methods as specified for new work of similar nature; if not specified, use best recommended practice of manufacturer or appropriate trade association.
6. Restore damaged work so there is a secure and intimate bond or fastening between new and old work. Finish restored surfaces to such planes, shapes, and textures that no transition between new and old work is evident in finished surfaces.

3.02 ELECTRICAL AND CONTROLS GENERAL COORDINATION

- A. All modifications to the electrical distribution system and control system must be completed prior to placing new/modified facilities into service. Service continuity must be maintained except for brief outages for cut-overs.
- B. The standby power system's service continuity must be continuously maintained, except for brief cut-over periods. Provide temporary standby generation for any other required shutdown periods. Any temporary standard generation system shall include automatic transfer capability.

END OF SECTION 01 14 16

PART 1 GENERAL

1.01 SUMMARY

- A. This section lists many of the construction industry organizations, professional and technical associations, societies and institutes, and government agencies issuing, promoting, or enforcing standards to which references may be made in the Contract Documents along with the abbreviations commonly used for those references. Also included are certain general requirements for the use of industry standards specified, and for application of the standards in quality control.

1.02 USE OF REFERENCE STANDARDS

- A. Work specified by reference to the published standard or specification of a government agency, technical association, trade association, professional society or institute, testing agency, or other organization shall conform to or surpass the minimum standards of quality for materials and workmanship established by the designated standard or specification.
- B. Where so specified, products or workmanship shall also conform to the additional prescriptive or performance requirements included within the Contract Documents to establish a higher or more stringent standard of quality than that required by the referenced standard.
- C. Where the specific date or issue of the standard is not included with the reference to the standard, the edition, including all amendments published and available on the first published date of the Invitation to Bid, shall apply, except where the specific date is established by code.
- D. Where two or more standards are specified to establish quality, the product and workmanship shall conform to or surpass the requirements of both.
- E. In case of conflict between referenced standards, the more stringent shall apply.
- F. Where both a standard and a brand name are specified for a product in the Contract Documents the proprietary product names shall conform to or surpass the requirements of the specified reference standard. The listing of a trade name in a Contract Document shall not be construed as warranting that such product conforms to the respective reference standard.
- G. Copies of standards:
 - 1. Copies of applicable referenced standards have not been bound in this Contract Document.

2. Where copies of standards are needed by the Contractor for superintendence and quality control of the work, obtain a copy or copies directly from the publication sources and maintain in an orderly manner at the job site, available to the Contractor personnel, Sub-Contractors, Owner, and Engineer.
3. Submittals: Submit for approval the requests to use products conforming to printed standards or publications with a different publication date from that effective under the Contract. Clearly indicate the changes in product or workmanship quality involved in the proposed change, if any, and reasons for the request.

1.03 ABBREVIATIONS

- A. Abbreviations for Trade Organizations and Government Agencies: Following is a list of construction industry organizations and government agencies to which references may be made in the Contract Documents, with abbreviations used. Not all abbreviations may be used on this project.

AA	Aluminum Association
AAMA	Architectural Aluminum Manufacturers' Association
AASHTO	American Association of State Highway and Transportation Officials
ACI	American Concrete Institute
AFBMA	Anti-Friction Bearing Manufacturers' Association
AGA	American Gas Association
AGMA	American Gear Manufacturers' Association
AISC	American Institute of Steel Construction
AISI	American Iron and Steel Institute
AITC	American Institute of Timber Construction
ALS	American Lumber Standards
AMCA	Air Moving and Conditioning Association
ANSI	American National Standards Institute
APA	American Plywood Association
API	American Petroleum Institute
AREA	American Railway Engineering Association
ARI	Air Conditioning and Refrigeration Institute
ASAE	American Society of Agricultural Engineers
ASCE	American Society of Civil Engineers
ASHRAE	American Society of Heating, Refrigerating and Air Conditioning Engineers, Inc.
ASME	American Society of Mechanical Engineers
ASSE	American Society of Sanitary Engineers
ASTM	American Society for Testing and Materials
AWI	Architectural Woodwork Institute

DIVISION 01 00 00 - GENERAL REQUIREMENTS	SECTION 01 19 00 ABBREVIATIONS AND REFERENCE STANDARDS

AWPA	American Wood Preservers' Association
AWPB	American Wood Preservers' Bureau
AWPI	American Wood Preservers' Institute
AWS	American Welding Society
AWWA	American Water Works Association
BHMA	Builders Hardware Manufacturers' Association
CBMA	Certified Ballast Manufacturers' Association
CDA	Copper Development Association
CGA	Compressed Gas Association
CISPI	Cast Iron Soil Pipe Institute
CMAA	Crane Manufacturers' Association of America
CRSI	Concrete Reinforcing Steel Institute
FGMA	Flat Glass Marketing Association
FM	Factory Mutual
Fed Spec.	Federal Specifications
FS	Federal Specification
GA	Gypsum Association
HI	Hydraulic Institute
HMI	Hoist Manufacturers' Institute
IBC	International Building Code
ICBO	International Conference of Building Officials
ICEA	Insulated Cable Engineers' Association
IEEE	Institute of Electrical and Electronics Engineers, Inc.
IES	Illuminating Engineering Society of North America
ISA	Instrument Society of America
JIC	Joint Industry Conferences of Hydraulic Manufacturers
MIA	Marble Institute of America
Mil.Sp.	Military Specification
MS	Military Specifications
MMA	Monorail Manufacturers' Association
NAAMM	National Association of Architectural Metal Manufacturers
NBHA	National Builders' Hardware Association
NEC	National Electrical Code
NEMA	National Electrical Manufacturers' Association
NESC	National Electrical Safety Code
NFPA	National Fire Protection Association
NHLA	National Hardwood Lumber Association
NLMA	National Lumber Manufacturers' Association
NSF	National Sanitation Foundation
NTMA	National Terrazzo and Mosaic Association
NWMA	National Woodwork Manufacturers' Association
OECI	Overhead Electrical Crane Institute
OSHA	Occupational Safety and Health Act (Federal and State)
PEI	Porcelain Enamel Institute
PS	Product Standards Section-U.S. Department of Commerce

DIVISION 01 00 00 - GENERAL REQUIREMENTS

SECTION 01 19 00
ABBREVIATIONS AND
REFERENCE STANDARDS

RLM	RLM Standards Institute, Inc.
RMA	Rubber Manufacturers' Association
SAE	Society of Automotive Engineers
SDI	Steel Deck Institute
SDI	Steel Door Institute
SIGMA	Sealed Insulating Glass Manufacturing Association
SJI	Steel Joist Institute
SMACNA	Sheet Metal and Air Conditioning Contractors National Association
SSPC	Steel Structures Painting Council
SWI	Steel Window Institute
TEMA	Tubular Exchanger Manufacturers' Association
TCA	Tile Council of America
UBC	Uniform Building Code
UFC	Uniform Fire Code
UL	Underwriters' Laboratories, Inc.
WCLIB	West Coast Lumber Inspection Bureau
WWPA	Western Wood Products Association

PART 2 PRODUCTS (NOT USED)

PART 3 EXECUTION (NOT USED)

END OF SECTION 01 19 00

DIVISION 01 00 00 - GENERAL REQUIREMENTS

PART 1 GENERAL

1.01 SCOPE

- A. This section describes the method of measurements and basis of payment for all work covered by the Contract Documents.
- B. For the purposes of this Contract, this Measurement and Payment Section shall govern and take precedence over all other references to measurement and payment (with exception to the Supplementary Provisions and any addenda) referenced in these specifications or the MAG Uniform Standard Specifications.

1.02 GENERAL REQUIREMENTS REGARDING BID PRICES

- A. The bid price for each item of the Contract in the Bid Form shall cover all work shown on the Drawings and required by the specifications and other Contract Documents. All costs in connection with the work, including furnishing all materials, equipment, supplies and appurtenances; providing all required construction support plants, equipment, and tools; and performing all necessary labor, testing, and supervision to fully complete the work, shall be included in the unit and/or lump sum bid prices in the Bid Form. The amounts shown on the Bid Form shall be the Contract Price.
- B. No item that is required by the Contract Documents for the proper and successful completion of the work will be paid for outside of, or in addition to, the prices submitted in the bid. All work not specifically set forth as a pay item in the Bid Form shall be considered a subsidiary obligation of the Contractor and all costs in connection therewith shall be included in the prices bid.

1.03 OWNER CONTINGENCY ALLOWANCE

- A. The Bid Form includes a stipulated price for use upon Owner's concurrence and instruction as a contingency allowance. Contractor's cost for products, delivery, installation, labor, insurance, payroll, taxes, bonding, equipment rental, overhead, and profit will be included in Change Orders authorizing expenditure of funds from this contingency allowance.
- B. Funds will be withdrawn from contingency allowance only by Change Order. At closeout of Contract, funds remaining in the contingency allowance will be credited to Owner by a final Change Order.

1.04 ESTIMATED QUANTITIES

- A. All estimated quantities stipulated in the Bid Form or other Contract Documents are approximate and are to be used; (1) only as a basis for

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estimating the probable cost of the work and (2) for the purpose of comparing the bids submitted for the work.

- B. The actual amounts of work done and materials furnished under unit price items may differ from the estimated quantities. The basis of payment for work and materials will be the actual amount of work done and materials furnished to the pay lines defined in this section. The Contractor agrees that they will make no claim for damages, anticipated profits, or otherwise on account of any difference between the amount of work actually performed and materials actually furnished and the estimated amounts herein except as allowed in the Contract Documents.

1.05 SURVEYS AND MEASUREMENTS

- A. All quantity measurements shall be the responsibility of the Contractor, and will be checked by the Owner and Engineer.

1.06 METHOD OF MEASUREMENT

- A. No measurement of lump sum bid items contained in this Contract will be made.
- B. Measurement of unit price items contained in this Contract will be made in the field by the Contractor and will be verified by the Owner or Engineer.

1.07 BASIS OF PAYMENT

- A. Base Bid: The bid for the work in this Contract is a lump sum bid for all construction activities and material required to complete the work described in the Contract Documents. The lump sum bid price is broken down into the following items for the purpose of progress payments and for the information of the Owner. Payment shall be at the lump sum price bid for each item. Payment for the items shall include all labor, materials, equipment, and incidentals required to complete the item. Lump sum bid items will be paid on a periodic basis in an amount equal to the percentage of the total work deemed complete by the Engineer. The work included in each item is more completely described below:

Item 1 - Mobilization/Demobilization shall include moving equipment and other necessary work items to and from the project site. This item shall also include a temporary project sign. Payment will be at the lump sum contract price with 60 percent to be paid on the first progress payment and 40 percent paid on the final progress payment following completion and acceptance of the work. The bid price for this item cannot exceed three (3) percent of the total bid.

DIVISION 01 00 00 - GENERAL REQUIREMENTS

Item 2 - Taxes, Bonds, and Insurance. This item shall be limited to a maximum of four (4) percent of the Base Bid Amount and shall include any and all taxes, bonds, and insurance costs in relation to this project together with any fees, permits, licenses, and/or other incidental regulatory costs assessed by local, state or Federal agencies as required for successful completion of this project. Payment shall be at the contract lump sum price and will be paid 100 percent upon mobilizing to the begin construction.

Item 3 - General Requirements. This item includes project coordination; scheduling; submittals; quality control; construction facilities and temporary controls; safety at the site; environmental quality control; stormwater and other permits; product shipment, handling, storage, and protection; manufacturer's services; operation and maintenance manuals; completed Record Drawings; final cleanup and contract closeout; complete. Progress payments for the work in this item will be made according to the following schedule:

Amount of Construction	For Payment, the Cumulative Percentage of the Amount in the Bidder's Breakdown for the Work under
<i>Time Expended</i>	<i>This Section Will Equal</i>
30 days	15 percent
60 days	30 percent
Remainder of Project	Equal monthly disbursements for the remainder of the project.

Items 4 to 19. All of these items are lump sum bid items with payment to be at the lump sum contract price. The price shall include all labor, materials, sitework, concrete, metals, thermal and moisture protection, finishes, specialties, HVAC, mechanical, electrical, earthwork, exterior improvements, process interconnections, process liquid and gas handling, equipment demolishing, removal and abandonment of items, etc. as applicable to complete the Work. A partial payment of up to no more than 90 percent will be allowed for work completed, but not yet tested (i.e. earthwork, concrete, concrete basins, pipelines, equipment, electrical, etc.).

Item 20 – Owner Contingency. This item includes the provisions for work as outlined in Section 9.33 of Volume 1

PART 2 PRODUCTS (NOT USED)

PART 3 EXECUTION (NOT USED)

END OF SECTION 01 29 76

PART 1 GENERAL**1.01 SECTION INCLUDES**

- A. Submittal procedures.
- B. Substitutions.
- C. Construction progress schedules.
- D. Proposed products list.
- E. Shop drawings.
- F. Product data.
- G. Samples and test specimens.
- H. Quality control submittals.
- I. Manufacturers' instructions.
- J. Manufacturers' certificates.

1.02 RELATED SECTIONS

- A. Article 8 – General Conditions of Volume 1
- B. Section 01 40 00, QUALITY CONTROL: Manufacturer's field services and reports.
- C. Section 01 77 00, CONTRACT CLOSEOUT: Contract closeout submittals.
- D. Individual specification sections in these Contract Documents contain additional and special submittal requirements. Individual sections shall take precedence in the event of a conflict with this section.

1.03 SUBMITTAL PROCEDURES

- A. These requirements supplement and are in addition to requirements in Article 8.51 and Article 9.11, Volume 1.
- B. Submittal Register: The Contractor shall submit to the Engineer a register indicating the required submittal data and Contractor's proposed submittal dates for all equipment and materials for which a submittal is required by individual specifications. It is the Contractor's responsibility to ensure that the register is complete. The completed register shall be submitted to the

Engineer by the Contractor within fifteen (15) working days after the date of the Notice of Award.

C. General Procedures:

1. Procedures and requirements for submittals are specified herein. Owner reserves the right to modify the procedures and requirements for submittals, as necessary to accomplish the specific purpose of each submittal. Direct all inquiries to Engineer regarding the procedure, purpose, or extent of any submittal.
2. Review, acceptance, or approval of substitutions, schedules, shop drawings, lists of materials, and procedures submitted or requested by Contractor shall not add to the Contract Price amount, and additional costs which may result therefrom shall be solely the obligation of Contractor. Where Contractor suggests use of a substitution, he must demonstrate why the substitution is in the Owner's best interest and pay all associated costs for re-engineering, as required.
3. Owner is not precluded, by virtue of review, acceptance, or approval, from obtaining a credit for construction savings resulting from allowed concessions in the work or materials, therefore.
4. Owner is not responsible to provide Engineering or other services to protect Contractor from additional costs accruing from submittals.
5. Submittals processed by Engineer do not become Contract Documents and are not Change Orders; the purpose of submittal review is to establish a reporting procedure and is intended for Contractor's convenience in organizing the work and to permit Engineer to monitor Contractor's progress and understanding of the design.
6. Submittals will be acted on by the Engineer as promptly as possible and returned to the Contractor not later than the time allowed for review in the Paragraph entitled SPECIFIC SUBMITTAL PROCEDURES. Delays caused by the need for resubmittal shall not constitute basis for claim or for an extension of contract time.
7. After checking and verifying all field measurements, make submittals to Engineer, in accordance with the submittal register for review.
 - a. Submittals shall bear a stamp or specific written indication that Contractor has satisfied its responsibilities under the Contract Documents with respect to the review of the submittal.

- b. Data shown shall be complete with respect to quantities, dimensions, specified performance and redesign criteria, materials, and similar data to enable Engineer to review the information.
 - c. Submitted data shall be fully sufficient in detail for determination of compliance with the Contract Documents.
- 8. Before submission of each submittal, determine and verify quantities, dimensions, specified performance criteria, installation requirements, materials, catalog numbers, and similar data with respect thereto; review and coordinate each submittal with other submittals, requirements of the work, and Contract Documents.
- 9. At the time of each submission, provide mark-ups of the technical specification indicating each variation that the submittal may have from the requirements of the Contract Documents; if variations are not listed, it is assumed that the submitted equipment meets the specification. In addition, make specific notation on each shop drawing submitted to Engineer for review and approval of each such variation.
- 10. Engineer's review will be only for conformance with the design concept of the project and for compliance with the information given in the Contract Documents, not extending to means, methods, techniques, sequences, or procedures of construction (except where a specific means, method, technique, sequence, or procedure of construction is indicated in or required by the Contract Documents) nor to safety precautions or programs incident thereto. The review of a separate item as such will not indicate review of the assembly in which the item functions.
- 11. Engineer's review of submittals shall not relieve Contractor from responsibility for any variation from the requirements of the Contract Documents unless Contractor has in writing called Engineer's attention to each such variation at the time of submission, and Engineer has given written approval of each such variation by a specific written notation thereof incorporated in or accompanying the shop drawing or sample approval; nor will any approval by Engineer relieve Contractor from responsibility for errors or omissions in the shop drawings or from responsibility for having complied with the provisions therein.
- 12. Where a shop drawing or sample is required by the Specifications, related work performed prior to Engineer's review and approval of the pertinent submission shall be the sole expense and responsibility of Contractor.

13. Should the Contractor propose any item on his shop drawings, or incorporate an item into the work, and that item should subsequently prove to be defective or otherwise unsatisfactory, (regardless of the Engineer's preliminary review), the Contractor shall, at his own expense, replace the item with another item that will perform satisfactorily.
14. Review of first submittal and one resubmittal will be performed by the Engineer at no cost to the Contractor. Subsequent submittals will be reviewed by the Engineer; however, the Engineer will document the work-hours and other expenses required for such review(s) and the Contractor shall reimburse the Owner for the charges of the Engineer with a deduction from the Contractor's monthly pay estimate.

D. Specific Submittal Procedures:

1. Contractor may choose to use an Internet-based submittal service such as Procore or ConDoc. Use of such a service shall not relieve the Contractor from complying with the submittal procedures specified herein.
2. Submittals by Contractor shall be transmitted as a PDF file (as defined below).
 - a. If an Internet-based submittal service is not used, for large shop drawing files greater than 20MB, submittals shall be made to an FTP site.
 - b. Review comments and resubmittals are to be provided electronically, after which a minimum of two hard copies of the final and approved shop drawings are submitted for distribution. Distribution would be to the Engineer and Owner.
 - c. Submittals shall be an electronic file in Adobe Acrobat Portable Document File (PDF) format created directly to PDF (preferred) or via scans of the hard copy. Scans must be legible.
 - d. Electronic files that contain more than 10 pages in PDF format shall contain internal bookmarks linked from an index page to major sections of the document.
 - e. General submittal information shall be added to each PDF file, including project, subject, submittal number, supplier, and keywords.
 - f. PDF files shall be set up to print legibly at 8.5-inch by 11-inch, 11-inch by 17-inch, or 22-inch by 34-inch. No other paper sizes will be accepted.

- g. New electronic files shall be submitted for each resubmittal, i.e., resubmit entire submittal when individual pages or portions thereof are modified.
- 3. Combine submittals specified in each Specification section into a single package. Partial packages will not be reviewed until all submittals required for the section have been received. If Contractor requests review of a partial submittal and Engineer accepts to assist the Contractor, all subsequent submittals shall be treated as re-submittals and the Contractor will be charged for review of the second and any subsequent re-submittals.
- 4. The shop drawings shall be accurate, distinct, and complete, and shall contain all required information, including satisfactory identification of items, units, and assemblies in relation to the Contract Drawings and Specifications, and as specified further hereinafter.
- 5. Transmit each submittal with an Engineer accepted form signed and dated by the Contractor.
- 6. Number the transmittal forms by specification number with a sequential suffix for each resubmittal.
- 7. Identify project, Contractor, subcontractor or supplier; pertinent Drawing sheet and detail number(s), and Specification section number, as appropriate.
- 8. Apply Contractor's stamp, signed or initialed certifying that review, verification of products required, field dimensions, adjacent construction work, and coordination of information is in accordance with the requirements of the work and Contract Documents.
- 9. Deliver hard copy submittals to Morrison-Maierle, Jason C. Mercer, P.E., 1 Engineering Place, Helena, Montana 59602. Coordinate submission of related items.
- 10. Identify variations from Contract Documents and product or system limitations which may be detrimental to successful performance of the completed work.
- 11. Revise and resubmit submittals as required, identify all changes made since previous submittal.
- 12. Distribute copies of reviewed submittals to concerned parties. Instruct parties to promptly report any inability to comply with provisions.

13. Submittals will be acted upon by Engineer and transmitted to Contractor not later than 21 regular working days after receipt by Engineer. Shop drawings shall be submitted in sufficient time to allow the Engineer not less than 21 regular working days for examining the shop drawings.
14. When shop drawings have been reviewed by the Engineer, one PDF copy will be returned to the Contractor appropriately annotated.
 - a. If major changes or corrections are necessary, shop drawing may be rejected and PDF will be returned to the Contractor with such changes or corrections indicated.
 - b. Correct and resubmit the shop drawings in the same manner and quantity as specified for the original submittal, unless otherwise directed by the Engineer. If changes are made by the Contractor (in addition to those requested by the Engineer) on the resubmitted shop drawings, such changes shall be clearly explained in a transmittal letter accompanying the resubmitted shop drawings.

1.04 SUBSTITUTIONS

- A. Where items of equipment and materials are identified herein by a manufacturer's name, model, or catalog number followed by the words "or equal" or "or approved equal," Contractor must obtain Engineer's approval as required by the General Conditions.
- B. Note that use of an "or equal" item shall not increase the cost to the Owner or increase contract times.
- C. If using a "substitute," note that Contractor shall be responsible for any costs resulting from a change in Contract Documents, design change, Engineer's review and evaluation in accordance with the General Conditions.

1.05 CONSTRUCTION PROGRESS SCHEDULES

- A. Submit initial progress schedule in duplicate within 15 days after date of Owner's Notice of Award for the Engineer's review.
- B. Submit revised schedules with each Application for Payment, identifying changes since previous version.
- C. Submit a Critical Path Method (CPM) chart with separate line for each major section of work or operation, identifying first work day of each week.

- D. Show complete sequence of construction by activity, identifying work of separate stages and other logically grouped activities. Indicate the early and late start, early and late finish, float dates, critical path, and duration.
- E. Indicate estimated percentage of completion for each item of work at each submission.
- F. Indicate submittal dates required for shop drawings, product data, samples, and product delivery dates.

1.06 PROPOSED PRODUCTS LIST

- A. Within 14 calendar days after date of Owners Notice of Award, submit complete list of major products proposed for use, with name of manufacturer, trade name, and model number of each product.
- B. For products specified only by reference standards, give manufacturer, trade name, model or catalog designation, and reference standards.
- C. Should the Contractor elect to substitute a proposed equivalent material to an "or equal" or "or approved equal" specification, the Contractor shall submit to the Engineer adequate documentation allowing the Engineer to determine the equivalency of the material. Contractor shall pay Engineer for costs incurred by Engineer in reviewing the proposed substitution for any substitutions that do not meet the specifications.

1.07 SHOP DRAWINGS

These requirements supplement and are in addition to requirements in Article 8.51, Volume 1.

A. General:

- 1. The Contractor shall submit shop drawings, equipment and materials data as required in the Technical Provisions of these specifications concerning the specific item as soon as practical. The Contractor may proceed, only at his own risk, with manufacture or installation of any equipment or work covered by said drawings, etc. until they are approved, and no claim, by the Contractor, for extension of the contract time will be granted by reason of his failure in this respect.
- 2. Shop drawings, as defined herein, consist of all drawings, diagrams, illustrations, schedules, and other data which are specifically prepared by or for Contractor to illustrate some portion of the work; and all illustrations, brochures, standard schedules, performance charts, instructions, diagrams, and other information prepared by a

manufacturer and submitted by Contractor to illustrate material or equipment for distinct portions of the work.

3. Submittal of incomplete or unchecked shop drawings will not be acceptable. Shop drawing submittals which do not clearly show Contractor's review stamp or specific written indication of Contractor review will be returned to Contractor for resubmission.
 4. Submittal of shop drawings not required under these Contract Documents and not shown on the Submittal Register will be returned to the Contractor unreviewed and unstamped by the Engineer.
- B. Stamp of Approval: All drawings, equipment, materials, and other submitted data shall be carefully reviewed by an authorized representative of the Contractor prior to submission to the Engineer. Each submittal shall be dated, signed, and certified by the Contractor, as being correct and in strict conformance with the Contract Documents. No consideration for review by the Engineer of any Contractor submittals will be made for any items which have not been so certified by the Contractor. All non-certified submittals will be returned to the Contractor without action taken by the Engineer, and any delays caused thereby shall be the total responsibility of the Contractor.
- C. Shop Drawing Contents:
1. Shop drawings referred to herein shall include shop drawings and other submittals for both shop and field-fabricated items. The Contractor shall submit, as applicable, the following for all prefabricated or manufactured structural, mechanical, electrical, plumbing, process systems, and equipment:
 - a. Shop drawings or equipment drawings, including dimensions, size and location of connections to other work, and weight of equipment.
 - b. Catalog information and cuts.
 - c. Installation and/or placing drawings for equipment, drives, and bases.
 - d. Supporting calculations for equipment and associated supports specified to be designed by equipment manufacturers or suppliers.
 - e. Wiring and control diagrams of systems and equipment.
 - f. Complete manufacturer's specifications, including materials description and paint systems.
 - g. Complete motor rating for all motors 5 horsepower and larger, including motor no-load, starting, and full-load current at rated voltage; full-load speed and current at 110 percent voltage; motor efficiency and power factor at 1/2, 3/4, and full-load at rated voltage.

- h. List of special motor features being provided (i.e. space heater, altitude corrections, thermal protectors, etc.).
 - i. Performance data and pump or mixer performance curves.
 - j. Suggested spare parts list with current price information.
 - k. List of special tools required for checking, testing, parts replacement, and maintenance (special tools are those which have been specially designed or adapted for use on parts of the equipment, and which are not customarily and routinely carried by maintenance mechanics).
 - l. List of special tools furnished with the equipment.
 - m. List of materials and supplies required for the equipment prior to, and during startup.
 - n. List of materials and supplies furnished with the equipment.
 - o. Samples of finish colors for selection.
 - p. Special handling instructions.
 - q. Requirements for storage and protection prior to installation.
 - r. Requirements for routine maintenance prior to startup.
 - s. List of all requested exceptions to the Contract Documents.
- D. Where the Drawings or individual specifications require that the shop drawings or specific design calculations be certified by an Engineer, the shop drawings or design calculations shall be stamped, signed, and dated by a Professional Engineer registered in the State of Arizona, or the state where the specific item is to be manufactured. Submittals missing the stamp, signature and/or date will be rejected and must be re-submitted.
- E. Interfacing Work: Where called for in the Specifications, and as determined necessary by Engineer to provide proper correlation with other work, complete interface information shall be submitted. This interface information shall be accurate and contain all information necessary to allow for manufacturing and construction of the interfacing or connecting work.

1.08 PRODUCT DATA

- A. Where required in the Specifications and as determined necessary by Engineer, submit product data for review for assessing conformance with the information given and design concept expressed in the Project Manual.
- B. Product data may be catalog cuts, sheets, or other similar information provided from the manufacturer. Mark each copy to identify the applicable products, models, options, reference standards, and other data. Supplement manufacturer's standard data to provide information specific to the project. Indicate product utility and electrical characteristics, utility and electrical connection locations and requirements, and other similar information for functional equipment and appliances.

- C. For products specified only by reference standards, indicate the manufacturer, trade name, model or catalog designation, and applicable standard(s).

1.09 SAMPLES AND TEST SPECIMENS

- A. Where required in the Specifications and as determined necessary by Engineer, submit test specimens or samples of materials, appliances, and fittings to be used or offered for use in connection with the work. Include information as to their sources, prepay cartage charges, and submit such quantities and sizes for proper examination and tests to establish the quality or equality thereof, as applicable.
- B. Submit samples and test specimens in ample time to enable Engineer to make tests or examinations necessary, without delay to the work.
- C. Submit additional samples as required by Engineer to ensure equality with the original approved sample and/or for determination of Specification compliance.
- D. Approved sample items (fixtures, hardware, etc.) may be incorporated into the work upon approval and when no longer needed by Engineer for reference.

1.10 QUALITY CONTROL SUBMITTALS

- A. Quality control submittals shall be made in accordance with Section 01 40 00, QUALITY CONTROL and the following requirements in this article.
- B. Manufacturer Certificates: When specified in individual specification Sections, submit manufacturer's certificate to the Engineer for review.
 - 1. Indicate that the material or product conforms to or exceeds specified requirements. Submit supporting reference data, affidavits, and certifications as appropriate.
 - 2. Certificates may be recent or previous test results on the material or product, but must be acceptable to Engineer.
 - 3. Wherever an item is specified as per industry standard, provide manufacturer's certification of compliance regardless of whether or not specifically called for.
- C. Manufacturer's Certification of Proper Installation: Where manufacturer's certification of proper installation is required in the Specifications, the manufacturer shall provide certification stating the following:

1. The product or system has been installed in accordance with the manufacturer's recommendations.
 2. The product or system has been inspected by a manufacturer's authorized representative.
 3. Applicable safety equipment has been properly installed.
 4. Proper electrical and mechanical connections have been made.
 5. The product or system has been serviced with the proper lubricants.
 6. Proper adjustments have been made and the product or system is ready for functional testing, startup, and operation.
 7. Compliance with all specified standards.
- D. Functional Test Certification: Where a certification of functional testing is specified for certain facilities or equipment, Contractor (as applicable to the facilities or equipment furnished) shall state in writing that:
1. Necessary hydraulic structures, piping systems, valves, and similar facilities have been successfully tested.
 2. Necessary equipment systems and subsystems have been checked for proper installation, started, and successfully tested to indicate they are operational.
 3. Adjustments and calibrations have been made.
 4. The systems and subsystems are capable of performing their intended functions.
 5. The facilities are ready for performance testing, or for startup and intended operation, as applicable.
 6. The manufacturer has reviewed and acknowledged this certification. Where several manufacturers have furnished equipment in a system, obtain each manufacturer's review and acknowledgment of its respective equipment as part of a functional test for the overall system.
- E. Performance Test Reports: Prepare and submit performance test reports where specified for equipment and systems.
- F. Certification of Compliance:

1. Where specified, furnish certification of compliance for products specified to a recognized standard or code prior to the use of such products in the work.
 - a. Engineer may permit use of certain materials or assemblies prior to sampling and testing if accompanied by a certification of compliance.
 - b. Certifications shall be signed by the manufacturer of the product; state that the components involved comply in all respects with the requirements of the Specifications.
 - c. Furnish certification of compliance with each lot delivered to the jobsite and clearly identify the lot so certified.
2. Products used on the basis of a certification of compliance may be sampled and tested at any time. The fact that a product is used on the basis of a certification of compliance shall not relieve Contractor of responsibility for incorporating products in the work which conforms to requirements of the Contract Documents. Products not conforming to such requirements will be subject to rejection whether in-place or not.
3. Engineer reserves the right to refuse permission for use of products on the basis of a lack of a certification of compliance.

1.11 MANUFACTURER'S INSTRUCTIONS

- A. Refer to Section 01 77 00, CONTRACT CLOSEOUT for detailed instructions regarding installation, operation, and maintenance manuals.
- B. Submit manufacturer's printed instructions for delivery, storage, assembly, installation, start-up, adjusting, and finishing prior to, or with, the shipment of all equipment and other major construction items (piping, valves, gates, tanks, mechanical and electrical panels, etc.).
- C. Identify conflicts between manufacturer's instructions and Contract Documents.
- D. Indicate special procedures, perimeter conditions requiring special attention, and special environmental criteria required for application or installation.

PART 2 PRODUCTS (NOT USED)

PART 3 EXECUTION (NOT USED)

END OF SECTION 01 33 00

PART 1 GENERAL**1.01 SECTION INCLUDES**

- A. Quality assurance and control of installation.
- B. Tolerances.
- C. References.
- D. Testing and Special Inspections.
- E. Product standardization and installation.
- F. Cleaning during construction.

1.02 RELATED SECTIONS

- A. SECTION 01 33 00, Submittals. See information regarding Manufacturer's Instructions and Certificates.
- B. Individual specifications.

1.03 GENERAL

- A. Provide all testing and Special Inspections in accordance with the General Conditions and other technical specifications in the Contract Documents.

1.04 QUALITY ASSURANCE/CONTROL OF INSTALLATION

- A. Monitor quality control over suppliers, manufacturers, products, services, site conditions, and workmanship, to produce work of specified quality.
- B. Comply fully with manufacturers' instructions, including each step in installation or construction sequence.
- C. Should the manufacturers' instructions conflict with the Contract Documents, request a clarification from the Engineer before proceeding.
- D. Comply with all specified standards as a minimum quality for the work except when more stringent tolerances, codes, or specified requirements indicate higher standards or more precise workmanship.
- E. Perform work by person qualified to produce workmanship of specified quality.
- F. Supervise performance of all work in such manner and by such means to ensure that the work, whether completed or in progress, will not be

subjected to harmful, dangerous, damaging, or otherwise deleterious exposure during construction period.

- G. Products, materials, and equipment may be subject to inspection by Engineer and Owner at place of manufacture or fabrication. Such inspection shall not relieve Contractor of complying with the requirements of the Contract Documents.
- H. Secure products in place as recommended by manufacturer with proper anchorage devices designed and sized to withstand pressures, vibration, physical distortion or disfigurement.

1.05 TOLERANCES

- A. Monitor fabrication and installation tolerance control of products to produce acceptable work. Do not permit tolerances to accumulate.
- B. Comply with manufacturers' recommended tolerances and tolerance requirements in reference standards. When such tolerances conflict with the Contract Documents, request clarification from Engineer before proceeding.
- C. Adjust products to appropriate dimensions; position before securing products in place.

1.06 REFERENCES

- A. Conform to reference standards by the date of current issue as of the date for receiving Bids except where a specific date is established by code or as specially noted in these Specifications or the Drawings.
- B. Obtain copies of standards and maintain on site when required by the Contract Documents.
- C. For products or workmanship specified by association, trade, or other consensus standards, comply with the requirements of the standards except when more stringent requirements are specified in the Contract Documents or are required by code.
- D. Should the requirements of specified reference standards conflict with the Contract Documents, request clarification from the Engineer before proceeding.
- E. The contractual relationship, duties, or responsibilities of the parties to the Contract, nor those of the Engineer, shall not be altered from the Contract Documents by mention or inference in any reference documents.

1.07 TESTING AND SPECIAL INSPECTIONS**A. General:**

1. Testing and inspections shall be provided as required by the Drawings and Specifications and in accordance with the General Conditions. The following summarizes testing and inspection responsibilities and requirements, but the General Conditions, individual materials and equipment specifications, and the Drawings must be consulted for complete and detailed testing and inspection requirements.

B. Owner Provided Quality Assurance Testing and Special Inspections:

1. Where explicitly stated by the Drawings or Specifications, the Owner will retain a qualified inspector or testing agency to perform the specified Special Inspections or quality assurance testing. If not explicitly stated in the Drawings or Specifications that the Owner is providing quality assurance testing, it shall be the Contractor's responsibility to provide this testing.
2. The Contractor shall be responsible for coordinating with the Engineer and Owner and scheduling the testing and Special Inspections to ensure that inspections are completed as required by the Drawings and Specifications and in accordance with the General Conditions.
3. Assure that Owner and Engineer and their quality assurance agency have access to all work areas at all times work is in progress.

C. Contractor Provided Testing:

1. With the exception of the explicitly specified Owner provided Special Inspections and quality assurance testing, the Contractor shall be responsible for and pay for all testing required to control contractor production and construction processes and as required by the Drawings and Specifications. The Contractor shall notify the Engineer when the Work is ready for quality control testing to allow Engineer's representative to witness the testing.
2. All Contractor testing, except leakage testing, pressure testing, and most equipment startup testing, shall be performed by an independent, certified testing laboratory paid for by the Contractor and approved by the Owner and Engineer. All test results shall be provided to the Engineer and the Contractor shall provide written authorization to the testing laboratory to release test results to the Engineer. A copy of this authorization shall be submitted to the

Engineer prior to construction startup. The Engineer shall have the authority to select when and where tests are taken (i.e. select concrete truck(s), areas of backfill for density, etc.). However, this does not relieve the Contractor from the requirement of giving reasonable notice that Work is ready for inspection.

3. The Contractor shall be responsible for all labor and materials associated with the filling, flushing, and hydrostatic and leakage testing of all pipelines, structures, tanks, and other appurtenances. Hydrostatic and leakage testing shall be conducted in the presence of the Engineer/Owner.
- D. The Engineer reserves the right to conduct additional testing to assure compliance with the specifications.
 - E. Tests made by the Owner or the Engineer will not relieve the Contractor from his obligation to perform the work in accordance with the Technical Specifications.
 - F. All laboratory and material test results shall be submitted to the Owner and Engineer for review and approval prior to incorporation into the work, or covering of the tested material or work.
 - G. Testing and Work results not meeting requirements or found to be defective shall be re-tested, repaired, or replaced at the Contractor's expense.
 - H. The Contractor shall be responsible for material mix designs and testing including, but not necessarily limited to:
 1. Gradation, liquid limit, plasticity index and moisture/ density tests for native soil backfill, imported soil backfill, imported bedding, and aggregate base and sub-base courses.
 2. In-place density tests of compacted soil backfill.
 3. Gradation and fracture tests for base and surfacing aggregates.
 4. Portland Cement concrete and asphaltic concrete pavement mix designs.
 5. Concrete strength cylinder tests.
 6. Marshall field stability tests and core sample density tests of asphalt concrete.
 7. Test failure as provided hereinbefore.

8. Pressure tests of water and other pipelines including cleaning and flushing.
9. Concrete water holding structure leakage tests.
10. Equipment performance and/or functional tests.
11. HVAC equipment testing and balancing.

1.08 PRODUCT STANDARDIZATION AND INSTALLATION

- A. Like items of products furnished and installed throughout the project shall be end products of one manufacturer to achieve standardization for appearance, operation and maintenance, spare parts and replacement, and manufacturers' services.
- B. Obtain manufacturers' services for installation and testing of products as specified in each product or equipment specification, and in accordance with Section 01 66 40, MANUFACTURER'S SERVICES.
- C. Installation of materials and equipment shall be as specified in the Contract Documents and as follows:
 1. In conformance with the manufacturer's written instructions.
 2. On concrete bases of proper size determined by equipment dimensions and at least 3 inches wider and longer than equipment baseplate, unless specified otherwise.
 3. With anchor bolts accurately placed using templates.

PART 2 PRODUCTS (NOT USED)**PART 3 EXECUTION****3.01 MINIMUM CONTRACTOR PROVIDED TESTING REQUIREMENTS**

- A. Minimum quality control testing provided by the Contractor shall include but not be limited to:
 1. Subgrade and Crushed Base Course Materials and Compaction Testing: Unless specified otherwise, provide at least one field density test for each 1000 square feet of subgrade prior to placing any fill and provide at least one field density test for each 1000 square feet of every compacted backfill layer prior to placing another level of fill.
 2. One moisture density curve for each type of backfill material used, with sieve analysis and plasticity index.

3. Concrete Strength Cylinder Tests: As specified in Section 03 30 00, CONCRETE and Section 43 41 65, TYPE III CONCRETE CLARIFIER.
4. Asphaltic Concrete Testing: As specified in Section 32 12 16, ASPHALT CONCRETE PAVEMENT.
5. Process Equipment Factory and Functional Testing: As specified in specific Division 43 00 00 and Division 46 00 00 equipment Sections.
6. Supervisory Control And Data Acquisition (SCADA) System Component and System Testing.
7. Pipeline Leakage/Pressure Testing: Provide for all new pipes as specified in Section 40 05 10, PIPING – GENERAL.
8. Leakage Testing of Clarifier: As specified in Section 43 41 65, TYPE III CONCRETE CLARIFIER.
9. Leakage Testing: All other new wastewater holding structures/basins as specified in Section 03 30 00, COONCRETE.
10. HVAC Equipment: As specified in Division 23 00 00 equipment Sections.

3.02 CLEANING DURING CONSTRUCTION

- A. During execution of work, clean site and public properties and dispose of waste materials, debris, and rubbish to assure that buildings, grounds, roads, and public properties are maintained free from accumulations of waste materials.
- B. Wet down dry materials and rubbish to prevent blowing dust.
- C. Provide approved containers for collection and disposal of waste material, debris, and rubbish.
- D. Remove grease, dust, dirt, stains, labels, fingerprints, and other foreign materials from exposed and partially exposed surfaces.
- E. Repair, patch, and touch up marred surfaces to specified finish and to match adjacent surfaces.
- F. Vacuum clean interior building areas when ready to receive finish painting, and continue vacuum cleaning as needed until building is ready for substantial completion or occupancy.

- G. Vacuum clean all interior spaces, including inside cabinets. Broom clean paved surfaces and rake clean other surfaces of grounds.
- H. Handle materials in a controlled manner with as few handlings as possible; do not drop or throw materials from heights.
- I. Schedule cleaning operations so that dust and other contaminants resulting from cleaning process will not fall on wet, newly painted surfaces.
- J. Use only cleaning materials recommended by manufacturer of surfaces to be cleaned. Use cleaning materials only on surfaces recommended by cleaning material manufacturer.

END OF SECTION 01 40 00

SECTION 01 50 00
CONSTRUCTION FACILITIES
AND TEMPORARY CONTROLS

DIVISION 01 00 00 - GENERAL REQUIREMENTS

PART 1 GENERAL

1.01 SECTION INCLUDES

- A. Temporary utilities required during construction.
- B. Temporary construction facilities, including access roads, field offices, and storage facilities.
- C. Requirements for security and protection of facilities and property.
- D. Requirements for traffic regulation and access to the work.

1.02 RELATED WORK SPECIFIED UNDER OTHER SECTIONS

- A. See the Volume 1 for jobsite safety requirements.
- B. See Section 01 11 00, SUMMARY OF WORK and Section 01 14 16, COORDINATION AND SITE CONDITIONS for site protection requirements.
- C. See Volume 1 for temporary controls for protection of the environment during construction.
- D. See Section 01 40 00, QUALITY CONTROL for cleaning during construction.
- E. See Section 02 01 90, MOVE IN AND SITE PREPARATION for additional information pertaining to the coordination and work necessary to move in personnel and equipment; set up all temporary offices, buildings, facilities, storage areas, and utilities; and prepare the site for construction.

1.03 MOBILIZATION AND STAGING

- A. Use area designated for Contractor's temporary facilities as shown as the staging area on Drawings. Arrange and pay for additional area if needed for construction operations, as acceptable to Owner, Engineer, and adjacent property owners.
- B. Notify Owner of obstructions not shown or not readily apparent by visual inspection of the staging area. If such obstructions adversely affect Contractor's operations, proper adjustment to Contract will be considered. Do not remove obstructions without Owner's prior consent.

SECTION 01 50 00
CONSTRUCTION FACILITIES

DIVISION 01 00 00 - GENERAL REQUIREMENTS AND TEMPORARY CONTROLS

1.04 TEMPORARY UTILITIES

- A. Costs After Substantial Completion: Contractor shall pay for all temporary utility costs during construction. Upon acceptance of the work or a portion of the work defined and certified as substantially complete by Engineer, and Owner commences full-time successful operation of the facility or portion thereof, the Owner will bear the cost for utilities used for Owner's operation.
- B. Electric Power:
1. Electric power is available at or near the project site. Determine the type and amount available and make arrangements for obtaining temporary electric power service, metering equipment, and pay all costs for the electric power used during the Contract period, except as specifically provided for utilities used by the Owner on portions of the work designated in writing by the Engineer as substantially complete.
 2. Temporary electric power installations shall meet construction safety requirements of OSHA, state, and other governing agencies.
 3. Cost of electric power used in performance and acceptance testing shall be borne by Contractor.
- C. Water for Contractor's Use:
1. The Contractor shall provide an adequate supply of water of a quality suitable for all domestic and construction purposes.
 2. All drinking water on the site during construction shall be furnished by the Contractor and shall be bottled water or water furnished in approved metal or plastic dispensers. Notices shall be posted conspicuously throughout the site warning the Contractor's, Owner's, Engineer's, and other personnel that piped water may be contaminated or non-potable.
 3. The Contractor shall not make connection to or draw water from any fire hydrant or pipeline without first obtaining permission of the authority having jurisdiction over the use of said fire hydrant or pipeline and from the agency owning the affected water system. For each such connection made, the Contractor shall first attach to the fire hydrant or pipeline a valve and a meter, if required by the said authority, of a size and type acceptable to said authority and agency.
 4. The site shall be graded to drain. Excavations shall be maintained free of water. Provide, maintain, and operate groundwater pumping

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equipment as needed. Contractor shall make provisions for disposal of groundwater compatible with adjacent property owners and federal, state and local agencies.

5. Before final acceptance of the work on the project, all temporary connections and piping installed by the Contractor shall be entirely removed and all affected improvements shall be restored to their original condition, or better, to the satisfaction of the Engineer and to the agency owning the affected utility.
6. Fire Protection: Construction facilities and all parts of the work shall be adequately protected against damage by fire. Contractor shall not block access to fire hydrants and shall coordinate with the local fire department during road closures. Hose connections and hose, water casks, chemical equipment, or other sufficient means shall be provided for fighting fires in the temporary structures and other portions of the work, and a responsible person shall be designated and instructed in the operation of such fire apparatus so as to prevent or minimize the hazard of fire. The Contractor's fire protection program shall conform to the requirements of Subpart F of the OSHA Standards for Construction.
7. Plant Water: The Contractor will be allowed to connect to the existing non-potable plant water system during the construction period, but coordination of flow and duration will need to occur with the Utility Manager due to the limited capacity of the existing system. Plant water for leak tests and other similar uses may be used by the Contractor. The Contractor shall obtain permission from the Owner before using any plant water from the treatment plant and shall be solely responsible for the adequate functioning of his pumping system and any discharge or waste of water therefrom.

D. Sewage:

1. Provide and maintain sanitary facilities for Contractor's employees and subcontractors' employees that comply with regulations of local and state health departments. Provide chemical toilets of suitable types and maintain them in a sanitary condition at all times, conforming to code requirements and acceptable to the health authorities. They shall be watertight construction so that no contamination of the area can result from their use. Make arrangements for frequent emptying of toilets. Upon completion of the work, remove toilets and restore area to original condition. Location of portable toilets shall be approved by Owner and adjacent property owners prior to placement.

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2. Use of Owner's existing sanitary facilities by construction personnel will not be allowed.

E. Heat:

1. Definitions:
 - a. Heating required after enclosure of building is classified as "temporary heat". Building shall be considered as enclosed when it is roofed and is protected at doorways, windows, and other openings to provide reasonable heat retention.
 - b. Heating required before buildings are enclosed is classified as "cold weather protection."
2. Use warm air heat from electric, oil or gas indirect-fired portable unit heaters suitably vented to outside as required for protection of health and property. Open salamander type heaters will not be permitted.
3. Parts of buildings or products that become damaged because of insufficient or excessive heat shall be repaired or replaced to original condition by the Contractor at no additional cost to the Owner.
4. Except as otherwise specified, maintain temperatures in all parts of new buildings above 50 degrees F and no higher than 75 degrees F during the heating season.
5. Upon acceptance or occupancy of building by Owner, Contractor's responsibility for temporary heating shall terminate for that building.
6. If permanent system is used for temporary ventilation, provide temporary throwaway filters.
7. If permanent natural gas piping is used for temporary heating units, do not modify or reroute gas piping without approval of gas utility company and Engineer. Provide separate gas metering as required by gas utility company.

PART 2 PRODUCTS (NOT USED)

PART 3 EXECUTION

3.01 TEMPORARY CONSTRUCTION

A. Access Roads and Parking:

1. Construct temporary construction access roads and detours as necessary to execute the work and as approved by the Owner and

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Engineer. Maintain in good condition until no longer needed, then remove the temporary roads, revegetate the disturbance or otherwise leave the disturbed area in a preconstruction condition satisfactory to the Owner and Engineer.

2. Use area designated as staging area on Drawings or other area as designated by the Owner for parking of Contractor's employees' vehicles.

B. Storage Yards and Buildings:

1. Construct temporary storage yards for the storage of products that are not subject to damage by weather conditions. Materials such as pipe, and reinforcing and structural steel shall be stored on pallets or racks, off the ground, and in a manner to allow ready access for inspection and inventory. Temporary gravel surfacing of storage yards must be approved by the Owner and Engineer.
2. Erect or provide temporary storage buildings of various sizes needed to protect mechanical and electrical equipment and other materials, as recommended by manufacturers of such equipment and materials:
 - a. Provide environmental control systems that meet recommendations of manufacturers of equipment and materials stored in the building.
 - b. Buildings shall be of sufficient size.
 - c. Arrange or partition buildings to provide security for their contents and ready access for inspection and inventory.
 - d. At or near completion of the work, temporary storage buildings shall be dismantled, removed from the site, and remain the property of the Contractor.
3. Store combustible materials (paints, solvents, fuels, etc.) in a well-ventilated building remote from other buildings and in accordance with OSHA CFR 1910, 1926, and NFPA 30 requirements.

C. Fencing and Barricades:

1. Security Fence: If considered necessary by Contractor, erect a temporary security fence with gates and locks around the construction storage site, located and as approved by Owner and Engineer.
2. Barricades: Provide barricades as necessary to prevent unauthorized entry to construction areas, both inside and outside of

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fenced areas. Also provide barricades to protect existing facilities and adjacent properties from potential damage. Locate barriers to enable access by facility operators and property owners.

3.02 SAFETY AND PROTECTION

A. General Safety Requirements:

1. Contractor shall be solely responsible for initiating, maintaining, and supervising all safety precautions and programs per Volume 1.
2. Contractor shall do whatever work is necessary for safety and be solely and completely responsible for conditions of the jobsite, including safety of all persons (including employees) and property during the Contract period. This requirement shall apply continuously and not be limited to normal working hours.
3. Safety provisions shall conform to Federal and State Departments of Labor Occupational Safety and Health Act (OSHA), and other applicable federal, state, county, and local laws, ordinances, codes, requirements set forth herein, and regulations that may be specified in other parts of these Contract Documents. Where these are in conflict, the more stringent requirement shall be followed. Contractor shall become thoroughly familiar with governing safety provisions and shall comply with the obligations set forth therein.
4. Contractor shall develop and maintain for the duration of the Contract, a safety program that will effectively incorporate and implement required safety provisions including those of the Owner's safety program. Contractor shall appoint a qualified employee who is authorized to enforce compliance with the safety program.
5. Engineer's duty to conduct construction review of the Contractor's performance is not intended to include a review or approval of the adequacy of Contractor's safety supervisor, safety program, or safety measures.
6. Construct and maintain satisfactory and substantial temporary chain link fencing, solid fencing, railing, barricades or steel plates, as applicable, at all openings, obstructions, or other hazards in roads, streets, sidewalks, floors, roofs, and walkways. Such barriers shall have adequate warning lights as necessary or required for safety.
7. As part of safety program, Contractor shall maintain at its office or other well-known place at the jobsite, safety equipment applicable to the work as prescribed by the governing safety authorities, and

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articles necessary for giving first-aid to the injured. Establish procedures for the immediate removal to a hospital or a doctor's care of any person who may be injured on the jobsite.

8. If death or serious injuries or damages are caused, the accident shall be reported immediately by telephone or messenger to the Engineer and Owner. In addition, Contractor shall promptly report in writing all accidents whatsoever arising out of, or in connection with, the performance of the work whether on or adjacent to the site, giving full details and statements of witnesses.
9. If claim is made by anyone against Contractor or any subcontractor on account of accident, Contractor shall promptly report the facts in writing, giving full details of the claim.
10. All of the Contractor's jobsite personnel must be trained in the hazards associated with Confined Space Entry. All personnel (including subcontractors) entering a confined space must be certified for Confined Space Entry.

B. Protection of Work and Property:

1. Refer to Section 01 11 00, SUMMARY OF WORK and/or Section 01 14 16, COORDINATION AND SITE CONDITIONS for additional requirements for protection of the site.
2. General:
 - a. Contractor shall employ such means and methods necessary to adequately protect public property and property of the Owner against damage. In the event of damage to such property, immediately restore the property to a condition equal to its original condition and to the satisfaction of the Engineer and the owner of said property, and bear all costs therefore.
 - b. Protect stored materials, cultivated trees and crops, and other items located adjacent to the proposed work. Notify property owners affected by the construction at least 48 hours in advance of beginning of construction in different areas.
3. Examination of Existing Facilities:
 - a. After the Contract is awarded, but before the commencement of work, at the Contractor's request, Contractor and Engineer shall make a thorough examination of all existing buildings, structures, and other facilities in the vicinity of the work and for which permission for entry has been granted, as

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- applicable, which might be damaged by construction operations.
- b. Records in triplicate of all observations shall be prepared by the Contractor and each copy of every document shall be signed by the authorized representative of the Owner and of the Contractor.
 - c. Photographs, as requested by the Owner, shall be made by the Contractor and signed in the manner specified above. One signed copy of every document and photograph will be kept on file in the office of the Engineer.
 - d. These records and photographs are intended for use as indisputable evidence in ascertaining whether and to what extent damage occurred as a result of the Contractor's operations, and are for the protection of the adjacent property owners, the Contractor, and the Owner.
4. Finished Construction:
- a. Contractor shall assume the responsibility for protection of finished construction and shall repair and restore any and all damage to finished work to its original or better condition.
 - b. Prevent wheeling of loads over finished floors, either with or without plank protection, except in rubber-tired wheelbarrows, buggies, or dollies. Protect finished floors and concrete floors exposed as well as those covered with composition tile or other applied surfacing.
 - c. At such time temporary facilities and utilities are no longer required for the work, notify Engineer of intent and schedule for their removal. Remove temporary facilities and utilities from the site as Contractor's property and leave the site in such condition as specified, as shown on the Drawings or as directed by the Owner.
 - d. In unfinished areas, leave the site evenly graded, seeded, or planted as necessary, in a condition that will restore original drainage, and with an appearance equal to or better than original.
- C. Fire Prevention: Perform all work in a fire safe manner. Furnish and maintain on the site adequate firefighting equipment capable of extinguishing incipient fire. Comply with applicable federal, local, and state fire prevention regulations. Where these regulations do not apply, follow applicable parts of the National Fire Prevention Standard of Safeguarding Building Construction Operations (NFPA No. 241).
- D. Use of Explosives: No blasting or use of explosives will be allowed on the jobsite.

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CONSTRUCTION FACILITIES

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3.03 OSHA REGULATIONS

- A. General: Contractor shall develop a safety plan and perform all work in a manner to comply with all current requirements of the Amendment to the Occupational Safety and Health Administration Construction Standards for Excavations, 29 CFR Part 1926, Subpart P printed Tuesday October 31, 1989 and effective January 2, 1990.
- B. Any conflicting information between the OSHA document and these Contract Documents shall be revised so that the OSHA document requirements supersede and take precedence over all other conflicting information. Contractor shall be required to obtain copies of the OSHA document and to complete review of the same to avoid misinterpretation of their regulations.
- C. Trench Shoring:
 - 1. TYPE 1 TRENCH EXCAVATION: Excavation performed as Type 1 may not need to have protective support. The sides of all trenches shall be sloped back according to the soil type and in accordance with other criteria as defined in OSHA STANDARDS, 29 CFR, PART 1926, SUBPART P. Contractor shall solely be responsible for determination of soil type and full compliance.
 - 2. TYPE 2 TRENCH EXCAVATION: Excavation performed as Type 2 shall provide a support system, shielded system or other system, if required, which adequately protects employees against cave-in and which is designed in accordance with OSHA STANDARDS as defined in 29 CFR, PART 1926, SUBPART P.

Note: OSHA regulations require that all trenches which are deeper than 20 feet are to have the side slopes and/or the protective systems designed by a registered professional engineer.

3.04 SECURITY REQUIREMENTS

- A. Contractor's Materials: Contractor shall be responsible for the security of all materials, equipment, tools, etc. used on the job. All materials which can be easily removed shall be stored in a locked building provided by the Contractor.

END OF SECTION 01 50 00

SECTION 01 66 00

**PRODUCT SHIPMENT, HANDLING,
STORAGE, AND PROTECTION**

DIVISION 01 00 00 - GENERAL REQUIREMENTS

PART 1 GENERAL

1.01 SECTION INCLUDES

- A. Requirements and procedures for work necessary for shipment, handling, storage, and protection of material and equipment products.

1.02 RELATED WORK SPECIFIED UNDER OTHER SECTIONS

- A. See Section 01 66 40, MANUFACTURERS' SERVICES for requirements for products purchased from manufacturers by the Contractor.
- B. See appropriate detail equipment sections for installation of Owner-furnished products for Contractor's responsibilities for such items.

1.03 GENERAL REQUIREMENTS PRIOR TO SHIPMENT

- A. At minimum, provide products meeting specified requirements and reference standards.
- B. Specified products define the standard of quality, type, function, dimension, appearance, and performance required. Furnish products of qualified manufacturers that are suitable for intended use. Furnish products of each type from single manufacturer unless specified otherwise.
- C. Domestic Products: Except where specified otherwise, domestic products are required and interpreted to mean products mined, manufactured, fabricated, or produced in the United States or its territories.
- D. Do not use materials and equipment removed from existing premises except as specifically permitted by the Contract Documents and/or as shown on the Drawings.

1.04 PREPARATION FOR SHIPMENT

- A. When practical, products shall be factory assembled.
 - 1. Furnish assembly instructions for parts and assemblies that are shipped unassembled.
 - 2. Mark or tag the separate parts and assemblies for field assembly.
 - 3. Cover machined and unpainted parts that may be damaged by the elements with a strippable protective coating.
- B. Package or crate products to provide protection from damage during shipping, handling, and storage.

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PRODUCT SHIPMENT, HANDLING,

DIVISION 01 00 00 - GENERAL REQUIREMENTS STORAGE, AND PROTECTION

1. Mark or tag the outside of each package or crate to indicate its purchase order number, bill of lading number, contents by name, name of project and Contractor, equipment number, and approximate weight.
- C. Mark special tools to identify the associated products by name, equipment, and part number. Package tools for protection against damage from the elements during shipping, handling, and storage. Ship in boxes or containers marked to indicate the contents and as stated above. Deliver special tools before the associated equipment is scheduled for the initial test run.
- D. Contractor shall request a minimum 7-day advance notice of shipment from manufacturers.
- E. Where specified for specific product, factory test results shall be reviewed and accepted before such product is shipped.
- F. Transport and handle products according to manufacturer's instructions.

1.05 RECEIVING, INSPECTION, AND UNLOADING

- A. Contractor shall record the receipt of products at the jobsite.
- B. Upon receipt of products at the jobsite, Contractor shall inspect for completeness and evidence of damage during shipment.
 1. Owner or Engineer and manufacturer's representative may be present for inspection.
 2. Should there appear to be damage, notify the Engineer immediately and inform the manufacturers and the transportation company.
 3. Expedite replacement of damaged, incomplete, or lost items.
- C. After completion of inspection, unload products in accordance with manufacturer's instructions for unloading, or as specified. Do not unload damaged or incomplete products to be returned to manufacturer for replacement, except as necessary to expedite return shipment.
- D. Provide proper equipment and number of personnel to handle products; use methods to prevent soiling, damage, or disfigurement.

1.06 HANDLING, STORAGE, AND MAINTENANCE

- A. Handle products in accordance with the manufacturer's written recommendations, and in a manner to prevent damage.

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PRODUCT SHIPMENT, HANDLING,

DIVISION 01 00 00 - GENERAL REQUIREMENTS STORAGE, AND PROTECTION

- B. Store and protect products prior to installation as recommended by the manufacturer.
 - 1. Store products such as pipe and reinforcing steel off the ground in approved storage yards, leased, owned, or otherwise controlled by the Contractor.
 - 2. Store items subject to damage by the elements, vandalism, or theft in secure buildings.
 - 3. Provide environmentally controlled storage facilities for items requiring environmental control for protection.
 - 4. Storage yards and storage buildings shall also conform to requirements of Section 01 50 00, CONSTRUCTION FACILITIES AND TEMPORARY CONTROLS.
- C. Provide manufacturer's recommended maintenance during storage, installation, and until products are accepted for use by Owner.
- D. Store products to provide access for inspection and inventory control. Contractor shall document products in storage to facilitate inspection and to estimate progress payments for products delivered, but not installed in the work.
- E. Do not store products on private property without written permission of property owner or lessee.
- F. Cover products subject to deterioration with impervious sheet covering. Provide ventilation to prevent condensation and degradation of products.
- G. Store loose and/or granular materials on solid flat surfaces in well drained areas. Prevent mixing with foreign matter.
- H. Provide bonded off-site storage and protection when Project site does not permit or cannot handle on-site storage or protection.
- I. Also see Division 26 00 00, ELECTRICAL for handling, storage, and maintenance requirements for electrical equipment and motors.
- J. Where specific security measures are needed to protect stored equipment and materials at the jobsite, Contractor shall provide lockable security fencing, lockable enclosed buildings or trailers, or other similar and appropriate measures. Contractor shall be solely responsible for proper security measures and the costs for such measures shall be incidental to the work.

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PRODUCT SHIPMENT, HANDLING,

DIVISION 01 00 00 - GENERAL REQUIREMENTS STORAGE, AND PROTECTION

PART 2 PRODUCTS (NOT USED)

PART 3 EXECUTION (NOT USED)

END OF SECTION 01 66 00

PART 1 GENERAL

1.01 SECTION INCLUDES

- A. Contractor's requirements to provide services of the manufacturers' representatives, and special coordinating services required of the Contractor that apply during construction, facilities testing and startup, and training of the Owner's personnel for facilities operation.
- B. Where manufacturers' services are specified, Contractor shall furnish a qualified representative of the manufacturer to provide these services. Where time is necessary in excess of that stated in the Specifications for manufacturers' services, additional time required to perform the specified services shall be considered incidental work. Where repeat visits are required at no fault of the Owner, they shall be provided at no additional cost to the Owner.
- C. For those products purchased by the Owner, manufacturer's services shall be coordinated by the Owner with input and guidance from the Contractor regarding scheduling for those services.

1.02 DEFINITIONS

- A. For purposes of furnishing manufacturer's services, the following definitions shall apply:
 - 1. Manufacturer's Representative: Employee of manufacturer who is factory trained and knowledgeable in technical aspects of their products and systems.
 - 2. Construction Period: The time period from the Contractor's purchase order date to the date of certification by the manufacturer that the material or equipment is properly installed and that functional and performance tests, as applicable to the equipment specified, have been successfully demonstrated.
 - 3. Person-day or Man-day: One person for 8 hours straight time, exclusive of Saturdays, Sundays, or holidays.

1.03 FULFILLMENT OF SPECIFIED MINIMUM SERVICES

- A. Only those manufacturers' services, including trips to the jobsite for installation assistance or training in the classroom, receiving prior written acceptance by the Owner and Engineer shall act to fulfill the specified services. Submit requests for prior acceptance:
 - 1. In writing.

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2. Ten calendar days prior to providing the services.
 3. Stating the service to be provided.
 4. Stating the reason(s) why the timing of the service is appropriate.
- B. Requests made less than 10 calendar days prior to the providing of manufacturers' services may not receive written response prior to the times the services are requested to be provided.
- C. If manufacturer's representative is found deficient in training or experience by the Owner or Engineer, furnish other acceptable representatives after acceptance of resumes and other documentation of proposed representatives.
- D. Furnish manufacturers' representatives of products and systems as needed with appropriate levels of experience and expertise. Representatives shall resolve assembly or installation problems attributed to, or associated with, their products and systems, whether or not specifically required in the specifications, at no extra cost if the needed time on-site is more than the specified minimum time.
- E. Installation Completion Schedule: Required for scheduling equipment installation assistance, testing, start-up, and the training of Owner's operating personnel by equipment manufacturers.
1. List estimated installation completion dates for the equipment and systems requiring services of manufacturers' representatives.
 2. Submit the installation completion schedule for each equipment item or system not less than 21 calendar days prior to the time that associated equipment is installed and in a suitable condition for training the Owner's personnel.
 3. Revise the schedule to facilitate training of appropriate personnel, as deemed necessary by Owner, and to ensure full participation by manufacturers' representatives.
- F. The phased construction of the project may require phased manufacturer's services for startup of equipment.

1.04 FUNCTIONAL TESTING

- A. Where functional (or run) testing at the job site is required in the Specifications, furnish manufacturer's representative to assist with the test. Refer to individual equipment or component specifications for specific testing requirements. Testing shall generally include checking for proper

alignment, speed, quiet operation, proper connection, and satisfactory performance.

- B. Perform initial equipment and system adjustment and calibrations in the presence and with the assistance of the manufacturer's representative.
- C. Obtain manufacturer's review and acceptance of Contractor's certification of functional testing, where such certification is specified.
- D. The phased construction of the project will require phased testing for specified items and the facility constructed by their applicable manufacturer's representative during the construction and testing of the additional phases.

1.05 PERFORMANCE TESTING

- A. Where performance testing is specified, furnish manufacturer's representative to assist or conduct the test as specified for the particular equipment, and to correct malfunction of equipment. Follow specified test procedures.
- B. Manufacturer's services shall continue until equipment or systems have been successfully tested for performance, have been accepted by the Owner for startup, and the performance test has been reviewed and accepted by the manufacturer.
- C. Unless otherwise specified, performance testing shall use plant fluid or material that the equipment or system is designed to handle during normal service conditions.
- D. Prior to actual startup, performance testing shall use plant effluent water with suitable quality to simulate actual operating conditions for the following operations:
 - 1. All pipeline leak tests.
 - 2. All water holding structure leak tests.
 - 3. All pumping equipment functional and performance tests as specified in the detail equipment specifications.
 - 4. All other equipment functional and performance tests as specified in the detail equipment specifications.

1.06 STARTUP

- A. Prior to start-up of the facilities, the manufacturer shall have prepared and pre-tested all equipment insofar as possible to check its ability for sustained

operation, including inspections and adjustments by manufacturer's servicemen.

- B. After the facilities are sufficiently complete to permit start-up, the Contractor shall furnish competent personnel to start up the facilities as required. The Contractor will be responsible for start-up of all facilities constructed under the construction contract. During the initial start-up period for equipment and controls, the manufacturer shall check and provide for satisfactory mechanical operation of the facilities. Insofar as possible, the manufacturer's representatives shall be present during this period to instruct the operators in the care, operation, and maintenance of the equipment. Process considerations will be given secondary consideration during this period, but any process information or assistance required will be furnished by the Engineer or the Owner.
- C. Contractor shall conduct, with assistance of manufacturer's representative, startup and field test on equipment, systems, and subsystems, as specified in other sections.
 - 1. Contractor shall designate and provide personnel to be responsible for coordinating and expediting the startup of equipment and systems. The person(s) shall be present during pre-startup meetings and shall be available to Owner's personnel and Engineer during the startup period.
 - 2. Where startup services are required in the Specifications, furnish and coordinate the specified manufacturer's services for the startup period. When startup has commenced, schedule remaining work to not interfere with or delay completion of the project.
 - 3. Startup staff shall include, but not be limited to, major equipment and system manufacturers' representatives, subcontractors, electricians, instrumentation personnel, millwrights, pipefitters, and plumbers in addition to Contractor's startup coordinator(s).

1.07 TRAINING OF OWNER'S PERSONNEL

- A. Contractor's Personnel: Designate and provide Contractor's personnel to be responsible for coordinating and expediting training duties. The person(s) shall be present during training coordination meetings with the Owner and shall be familiar with the Operation and Maintenance (O&M) Manual information specified in Section 01 77 00, CONTRACT CLOSEOUT.
- B. Manufacturer's Representative: Where training of Owner's personnel is required in the Specifications, furnish manufacturer's representative to provide detailed instructions to Owner's personnel for operation and maintenance of the specified equipment.

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1. Training services include pre-startup classroom instruction, post-startup classroom instruction, and onsite equipment instruction, as stated in the Specifications.
 2. Manufacturer's representative shall be intimately familiar with O&M requirements of the specified equipment.
- C. Instruction Lesson Plan:
1. Manufacturer's proposed Lesson Plan shall include the elements presented in the Outline of Instruction Lesson Plan. Specific components and procedures shall be identified in the proposed Lesson Plan including the following topics:
 - a. Equipment Operation.
 - b. Detailed Component Descriptions.
 - c. Equipment Preventive Maintenance (PM).
 - d. Equipment Troubleshooting.
 - e. Equipment Corrective Maintenance.

1.08 TRAINING AIDS

- A. The manufacturer's instructor shall incorporate training aids as appropriate to assist in the instruction. At a minimum, the training aids shall include text and figure handouts. Other appropriate training aids are:
1. Audio-visual aids such as films, slides, videotapes, overhead transparencies, posters, blueprints, diagrams, and catalogue sheets.
 2. Equipment cutaways and samples such as parts, damaged equipment, etc.
 3. Tools such as repair tools, customized tools, measuring and calibrating instruments.
- B. The manufacturer's instructor shall use descriptive class handouts during the instruction. Photocopied class handouts shall be good quality reproductions. Class handouts should accompany the instruction with frequent reference made to them. Customized handouts developed especially for the instruction are encouraged. Handouts planned for the instruction shall be attached with the manufacturer's proposed Lesson Plan.

1.09 "HANDS ON" DEMONSTRATIONS

- A. The manufacturer's instructor shall present at least two "hands-on" demonstrations of common corrective maintenance repairs so that all operation and maintenance personnel have the opportunity to witness the demonstration. The manufacturer shall provide the tools and equipment to

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conduct the demonstrations. Requests for supplemental assistance and facilities should be submitted with the manufacturer's proposed Lesson Plan. The proposed "hands-on" demonstrations should be described in the manufacturer's proposed Lesson Plan.

- B. In any "hands-on" training situation where Owner's operation or maintenance personnel participate in disassembly or assembly of equipment components, the manufacturer shall be responsible for such disassembly or assembly and shall provide written certification of proper equipment operation to the Engineer.

1.10 PERMISSION TO VIDEO TAPE TRAINING

- A. The suppliers, manufacturers and contractors shall provide any necessary releases to permit the Owner to video tape any or all training sessions for exclusive use by the Owner for continuing training efforts.

1.11 OTHER SERVICES DURING CONSTRUCTION

- A. Furnish Manufacturers' representatives of products and systems for other services, when required by the Contractor for assistance during installation or testing. Representatives shall resolve assembly or installation problems attributable to, or associated with, their products and systems, whether or not specifically required in the Specifications at no additional cost.

PART 2 PRODUCTS (NOT USED)

PART 3 EXECUTION (NOT USED)

END OF SECTION 01 66 40

PART 1 GENERAL**1.01 SECTION INCLUDES**

- A. Damage to Existing Structures
- B. Closeout Procedures.
- C. Final Cleaning.
- D. Project Record Documents.
- E. Operation and Maintenance Data.
- F. Warranties, Bonds and Affidavits.
- G. Final Inspection.
- H. Spare Parts and Maintenance Materials.

1.02 DAMAGE TO EXISTING STRUCTURES

- A. Prior to final acceptance by the Owner, the Contractor shall repair or otherwise return to original condition any parts of the existing facilities which have been damaged during construction.

1.03 CLOSEOUT PROCEDURES

- A. These requirements supplement and are in addition to requirements, in Article 8.52, 8.68 and 9.7, of Volume 1.
- B. The Contractor shall submit written certification that the Contract Documents have been reviewed, the work has been inspected, and that the work is complete in accordance with the Contract Documents and is ready for the Engineer's final inspection.
- C. The Contractor shall provide any submittals to the Engineer and/or the Owner that are required by governing or other authorities.
- D. The Contractor shall submit the final Application for Payment identifying the total adjusted Contract Sum, previous payments, and the sum remaining due.

1.04 FINAL CLEANING

- A. The Contractor shall keep the premises free of the accumulation of surplus materials and rubbish resulting from his construction operations and the

operations of his subcontractors. The Contractor shall remove all waste and surplus materials, rubbish, and construction facilities from the site.

B. The Contractor shall execute final cleaning prior to the final inspection according to the following provisions:

1. Clean, sweep, wash, and polish work and equipment provided under the Contract, including finishes. Leave the site in a complete and finished condition to the satisfaction of the Engineer and Owner.
2. Remove debris including dirt, sand, and gravel from pipelines, channels, and any water holding structures.
3. Should Contractor not remove rubbish or debris or not clean the facilities and site as specified above, the Owner reserves the right to have final cleaning done at the sole expense of the Contractor.

C. The Contractor shall also provide for the following:

1. Employ experienced workers or professional cleaners for final cleaning.
2. Conduct final inspection of exposed interior and exterior surfaces and of concealed spaces in preparation for substantial completion or occupancy.
3. Remove grease, dust, dirt, stains, labels, fingerprints, and other foreign materials from exposed interior and exterior finished surfaces.
4. Repair, patch, and touch up marred surfaces to specified finish, and match adjacent surfaces.
5. Broom clean paved surfaces; rake clean other surfaces.
6. Remove from the Owner's property temporary structures and materials, equipment, and appurtenances not required as part of, or appurtenant to, the completed work.
7. Leave water courses, gutters, and ditches open and in condition satisfactory to Engineer and Owner.
8. Remove all construction survey stakes and other construction markers from the site.

D. Owner will assume responsibility for cleaning as of the date of Substantial Completion. Substantial completion date for the Contract shall be established as stated in the General Conditions.

1.05 PROJECT RECORD DOCUMENTS

- A. The Contractor shall maintain on site, one set of the following record documents to record actual revisions to the work, to be submitted in their entirety at the completion of construction.
 - 1. Contract Drawings, Specifications, and Addenda.
 - 2. Change Orders and other Contract Modifications.
 - 3. Reviewed shop drawings, product data, and samples.
- B. The Contractor shall store Record Documents separate from the documents used for construction.
- C. The Contractor shall record information concurrent with the construction progress, not less than once every week.
- D. The Contractor shall legibly mark and record in the Construction Documents at each product section, the description of actual products installed, including the following:
 - 1. Manufacturer's name and product model and number.
 - 2. Product substitutions or alternates utilized.
 - 3. Changes made by Addenda and Modifications.
- E. The Contractor shall legibly record all Documents and Shop Drawings to record actual construction characteristics including:
 - 1. Measured horizontal and vertical locations of any underground utilities and appurtenances, referenced to permanent surface improvements.
 - 2. Measured depths of foundations in relation to project datum.
 - 3. Field changes of dimension and detail.
 - 4. Details not on the original Contract Drawings.
 - 5. Measured locations of internal utilities and appurtenances concealed in construction, referenced to visible and accessible features of the work.
- F. Additional Record Drawing Requirements:

1. Record drawings refer to those documents maintained and annotated by the Contractor during construction and are defined as (1) a neatly and legibly marked set of contract drawings knowing the final location of piping, equipment, and electrical conduits, outlet boxes and cables; (2) additional documents such as diagrams included in the Specifications; and (3) Contractor layout and installation drawings.
2. Unless otherwise specified, record drawings shall be full size and maintained in a clean, dry, and legible condition. Record documents shall not be used for construction purposes and shall be available for review by the Engineer during normal working hours at the Contractor's field office. Record drawings shall be reviewed for completeness by the Engineer each month as part of the progress payment review process. Record drawings shall be up to date prior to the Engineer approving monthly payment requests. At the completion of the work, prior to final payment, complete record drawings shall be submitted to the Engineer.
3. Marking of the drawings shall be kept current and shall be done at the time the material and equipment are installed. Annotations to the record documents shall be made with an erasable colored pencil conforming to the following color code:

Additions:	Red
Deletions:	Green
Comments:	Blue
Dimensions:	Graphite*

*Legibly mark to record actual depths, horizontal and vertical location of underground raceways, cables, and appurtenances referenced to permanent surface improvements.

- G. The Contractor shall submit the required documents to Engineer with claim for Final Application for Payment.

1.06 OPERATION AND MAINTENANCE (O&M) DATA

- A. The Contractor shall prepare binder covers with the printed title "OPERATION AND MAINTENANCE DATA", the title of project, and all subject matter contained in the binder when multiple binders are required. Engineer will determine adequacy of each O&M Manual as to content, organization, quality, and adequacy. Furnish acceptable manuals as reviewed by the Engineer.

B. Procedures:

1. Unless specified otherwise, furnish one hard copy and one electronic copy of complete instruction manuals for installation, operation, maintenance, and lubrication requirements for each unit or common units of mechanical and electrical equipment or system. Contractor shall assemble the O & M Manuals into complete sets for the entire project.
2. Furnish manufacturer's data and installation instructions prior to installation of the respective equipment. Furnish initial manual a minimum of 30 days prior to field test or equipment startup of the respective equipment. In all cases, the manuals shall be furnished at least 30 calendar days prior to the scheduled completion of the work. In no case shall submission of the manuals be delayed beyond 75 percent completion of the work. Submission of the manuals shall precede any payment to the Contractor for work completed in excess of the 75 percent completion level. Correct deficiencies found in the submitted manuals within 30 calendar days following notification of the deficiencies.
3. Manuals shall be customized to describe the equipment actually furnished, and shall not include extraneous data for models, options, or sizes not furnished.
 - a. Where more than one model, option, or size of an equipment type is furnished, clearly indicate the information pertaining to each model, option, or size furnished.
 - b. Manufacturer's preprinted literature may be accepted provided it has been customized to clearly indicate the models, options, and sizes actually furnished, and that equipment models not furnished have been clearly crossed out or deleted.
4. Assemble each hard copy of the manual in one or more three-ring, hardback type binders.
 - a. Clearly label each binder to designate the system or equipment for which it is intended with reference to the building and equipment number, and the Specification section where the equipment is specified.
 - b. Provide each binder with title page, typed table of contents with page numbers, and heavy section dividers with numbered plastic index tabs.
 - c. Divide each manual into sections paralleling the equipment Specifications.

- d. Where more than one binder is required, they shall be labeled "Vol. 1", "Vol. 2", and so on. Place the table of contents for the entire set, identified by volume number, in each binder.
 - e. Submit manual organization and format to Engineer for approval prior to manual preparation.
 - f. Punch all data for binding and composition; arrange printing so that punching holes do not obliterate data.
- 5. Material in manuals shall be suitable for photographic reproduction. Where copies of identical material are included, clarity and quality of copies shall equal the original.
- 6. Assemble each electronic copy of the manual on one or more compact discs (CD), digital video discs (DVD), USB drives, or another file storage device approved by the Owner's Representative.
 - a. When electronic O&M manuals are provided, hard copies must also be provided.
 - b. Electronic files are to be provided in the latest version of Adobe Acrobat and the files are to be created directly to PDF if at all possible.
 - c. Organization of the electronic manual must correspond to the hard copy organization, and contain internal bookmarks linked from an index page to major sections of the manual.
 - d. The electronic files must be searchable. Scanned documents must be processed by optical character recognition so that all text is recognized and searchable.
- C. Contents: Each manual shall be complete in all respects for equipment, controls, accessories, and associated appurtenances, and shall include the following:
 - 1. Diagrams and illustrations.
 - 2. Detailed description of the function of each principal component of the system.
 - 3. Performance and nameplate data.
 - 4. Installation instructions.
 - 5. Procedure for starting.
 - 6. Proper adjustment.
 - 7. Test procedures and results of factory tests where required.

8. Procedure for operating.
9. Shutdown instructions for both short and extended durations.
10. Emergency operating instructions and trouble-shooting guide.
11. Safety precautions.
12. Maintenance and overhaul instructions illustrated with detailed assembly drawings showing each part with part numbers and sequentially numbered parts list. Include instructions for ordering spare parts, and complete preventive maintenance and overhaul instructions required to ensure satisfactory performance and longevity of the equipment.
13. Lubrication instructions and diagrams showing points to be greased or oiled; recommend type, grade, and temperature range of lubricants and frequency of lubrication; see paragraph Equipment Maintenance Summary Sheets.
14. List of electrical relay settings and control and alarm contact settings.
15. Electrical interconnection wiring diagram for equipment furnished, including all control and lighting systems.
16. Results of field functional and performance tests as required under Article CONTRACT CLOSEOUT SUBMITTALS.
17. Results of any factory tests.
18. See Divisions 43 00 00 and 46 00 00, with individual equipment specifications, and Division 26 00 00, ELECTRICAL, for additional specific O & M Manual requirements.

D. Equipment Maintenance Summary Sheets:

1. In addition to the O & M Manuals, provide completed Equipment Maintenance Summary Sheets as provided at the end of this specification; submit at the same time as prescribed above for the O & M Manuals.
2. Compile individual Equipment Maintenance Summary Sheets for each equipment item. Submit a complete set of Equipment Maintenance Summary Sheets with each hard copy O&M Manual; provide electronic copies of the Equipment Maintenance Summary Sheets with each electronic O&M Manual.

3. Provide a "Recommended Preventive Maintenance Schedule" as part of the Equipment Maintenance Summary Sheet. This schedule for preventative maintenance items is defined to mean any routine operation required to ensure the satisfactory performance and longevity of the equipment. Examples of typical preventative maintenance operations are lubrication, belt tensioning, adjustment of pump packing glands, and routine adjustments.
- E. The Contractor shall provide documents and certificates, including the following.
1. Shop drawings and product data.
 2. Manufacturer Certificates as specified in individual equipment specifications.
 3. Photocopies of warranties and bonds.
- F. The Contractor shall submit one PDF electronic copy of the completed volumes in final form with his request for final inspections. This copy will be returned after final inspection, with the Engineer comments. The Contractor shall revise the content of the documents as required and, within ten days, submit the required number of final sets bound in 8 ½ x 11-inch pages in binders with durable plastic covers and the required number of final sets of electronic copies.

1.07 WARRANTIES, BONDS AND AFFIDAVITS

- A. The Contractor shall submit all written warranties, bonds, and affidavits, along with notarized copies, as required to the Owner prior to final payment.
- B. Warranties shall extend for the full period of the required guarantee period after:
1. Replacement of work found defective during guarantee period.
 2. Repair of inoperative items or adjustments to proper working condition of items not operating properly at time of final inspection.
- C. The Contractor shall execute and assemble documents from all subcontractors, suppliers, and manufacturers.
- D. The Contractor shall submit one set prior to the application for final payment, bound in 8 ½ x 11-inch pages, in binders with durable plastic covers and one set of electronic copies. The binder shall be provided with a printed title "WARRANTIES, BONDS AND AFFIDAVITS" and the project title.

- E. For Items of Work delayed beyond the date of Substantial Completion, the Contractor shall provide an updated submittal within ten days after acceptance, listing the date of acceptance as the start of warranty period.

1.08 FINAL INSPECTION

- A. After final cleaning, the Contractor shall request a final inspection in writing prior to the anticipated date of completion.
- B. Work will not be considered ready for final inspection until it has been completed and the Contractor has certified that all items are properly operating and tested in strict compliance with the Contract Documents.
- C. The Contractor or his project supervisor shall be at the job-site during the final inspection.
- D. The Engineer will present to the Contractor, after the final inspection, a list of any items not meeting contract requirements. This list will be confirmed in writing by the Engineer and all items on it must be made acceptable before final payment will be made. Contractor shall immediately undertake work required to remedy defects and complete the work to the satisfaction of the Engineer and Owner.

PART 2 PRODUCTS

2.01 ACCESSORIES

- A. Furnish to Owner, upon acceptance of equipment, all accessories required to place each item of equipment in full operation including, but not limited to, special tools, adequate oil and grease as required for first lubrication of equipment (after field testing), valve keys, handwheels, and other items as required for initial operation.
- B. Extra Materials:
 - 1. Furnish, tag, and box for shipment and storage the special tools and other extra materials specified in the individual Specification sections.
 - 2. Deliver all extra materials prior to 90 percent project completion to the project site.
 - 3. Notify Engineer upon arrival of extra materials.

2.02 SPARE PARTS AND MAINTENANCE MATERIALS

- A. Provide products, spare parts, and maintenance materials in quantities specified in individual specifications sections, in addition to that used for

construction of Work. Coordinate with Owner, deliver to Owner and obtain receipt prior to final payment.

- B. Parts and materials shall be furnished in manufacturer's unopened cartons, boxes, crates or other protective covering suitable for preventing corrosion or deterioration for the maximum length of storage which may be normally anticipated. They shall be clearly marked and identified for each individual piece of equipment on which the part will be used.
- C. Parts and materials shall be delivered to the Owner upon completion of the work or when the Owner assumes delivery of equipment. Contractor shall then place them in permanent storage rooms or areas approved by the Owner.
- D. Provide a letter of transmittal including the following:
 - 1. Date of letter and transfer of parts and materials.
 - 2. Contract title and number.
 - 3. Contractor's name and address.
 - 4. A complete inventory of the parts and material, listing the applicable specification section for each.
 - 5. A place for the Owner to sign and signify receipt of the parts and materials.
- E. Contractor shall be fully responsible for loss or damage to parts and materials until they are transmitted to the Owner.

PART 3 EXECUTION (NOT USED)

END OF SECTION 01 77 00

PART 1 GENERAL

1.01 WORK INCLUDED

- A. This section provides additional information pertaining to the coordination and work necessary to move in personnel and equipment, set up all temporary offices, buildings, facilities, utilities, and prepare the site for construction.

1.02 GENERAL

- A. The limits of the site are shown on the Drawings. The Contractor shall coordinate the location of their temporary facilities with the Owner.

1.03 WORK INCLUDED HEREIN, BUT SPECIFIED IN OTHER SECTIONS

- A. Article 9, Volume 1
- B. Section 01 14 16, COORDINATION AND SITE CONDITIONS
- C. Section 01 50 00, CONSTRUCTION FACILITIES AND TEMPORARY CONTROLS

PART 2 PRODUCTS

2.01 TEMPORARY FACILITIES

- A. The Contractor shall provide all temporary facilities as required for performing the work. See Article 9, Volume 1 and Section 01 50 00, CONSTRUCTION FACILITIES AND TEMPORARY CONTROLS.

PART 3 EXECUTION

3.01 COORDINATION

- A. The project site is located within property owned by the City of Bullhead City for their existing wastewater treatment system.
- B. Before move in and site preparation, the Contractor shall notify and coordinate with the Owner's representative. Contact person is Tim Fontenot, Utility Manager at address 901 Richardo Avenue, Bullhead City, Arizona and telephone number 928-763-7299.
- C. Coordination required prior to the start of construction as specified in Section 01 14 16, COORDINATION AND SITE CONDITIONS shall be completed before move in and site preparation.

3.02 CLEARING THE SITE

- A. As specified in Section 31 11 00, CLEARING AND GRUBBING.

3.03 LAYOUT

- A. Set up construction facilities in a neat and orderly manner within designated area at location of choice. Accomplish all required work in accordance with applicable portions of these Specifications. Confine operations to work area shown.

3.04 OBSTRUCTIONS

- A. Some obstructions may not be shown. Bidders are advised to carefully inspect the existing site before preparing their proposals. The removal and replacement of minor obstructions such as duct banks, fences, culverts, small piping, and similar items shall be anticipated and accomplished within the Contract Price, even though not shown or specifically mentioned.
- B. Major obstructions encountered that are not shown on the Drawings, or could not have been foreseen by visual inspection of the site prior to bidding, should immediately be brought to the attention of the Engineer. The Engineer will make a determination for proceeding with the work. If the Engineer finds that the obstruction adversely affects the Contractor's costs or schedule of completion, a proper adjustment to the Contract will be made in accordance with the General Conditions.

END OF SECTION 02 01 90

PART 1 GENERAL**1.01 WORK INCLUDED**

- A. This section covers the labor and materials necessary for the work associated with the demolition of structures, equipment and appurtenances, pipelines and associated appurtenances, as shown on the Drawings and specified herein.
- B. The following existing facilities, equipment and appurtenances, or portions of existing facilities are scheduled for demolition, abandonment, salvage, modification, or relocation as indicated on the Drawings:
 - 1. RAS/WAS pumps and piping.
 - 2. Clarifier splitter box.
 - 3. Yard piping.
 - 4. RAS/WAS room HVAC equipment.
 - 5. Miscellaneous control panels and electrical equipment.

1.02 GENERAL

- A. See the GENERAL CONDITIONS and Division 01 00 00, GENERAL REQUIREMENTS, which contains information and other requirements that apply to the work specified herein and are mandatory for this project. In addition, all demolition work must be scheduled with the Owner a minimum of 14 calendar days before such work is to begin.

1.03 RELATED WORK SPECIFIED IN OTHER SECTIONS

- A. The following sections describe some of the work closely related to this section. All demolition and salvage work performed by the Contractor shall be in accordance with these related Specifications:
 - 1. Section 01 10 00, SUMMARY OF WORK.
 - 2. Section 01 14 16, COORDINATION AND SITE CONDITIONS.
 - 3. Section 01 50 00, CONSTRUCTION FACILITIES AND TEMPORARY CONTROLS

PART 2 PRODUCTS**2.01 GENERAL**

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

PART 3 EXECUTION**3.01 GENERAL REQUIREMENTS**

- A. All work shall be done in conformance with the rules and regulations pertaining to safety established by federal, state, and local authorities, and as specified elsewhere in these Specifications.
- B. Examine existing buildings, structures, and other facilities indicated for demolition before starting work. Determine where demolition activities may result in structural deficiency or other similar unplanned event during demolition. Coordinate demolition sequencing and procedures to prevent structures from becoming unstable, collapsing, or otherwise failing before demolition is complete.
- C. Determine where demolition may affect structural integrity, weather resistance, or other portions of adjacent buildings, structures, or facilities indicated to remain. Identify measures to protect adjacent facilities from damage.
- D. Plant Utilities: Refer to the Drawings for management of plant utilities that must be protected or temporarily moved to allow for demolition or construction. Coordinate all work on plant utilities with the Owner.

3.02 SUMMARY OF DEMOLITION AND SALVAGE WORK

- A. RAS/WAS Room:
 - 1. Demolition work at the existing RAS/WAS Room generally includes:
 - a. The salvage of one existing valve as indicated on the Drawings and delivery to Owner;
 - b. Demolition, removal and disposal of pumps, pipe, valves, fittings, meters, and concrete equipment pads as shown on the Drawings;
 - c. Removal of control panels, and miscellaneous conduit and wiring as shown on the Drawings.
 - d. Removal of VFDs from MCC E.
 - e. Removal of HVAC equipment.

2. All work shall be performed in accordance with the constraints specified in Sections 01 14 16, COORDINATION AND SITE CONDITIONS, 40 05 10, PIPING - GENERAL, and Division 26 00 00, ELECTRICAL.

B. Clarifier Splitter Box:

1. Demolition work at the existing Clarifier Splitter Box generally includes:
 - a. Demolition, removal and disposal of miscellaneous pipe, foundation, and other concrete work as shown on the Drawings.
 - b. Removal of all slide gates and appurtenances, grating, handrails, stairs as shown on the Drawings. Dispose of all items.
2. All work shall be performed in accordance with the constraints specified in Sections 01 14 16, COORDINATION AND SITE and 40 05 10, PIPING – GENERAL.

C. Yard Piping:

1. The Drawings indicate where existing pipes and appurtenances are to be removed, relocated, or replaced; and where new pipes and appurtenances, are to be added. Any existing asphalt pavement, excess excavation materials, old pipes, old conduit, concrete, miscellaneous structures, and other materials removed to accomplish this work shall be disposed of off-site by the Contractor.
2. All work shall be performed in accordance with the constraints specified in Section 01 14 16, COORDINATION AND SITE CONDITIONS, and Section 40 05 10, PIPING – GENERAL.

3.03 DEMOLITION

- A. The Drawings are based on the best available information, but the structures and facilities may differ. The Contractor shall be responsible for determining the work required by inspecting the site, and perform all work within the constraints as specified in Section 01 14 16, COORDINATION AND SITE CONDITIONS.
- B. All equipment, materials, and piping, except as specified hereinafter to be salvaged or shown to remain in place, within the limits of the demolition shall become the property of the Contractor. Piping, thrust blocks, chunks of asphalt and concrete, etc., shall be removed from any area to be backfilled. The Contractor may remove additional pipe, fittings, etc. adjacent to those

to be removed if these materials have salvage value to the Contractor and in turn would lower the cost of work.

- C. Items shown to remain in place shall be protected from damage by the Contractor during the demolition, salvage, and modifications work.
- D. The Drawings define the minimum portion of the structures and facilities to be removed. Unless shown otherwise on the Drawings, the Contractor may make rough cuts or breaks that are within the limits of demolition shown.

3.04 SALVAGE

- A. All equipment to be salvaged, as specified hereinafter or shown on the Drawings, will remain the property of the Owner. This equipment must be protected by the Contractor prior to removal and delivered to the Owner's designated storage area by the Contractor in operating condition.
 - 1. Salvage one 12" plug valve to the Owner as indicated on the Drawings.
- B. No equipment shall be removed without the approval and consent of the Owner and such removal shall be scheduled as specified in Section 01 14 16, COORDINATION AND SITE CONDITIONS. The Contractor shall agree to maintain all equipment to be salvaged or reused in the same, or better, condition as when it was removed until it is properly stored. The condition of the equipment shall be determined prior to removal by the Owner and/or the Engineer. The Contractor assumes the responsibility of assuring that the equipment is properly moved and stored in the Owner's designated storage area. Once properly stored, responsibility becomes the Owner's. Equipment and accessories to be stored are summarized hereinbefore.

3.05 BACKFILLING

- A. The Contractor shall backfill all demolition areas approximately to existing ground level or foundation level of new construction, as applicable, and as shown on the Drawings.
- B. Backfill material shall meet the requirements of native earth or imported select backfill, as applicable, and backfill compaction shall be in accordance with the applicable requirements of Section 31 23 00, EARTHWORK FOR STRUCTURES and/or Section 31 23 33, TRENCH EXCAVATION AND BACKFILL FOR PIPELINES AND APPURTENANT STRUCTURES. Building debris shall not be used as backfill material.
- C. In all areas not yet backfilled to ground level, the Contractor shall erect safety barriers around the excavation.

3.06 ASPHALT PAVEMENT/CONCRETE SIDEWALK AND CURB/GUTTER

- A. Asphalt pavement, concrete sidewalk, concrete curb and gutter, and valley gutter shall be removed as shown on the Drawings and/or at locations where new structures, equipment, piping, and electrical corridors are to be installed. Remove the pavement or concrete and material below the pavement or concrete to a depth sufficient to allow replacement of pavement or concrete, base, and surface course materials to the depth and finish grade shown on the Drawings. Neatly cut edges of paving or concrete that meet with pavement or concrete that is to remain in a straight line with a pavement breaker, cutting wheel, saw cutter, or other approved means, as applicable. Asphalt pavement, concrete sidewalk, concrete curb and gutter, and concrete valley gutter removed at the site shall be disposed of offsite by the Contractor at his own expense.

3.07 OFFSITE REMOVAL

- A. All material and items not specified hereinafter to be salvaged shall be removed and disposed of offsite by the Contractor as specified in Section 01 50 00, CONSTRUCTION FACILITIES AND TEMPORARY CONTROLS. The Contractor shall make all necessary arrangements for this disposal and shall bear any costs or retain any profit incidental to this disposal.

END OF SECTION 02 41 10

SECTION 02 41 20

**REMOVAL OF EXISTING PAVEMENT, CONCRETE,
CURB, SIDEWALK, DRIVEWAY
AND/OR STRUCTURES**

DIVISION 02 00 00 – EXISTING CONDITIONS

PART 1 GENERAL

1.01 STANDARD SPECIFICATION

- A. All applicable portions of the specification Section 350 REMOVAL OF EXISTING IMPROVEMENTS in the MAG Standard Specifications for Public Works Construction shall apply with the following additions, deletions, and/or modifications. Modifications are listed below with numbers corresponding to the MAG Standard Specification.

350.4 PAYMENT: Delete this section.

END OF SECTION 02 41 20

DIVISION 03 00 00 - CONCRETE

PART 1 GENERAL

1.01 WORK INCLUDED

- A. This item of work includes the formwork and shoring for cast-in-place concrete and the installation into formwork of items such as anchor bolts, pipe and pipe fittings, and other items to be embedded in concrete (but not including waterstops and other expansion or construction joint materials - see Section 03 15 00, EXPANSION, CONSTRUCTION, AND CONTROL JOINTS; or reinforcing steel - see Section 03 20 00, CONCRETE REINFORCEMENT).

1.02 RELATED WORK SPECIFIED IN OTHER SECTIONS

- A. Submittals: Section 01 33 00.
- B. Quality Control: Section 01 40 00.
- C. Expansion, Construction, and Control Joints: Section 03 15 00.
- D. Concrete Reinforcing: Section 03 20 00.
- E. Cast-In-Place Concrete: Section 03 30 00.
- F. Miscellaneous Metal Items: Section 05 50 00.

1.03 QUALITY ASSURANCE

- A. Codes and Standards:
 - 1. The Contractor shall design, construct, erect, maintain, and remove forms and related structures for cast-in-place concrete work in compliance with the American Concrete Institute (ACI) Standard ACI 347R, "Guide to Formwork for Concrete."
 - 2. ACI 117, "Specifications for Tolerances for Concrete Construction and Materials."
 - 3. ACI 318, "Building Code Requirements for Structural Concrete."
 - 4. ACI 301, "Specifications for Structural Concrete."
 - 5. ACI 350, "Code Requirements for Environmental Engineering Concrete Structures."
- B. Allowable Tolerances:

DIVISION 03 00 00 - CONCRETE

1. The Contractor shall construct formwork to provide complete cast-in-place concrete work within tolerances in accordance with ACI 117 and ACI 318, or as follows, whichever is more stringent:
 - a. Variation from plumb lines and surfaces: $\frac{1}{4}$ -inch per 10 feet, but not more than 1-inch total in entire height from top to bottom for walls over 40 feet high.
 - b. Exposed corners, control joints grooves and other conspicuous lines: $\frac{1}{4}$ -inch in 20 feet maximum; $\frac{1}{2}$ -inch maximum in 40 feet or more.
 - c. Depressions In Wall Surface: Maximum $\frac{1}{4}$ -inch when 10-foot straightedge is placed on high points in any direction or at any location.
 - d. Wall Thicknesses: Maximum $\frac{1}{4}$ -inch minus or $\frac{1}{2}$ -inch plus from dimension shown.
 - e. Variation from level or grade in slabs, and in arises: $\frac{1}{4}$ -inch in 10 feet, $\frac{3}{8}$ -inch in 40 feet or more.
 - f. Exposed horizontal grooves and other conspicuous lines: $\frac{1}{4}$ -inch in 20 feet maximum and $\frac{1}{2}$ -inch in 40 feet or more.
 - g. Slab Finish Flatness Tolerances: Floor surface shall not have crowns so high as to prevent 10-foot straightedge from resting on $\frac{1}{4}$ -inch end blocks, nor low spots that allow a block of twice the tolerance in thickness to pass under the supported 10-foot straightedge.
 - h. Finish Slab Elevation and Slope Tolerance: Within $\frac{1}{2}$ -inch of elevation specified except slabs which are designed and detailed to drain to floor drain or gutter shall adequately drain regardless of tolerances. Repair floor slopes in an approved manner if necessary to provide complete drainage.
 - i. Slab Thickness: Maximum $\frac{1}{4}$ -inch minus or $\frac{1}{2}$ -inch plus from thickness shown.
 - j. Beams and columns physical dimensions tolerance: Maximum $\frac{1}{4}$ -inch minus or $\frac{1}{2}$ -inch plus from dimension shown.
 - k. Beam Elevations: Within $\frac{1}{2}$ -inch plus or minus of specified elevation. Where tops of beams become part of finished slab, refer to slab tolerances.
 - l. Forms for sidewalks and driveways: Use standard steel forms or wood forms constructed and fastened to prevent movement. Set forms to true lines and grades, and securely stake in position. Tolerances shall conform to those for slabs.
2. Before concrete placement, the Contractor must check the lines and levels of erected formwork. The Contractor shall make corrections

and adjustments to ensure proper size and locations of concrete members and stability of forming systems.

3. During concrete placement, the Contractor must check formwork and related supports to ensure that forms are not displaced and that completed work will be within the specified tolerances.

1.04 SUBMITTALS

- A. Samples: Prior to start of work, submit one sample each as follows:
 1. Form ties.
- B. Shoring Plan: Submit formwork and shoring plan for all walls greater than 8 feet in height and all elevated slabs stamped by a registered Arizona Professional Engineer. Plan must be submitted at least 15 working days prior to starting work.

1.05 COORDINATION, SEQUENCING AND SCHEDULING

- A. Schedule work for embedded, buried, or other items of work that affects form layout before completing concrete formwork. Coordinate all work in this section with other sections of work in this Project Manual and the Drawings in forming and placing openings, slots, reglets, recesses, sleeves, bolts, anchors, other inserts, and components of other work.

PART 2 PRODUCTS

2.01 FORMS FOR EXPOSED FINISH CONCRETE

- A. Unless otherwise shown, the Contractor shall construct formwork for exposed concrete surfaces with plywood, plywood-faced metal frames, hard plastic finished plywood, overlaid waterproof particle board, tempered concrete-form-grade hardboard, steel, or other panel-type materials, in new and undamaged condition, to provide continuous, straight and smooth as-cast surfaces and that create the specified appearance and texture of concrete surfaces. The Contractor shall furnish the forms in the largest practicable sizes to minimize the number of joints and to conform to the joint system shown on the construction Drawings. The Contractor shall provide form material with sufficient thickness to withstand the pressure of the newly placed concrete without bow or deflection.
- B. Chamfer materials shall be lumber with dimensions of $\frac{3}{4}$ -inch by $\frac{3}{4}$ -inch, unless a different size is shown on the Drawings. Material must be non-absorbent, compatible with form surface, adequately attached, and fully

DIVISION 03 00 00 - CONCRETE

sealed on all sides to prevent loss of concrete or water between the two surfaces.

2.02 FORM TIES

- A. The Contractor shall provide factory-fabricated, adjustable-length, removable or snap-off metal form ties with conical or spherical type inserts, designed to prevent form deflection and to prevent spalling concrete surfaces upon removal.
- B. The Contractor shall provide ties so that portion remaining within the concrete after removal of exterior parts is at least 1-1/2 inches from the outer concrete surface except as otherwise specified. Form ties shall be provided which will not leave a hole larger than 1-inch diameter in the concrete surface. The holes shall be filled with non-shrink grout as specified in Section 03 30 00, CONCRETE.
- C. Form ties and wire ties fabricated on the project site are not acceptable. Field modifications to factory fabricated form ties are not acceptable. Do not use wire ties of any kind. Ties shall withstand form pressures and limit form deflection to specified tolerances.
- D. Flat bar ties for panel forms shall have plastic or rubber inserts with minimum 1-inch depth and sufficient dimensions to permit proper patching of tie hole.
- E. Form ties shall not be used to support any embedded items in the concrete and shall not be in contact with any metallic embedded items.
- F. Water Stop Ties:
 - 1. Provide for water-holding structures or dry structures with access such as basements, tunnels, pipe galleries, etc., that are below finish grade.
 - 2. Ties shall have either an integral steel water stop 0.103-inch thick and 0.625-inch in diameter tightly and continuously welded to tie, or neoprene water stop 3/16-inch thick and 15/16-inch in diameter whose center hole is 1/2 diameter of snap tie, or a molded plastic water stop of comparable size.
 - 3. Flat snap ties meeting these Specifications may be provided.
 - 4. In all cases, the water stop shall be considerably larger in area than tie cross-sectional area, oriented perpendicular to tie and symmetrical about center of tie.

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5. Construct ties to provide positive means of preventing rotation or disturbance of center portion of tie during removal of ends and prevent water leaking along tie.

2.03 FORM COATING RELEASE AGENT

- A. The Contractor shall provide commercial formulation form-coating compounds that will not bond with, stain, or adversely affect concrete surfaces and will not impair subsequent treatment of concrete surfaces requiring bond or adhesion, or impede the wetting of surfaces to be cured with water or curing compounds.
- B. Use a ready-to-use water based material formulated to reduce or eliminate surface imperfections, containing no mineral oil, kerosene, or organic solvents. Material shall be environmentally safe involving no health risks within the work place and shall be VOC compliant with a maximum VOC content of 1.0 pounds per gallon, or less where local area restrictions are more stringent. Material shall be non-toxic after 30 days and be able to be used for potable water treatment plants. Formulate form reuse agent with rust inhibitor for steel form facing materials.
- C. Form coating (non-staining form release agent) shall be:
 1. Master Finish RL 211 by Master Builders Solutions/BASF Corporation.
 2. DUOGARD II by W.R. Meadows.
 3. Form Release WB by Lambert Corporation.
 4. Grifcote LV-50 by Hill and Griffith Company.
 5. Or equal.

2.04 DESIGN OF FORMWORK

- A. The design of forms, shores, and bracing is the responsibility of the Contractor. Design shall be done prior to fabrication, placing orders, or use on the project. Design shall conform to applicable ACI and other code requirements to achieve concrete shape, line, and dimensions as shown on the Drawings.
- B. The Contractor shall design, erect, support, brace, and maintain formwork so that it will safely support vertical and lateral loads that might be applied, until such loads can be supported by the concrete structure. Formwork shall

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be constructed so that concrete members and structures are of correct size, shape, alignment, elevation, and position.

- C. The Contractor shall provide shores and struts with positive means of adjustment capable of taking up formwork settlement during concrete placing and vibration operations, using wedges or jacks or a combination thereof and maintain specified tolerances. Trussed supports shall be provided when adequate foundations for shores and struts cannot be secured.
- D. The Contractor shall support form facing materials by structural members spaced sufficiently close to minimize deflection. Forms placed in successive units for continuous surfaces shall be fitted to accurate alignment, free from irregularities, and within allowable tolerances.
- E. Design joints in forms to remain watertight and withstand placing pressures without bulging outward or creating surface patterns. Do not use formwork that leaks concrete mortar.
- F. Where poor formwork is used and finish obtained is less than specified, upgrade finish to an acceptable finish at no additional cost to the Owner.
- G. Panel Deflections: Limit as required to achieve construction tolerances specified herein.
- H. Design shall account for tolerances, form ties, finishes, architectural features, rebar supports, construction joint locations, and other nonstructural formwork requirements specified. Design formwork to accommodate waterstop materials in joints at locations indicated on the Drawings.
- I. Design formwork strong enough to hold high liquid heads without form distortion and to meet tolerances as specified herein. Coordinate form design with admixture company information and concrete slump.
- J. Structurally design forms, falsework, shoring, and other structural formwork and meet applicable safety regulations, current OSHA regulations, and other codes. Where noted or where formwork is of a critical nature (in terms of size, complexity, etc.), a licensed engineer shall prepare formwork, falsework, and shoring designs to meet these Specifications and to meet all federal and state requirements.
- K. Meet applicable portions of ACI 347, ACI 301, ACI 350, ACI 318 current edition, and these Specifications.

2.05 REINFORCING SPACERS AND REBAR SUPPORTS

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- A. Walls:
 - 1. Provide positive spacers or chairs specifically designed for wall forms to hold forms and reinforcing at correct dimensions and clearances.
 - 2. Remove spacer or chair if not designed to remain in place as concrete is placed, consolidated, and proper support and spacing is achieved.
- B. Columns:
 - 1. Provide a positive spacer between column reinforcing and column forms to ensure adequate cover.
 - 2. Remove spacer as concrete is place, consolidated, and proper support and spacing is achieved.
 - 3. Provide concrete blocks of same strength and density as column concrete for permanent spacers and rebar supports designed to be left in place. Color shall match concrete.

PART 3 EXECUTION

3.01 FORM CONSTRUCTION

- A. General: The Contractor shall construct forms complying with ACI Standards 301, 318, and 347R, to the exact sizes, shapes, lines, and dimensions shown, and as required to obtain accurate alignment, location, grades, level and plumb work in finish structures. All necessary detail work, construction aids, and embedded items shall be provided as required. Notify Engineer one full working day prior to concrete placement so forms can be observed for compliance. Correct defective work identified prior to delivery of concrete.
- B. Design, erect, shore, brace and maintain formwork in accordance with ACI 301 to support vertical, lateral, static, and dynamic loads and construction loads that might be applied until concrete structure can support such loads.
- C. The Contractor shall fabricate forms for easy removal without hammering or prying against concrete surfaces. Crush plates or wrecking plates shall be provided where stripping may damage cast concrete surfaces. Kerf wood inserts shall be provided for forming key-ways, reglets, recesses, chamfers and the like, to prevent swelling and assure ease of removal.
- D. Forms for Exposed Concrete:

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1. Construct formwork so concrete members and structures are of the size, shape, alignment, elevation, and position indicated, all within tolerance limits specified herein. Limit concrete surface irregularities designated by ACI 347R as Abrupt or Gradual as follows: Class B, ¼-inch.
 2. The Contractor shall drill forms to suit the ties used and to prevent leakage of concrete mortar around the tie holes. The Contractor shall not splinter forms by driving ties through improperly prepared holes. Locate form ties in a uniform pattern and construct so that tie remains embedded in wall, except for removable portion at each end. Place ties at least 1-1/2 inches away from finished surface of concrete. Provide sufficient strength and quantity of form ties to prevent spreading of forms.
 3. The Contractor shall not use metal cover slates for patching holes or defects in forms.
 4. The Contractor shall provide sharp, clean corners at intersecting planes, without visible edges or offsets. Back joints with extra studs or girts to maintain true, square intersections.
 5. The Contractor shall use extra studs, walers, and bracing to prevent bowing of forms between studs and to avoid bowed appearance in concrete. Narrow strips of form material which will allow the forms to bow shall not be used.
 6. The Contractor shall assemble forms so that they may be readily removed without damage to exposed concrete surfaces.
 7. The Contractor shall place carefully and accurately all bracing to prevent sagging or misalignment.
 8. All forms shall be new or in good condition free from holes, indentations, or irregular surfaces.
 9. The exposed concrete joints shall be formed with special care to assure proper alignment and uniform cross section.
 10. The Contractor shall form molding shapes, recesses and projections with smooth-finish materials, and install these in the forms with sealed joints to prevent displacement.
- E. **Cleaning and Tightening:** The Contractor shall thoroughly clean forms and adjacent surfaces to receive concrete. All chips, wood sawdust, dirt, or other debris shall be removed just before concrete is to be placed. All forms

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shall be retightened immediately after concrete placement as required to eliminate leaks.

3.02 FORM COATINGS

- A. The Contractor shall coat the contact surfaces of forms with form-coating compound before steel reinforcement is placed. No form coating shall be allowed on steel reinforcement or on previously cast concrete sections which abut the new concrete pour.
- B. The Contractor shall thin form-coating compounds only with the thinning agent of type and in amount and under the conditions recommended by the coating compound manufacturer. Excess form-coating material shall not be allowed to accumulate in the forms or to come into contact with concrete surfaces against which fresh concrete will be placed. All form coatings shall be applied in compliance with the manufacturer's instructions.
- C. Steel forms shall be coated with a non-staining, rust-preventative form oil or otherwise to protect against rusting. Rust-stained steel formwork will not be accepted. Coat contact surfaces of forms with a light uniform film (a coverage rate of 1,200 square feet per gallon or higher) of the surface consolidation agent. Apply to steel forms as soon as they are cleaned to prevent discoloration of concrete from rust. Do not get surface consolidation agent on concrete surfaces or reinforcing steel against which fresh concrete will be placed.

3.03 INSTALLATION OF EMBEDDED ITEMS

- A. General: Set and build into the work anchorage devices and other embedded items required for other work that is attached to, or supported by, cast-in-place concrete. Use setting drawings, diagrams, instructions, and directions provided by suppliers of the items to be attached thereto. Securely anchor embedded items to prevent displacement during placement of concrete.
- B. Edge Forms and Screed Strips for Slabs: The edge forms or bulkheads and intermediate screed strips for slabs shall be set to obtain the required elevations and contours in the finished slab surface. The Contractor shall provide and secure units to support the types of screeds required.

3.04 BEVELED EDGES (CHAMFER)

- A. Form $\frac{3}{4}$ -inch bevels at concrete edges, unless otherwise shown. Place in all forms to provide chamfer where concrete will have exposed projecting corners.

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- B. Where beveled edges on existing adjacent structures are other than $\frac{3}{4}$ -inch, obtain Engineer's approval of size prior to placement of bevel form strip.

3.05 REMOVAL OF FORMS

- A. General: Formwork not supporting concrete, such as sides of walls, and similar parts of the work, may be removed after cumulatively curing at not less than 50 degrees Fahrenheit for 24 hours after placing concrete, provided: (1) concrete strength is sufficient to withstand damage by form removal operation and the forces acting on it, and (2) that curing and protection operations are maintained.
- B. Formwork supporting the weight of concrete, such as elevated slabs and other structural elements, may not be removed in less than 14 days unless approved otherwise by the Engineer, and not until the concrete has attained the minimum 28-day compressive strength as indicated by field cured test cylinders taken from that placement in accordance with ACI 301. Remove forms only if shores have been arranged to permit removal of forms without loosening or disturbing shores.
- C. Contractor shall assume responsibility for damage resulting from improper and premature removal of forms.
- D. Satisfy applicable OSHA requirements with regard to safety of personnel and property.
- E. Do not remove supports and reshore prior to obtaining adequate field cured cylinder results.

3.06 SHORES AND RESHORES

- A. For floors supporting shores under newly placed concrete, either leave original supporting shores in place, or install reshores or backshores. Shoring system and supporting slabs must resist anticipated loads. Locate reshores and backshores directly under a shore position unless designed otherwise by Contractor provided design. Comply with ACI 318, ACI 301, and recommendations in ACI 347R for design, installation, and removal of shoring and reshoring.

3.07 CONCRETE FINISHES

- A. As specified in Section 03 30 00, CONCRETE.

3.08 BACKFILL AGAINST WALLS

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- A. Do not backfill against walls until concrete has obtained compressive strength equal to specified 28-day compressive strength and all permanent supporting structure is in place. Do not backfill for minimum of 7 days regardless of compressive strength. For water holding structures, do not backfill until leakage tests have been completed and passed.
- B. Place backfill simultaneously on both sides of wall where required to prevent differential pressures.

3.09 FIELD TESTS

- A. Wall Finish Tolerances: Test for compliance with tolerances as specified.
- B. Slab Finish Tolerances and Slope Tolerances:
 - 1. Floor flatness measurements will be made the day after floor is finished and before shoring is removed, to eliminate effect of shrinkage, curling, and deflection.
 - 2. Support 10-foot long straightedge at each end with steel gauge blocks of thicknesses equal to specified tolerance.
 - 3. Compliance with designated limits in four of five consecutive measurements is satisfactory unless obvious faults are observed.
 - 4. A check for adequate slope and drainage will also be made to confirm compliance with these Specifications.
 - 5. Slab tolerances may be tested per ASTM E1155, Standard Test Method for Determining Floor Flatness and Floor Levelness Numbers and all slab construction shall comply with ACI 302.1R-04, Guide for Concrete Floor and Slab Construction.
- C. Finish Tolerance Failures: Repair or replace concrete as specified in Section 03 30 00, CONCRETE.

3.10 RE-USE OF FORMS

- A. All forms to be re-used in following work shall be clean and surfaces repaired the satisfaction of the Engineer. Forms may only be re-used if the structural integrity of concrete and the aesthetics of exposed concrete are not compromised. Split, frayed, delaminated, or otherwise damaged form-facing material will not be acceptable. The Contractor shall apply new form-coating compound material to concrete contact surfaces as specified for new formwork.

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- B. When forms are extended for successive concrete placement, the Contractor shall thoroughly clean all surfaces, remove fins and laitance, and tighten forms to close all joints. All joints shall be secured and tightened to avoid offsets.

END OF SECTION 03 11 00

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PART 1 GENERAL

1.01 WORK INCLUDED

- A. Work necessary to furnish, install and complete, the concrete expansion, construction, and control joints including waterstops and premolded, pourable, and gun grade fillers.

1.02 RELATED WORK SPECIFIED UNDER OTHER SECTIONS

- A. Submittals: Section 01 33 00.
- B. Concrete Forming: Section 03 11 00.
- C. Concrete Reinforcement: Section 03 20 00.
- D. Cast-In-Place Concrete and Grout: Section 03 30 00.
- E. Joint Sealants: Section 07 90 00.

1.03 SUBMITTALS

- A. Product Data: Furnish for the following:
 - 1. Joint fillers for horizontal and sloped joints.
 - 2. Preformed control joints.
 - 3. Waterstop(s) with installation requirements.
 - 4. Sealants.
- B. Shop Drawings: Furnish information listed below:
 - 1. Plastic Type Waterstops: Details of construction joint types; show in sufficient detail waterstop support used in both concrete pours to demonstrate waterstop will remain secure until complete encasement.
 - 2. Construction and Control Joints: Layout and location indicating type to be used.
- C. Quality Control Submittals: Furnish the following documents:
 - 1. Waterstop manufacturer's written instructions for product shipment, storage, handling, installation and repair.

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2. Joint Filler and Primer: Manufacturer's written instructions for product shipment, storage, handling, application, and repair.

1.04 DELIVERY, STORAGE, AND HANDLING

- A. Packing and Shipping: Prepare and protect materials for shipment in accordance with manufacturer's recommendations.
- B. Acceptance at Site: Verify that plastic waterstops delivered meet the cross-section dimensions shown on the Drawings and manufacturer's reviewed product data prior to unloading and storage at the site.
- C. Protect hydrophilic waterstop from premature exposure to moisture which may cause premature swelling of waterstop. Store waterstops under tarps to protect from oil, dirt, and sunlight.

PART 2 PRODUCTS

2.01 PLASTIC WATERSTOP

- A. Extruded from an elastomeric plastic compound of which the basic resin shall be polyvinyl chloride (PVC). Reclaimed PVC in the compound is not acceptable. Provide factory fabricated waterstop corner transitions and intersections leaving only straight butt joint splices for the field.
- B. Specific Gravity: Approximately 1.37.
- C. Shore Durometer Type A Hardness: 65 to 80.
- D. Performance Requirements: Corps of Engineers' Specification CRD-C-572.
- E. Type: Center bulb with a number of parallel ribs or protrusions on each side of strip center.
 1. Corrugated or tapered type water stops are not acceptable.
 2. Standard waterstop geometry as shown.
- F. Size: Four-inch with 3/16-inch web, 6-inch or 9-inch with 3/8-inch web, as shown on the details in the Drawings. Use 4-inch size only where specifically shown on the Drawings.
- G. Thickness: Constant from bulb edge to the outside stop edge.
- H. Minimum Weight per Foot of Water Stop:

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1. 0.74 pounds for 3/16-inch by 4 inch.
 2. 1.60 pounds for 3/8-inch by 6-inch.
 3. 2.45 pounds for 3/8-inch by 9-inch.
- I. Provide for at all construction, expansion and control joints indicated on the Drawings, and as specified in Part 3 EXECUTION.
- J. Manufacturers and Catalog Numbers:
1. Sika Corporation/Greenstreak: Style 702 (4-inch by 3/16-inch), Style 732 (6-inch by 3/8-inch) and Style 735 (9-inch by 3/8-inch).
 2. Vynlex Waterstop and Accessories: No. RB6-38H (6-inch by 3/8-inch) and No. RB9-38H (9-inch by 3/8 inch).
 3. DCA Construction Products Durajoint Waterstop: Type 3A (4-inch by 3/16-inch), Type 9 (6-inch by 3/8-inch) and Type 10 (3/8-inch by 9-inch).
 4. Or equal.

2.02 WIRE LOOPED OR HOG RING PLASTIC WATERSTOP

- A. May be provided as an alternative to hereinbefore specified plastic waterstops without wire loops or hog rings.
- B. Comply with hereinbefore specified material and geometry requirements of Article PLASTIC WATERSTOP, except as follows:
1. Add continuous galvanized wire looping at plastic water stop edge for convenience in positioning and securing waterstop in-place in the forms.
 2. Add galvanized hog rings at 12 inches on center at plastic water stop edge for convenience in positioning and securing waterstop in-place in the forms.
- C. Manufacturer and Catalog Numbers:
1. BoMetals Inc. Waterstops with hog rings: Catalog numbers RCB-4316LB (4-inch by 3/16-inch), RCB-638LB (6-inch by 3/8-inch) and RCB-938NT (9-inch by 3/8-inch).
 2. Or approved equal.

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2.03 HYDROPHILIC SWELLABLE WATERSTOP

- A. Provide flexible strip applied waterstop comprised of bentonite clay and butyl rubber where specifically shown on the Drawings, or where otherwise approved by the Engineer. Hydrophilic swellable waterstop shall be Sika Corporation/Greenstreak Swellstop (3/4-inch by 1-inch size); Mineral Technologies/CETCO Building Materials Waterstop-RX 101 (3/4-inch by 1-inch size); or equal.
- B. Accessories shall be provided as follows:
 - 1. Provide manufacturer's recommended primer and adhesive to secure waterstop to concrete, or other specific surfaces as required to ensure watertight construction.
 - 2. Provide concrete nails as required to secure waterstop in vertical applications to concrete surfaces, or in any location where concrete consolidation or placement methods may dislodge surface contact.

2.04 RETROFIT PLASTIC WATERSTOP

- A. Where specifically shown on the Drawings, provide "Retrofit" plastic waterstop similar to Plastic Waterstop specified hereinbefore but designed for applications where new concrete meets an existing structure.
- B. Manufacturers and Catalog Numbers:
 - 1. Sika Corporation/Greenstreak: Style 667.
 - 2. DCA Construction Products Durajoint Waterstop: Type 36RT.
 - 3. Or equal.
- C. Accessories shall be provided as follows:
 - 1. Provide manufacturer's recommended epoxy to secure waterstop to existing concrete, or other specific surfaces as required to ensure watertight construction.
 - 2. Provide stainless steel adhesive anchor bolts and batten bars as required to secure waterstop to existing concrete surfaces, as recommended by the waterstop manufacturer and also in accordance with Section 05 50 00, MISCELLANEOUS METAL ITEMS.

2.05 BOND BREAKER TAPE FOR EXPANSION JOINT

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- A. Adhesive-backed glazed butyl or polyethylene tape which will adhere to the premolded joint material or concrete surface.
- B. Width: Same as the joint.
- C. Location: As shown.

2.06 BOND BREAKER

- A. Provide either bond breaker tape as hereinbefore specified or a bond prevention material, non-staining type, as specified in Section 03 30 00, CONCRETE, except where a tape is specifically called for.

2.07 PREMOLDED JOINT FILLER (PJF)

- A. Asphalt Impregnated Bituminous Fiberboard or Felt Type: ASTM D994 or D1751, Fibre Expansion Joint as manufactured by W.R. Meadows, Inc.; Fiber Expansion Joint as manufactured by Masons Supply Company; or equal. Thickness as shown on the Drawings, or ½-inch.
- B. Sponge Rubber Closed-Cell Neoprene: ASTM D1752, Type I; as manufactured by W.R. Meadows, Inc.; Masons Supply Company; or equal. Thickness as shown on the Drawings, or ½-inch.

2.08 PREFORMED CONTROL JOINT

- A. One-piece, flexible, polyvinyl chloride joint former; VX2 Series as manufactured by Vinylex Waterstop and Accessories; or equal.
- B. One-piece steel strip with preformed groove; Steelflex Strip Seal as manufactured by D.S. Brown; or equal.
- C. Provide in full-length un-spliced pieces, where possible.
- D. Provide only where specifically permitted by Drawings, size as shown.

2.09 POURABLE JOINT FILLERS

- A. Pourable joint filler shall be approved for use in wastewater systems. The specific gravity of the in-place filler after curing shall be greater than 1.0. The manufacturers of the fillers shall provide written certification that the products are approved for use in wastewater systems. Filler shall be gun grade material of below listed products for sloping joints.
- B. Manufacturers and Products:

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1. W.R. Meadows, Inc.: No. 164 Polymeric sealing compound, hot-pour compound, or Hi-Spec Polymeric joint sealing hot-pour compound; or
2. Sunshine Supply Company: SOF-SEAL two-component polymeric material, cold-applied, self-leveling filler; or
3. W.R. Meadows Inc.: Pouthane SL, one-component, cold-applied polyurethane compound, self-leveling filler.
4. Or equal.

2.10 STEEL EXPANSION JOINT DOWELS

- A. Dowels: Round smooth steel bars; ASTM A36.
- B. Dowel Coating: Fusion bonded coating system consisting of 2 coats of 100-percent solids epoxy having a total thickness of 10 to 14 MDFT.

2.11 CONTROL JOINT FORMS

- A. Provide a standard manufacturer's item causing a control joint in the slab while providing keying across the joint. It shall not leave any portion projecting at the finished surface and it shall interrupt at least 1/4 of the slab depth. The joint or the method of installation shall insure a straight joint deviating not more than 1/2-inch from a straight line.
- B. Speed-E-Joint T-shaped plastic strip as manufactured by W.R. Meadows, Inc.; ZipStrip T-shaped plastic strip as manufactured by Superior Profiles; or equal.

2.12 ACCESSORIES

- A. Joint Sealant: Joint sealant shall be as specified in Section 07 90 00, CAULKING AND SEALANTS. The type used shall be specifically intended for exterior, submerged control joint applications. A non-sag joint sealant shall be used for vertical joints and self-leveling for horizontal joints.
- B. Nonshrink Grout:
 1. As specified in Section 03 30 00, CONCRETE.
 2. Compatible with joint sealant.
- C. Roofing Felt: 30-pound asphalt-saturated; ASTM D226, Type II; or a tar-saturated roofing felt of equal quality.

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- D. Reinforcing Steel: As specified in Section 03 20 00, CONCRETE REINFORCEMENT.
- E. Nails: Provide manufacturer approved attachment for securing bituminous type premolded joint filler.
- F. Concrete Bonding Agent: As specified in Section 03 30 00, CONCRETE.

PART 3 EXECUTION

3.01 GENERAL

- A. Locate joints as shown, or noted, on the Drawings. Conform to ACI 318.
- B. Verify conformance of waterstops with dimensions shown and with reviewed product data prior to embedding waterstops in concrete.
- C. Construct straight joints; make vertical or horizontal, except where walls intersect sloping floors.
- D. Commence concrete placement after the joint preparation is complete.
- E. Time Between Concrete Pours:
 - 1. At least 2 hours must elapse after depositing concrete in long or high columns and/or heavy walls before depositing concrete in beams, girders, or slabs supported thereon.
 - 2. For short columns and low height walls, 10 feet or less, wait at least 45 minutes prior to depositing concrete in beams, girders, brackets, column capitals, or slabs supported thereon.
 - 3. Consider beams, girders, brackets, column capitals, and haunches as part of the floor or roof system and place monolithically with the floor or roof system.
 - 4. Should concrete placement sequence result in cold joint located below finished water surface, install waterstop in joint prior to additional concrete placement. Notify Engineer prior to installing waterstop. Engineer shall approve preparations prior to concrete pour.
- F. Provide waterstop type as indicated in Drawings. Where plastic (or PVC) waterstop is shown, provide only approved plastic waterstop. Where hydrophilic waterstop is shown, provide approved plastic or hydrophilic water stop. Where retrofit plastic (or PVC) waterstop is shown, provide only approved retrofit plastic waterstop

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3.02 SURFACE PREPARATION

- A. Construction Joints: Prior to placement of abutting concrete, clean contact surface:
 - 1. Remove laitance and spillage from reinforcing steel and dowels.
 - 2. Roughen surface to a minimum of 1/4-inch amplitude:
 - a. Sandblast after the concrete has fully cured.
 - b. Water blast after the concrete has partially cured.
 - c. Green cut fresh concrete with high pressure water and hand tools.
 - 3. Perform cleaning so as not to damage waterstop, if one is present.
 - 4. Coat concrete surfaces above and below plastic waterstop with bond breaker. Do not get bond breaker on waterstop. For joints older than 60 days, use a concrete bonding agent as specified in Section 03 30 00, CONCRETE.
 - 5. Avoid damage to waterstop.
 - 6. Verify that proper type and size of reinforcing and dowels are provided.
- B. Expansion Joints with Pourable Filler:
 - 1. Use motorized wire brush or other motorized device to mechanically roughen and thoroughly clean concrete surfaces on each side of joint from plastic waterstop to the top of the joint.
 - 2. Use clean and dry high pressure air to remove dust and foreign material, and dry joint.
 - 3. Prime surfaces before placing joint filler.
 - 4. Avoid damage to waterstop.

3.03 INSTALLATION OF WATERSTOPS

- A. General:
 - 1. Join waterstops at intersections to provide continuous seal as recommended by the waterstop manufacturer, and as specified hereinafter.

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2. Center waterstop on joint, unless detailed otherwise on the Drawings.
 3. Secure waterstop in correct position to avoid displacement during concrete placement.
 4. Repair or replace damaged waterstop.
 5. Vibrate concrete to obtain impervious concrete in the vicinity of all joints.
 6. Joints in Footings and Slabs:
 - a. Ensure that space beneath plastic waterstop is completely filled with concrete.
 - b. During concrete placement make a visual inspection of the entire waterstop area as shown.
 - c. Limit grout with concrete placement to elevation of waterstop in first pass, vibrate the grout and concrete under the water stop, lift plastic water stop to confirm full consolidation without voids, then place remaining concrete to full height of slab as shown.
 - d. Apply procedure to full length of plastic waterstops.
 7. Waterstops shall be provided where shown on the Drawings and at the following locations with any joints:
 - a. Joints in parts of structures exposed to ground or water on one side and occupied by non-submerged equipment or by personnel on the other.
 - b. Wall and slab joints of tanks and channels subject to water pressure. Waterstops shall be provided from the base to at least 6 inches above high water level.
- B. Plastic Waterstop: Install in accordance with details shown and manufacturer's written instructions.
- C. Hydrophilic Waterstop:
1. Inspect waterstop for premature swelling, discontinuity, and debris contamination prior to concrete pour. Replace unacceptable waterstop.
 2. Adhere waterstop to concrete or other surfaces shown utilizing proper primer adhesive. For vertical applications, use manufacturer

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approved nails in addition to the primer adhesive to secure waterstop to concrete.

3. Primer shall be allowed to dry for two hours prior to application of waterstop.
 4. Apply waterstop the same day as primer adhesive.
 5. Protect waterstop from moisture, dirt, oil, and sunlight during the progress of work.
 6. Install waterstop with 2 inches minimum clear cover to concrete face.
 7. Waterstop shall be butt spliced pressing ends together ensuring no separation or air pockets.
- D. Plastic Waterstop Splices and Joints: In accordance with plastic waterstop manufacturer's written instructions using a thermostatically controlled heating iron. Butt splice unless specifically detailed otherwise.
1. Allow at least 10 minutes before the new splice is pulled or strained in any way.
 2. Finished splices shall provide a cross-section that is dense and free of porosity with tensile strength of not less than 80 percent of the unspliced material.

3.04 EXPANSION JOINT INSTALLATION

A. General:

1. Place bond breaker above and below waterstop when premolded joint filler and pourable joint filler is not used.
2. Premolded Joint Filler:
 - a. Sufficient in width to completely fill the joint space where shown.
 - b. If a waterstop is in the joint, cut premolded joint filler to butt tightly against the water stop and the side forms.
3. Precut premolded joint filler to the required depth, as detailed, at locations where joint filler or sealant is to be applied.
4. Form cavities for joint filler with either precut, premolded joint filler, or smooth removable accurately-shaped material.

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5. Bed with 1-inch of grout for bonding in vertical joints. Vibrate concrete thoroughly along the joint form to produce a dense, smooth surface.
- B. Bituminous Type Premolded Joint Filler:
 1. Drive nails approximately 1-foot 6- inches on center through the filler to provide anchorage embedment into concrete prior to concrete placement.
 2. Secure premolded joint filler in forms before concrete is placed.
 3. Install in walks, at changes in direction at intersections, and at each side of driveway entrances.
- C. Pourable Joint Filler:
 1. General: Install in accordance with the manufacturer's written instructions, except as specified below:
 - a. Apply primer prior to pouring joint filler.
 - b. Fill entire joint above the waterstop with joint filler as shown.
 - c. Use masking tape on top of slabs at sides of joints; clean all spillage.
 2. Place cold-applied, two-component fillers in accordance with manufacturer's written instructions.
- D. Steel Expansion Joint Dowels:
 1. Install coated dowels parallel to wall or slab surface and in true horizontal position perpendicular to the joint in both plan and section views so as to permit joint to expand or contract without bending the dowels.
 2. Secure dowels tightly in forms with rigid ties.
 3. Install reinforcing steel in the concrete as shown to protect the concrete on each side of the dowels and to resist any forces created by joint movement.

3.05 CONSTRUCTION JOINT INSTALLATION

- A. Locate reinforcing and/or dowels as shown on the Drawings.
- B. Install PVC waterstop or hydrophilic waterstop as shown on the Drawings.

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- C. Concrete surface to be dense and smooth.
- D. Install bond breaker to concrete surfaces above and below water stop. For concrete older than 60 days, use a concrete bonding agent as specified in Section 03 30 00, CONCRETE.
- E. Bed with 1-inch of grout for bonding in vertical joints. Vibrate concrete thoroughly along the joint form to produce a dense, smooth surface.

3.06 PREFORMED CONTROL JOINTS

- A. Use only where specifically shown.
- B. Locate flush, or slightly below the top of slab.
- C. Install in accordance with manufacturer's written instructions in straight, maximum full-length pieces.
- D. Steel Strip Type with Preformed Groove: Brace to withstand pressure of concrete during and after placement.

3.07 CONTROL JOINTS IN SLABS ON GRADE

- A. Locate as shown on the Drawings. Where not indicated, locate at 13 foot maximum intervals in both directions. This applies to non-water holding structures. Construct control joints for a depth of at least one-fourth of concrete thickness unless indicated otherwise on the Drawings.
- B. Construct with a manufactured, embedded, preformed control joint form or stop pour at each control joint using keyway forms. Install form with no offsets and in straight lines as specified elsewhere.
- C. Grooved Joints for Sidewalks: Form control joints in sidewalks after initial floating by grooving and finishing each edge of joint to a radius of 1/8-inch. Repeat grooving of control joints after applying any surface finishes. Eliminate groover tool marks on concrete surfaces.
- D. Sawed Joints: If specifically allowed on the Drawings, Contractor may form control joints with power saws equipped with shatterproof abrasive or diamond-rimmed blades. Cut 1/8-inch wide joints into concrete after approximately 4 to 12 hours when cutting action does not tear, abrade, or otherwise damage concrete surface and before concrete surface develops random contraction joint cracks.

3.08 CONCRETE INSTALLATION AT JOINTS

- A. As specified in Section 03 30 00, CONCRETE.

END OF SECTION 03 15 00

PART 1 GENERAL**1.01 WORK INCLUDED**

- A. This section includes the fabrication and placement of steel reinforcement for cast-in-place concrete structures, including bars, ties, supports, and welded wire fabric.

1.02 RELATED WORK SPECIFIED IN OTHER SECTIONS

- A. Submittals: Section 01 33 00.
- B. Expansion and Construction Joints: Section 03 15 00.
- C. Cast-in-Place Concrete: Section 03 30 00.
- D. Epoxy Anchoring of Concrete Reinforcing and Other Miscellaneous Metal Items: Section 05 50 00.

1.03 QUALITY ASSURANCE

- A. Codes and Standards: The Contractor shall comply with all requirements of the following codes and standards (most recent edition) listed below or otherwise referenced in this Section, except as modified herein:
 - 1. American Welding Society, AWS D12.1 "Recommended Practices for Welding Reinforcing Steel, Metal Inserts and Connections in Reinforced Concrete Construction."
 - 2. Concrete Reinforcing Steel Institute, "Manual of Standard Practice."
 - 3. American Concrete Institute, ACI 318 "Building Code Requirements for Reinforced Concrete."
 - 4. American Concrete Institute, ACI 301 "Specifications for Structural Concrete."
 - 5. American Concrete Institute, ACI 315 "Manual of Standard Practice for Detailing Reinforced Concrete Structure."
 - 6. Other Standard References:
 - a. ASTM A184 - Specification for Welded Deformed Steel Bar Mats for Concrete Reinforcement.
 - b. ASTM A1064 - Specification for Welded Wire, Fabric, Plain and Deformed, for Concrete Reinforcement.
 - c. ASTM A615 - Specification for Deformed and Plain Billet-Steel Bars for Concrete Reinforcement.

- d. AASHTO M31 - Deformed and Plain Billet-Steel Bars for Concrete Reinforcement.
- e. AASHTO M32 - Cold Drawn Steel Wire for Concrete.
- f. AASHTO M54 - Welded Deformed Steel Bar Mats for Concrete Reinforcement.
- g. AASHTO M55 - Welded Steel Wire Fabric for Reinforced Concrete.
- h. AASHTO M221 - Welded Steel Wire Fabric for Reinforced Concrete.

1.04 SUBMITTALS

- A. Manufacturer's Data: The Contractor shall submit the manufacturer's specifications and installation instructions for all proprietary materials and reinforcement accessories where required or where proposed, including but not necessarily limited to:
 - 1. Mechanical Threaded Connections and Metal Sleeve Connectors: Furnish current International Conference of Building Officials (ICBO) Research Report or equivalent code agency report listing findings to include acceptance, special inspection requirements, and restrictions.
- B. Shop Drawings:
 - 1. The Contractor shall submit shop drawings for the fabrication, bending, and placement of concrete reinforcement. All work shall comply with the ACI 315 "Manual of Standard Practice for Detailing Reinforced Concrete Structures." Submittals shall show bar schedules, stirrup and tie spacing, diagrams of bent bars, arrangements and assemblies. Indicate required lap lengths and construction joints. Provide submittal of proposed joint locations that differ from those shown on the Drawings for approval by the Engineer prior to submittal of reinforcing steel shop drawings.
 - 2. The Contractor shall submit certification of grade, chemical analysis and tensile properties of the steel furnished.
 - 3. Also see Section 01 33 00, SUBMITTALS.
- C. Quality Control Submittals:
 - 1. Mechanical Threaded Connections: Provide verification that device threads have been checked and meet all requirements for thread quality, in accordance with manufacturer's published methods.

1.05 DELIVERY, HANDLING, AND STORAGE

- A. All steel reinforcement delivered to the project site shall be bundled, tagged, and marked. Metal tags shall be used indicating the bar size, lengths, and other information corresponding to markings shown on placement diagrams in accordance with ACI 315.
- B. The Contractor shall store concrete reinforcement materials at the site in a manner that will prevent damage and accumulation of dirt or excessive rust. Store to prevent contact with the ground. Protect all reinforcement from any contact with oil, grease, or petroleum based products of any kind.

PART 2 PRODUCTS

2.01 REINFORCING STEEL GRADE

- A. Unless otherwise called for on the Drawings, all reinforcing steel for this project shall be uncoated deformed billet steel bars and conform to ASTM A615 Grade 60. Reinforcing which is welded shall conform to ASTM A706 Grade 60.
- B. Deformed bar mats shall conform to the requirements of ASTM A184 and ASTM A615, Grade 60.

2.02 ACCESSORIES

- A. Chairs and spacers shall be metal stock, designed for the purpose intended.
- B. All accessories shall comply with Concrete Reinforcing Steel Institute (CRSI) "Recommended Practice for Placing Bar Supports, Specifications and Nomenclature."
- C. The Contractor shall provide stainless steel accessories for sight-exposed concrete (exterior) and at surfaces exposed to moisture (such as water holding basins, etc.).
- D. Slabs on grade where the base material will not support chairs, shall use supports with sand plates or horizontal runners to properly locate steel reinforcing in the slab.
- E. Wire-bar type supports shall comply with CRSI recommendations. Wood, brick, or other materials will not be accepted.
- F. Tie wire shall be 16-gauge, black, soft-annealed wire. Tie wire shall not be closer than 1-inch from surface of wall or slab after tying in place.

2.03 SPLICES AND MECHANICAL CONNECTIONS

- A. Metal Sleeve: If used for splice, provide with cast filler metal, capable of developing in tension or compression 125 percent of specified yield strength of the bar, as manufactured by:
 - 1. nVent Lenton Cadweld Metal-Filled Splicing System.
 - 2. Or approved equal.
- B. Mechanical Threaded Connections (Rebar Couplers): Metal coupling sleeve with internal threads which engage threaded ends of bars to be spliced, and develops in tension or compression 125 percent of the specified yield strength of the bar, as manufactured by:
 - 1. nVent Lenton Taper-Threaded Reinforcing Steel Couplers.
 - 2. Meadow Burke RC Series Threaded rebar Couplers.
 - 3. OCM Inc. Threaded Rebar Couplers.
 - 4. Or equal.

2.04 WELDED WIRE FABRIC

- A. Welded-wire fabric shall be electrically welded, 65,000 psi yield strength minimum, and shall conform to ASTM A1064 (AASHTO M55 and M221) and ACI 318, latest edition.
- B. Fabric shall be wide spaced standard, plain or deformed, provided in flat sheets.

PART 3 EXECUTION

3.01 FABRICATION

- A. General: The Contractor shall fabricate reinforcing bars to conform to required shapes and dimensions, with fabrication tolerances complying with CRSI "Manual of Standard Practice", ACI 117, ACI 301, and ACI 318. Bend reinforcement cold. In case of fabricating errors, the heating, re-bending or straightening of reinforcement will not be permitted.

3.02 GENERAL REQUIREMENTS

- A. Meet requirements in the CRSI manual titled, "Placing Reinforcing Bars".
- B. Steel reinforcement shall be protected at all times from injury. When placed in the work, it shall be free from dirt, detrimental scale, paint, oil and other foreign substance. When steel reinforcement has detrimental rust, loose

scale and dust which is easily removable, it shall be cleaned by a satisfactory method, if approved.

- C. All bars shall be bent cold, unless otherwise permitted. No bars partially embedded in concrete shall be field bent except as shown on the Drawings or otherwise permitted.
- D. Details of concrete reinforcement and accessories not covered herein or on the Drawings shall be in accordance with ACI 315.
- E. Notify Engineer when reinforcing is ready for inspection and allow sufficient time for this inspection prior to close-up of the forming system or placing concrete.

3.03 INSTALLATION OF REINFORCING STEEL

- A. The Contractor shall clean reinforcement to remove all loose rust and mill scale, earth, ice, oil or grease, and other materials which reduce or destroy the bond between the concrete and reinforcing steel.
- B. The Contractor shall position, support, and secure all reinforcement to prevent displacement by formwork, construction loadings, or concrete placement operations. Steel reinforcing shall be located and supported by metal chairs, runners, bolsters, spacers and hangers, as required. The reinforcement shall be placed to obtain the coverage for concrete protection noted on the Drawings. Where the coverage is not shown, the reinforcement shall be placed to obtain at least the minimum coverage specified hereinafter and/or in ACI 318.
- C. The Contractor shall arrange, space, and securely tie bars and bar supports together with 16-gauge wire to hold reinforcement accurately and solidly in position during concrete placement operations. Wire ties shall be set so that the twisted ends are directed away from the exposed concrete surfaces. All reinforcement will be tied and secured in the correct position in the forms before placing concrete. Do not stab reinforcing into fresh placed concrete.
- D. The Contractor shall provide a sufficient number of supports of adequate strength to carry the reinforcement. Reinforcing bars shall not be placed more than 2 inches beyond the last leg of any continuous bar support. Supports shall not be used as bases for runways for concrete conveying equipment and similar construction loads.
- E. Supports or spacers of pebbles, pieces of rounded or broken stone, concrete rubble, broken brick or building blocks, metal pipe or wooden blocks will not be permitted.

- F. Space reinforcement bars with minimum clear spacing according to ACI 318, or equal to one bar diameter, but not less than 1-inch. If bars are indicated in multiple layers, place upper bars directly above lower bars.
- G. Splices:
1. Standard reinforcement splices shall be done by lapping the ends, placing the bars in contact, and tightly wiring the splice together. The requirements of ACI 318 for minimum lap of spliced bars shall be provided. Use lap splices unless otherwise shown on the Drawings or permitted in writing by the Engineer. Stagger splices in adjacent bars.
 2. No field welding or tacking of reinforcement will be permitted.
 3. As an alternative, perform splices using metal sleeve as specified hereinbefore.
 4. Vertical bars in columns shall be offset at least one bar diameter at lapped splices. To ensure proper placement, templates shall be furnished for all column dowels.
- H. Unless otherwise shown on the Drawings, the Contractor shall provide minimum cover specified in ACI 318 or as follows:
1. Not less than 3 inches where the concrete is placed against the earth and without use of forms.
 2. Not less than 1 ½-inches for No. 5 bars and smaller and not less than 2-inches for No. 6 bars and larger where concrete is exposed to the weather or in contact with earth, but placed in forms.
 3. Not less than 1 ½-inches for interior slabs, walls, beams, and columns.
 4. Not less than 2 inches for interior slabs, walls, beams and columns in contact with water or on the side of water.
- I. The Contractor shall provide extra reinforcing at all openings in structural walls as shown on the Drawings. Place an equivalent area of steel around pipe or opening and extend on each side sufficiently to develop bond in each bar. Where welded wire fabric is used, provide extra reinforcing using fabric or deformed bars.
- J. The Contractor shall notify the Engineer when reinforcing is in place so that an inspection of reinforcement placement can be made prior to the close-up of formwork or the placement of concrete.

- K. Conform to ACI 301 for all placing tolerances.
- L. Bars may be moved to avoid interference with other reinforcing steel, conduits, or embedded items. If moved more than one bar diameter or the stipulated tolerance, the Contractor shall consult with the Engineer to determine final placement.
- M. At construction joints and before constructing concrete form work for next stage of construction, the Contractor shall clean all dowels, reinforcing bars and concrete surfaces. All loose material and foreign objects shall be cleaned out of forming before placement of concrete.
- N. Field Bending:
 - 1. Straightening and Re-bending: Do not straighten or re-bend metal reinforcement. Field bending of reinforcing steel bars is not permitted unless approved by the Engineer.
 - 2. Unless permitted by Engineer, do not cut reinforcing bars in the field.

3.04 MECHANICAL SPLICES AND CONNECTIONS

- A. Install as required by manufacturer with threads tightened as required by referenced ICBO Report.
- B. Carefully inspect each splice and verify that each component meets manufacturer's and ICBO requirements.
- C. Maintain minimum edge distance and concrete cover.

3.05 WELDED WIRE FABRIC PLACING

- A. Extend fabric to within 2-inches of edges of slab, and slab control joints; and lap splices at least 1 ½ courses of fabric or minimum 8-inches.
- B. Tie laps and splices securely at ends and at least every 24-inches with 16-gauge black annealed steel wire.
- C. Place welded wire fabric on #4 continuous bars at 4-foot 0-inches supported at proper distance above bottom of slab. All slab reinforcing is to be discontinuous at slab control joints.
- D. Meet current ACI 318 and current Manual of Standard Practice, Welded Wire Fabric, by the Wire Reinforcement Institute regarding placement, bends, laps, and other requirements.
- E. All welded wire fabric shall be provided in flat sheets. Rolled fabric will not be permitted.

END OF SECTION 03 20 00

PART 1 GENERAL**1.01 WORK INCLUDED**

- A. This section shall include constructing the cast-in-place concrete structures consisting of Portland cement, fine and coarse aggregate, water and selected admixtures, combined, mixed, transported, placed, finished, and cured, complete, as herein specified.
- B. This section also includes grout for miscellaneous uses, surface hardeners, bonding agents, and other related concrete accessories and construction requirements.
- C. Contractor is responsible to repair all cracks in water-holding structures as specified herein. The work shall be done by an experienced and certified applicator as specified herein.

1.02 RELATED WORK

- A. Submittals: Section 01 33 00.
- B. Quality Control: Section 01 40 00.
- C. Concrete Forming and Accessories: Section 03 11 00.
- D. Concrete Reinforcing: Section 03 20 00.
- E. Expansion, Construction, and Control Joints: Section 03 15 00.

1.03 QUALITY ASSURANCE

- A. The Contractor shall have available on-site a copy of ACI SP-15 "Specifications for Structural Concrete for Buildings with Selected ACI and ASTM References."
- B. The Contractor shall comply with all requirements of the following codes and standards, except as modified herein:
 - 1. ACI 301 "Recommended Practice for Concrete Inspection."
 - 2. ACI 318 "Building Code Requirements for Reinforced Concrete."
 - 3. ACI 304 "Recommended Practice for Measuring, Mixing, Transporting and Placing Concrete."
 - 4. ACI 305 "Recommended Practice for Hot Weather Concreting."
 - 5. ACI 306 "Recommended Practice for Cold Weather Concreting."

6. ACI 308 "Recommended Practice for Curing Concrete."
 7. ACI 350, "Code Requirements for Environmental Engineering Concrete Structures."
- C. Other references:
1. ASTM C31: Making and Curing Concrete Test Specimens in the Field.
 2. ASTM C33: Specification for Concrete Aggregates.
 3. ASTM C39: Test Method for Compressive Strength of Cylindrical Concrete Specimens.
 4. ASTM C94: Specification for Ready-Mixed Concrete.
 5. ASTM C143: Standard Test Method for Slump of Portland Cement Concrete.
 6. ASTM C150: Specification for Portland Cement.
 7. ASTM C260: Specification for Air-Entraining Admixtures for Concrete.
 8. ASTM C309: Specification for Liquid Membrane-Forming Compounds for Curing.
 9. ASTM C311: Test Methods for Sampling and Testing Fly Ash or Natural Pozzolans for Use in Portland Cement Concrete.
 10. ASTM C494: Chemical Admixtures for Concrete.
 11. ASTM C1260: Standard Test Method for Potential Alkali Reactivity of Aggregates (Mortar-Bar Method).
 12. ASTM C1567: Standard Test Method for Determining the Potential Alkali-Silica Reactivity of Combinations of Cementitious Materials and Aggregate (Accelerated Mortar-Bar Method).
 13. ACI 302: Concrete Floor and Slab Construction.
 14. ACI 614: Specification for Concrete Placement.
 15. ACI SP 66: Detailing Manual.
 16. U.S. Army Corps of Engineers Concrete Research Division (CRD) C662: Determining the Potential Alkali-Silica Reactivity of

Combinations of Cementitious Materials, Lithium Nitrate Admixture and Aggregate (Accelerated Mortar-Bar Method).

- D. Coordinate testing and Special Inspections as specified in Part 4, TESTING AND SPECIAL INSPECTIONS of this Section and as noted on the Drawings.

1.04 SUBMITTALS

- A. Refer to Section 01 33 00, SUBMITTALS.
- B. The Contractor shall submit copies of the manufacturer's data with the application and installation instructions for proprietary materials and items, including reinforcement and forming accessories, admixtures, bonding and patching compounds, joint systems, curing compounds, floor hardeners, grout, and others as requested by the Engineer.
- C. A placement schedule shall be prepared by the Contractor and submitted to the Engineer for review prior to the start of concrete placement operations. Include information on time between adjacent pours and identification of the location of each type of construction joint to be used.
 - 1. Cold Weather Concreting Plan: Submit a plan describing cold weather placement of concrete, including concrete mix design, freeze protection, placement, and curing methods as specified in this Section. Submit plan at least 14 days prior to placing concrete.
- D. The Contractor shall furnish copies of the delivery tickets for each load of concrete delivered to the site and other information as specified under ASTM C94, Certification.
- E. Concrete Mix Design Proposals
 - 1. Concrete Mix: Submit each mix design to the Engineer for review at least 14 days before first use is planned. Include substantiating test data and mix design details, including aggregate gradation and source, test results on fine and coarse aggregate Alkali-Silica Reactivity (ASR), water/cement ratio, mix proportions, air content, slump, and strength tests. Substantiating data must include tests by an independent testing laboratory within the past 3 years verifying the requirements specified under "Part 2 Article PROPORTIONING AND DESIGN OF MIXES" and "PART 4 TESTING AND SPECIAL INSPECTIONS". Submit complete information for each mix design which has different strength, different aggregate size or gradation, different proportions or is to be transported differently. For previously used mix submit copies of at least 10 tests meeting these

specifications. Do not place any concrete until the mix design and substantiating data for that concrete has been reviewed.

2. Pumped Concrete: At least 14 days before starting work, submit details of proposed pumping operation, equipment to be used, and any required adjustments to mix designs. Do not pump concrete if Engineer feels an unsatisfactory concrete may result from the overall planned process and equipment.
- F. To demonstrate their capabilities and experience, provide qualification data for Contractor's proposed independent testing agency that will provide the concrete mix design, trial mix batch mixtures, and initial mix design testing services.
- G. Water-Holding Basin Repair Methods: As necessary if water holding basins fail tests or if damp spots or observed seepage is present as specified. Cracks shall be repaired by the epoxy or hydrophobic grout injection process. Submit crack injection data and procedures to Engineer for review. Crack repair personnel shall have a minimum of 5 years licensed and documented experience. Submit documentation of certification and past project experience including project name, location, type and amount of repair work completed, and contact name.
- H. Crack Repair Report: Epoxy or hydrophobic grout injection materials manufacturer certification that crack repair was performed by a licensed and certified applicator per the manufacturer's recommendations.
- I. Submit all reports resulting from testing and special inspections as specified herein and on the Drawings.

PART 2 PRODUCTS

2.01 PROPORTIONING AND DESIGN OF MIXES

- A. The following mix properties are required for all concrete placement within forms, unless noted differently in design drawings:
 1. Proportion and design of concrete mix shall meet the following requirements:

Strength at 7 days	2400 psi minimum
Strength at 28 days	4500 psi minimum
Maximum water/cement ratio	0.43 by weight
Slump at point of placement	
Without superplasticizer	3-5 inches
With superplasticizer	5-10 inches
Minimum Cement Content	6 sacks per cubic yard or

Entrained Air	564 pounds per cubic yard 4.5-7.5% general 3-6% exterior slabs
Maximum Aggregate Size	¾-inch as defined below, unless shown otherwise on the Drawings.

2. Design shall be by an approved independent concrete mix and testing laboratory and a trial mix batch shall be made and tested by that laboratory. Average strength of cylinders in trial batch must exceed specified strength by 15 percent.
 3. A previously used mix design may be used provided aggregate source is the same, the mixing equipment is the same, and provided at least 10 tests were made by an independent laboratory with results meeting these specifications.
 4. If any of the first three 7-day cylinder tests fail to meet the specified 7-day strength, the mix shall be modified for more strength. Submit modified mix for review before use.
 5. Adjustment to Concrete Mixes: Mix design adjustments may be requested by the Contractor when characteristics of materials, job conditions, weather, test results, or other circumstances warrant, at no additional cost to the Owner. Test data for revised mix designs and strength results must be submitted and accepted before using the mix adjustments.
 6. Entrained Air: Air-entraining admixture shall be used unless otherwise shown or specified. Air-entraining admixture shall be added at the manufacturer's prescribed rate to result in concrete at the point of placement with an air content as specified herein (volume basis).
 7. Concrete shall be mixed in conformance with ASTM C94.
- B. Entrained air admixtures shall be used according to the manufacturer's prescribed rate. Test in accordance with ASTM C231.
- C. The use of an accelerating agent is not permitted unless specifically authorized by the Engineer.
- D. Combined Aggregate Grading Limits:
1. Aggregate size shall be ¾-inch maximum for slabs, beams, columns, walls and footings.

2. Aggregate size shall be 3/4-inch maximum for structures with textured surfaces.
3. Grading limits for coarse aggregate shall be as follows:

Sieve Size	Percentage Passing	
	1-inch Max.	3/4-inch Max.
2-inch	--	--
1-1/2-inch	-100	--
1-inch	95-100	-100
3/4-inch	--	90-100
1/2-inch	25-60	--
3/8-inch	--	40-90
No. 4	0-10	5-20
No. 8	0-5	0-5

4. Grading limits for fine aggregate shall be as follows

Sieve Size	Percentage Passing
3/8-inch	-100
No. 4	95-100
No. 8	80-100
No. 16	50-85
No. 30	25-60
No. 50	10-30
No. 100	2-10
No. 200	0-4

5. The combined mixture of fine and coarse aggregate shall be such that not more than 1.5 percent passes the No. 200 sieve.

2.02 PORTLAND CEMENT

- A. Meet ASTM C150, Type I or Type II, or Type I-II (sulfate resistant)
- B. Non-Hydraulic Above-grade Structures: Use either Type I or Type II cement.
- C. Hydraulic and Below-grade Structures: Use Type I-II (sulfate resistant) or cement.

2.03 AGGREGATES

- A. Fine: Clean, sharp, natural sand, ASTM C33. Fineness modulus shall not be less than 2.5 nor more than 3.0. Materials passing 200 sieve shall be 4 percent maximum.
- B. Coarse: Crushed stone or gravel, ASTM C33. Maximum size of coarse aggregate shall be $\frac{3}{4}$ -inch as defined hereinbefore, unless otherwise indicated on the Drawings. Materials passing 200 sieve shall be 0.5 percent maximum.
- C. Aggregates shall be natural, free from deleterious coatings, meeting ASTM C33, nonreactive. Thoroughly and uniformly wash before use. Reactivity must be determined by testing in accordance with ASTM C1293 and categorized in accordance with ASTM C1778. Tests done within the previous 12 months are acceptable. In accordance with ASTM C33, Appendix XI, paragraph X1.1, evidence of reactive problems on existing structures may be used to prove sources of aggregates are reactive and are unsuitable for use in the work. Import nonreactive aggregates if local aggregates are reactive
- D. Aggregate soundness testing for fine and coarse aggregates shall be in accordance with ASTM C88 using a sodium sulfate solution.
- E. Local aggregates not in compliance with the soundness and durability requirements of this standard shall not be used except with prior written approval of the Engineer and provided it can be shown by special testing or a record of past performance that these aggregates produce concrete of adequate strength and durability.

2.04 WATER

- A. All water for concrete mixtures shall be clean, potable, and free from injurious substances and conforming to ASTM C94 and ASTM C1602. Water containing 2 percent or more common salt shall not be used and chloride levels shall be less than 500 parts per million.

2.05 AIR ENTRAINING ADMIXTURES

- A. Air entraining admixtures shall be used in all concrete exposed to the weather and as specified for quality of concrete used, ASTM C260, except

that admixture shall be non-toxic after 30 days and contain no chlorides or other chemicals causing corrosion.

1. MasterAir AE 200 by BASF/Master Builders Solutions.
 2. Sika AIR-260 by Sika Corporation.
 3. EUCON Air Mix 200 by Euclid Chemical Company..
 4. Or equal.
- B. Must be compatible with water-reducing admixture. Concrete with air-entrainment admixture added shall maintain air percentage as batched, within 2 percent for minimum time required for placement into the structure.

2.06 WATER-REDUCING ADMIXTURES

- A. Water-reducing admixtures shall conform to ASTM C494, Type A or Type D.
- B. Complex, multi-component, non-chloride, non-corrosive admixture providing unique performance qualities unobtainable from conventional water-reducing admixtures.
- C. Manufacturer and Product:
1. BASF/Master Builders Solutions Master Pozzolath 200, 210, or 322.
 2. W.R. Grace and Company Daracem 19.
 3. Euclid Chemical Company EUCON NW.
 4. Or equal.
- D. Must be compatible with air entraining admixture.

2.07 SUPERPLASTICIZERS

- A. Meet ASTM C494 and use only Type F or G, of second or third generation type, or ASTM C1017, Type I.
- B. Hold slump of 5 inches or greater for the time required for placement into the structure, or 2 hours minimum.
- C. Type F Superplasticizer: Batch plant added to extend plasticity time, control temperature of fresh concrete, reduce water 20 to 30 percent, and give higher strengths at all ages.

- D. Type G Superplasticizer: Batch plant added to extend plasticity time, maintain setting characteristics similar to normal concrete throughout its recommended dosage range and at varying concrete temperatures, reduce water 30 to 40 percent, and give high-early and ultimate strengths.
- E. Superplasticizers for Hot Weather Placements:
 - 1. A synthesized sulfonated complex polymer type superplasticizer containing no chlorides, other corrosive chemicals, or alkalines.
 - 2. Add to concrete mix at manufacturer's recommended dosage to allow placement with concrete temperatures up to 90 degrees F.
- F. Manufacturer and Product:
 - 1. BASF/Master Builders Solutions Master Rheobuild 1000.
 - 2. W.R. Grace and Company Daracem 19.
 - 3. Euclid Chemical Company EUCON SP or 537.
 - 4. Or equal.

2.08 FREEZE PROTECTION ADMIXTURE

- A. ASTM C494 Type E admixture, non-chloride, specially formulated to provide protection from freezing down to 20 degrees F (-7 degrees C) until initial set has been reached and surface has been sealed.
- B. Manufacturer and Product:
 - 1. BASF/Master Builders Solutions MasterSet FP 20.
 - 2. Euclid Chemical Company ACCELGUARD AcN 200.
 - 3. Or equal.
- C. Use is Contractor's option. If used, full responsibility for providing concrete meeting this Specification rests with the Contractor, including replacement of defective concrete and delayed costs.

2.09 CALCIUM CHLORIDE

- A. Calcium chloride and products containing more than 0.1 percent chloride ions are not permitted. Provide admixture manufacturer's written certification that chloride ion content complies with specified requirements.

2.10 CONCRETE CURING MATERIALS

- A. Do not use curing compound where additional finishes such as hardeners, paintings, and other special coatings are required. Use water curing as specified instead. Water shall be potable and not detrimental to concrete.
- B. Absorptive cover shall be provided by burlap cloth made from jute or kenaf, weighing approximately 9 ounces per square yard and complying with AASHTO M182, Class 2 or ASTM C171, Type C.
- C. A moisture retaining cover shall comply with one of the following:
 - 1. Waterproof paper, ASTM C171, Type D.
 - 2. Polyethylene film, ASTM C171, Type E.
 - 3. Curing Compound: Resin based compound conforming to ASTM C309, with additional requirement that the moisture loss shall not exceed 0.030 gm/square cm/72 hours. Use Type 1 (clear without dye) for concrete not exposed to sunlight, Type 1D (clear with fugitive dye) for concrete exposed to sunlight, and Type 2 (white pigmented) for hot weather concreting. Curing compound shall be VOC compliant with a maximum VOC content of 2.90 pounds per gallon (350 grams per liter), or less where the project location regulations are more stringent.
- D. Manufacturer's certification shall state that curing compound can be applied in one coat and shall show the quantity or coverage required to meet or exceed that above moisture retention.
- E. Provide manufacturer's certification that curing compound is acceptable to the appropriate state agency or health department.

2.11 CRACK REPAIR MATERIALS

- A. Two-component epoxy resin injection; conforming to ASTM C881, Types I, II, and IV, Grade 1 or 3, and Class B or C; and AASHTO M235. Epoxy crack repair material shall be Sikadur 35, Hi-Mod LV, by Sika Corporation; BASF/Master Builders Solutions MasterInject 1380; or equal.
- B. In special applications, an expanding polyurethane chemical hydrophobic grout such as Sika Fix HH by Sika Corporation, or approved equivalent may also be considered.

2.12 NON-SHRINK GROUT

- A. Non-shrink Grout Category I:
 - 1. Non-shrink, non-metallic, non-gas liberating grout for use in filling tie holes in concrete, blockouts for gate guides, joints of precast

components or members, and grouting baseplates of columns that do not exceed one story in height shall be one of the following:

- a. L&M Crystex by Laticrete International.
 - b. NS Grout or Dry Pack Grout by Euclid Chemical Company.
 - c. MasterFlow 110AN by BASF/Master Builders Solutions.
 - d. Sika Grout 328 by Sika Corporation.
 - e. Or equal.
2. All grout shall be a fluid consistency in use except that for formwork tie holes the grout shall be dry pack consistency and shall fill the conical section with dense grout hammered in with steel tool and steel hammer. Grout shall meet all requirements of ASTM C1107 and Corps of Engineers CRD-C261 and have a fluid grout minimum compressive strength of 5,000 psi at 7 days and 6,800 psi at 28 days.
 3. Use Category II grouts for patching defects in walls and slabs after form removal.
 4. No material other than water shall be added to the premixed grout at the jobsite. Follow manufacturer's instructions relative to mixing, placing, and curing.

B. Non-shrink Grout Category II:

1. Non-shrink grout with natural aggregate for use in high strength, precision support of machine bases of 25 horsepower or less; bases for precast wall sections, columns, and precast members more than one story in height; and patching defects in walls and slabs after form removal shall conform to the Corps of Engineers' Specification for Non-Shrink Grout, CRD-C621, ASTM C1107, and to these specifications. Fluid grout as determined by the flow cone, CRD-C611, shall have a minimum strength of 5,000 psi at 7 days and 7,000 psi at 28 days. The following listed grouts are acceptable for use as Category II grout (field test requirement shall be met):
 - a. HI-FLOW Grout by Euclid Chemical Company.
 - b. MasterFlow 713, by BASF/Master Builders Solutions.
 - c. SIKA Grout 328 by Sika Corporation.
 - d. Or equal.
2. No material other than water shall be added to the premixed grout at the jobsite. Follow manufacturer's instructions relative to mixing, placing, and curing.

C. Non-shrink Grout Category III:

1. Non-shrink grout for use in high strength, precision support of machine bases for machinery of 30 horsepower or greater and soleplates where very large loads and stresses from vibration and other dynamic loads are involved and when the equipment will be subject to thermal movements. Grout shall conform to the Corps of Engineers' Specification for Non-Shrink Grout, CRD-C621, ASTM C1107, and to these specifications. The following grouts are acceptable for use as Category III grout (field test requirements shall be met):
 - a. MasterFlow 885 by BASF/ Master Builders Solutions.
 - b. HI-FLOW METALLIC grout by Euclid Chemical Company.
 - c. SIKA Grout 428-FS by Sika Corporation.
 - d. Or equal.
2. The location for use, other than that specified above, shall be as shown on the Drawings and/or as specified hereinafter.
3. The grout shall be free of gas-producing or gas-releasing agents, free of oxidizing catalysts, free of inorganic accelerators, and free of chlorides. Provide performance characteristics when mixed to fluid consistency, 22 to 25 seconds (flow cone method, CRD-C611) as follows:
 - a. When mixed and maintained at 45 degrees F (7 degrees C) or higher, no visible bleeding and/or settlement up to 2 hours on 1/2 gallon grout poured into gallon can, covered with glass plate to prevent evaporation.
 - b. Grout shall be cured in accordance with grout manufacturer's instructions.
 - c. Provide (2-inch by 2-inch cube) strengths as specified. Prepare specimens and test in accordance with ASTM C109 except as follows: Mix grout in accordance with manufacturer's instructions. Fill molds in two layers, puddling each layer gently with gloved finger five times; strike off excess grout; wipe edges of mold clean with rag and cover with steel plate clamped to mold until time to test. Seal cover 24 hours after placement.
4. The grout shall obtain a minimum compressive cube strength of 5,000 psi at 3 days and 9,000 psi at 28 days.
5. No material other than water shall be added to the premixed grout at the jobsite. Follow manufacturer's instructions relative to mixing, placing, and curing.

2.13 SURFACE (FLOOR) HARDENERS

- A. Surface hardeners shall consist of a colorless (natural) aqueous solution of sodium silicate and magnesium and zinc fluosilicates suitable for application to cured or partially cured concrete surfaces and capable of reacting with the soluble calcium compounds present in the concrete to form a thin surface of increased hardness with reduced potential for dusting.
- B. Approved proprietary hardeners include:
 - 1. MasterKure HD 300WB by BASF/Master Builders Solutions.
 - 2. Hornolith by Tamms Industries.
 - 3. MED-CURE by W.R. Meadows Incorporated.
 - 4. Or equal.
- C. The solution shall be delivered ready for use at the job site.

2.14 CONTROL JOINT FORMS

- A. Control Joint Forms: As specified in Section 03 15 00, EXPANSION, CONSTRUCTION, AND CONTROL JOINTS.

2.15 EPOXY BONDING AGENT

- A. Two component material suitable for use on dry or damp surfaces. Provide material "Type", "Grade", and "Class", to suit project requirements. Meet the requirements of ASTM C881, Type I, II, IV, or V.
- B. Products: Subject to compliance with specific project requirements, provide one of the following:
 - 1. Sikadur-32 Hi-Mod by Sika Corporation.
 - 2. Dural 452 MV or Euco 452 by Euclid Chemical Company.
 - 3. CRACKBOND 2100 MV and MV-LPL by Adhesives Technology Corporation.
 - 4. Or equal.

2.16 NEAT CEMENT GROUT FOR BONDING

- A. Provide flowable neat cement grout for expansion and construction joints bonding consisting of one part Portland cement to 1-1/2 parts sand, with minimum 12 sacks of cement per cubic yard. Keep water to a minimum.

2.17 CONTROLLED DENSITY FILL, FLOWABLE FILL

- A. Controlled density fill (CDF) or flowable fill shall be as specified in Section 31 23 23, FLOWABLE FILL.

2.18 GROUT FILLET OR TOPPING FOR PROCESSING EQUIPMENT

- A. Purpose of grout topping is to provide a smooth, even surface equipment to operate on. Obtain tolerance and finish requirements from manufacturer.
- B. Components: Screened sand, water, water reducing admixture, fiber reinforcing, cement, pozzolan, and other admixtures.
- C. Consistency: As required for placement, tolerance, bond, and strength, and as specified hereinafter in Part 3 EXECUTION for Screed Finish on Clarifier Slabs.
- D. Design Strength: 4,000 psi at 28 days minimum. Provide minimum cement content specified hereinafter, regardless of strength.
- E. Minimum Cement Content: 536 pounds per cubic yard. Pozzolan shall be 30 percent of the total cementitious content.
- F. Cement: Type II.
- G. Water/ Cementitious Ratio: 0.35 maximum.
- H. Use water reducing admixtures.
- I. Use fiber reinforcing as specified hereinbefore to provide greater control of cracking.
- J. Entrained Air Content: 4% to 6%.
- K. Slump shall be as required to maintain a homogeneous mix and to allow placement to meet equipment manufacturer's requirements.
- L. Combined Aggregate Gradings:
1. Combine aggregates for grout in proportions that will provide a mixture within grading limits shown below, unless otherwise approved in writing by Engineer:

Sieve Sizes	Percentage Passing Sand for Grout
No. 4	95 – 100
No. 8	80 – 100
No. 16	50 – 85
No. 30	25 – 60
No. 50	10 – 30

No. 100	2 – 10
No. 200	-

PART 3 EXECUTION**3.01 CONCRETE MIXING**

- A. The materials for concrete shall be mixed at an acceptable and established concrete batch plant. Meet ACI 304 current edition, ASTM C94, ACI 301, ACI 302, and other requirements as specified for mix design, testing, and quality control.
- B. Ready-mix or portable temporary batch plant concrete shall comply with the requirements of ASTM C94, ACI 301, ACI 302.1R, ACI 304R, and as herein specified:
1. Use of a portable temporary batch plant shall be only as approved by Engineer. Submit data on portable temporary batch unit to demonstrate conformance with referenced standards and these specifications.
 2. Batching equipment shall be such that the concrete ingredients are consistently measured within the following tolerances: 1 percent for cement and water, 2 percent for aggregate, and 3 percent for admixtures.
 3. The addition of water to the mix at project site must be approved by the Engineer and the maximum water-cement ratio shall not be exceeded.
 4. Machine mix concrete. Begin mixing within 30 minutes after the cement has been added to the aggregates.
 5. Concrete shall be discharged at the job within 1-1/2 hours after water has been added to the cement and aggregates or cement batched with the aggregates, unless a longer time is specifically authorized by the Engineer.
 6. During hot weather or under conditions contributing to rapid setting of concrete, a shorter mixing time than specified in ASTM C94 may be required:
 - a. When the air temperature is between 85 degrees Fahrenheit and 90 degrees Fahrenheit, the mixing and delivery time shall be reduced from a maximum of 1-1/2 hours to 75 minutes and when the air temperature is above 90 degrees Fahrenheit, the

mixing and delivery time shall be reduced to no more than 60 minutes.

7. Transport concrete from the mixer to the forms as rapidly as practicable. Prevent segregation or loss of ingredients. Clean transporting equipment thoroughly before each batch. Do not use aluminum pipe or chutes. Remove concrete which has segregated in transporting and dispose of off-site as directed.

C. Truck Mixers:

1. Equip with electrically actuated counters to readily verify the number of revolutions of the drum or blades.
2. Counter:
 - a. Resettable, recording type, mounted in driver's cab.
 - b. Actuated at time of starting mixers at mixing speeds.
3. Performance Requirements:
 - a. Truck mixer operation shall provide a concrete batch as discharged within acceptable limits of uniformity with respect to consistency, mix and grading.
 - b. If slump tests taken at approximately the 1/4 and 3/4 points of the load during discharge give slumps differing by more than 1 inch when specified slump is 3 inches or less, or differing by more than 2 inches when specified slump is more than 3 inches, discontinue use of truck mixer unless causing condition is corrected and satisfactory performance is verified by additional slump tests.
 - c. Check mechanical details of mixer, such as water measuring, and discharge apparatus, condition of blades, speed of rotation, general mechanical condition of unit, and clearance of drum before attempting to reuse unit.
4. Do not use non-agitating or combination truck and trailer equipment for transporting ready-mixed concrete.

D. Mixing Process:

1. Concrete Volume in Truck:
 - a. Limit to 63 percent of total volume capacity per ASTM C94 when truck mixed.
 - b. Limit to 80 percent of total volume capacity when central mixed.

2. Mix each batch of concrete in truck mixer for minimum 70 revolutions of drum or blades at rate of rotation designated by equipment manufacturer as mixing speed.
 3. Perform additional mixing, if required, at speed designated by equipment manufacturer as agitating speed.
 4. Place materials, including mixing water, in mixer drum before actuating the revolution counter for determining the number of mixing revolutions.
- E. Superplasticizers and Air Admixtures: Add at concrete plant only through equipment furnished and/or approved by admixture manufacturer. Equipment shall provide for easy and quick visual verification of admixture amount used for each dose. Discharge amount to be added to each load of concrete into separate dispensing container, measured verified as to amount, then add to concrete. Re-dosing of concrete in the field is not permitted, unless specifically approved by the Engineer.

3.02 PREPARATION

- A. Pre-Placement Inspection:
1. Before placing concrete, the Contractor will inspect and complete the formwork installation, placement of reinforcing steel, and items to be embedded or cast-in. Reinforcing shall not be stabbed into freshly placed concrete.
 2. The wood forms shall be wetted immediately before placing the concrete when form coatings are not used. Dampen subgrade before placing concrete for slabs on grade unless a vapor barrier is used.
 3. The installation of joint materials shall be coordinated with the placement of forms and reinforcing steel.
 4. Secure reinforcement in position and allow Engineer to review acceptability before placing concrete.
- B. Sleeves, Anchors and Inserts: All sleeves, anchors, and inserts required shall be properly placed, as detailed in the Drawings, in the concrete formwork and securely anchored to prevent displacement during the placing of the concrete.
- C. Contractor shall protect formwork overnight, and at other times as required, when adverse weather is forecasted to prevent snow or water from building up in forms or frost from depositing on forms or reinforcing steel.

3.03 CONCRETE PLACEMENT

- A. Concrete shall be placed in compliance with the practices and recommendations of ACI Standards 301, 304, 318, and 614, and as herein specified:
1. Concrete shall be placed continuously or in layers of such thickness that no concrete will be placed on concrete which has hardened sufficiently to cause the formation of seams or planes of weakness within the section. If a section cannot be placed continuously, the Contractor shall provide construction joints as specified in Section 03 15 00, EXPANSION, CONSTRUCTION, AND CONTROL JOINTS. The placement of concrete shall be done at such a rate that concrete is still workable. Concrete shall be placed as near as practicable to its final location to prevent segregation due to re-handling or flowing. Do not subject concrete to any procedure which will cause segregation.
 2. For flat work and slabs, concrete shall not be allowed to fall freely more than five feet. In no case shall concrete be allowed to freely drop more than eight feet, or as specified hereinafter for super plasticized concrete.
 3. Screed concrete which is to receive other construction to the proper level to avoid excessive skimming or grouting.
 4. Concrete which has become non-plastic and unworkable, or does not meet the required quality control limits, or which has been contaminated by foreign material shall not be used. Do not use re-tempered concrete. Remove rejected concrete from the project site and dispose of it at an approved location.
 5. Concrete discharge time shall be less than 90 minutes after adding cement to water and aggregate.
- B. Placing Concrete into Forms:
1. Concrete shall be placed in forms in horizontal layers not deeper than 18 inches and in a manner to avoid inclined or unplanned cold construction joints. Where placement consists of several layers, place each layer while the preceding layer is still workable to avoid cold joints.
 2. Temporary spreaders in forms shall be removed when concrete placement has reached the elevation of such spreaders.
 3. Concrete placed in forms shall be consolidated by mechanical vibrating equipment, capable of reaching all extents of the formwork, supplemented by hand-spading, rodding, and tamping. Use

equipment and procedures for consolidation of concrete in accordance with the recommended practices of ACI 309, to suit the type of concrete and project conditions. Vibration of forms and reinforcing will not be permitted.

4. Vibrators shall not be used to transport concrete inside of the forms. Insert and withdraw vibrators vertically at uniformly spaced locations not farther than the visible effectiveness of the machine. Place vibrators to rapidly penetrate the layer of concrete and at least 6 inches into the preceding layer. Do not insert vibrators into lower layers of concrete that have begun to set. At each insertion, limit the duration of the vibration to the time necessary to consolidate the concrete and complete embedment of reinforcement and other embedded items without causing segregation of the mix. Generally, this will be from 5 to 15 seconds in accordance with ACI 301.
5. Allowable Vertical Free Fall Drop to Final Placement:
 - a. 5-feet in forms 8-inch or less wide and 8 feet in forms wider than 8 inches, except as hereinafter specified.
 - b. Super-plasticized Mixes: Up to 15 feet of slump is over 6 inches.
6. Do not use aluminum pipe or other aluminum conveying devices.
7. Provide sufficient illumination for interior of forms so concrete at places of deposit is visible to permit confirmation of consolidation quality.

C. Conveyor Belts and Chutes:

1. Design and arrange ends of chutes, hopper gates, and other points of concrete discharge throughout conveying, hoisting, and placing system such that concrete passing from them will not become segregated.
2. Do not use chutes longer than 50 feet.
3. Minimum Slopes of Chutes: Angled to allow concrete of specified consistency to readily flow without segregation.
4. Conveyor Belts:
 - a. Approved by Engineer.
 - b. Wipe clean with a device which does not allow mortar adhering to the belt to be wasted.
 - c. Cover conveyor belts and chutes.

- D. Re-tempering: For concrete or mortar in which cement has partially hydrated, re-tempering is not permitted.
- E. Pumping of Concrete:
 - 1. General:
 - a. Pumping is the preferred method of placing concrete.
 - b. If pumped concrete does not produce satisfactory end results, discontinue pumping operation until the problem is corrected.
 - c. At Contractor's option, other approved methods of placement may be used.
 - 2. Equipment:
 - a. Provide standby pump, conveyor system, crane and concrete bucket, or other system acceptable to Engineer, on site during pumping, for adequate redundancy to assure completion of concrete placement without cold joints in case of a primary placing equipment breakdown.
 - b. Minimum Pump Hose (Conduit) Diameter: 4 inches.
 - c. Replace pumping equipment and hoses (conduits) that are not functioning properly.
 - d. Do not use aluminum conduits for conveying concrete.
 - 3. Field Control (For Pumped Concrete): Concrete samples will be taken for slump (ASTM C143) and test cylinders (ASTM C31 and C39) including air content and shrinkage specimens (ASTM C157) at placement (discharge) end of line, unless approved otherwise by the Engineer.
- F. Maximum Size of Concrete Placements:
 - 1. Limit size of each pour regardless whether slabs or walls, to allow for strength gain and some volume change due to shrinkage to take place. Size shall be as specified hereinafter.
 - 2. Expansion and Construction Joints:
 - a. Unless otherwise shown, where expansion or construction joints are shown at approximately 60 to 70 feet spacing, intermediate construction joints are not required.
 - b. Where expansion or construction joints are not shown or where expansion or construction joints are spaced at larger distances than 70 feet, provide intermediate construction joints at maximum 40 feet unless approved otherwise in writing.

- c. Locate joints, where not otherwise shown, as detailed on approved shop drawings.
 - d. Alternate pours at each side of expansion or construction joints with 10 days minimum curing time between pours.
 - e. Also see Section 03 15 00, EXPANSION, CONSTRUCTION, AND CONTROL JOINTS.
- G. Removal of Water: Remove all water from space to be occupied by concrete.
- H. Consolidation and Visual Observation:
 - 1. Consolidate concrete with internal vibrators with minimum frequency of 8,000 vpm and amplitude required to consolidate concrete in section being placed.
 - 2. Provide at least one standby vibrator in operable condition at placement site prior to placing concrete.
 - 3. Consolidation equipment and methods shall meet ACI 309.
 - 4. Provide sufficient windows in the forms or limit form height to allow visual observation of concrete.
 - 5. Vibrator operator shall be required to see concrete being consolidated to ensure good quality workmanship, or an individual shall actually observe the vibration of concrete at all times and advise vibrator operator of any changes needed to ensure complete consolidation.
 - 6. Consolidation and placement locations shall be planned and accomplished so that vibrators shall be inserted in the concrete as it is placed and in locations not to exceed a distance of 5 feet from point of placement.
- I. Placing Concrete Slabs on Grade:
 - 1. Prior to concrete placing, any area of subgrade on which concrete is to be placed shall be properly wetted. Concrete slabs shall be placed in a continuous operation, within the limits of construction joints, until the placement of a panel or section is completed. When in-place concrete has sufficiently set up (at least 24 to 36 hours), an alternate section shall be placed. All joints between sections shall be properly keyed. The edges of all sections shall be tooled with a minimum radius or chamfer edging tool.

2. Concrete shall be consolidated during placement operations using vibrating equipment, so that the concrete is thoroughly worked around reinforcement and other embedded items and into the corners.
 3. Slab surfaces shall be brought up to the correct level with a straightedge and struck off. Bull floats or darbies may be used to smooth the surface, leaving it free from humps or hollows. Do not sprinkle water on the plastic surface. Do not disturb the slab surfaces prior to beginning finishing operations.
 4. Control Joints for Non-Water Holding Slabs on Grade:
 - a. Locate as shown on the Drawings. Where not indicated, locate at 13 foot maximum intervals in both directions.
 - b. Construct with a manufactured, embedded, preformed control joint form or stop pour at each control joint using keyway forms. Install form with no offsets and in straight lines as specified elsewhere.
 - c. Also see Section 03 15 00, EXPANSION, CONSTRUCTION, AND CONTROL JOINTS.
 5. Reinforcing steel shall be continuously maintained in the proper position during concrete placement operations.
 6. All exterior concrete slabs shall be sloped in a manner to prevent the collection of water.
- J. Bonding:
1. Surfaces of set concrete at all joints shall be roughened, except where bonding is obtained by use of an approved concrete bonding agent, and the surfaces shall be cleaned of laitance coating, loose particles, and foreign matter. Surfaces shall be roughened in a manner to expose bonded aggregate uniformly and laitance, loose particles of aggregates, or damaged concrete at the surface shall be removed.
 2. Bonding of fresh concrete to new concrete that has set, but is less than 60 days old or is not fully cured shall be done as follows:
 - a. At joints between a footing and walls or columns, and between walls or columns and beams or slabs that they support, and elsewhere unless otherwise specified herein, dampen, but do not saturate, the roughened and cleaned surface of set concrete immediately before placing the fresh concrete.

- b. At horizontal joints in exposed work, and at joints designed to contain liquids, dampen, but do not saturate, the roughened and cleaned surface of set concrete and apply a minimum 2-inch layer of neat cement grout.
 - c. Neat cement grout as specified hereinbefore shall be applied to a minimum thickness of 2 inches and a maximum of 3 inches. Fresh concrete shall be placed before the cement grout has attained its initial set. Limit concrete lift placed immediately on top of grout to 12 inches.
 - d. In all cases, neat cement grout shall be used for all construction and expansion joints of water holding structures.
 - e. An approved commercial bonding agent may be used in lieu of neat cement grout for non-water holding structures. The agent shall be applied to cleaned concrete surfaces in accordance with the printed instruction of the bonding agent manufacturer.
3. Epoxy bonding agent shall be applied in accordance with the manufacturer's recommendations for bonding to old concrete (more than 60 days old). Coat contact surfaces with bonding agent after mechanically roughening surface to a clean, rough surface.

K. Cold Weather Placing:

- 1. All concrete work, including concrete finishes, shall be protected from physical damage or reduced strength which could be caused by freezing or low temperatures, in compliance with the requirements of ACI 306 and ACI 318 and as herein specified.
- 2. Contractor shall protect formwork overnight, and at other times as required, when adverse weather is forecasted to prevent snow from building up in forms or frost from depositing on forms or reinforcing steel.
- 3. When the temperature of the surrounding air is expected to be below 40 degrees Fahrenheit during concrete placement or within 3 days (72 hours) thereafter, the temperature of the placed concrete shall be maintained at temperatures no lower than 60 degrees Fahrenheit for sections less than 12 inches in any dimension or 55 degrees for any other section. Heated water and/or aggregate shall be used in accordance with ACI 306.
 - a. The placed concrete temperature shall be maintained at or above the specified temperatures for curing for at least 7 days.
- 4. Frozen concrete materials containing ice or snow shall not be used. Concrete shall not be placed on frozen subgrade or on subgrade

containing frozen materials. The Contractor shall determine that the forms, reinforcing steel, and adjacent concrete surfaces are entirely free of frost, snow, and ice before placing any concrete.

5. The use of calcium chloride, salt, or other materials containing antifreeze agents or chemical accelerators shall not be allowed, unless authorized in writing by the Engineer.
6. Strength requirements may require additional protection and curing during cold weather due to delayed field strength gain.
7. Determine strength, attainment, and the requirement for continue protection, from field test cylinders, cured alongside the cast concrete structure.
8. Surface Temperature:
 - a. The actual temperature of concrete surface determines effectiveness of protection, regardless of air temperatures or whether the objective is durability or strength.
 - b. Contractor shall provide a sufficient number of thermometers placed on concrete surfaces spaced throughout the work to allow inspection and monitoring of concrete surface temperatures representative of all the work.
9. External Heating Units:
 - a. Vent heating units and do not locally heat or dry concrete.
 - b. Do not exhaust flue gases directly into an enclosed area.
 - c. Ensure fire safety and fire prevention measures are enforced during use of heating units.
10. Maintain curing conditions which will foster normal strength development without excessive heat, and without critical saturation of concrete at the close of the protection period.
11. Limit rapid temperature changes, particularly before strength has developed sufficiently to withstand temperature stresses.
12. At end of the required period, discontinue protection in such a manner that the drop in temperature of any portion of concrete will be gradual and will not exceed, in 24 hours, 50 degrees F.

L. Hot Weather Placing:

1. When hot weather conditions exist that would seriously impair the quality and strength of concrete, place concrete in compliance with ACI 305 and as herein specified.

2. The ingredients shall be cooled before mixing to maintain the concrete temperatures at the time of placement below 80 degrees Fahrenheit. Mixing water may be chilled or chopped ice may be used.
3. The use of retarding admixtures will not be allowed, unless otherwise accepted in mix designs by the Engineer.
4. The forms shall be thoroughly wetted before placement of concrete. Make provisions for windbreaks, shading, fog sprays, sprinkling, or wet cover, when necessary.
5. Reflective Cracking:
 - a. Prevent reflective cracking due to differential temperatures between concrete and reinforcing steel.
 - b. If reinforcement is in direct sunlight or is more than 20 degrees F higher in temperature than concrete temperature before placement, wet reinforcement to cool it with water fog spray 10 minutes before placing concrete. Alternatively, reinforcing steel may be covered with water-soaked burlap if it becomes too hot, so that the steel temperature will not exceed the ambient air temperature immediately before embedment in concrete.
 - c. Verify temperature of reinforcing is not more than 20 degrees F higher than fresh concrete.

3.04 JOINTS

- A. Construction Joints: Construction joints shall be located and installed as shown on the Drawings in a manner that will not impair the strength and appearance of the structure. Construction joints, if not shown, shall be located only with approval of the Engineer to meet the requirements on Part 3 Article, Maximum Size of Concrete Placements, and as follows:
 1. The Contractor shall provide key-ways at least 1 ½-inch deep in all construction joints in walls, slabs, and between walls and footings of non-water holding structures.
 2. Construction joints shall be placed perpendicular to the main reinforcement and all reinforcement shall continue across construction joints.
 3. Construction joints shall be prepared as specified in ACI Standard 318, and as shown on the Drawings.
- B. Expansion Joints: Expansion joints shall be located and installed as shown on the Drawings. Expansion joints shall be held down to receive the joint

sealant. The horizontal and vertical waterstop shall be welded together to provide a continuous watertight seal.

- C. For bonding to new concrete horizontal construction joints, roughen the surface of the hardened concrete. Thoroughly clean and saturate with water, cover the horizontal surfaces only with two to three inches of neat cement grout, as hereinbefore specified, and immediately place concrete. New concrete is defined as less than 60 days old. Limit the concrete lift placed immediately on top of the grout to 12-inches thick and thoroughly vibrate to mix and consolidate the grout and concrete together.
- D. Also see Section 03 15 00, EXPANSION, CONSTRUCTION, AND CONTROL JOINTS.

3.05 FINISH OF FORMED SURFACES

A. Rough Form Finish:

- 1. This finish shall include formed concrete surfaces buried from view by backfill in the finish work or covered by other construction, unless otherwise shown or specified. Any surface which will be exposed to the air or water in the completed structure shall be a smooth form finish.
- 2. The standard rough form finish shall leave the concrete surface with the texture imparted by the form facing material used, with tie holes and defective areas repaired and patched and all fins and other projections exceeding 1/4-inch in height rubbed down or chipped off.
- 3. Fill snap-tie holes with non-shrink, non-metallic grout as specified herein. Patch honeycomb areas and rock pockets with grout as specified herein. Small air holes do not require patching.

B. Smooth Form Finish (Trowel Finish):

- 1. This finish includes formed concrete surfaces which will be exposed to the air or water in the completed structure or to be covered with a coating material applied directly to the concrete, or a covering material bonded to the concrete, such as water proofing, damp-proofing, painting, or other similar system.
- 2. A smooth form finish shall be provided by selecting form materials that will impart a smooth, hard, uniform texture and arranging them orderly and symmetrically with a minimum of seams. All defective areas shall be patched and repaired with all fins or other projections completely removed and smoothed.

3. For smooth form finish walls:
 - a. Fill snap-tie holes with approved non-shrink, non-metallic color matched grout as specified herein.
 - b. Grind off projections, fins, and rough spots.
 - c. Repair other defects such as honeycomb areas, rock pockets, and rough spots resulting from form release agent failure or other reason with color matched non-shrink grout as specified herein.
4. For smooth form trowel finish slabs:
 - a. Concrete floor finishing shall comply with ACI 301 and ACI 302.
 - b. Finish by screeding and floating with straight-edges to bring surface to required finish elevation shown.
 - c. While concrete is still green, but sufficiently hardened to bear a person's weight without deep imprint, wood float to true, even plane with no coarse aggregate visible.
 - d. Use sufficient pressure on wood floats to bring moisture to surface.
 - e. After surface moisture has disappeared, hand trowel concrete to produce smooth, impervious surface, free from trowel marks.
 - f. Burnish surface with an additional troweling. Final troweling shall produce a ringing sound from trowel.
 - g. Do not use dry cement or additional water during troweling. No excessive troweling will be permitted.
 - h. Power Finishing:
 - 1) An approved power machine may be used in lieu of hand finishing for finishing concrete floors and slabs in accordance with directions of machine manufacturer.
 - 2) Do not use power machine when concrete has not attained the necessary set to allow finishing without introducing high and low spots in slab.
 - 3) Do steel troweling for slab by hand first.

C. Grout Cleaned Finish (Sacked Rubbed Finish):

1. A grout cleaned finish will be applied to all concrete surfaces as specified hereinafter, or which have received smooth form finish treatment, and are exposed to view. Surfaces exposed to water or on the inside of structures below the typical water surface level require a smooth form finish, but do not require a grout cleaned finish.

2. The grout cleaned finish will use one part portland cement to 1-1/2 parts fine sand by volume, and shall be mixed with water to a consistency of thick paint. Proprietary additives may be used at the Contractor's option. Standard Portland cement and white Portland cement amounts shall be blended as determined by trial patches, so that final color of dry grout will match adjacent surfaces.
 3. The concrete surfaces shall be thoroughly wetted before the application of grout to the surfaces and to fill small holes. Excess grout will be removed by scraping and rubbing with clean burlap.
- D. Broomed Finish:
1. Finish as specified for smooth form trowel floor finish, except omit final troweling and finish surface by drawing a fine-hair broom lightly across the surface.
 2. Brooming: In same direction and parallel to expansion joints, or, in the case of inclined slabs, perpendicular to slope, except for round roof slab, broom surface in radial direction.
- E. Sidewalk Finish:
1. Slope walks down 1/4-inch per foot away from structures, unless otherwise shown.
 2. Strike off surface by means of strike board and float with wood or cork float to a true plane, then flat steel trowel before brooming.
 3. Broom surface at right angles to direction of traffic.
 4. Lay out sidewalk surfaces in sections with an approved grooving tool as shown on the Drawings.
- F. A 3/4-inch chamfer shall be provided at the top of all exposed walls, except where support angles are installed, and at exposed vertical corners.

- G. In addition to the description of various finishes above, concrete surfaces shall be finished in accordance with ACI Standards 301 and 302 as scheduled below:

Surface	Finish
Interior Slabs	Smooth Trowel Finish
Exterior Slabs	Broom Finish
Exterior Concrete Above Final Grade	Grout Cleaned Sacked Rubbed Finish
Interior Walls of Water Basins Below Low Water Level; Exposed Interior Walls, Columns, Beams and Ceilings	Smooth Finish
Exterior Concrete Below Final Grade	Rough Finish, Correct Defective Areas including Stone Pocket and Fill Tie Holes
Sidewalks	Sidewalk Finish

3.06 CONCRETE CURING AND PROTECTION

A. General:

1. Freshly placed concrete shall be protected from premature drying and excessive cold or hot temperature, and maintained without drying at a relatively constant temperature for the 7 day period of time necessary for the proper hydration of the cement. Concrete damaged by improper curing or placement methods shall be replaced by the Contractor at no additional expense to the Owner.
2. Curing procedures shall begin immediately after placement of the concrete and continue for at least seven days or until concrete has attained 75 percent of its compressive strength in accordance with ACI 308.

B. Curing Method:

1. Liquid membrane curing shall be provided as follows:
 - a. The Contractor shall use a commercially produced liquid membrane forming curing compound for curing concrete which meets the requirements of ASTM C309. Use proper Type for conditions in the field.
 - b. Apply the specified membrane-forming curing compound to damp concrete surfaces as soon as the water film has disappeared. Apply uniformly in a 2-coat continuous operation by power spray equipment in accordance with the manufacturer's directions, and with second coat applied at right angles to the first. Recoat all areas which are subjected to heavy rainfall within 3 hours after initial application. Maintain the continuity of the coating and repair any damage to the coat during the entire 7 day curing period.
 - c. Membrane compounds shall not be used on surfaces which are to be covered with a coating material applied directly to the concrete or with a covering material bonded to the concrete, such as other concrete, liquid floor hardener, water-proofing, damp-proofing, flooring, paintings, and other coatings and finish materials.
2. Use approved water curing method where membrane compounds are not allowed.
3. For walls, use one of the following curing methods:
 - a. Method 1: Leave concrete forms in place and keep entire exposed surfaces wet at all times.
 - b. Method 2: Apply specified curing compound as specified, where allowed, immediately after removal of forms. Apply curing compound in two coats. Each coat shall be applied at the manufacturers recommended rate for one coat application.
 - c. Method 3: Continuously sprinkle 100 percent of all exposed surfaces.
4. For slabs, curbs, and sidewalks use one of the following curing methods:
 - a. Method 1: Protect surface by ponding.
 - b. Method 2: Cover with burlap or cotton mats and keep continuously wet.
 - c. Method 3: Continuously sprinkle exposed surface.

- d. Other agreed upon method that will provide moisture to be present and uniform at all times on all surface of slabs.
- C. Unformed surfaces shall be cured after finishing operations have been completed and as soon as marring of the concrete will not occur. The curing procedures shall continue for 7 days or until the concrete has attained 70 percent of its compressive strength in accordance with ACI 308.
- D. Temperature of Concrete During Curing:
 - 1. When the atmospheric temperature is 40 degrees Fahrenheit and below, the concrete temperature shall be maintained between 50 and 70 degrees Fahrenheit continuously throughout the 7 day curing period. When necessary, the Contractor shall make arrangements before the placement of concrete for heating, covering, insulation or housing as required to maintain the specified temperature and moisture conditions continuously throughout the concrete curing period. Cold weather protections shall comply with the requirements of ACI 306.
 - a. Where water curing as specified herein for slabs is not possible, use an approved curing compound as herein specified at twice the manufacturer's recommended coverage per gallon.
 - b. Where specified curing compound cannot be used, special methods using moisture shall be agreed upon prior to pouring the concrete slabs.
 - c. Protect slabs during cold weather with polyethylene sheeting or other material inside required heated enclosure if foot traffic is permitted on slabs.
 - 2. When the atmospheric temperature is 80 degrees Fahrenheit and above, or during other climatic conditions which will cause a rapid drying of the concrete, the Contractor shall make arrangements before the start of concrete placement for the installation of wind breaks or shading, and for fog spraying, wet sprinkling, or a moisture-retaining covering. The concrete shall be protected continuously for the 7 day concrete curing period. Hot weather concrete protection shall comply with the requirements of ACI 305.
 - 3. The concrete temperature shall be maintained as uniformly as possible, and protected from rapid atmospheric temperature changes. Temperature changes in concrete which exceed 5 degrees Fahrenheit in any one hour and 50 degrees Fahrenheit in any 24-hour period shall be avoided and protected against.

- E. During the curing period the concrete shall be protected from damaging mechanical disturbances including load stresses, excessive vibration and from damage caused by rain or flowing water. All finished concrete surfaces shall be protected from damage by subsequent construction operations. Any damage incurred shall be repaired by the Contractor at no additional expense to the Owner.

3.07 CONCRETE REPAIRS

- A. Cracks in water-holding structures that are determined to have caused excessive leakage or damp spots, or if seepage is present on exposed surfaces:
 - 1. Inject all cracks with crack repair materials as specified hereinbefore. Crack repairs shall be performed by a licensed applicator as specified hereinbefore and in accordance with the crack repair material manufacturer's recommendations, unless approved otherwise. Drain structure and inject cracks from the inside of the structure. Repair of all cracks shall be by the Contractor at no extra cost to the Owner.
- B. Defective surface areas shall be repaired and patched with grout as specified hereinbefore immediately after removal of forms and as directed by the Engineer. All repairs shall be made by the Contractor at no extra cost to the Owner.
- C. Repair of Formed Surfaces:
 - 1. Formed surfaces which will be exposed-to-view or air in the completed structure and contain defects which adversely affect the appearance of the finish shall be repaired. The concrete with the defective surfaces shall be removed and replaced at no additional expense to the Owner if the defects cannot be repaired to the satisfaction of the Engineer. Surface defects include color and texture irregularities, cracks, spalls, air bubbles, honeycombs, and holes left by rods and bolts, fins, and other discolorations that cannot be removed by cleaning.
 - 2. Concealed formed concrete surfaces that contain defects that adversely affect the durability of the concrete shall be repaired. If defects cannot be repaired, the defective concrete shall be removed and replaced at no additional expense to the Owner.
- D. Repair of Unformed Surfaces:
 - 1. Unformed surfaces such as monolithic slabs may be tested by the Engineer for smoothness and to verify that the surface planeness

meets the tolerances specified for each surface and finish. Any low and high areas shall be repaired by the Contractor at no additional expense to the Owner as specified herein.

2. Unformed surfaces that contain defects which adversely affect the durability of the concrete shall be repaired. Surface defects include crazing, cracks in excess of 0.01-inch in width or which penetrate to the reinforcement or completely through non-reinforced sections regardless of width, spalling, pop-outs, honeycomb, rock pockets, and other objectionable conditions.
3. High areas in unformed surfaces shall be repaired by grinding after the concrete has cured sufficiently so that repairs can be made without any damage to adjacent areas.
4. Low areas in unformed surfaces shall be repaired during, or immediately after, completion of surface finishing operations by cutting out the low areas and replacing with fresh concrete. The repaired areas shall be finished to blend into adjacent concrete. Proprietary patching compounds may be used when approved by the Engineer.
5. Defective areas, except random cracks and single holes not exceeding 1-inch diameter shall be repaired, by cutting the area out and placing fresh concrete. Defective areas shall be removed to sound concrete with clean, square cuts, and shall expose reinforcing steel with at least 3/4-inch clearance all around. Concrete surfaces in contact with patching concrete shall be dampened and brushed with a neat cement grout coating or approved epoxy adhesive, or a concrete of the same type or class as the original adjacent concrete. Place, compact, and finish as required to blend with the adjacent finished concrete. The repaired area shall be cured in the same manner as adjacent concrete.
6. Isolated random cracks in non-water holding structures and single holes not over 1-inch in diameter shall be repaired by the dry-pack method. Groove the top of cracks, and cut out holes to sound concrete. Clean off all dust, dirt, and loose particles. Dampen all cleaned concrete surfaces and apply by brush a neat grout coating. Place dry-pack before the cement grout takes its initial set. Mix dry-pack, consisting of one part Portland cement to 2-1/2 parts fine aggregate passing a No. 16 mesh sieve, using only enough water as required for handling and placing. Compact the dry-pack mixture in place and finish to match the adjacent concrete. Keep the patched areas continuously moist for not less than 72 hours.

7. Repair methods not specified above may only be used if approved by the Engineer.

3.08 SURFACE HARDENERS

- A. Interior floor slabs of all new buildings shall receive an application of surface hardener as recommended by the manufacturer of the surface hardener.
- B. Floors to receive hardener shall be thoroughly cured for at least 28 days, clean, unpainted, free from membrane curing compounds, and perfectly dry with all work above them completed. Apply liquid hardener evenly, using three coats, allowing 24 hours between coats, or as recommended by manufacturer.
- C. Apply approved proprietary hardeners in conformance with the manufacturer's instructions. After the final coat is completed and dry, remove surplus hardener from the surface by scrubbing and mopping with water.

3.09 CLEANING OF STRUCTURES

- A. Clean thoroughly all interior concrete surfaces using water under pressure. The cleaning method adopted should accomplish the following: (1) remove all deposits of foreign nature; (2) remove all growths; (3) clean the slopes, walls, top, and bottom; (4) avoid damage to the structure; and (5) avoid pollution or oil deposits by workers and equipment. All water used in cleaning the concrete structures should be disposed of before allowing water or sludge to the structure.

3.10 MISCELLANEOUS CONCRETE ITEMS

- A. Equipment Bases and Foundations: Provide machine and equipment bases and foundations, as shown on Drawings. Set anchor bolts for machines and equipment to template at correct elevations, complying with certified diagrams or templates of manufacturer furnishing machines and equipment.
- B. Grout base plates and foundations as indicated, using specified non-shrink grout. Use non-metallic grout for exposed conditions, unless otherwise indicated. Block out the original concrete or finish off a sufficient distance below the bottom of the machinery base to provide for the thickness of grout shown on the Drawings. After the machinery has been set in position and wedged to the proper elevation by steel wedges, the space between the bottom of the machinery base and the original pour of concrete shall be filled with a pourable non-shrinking type grout as hereinbefore specified.

3.11 REJECTIONS

- A. **Concrete Strength:** Concrete strength shall be considered satisfactory if the average test of the two 28-day specimens exceeds the specified strength and neither specimen test falls below 95 percent of the specified strength. If the average strength of the two test specimens is less than specified and/or either specimen test is less than 95 percent of the specified strength, the concrete represented by the tests is rejected and must be removed and replaced at the Contractor's expense.
- B. **Alignment:** Where concrete slabs or walls do not meet the alignment requirements, the Contractor must grind off irregularities until they comply. However, if such removal leaves less concrete section than indicated, the Engineer may reject concrete if they feel the remaining section would not be adequate.
- C. **Flatwork:** Finished flatwork exceeding the tolerances of these specifications shall be repaired or replaced so that strength or appearance is not adversely affected. Follow Part 3 Article CONCRETE REPAIRS for repair work or as directed by Engineer.
- D. **Appearance:** Concrete exposed to view with defects which adversely affect the appearance of the specified finish may be repaired, if possible in accordance with Part 3 Article CONCRETE REPAIRS. If, in the opinion of the Engineer, the defects cannot be repaired to equal the specified finish, the concrete shall be rejected.
- E. **Misplaced Members:** Concrete members cast in the wrong location may be rejected if the strength, appearance, or function of the structure is adversely affected or misplaced items interfere with other construction.
- F. **Rejected Concrete:** Rejected concrete shall be removed and replaced. Limits of removal shall be as directed by the Engineer to accomplish a structure equal in strength, serviceability, and appearance, to that which would have been achieved by acceptable concrete.
- G. **Leakage Repairs:** Water holding structures with any visible seepage or leakage at joints or due to cracks or other imperfections, or for any other reason does not pass leakage test defined hereinafter shall be replaced or repaired by Contractor.
- H. **Expense of Repairs:** The cost of all repairs, removal, replacement, etc., required by the provisions of this Article shall be borne by the Contractor.

PART 4 TESTING AND SPECIAL INSPECTIONS**4.01 GENERAL**

- A. Reference Structural General Notes on the Drawings with respect to testing and Special Inspections.

4.02 TESTING AGENCY/FIRMS AND COST

- A. The Contractor shall provide the services of an independent Special Inspector certified by the appropriate jurisdiction to perform the types of inspections specified. Costs of Special Inspection shall be borne by the Contractor.
- B. All quality assurance tests shall be made by an independent testing laboratory engaged by the Contractor Engineer shall direct when and where all tests are made and Contractor shall coordinate all pour scheduling with independent testing firm
- C. The Contractor shall bear all costs of initial quality control testing. Where retesting is required by this section including tests of hardened concrete where cylinder strengths indicate high or low strength concrete, the Contractor shall bear all retesting costs.

4.03 TEST RESULTS

- A. One copy of all tests shall be submitted to the Engineer within 48 hours of testing.

4.04 TESTS OF AGGREGATE

- A. Contractor shall provide tests of aggregate before concrete work per ASTM C33 and ASTM C1293. Tests may be waived by Engineer if aggregates to be used have shown actual use within the previous 18 months to produce concrete or required strength, durability, water-tightness, fire resistance, and wearing qualities.

4.05 STRENGTH TEST OF CYLINDERS DURING WORK

- A. Independent testing firm shall provide for test purposes, sets of four or five cylinders each, taken for each 50 cubic yards or portions placed each day. For 6-inch by 12-inch cylinders, provide four cylinders and test one cylinder per set at 7 days, two at 28 days, and retain one for backup. For 4-inch by 8-inch cylinders, provide five cylinders and test one cylinder per set at 7 days, three at 28 days, and retain one for backup.
- B. Evaluation will be in accordance with ACI Standard Building Code Requirements for Reinforced Concrete (ACI 318 latest edition), and these

Specifications. Where the term "building official" is used in ACI 318, term shall be redefined to "the Owner's representative".

- C. Specimens will be made, cured, and tested by the independent testing firm in accordance with ASTM C31 and ASTM C39. The Engineer shall determine which concrete trucks are to be tested in any pour and shall direct the independent testing firm. Only the Engineer or the testing firm may transport specimens or cylinders from the site to the laboratory.
 - 1. Provide a cure box with internal temperature monitoring device at the project site for initial cure of test cylinders. Construct and equip box to provide initial cure in accordance with ASTM C31.
- D. Frequency of testing may be increased at discretion of Engineer.
- E. Cold Weather Placement Tests:
 - 1. During cold weather concreting, the independent testing firm will cast cylinders for field curing as follows. Use method which will produce greater number of specimens:
 - a. Six extra test cylinders from the last 100 cubic yards of concrete.
 - b. Minimum three specimens for each 2 hours of placing time or for each 100 yards.
 - 2. These specimens shall be in addition to those cast by the independent testing firm for lab testing.
 - 3. Test cylinders will be protected from the weather until they can be placed under same protection provided for the parts of the structure which they represent.
 - 4. Keep field test cylinders in same protective environment as the parts of the structure they represent, to determine if specified strength has been obtained and no further protection is needed.
 - 5. Test cylinders in accordance with applicable sections of ASTM C31 and C39.
 - 6. Evaluation and Acceptance: As specified herein.
- F. Contractor Requested Expedited Testing: If Contractor desires additional cylinders to be tested at different times than specified hereinbefore to accelerate the schedule, this may be requested in writing to the Engineer who will coordinate this with the Independent Testing Firm. The cost of extra test cylinders and strength tests will be paid by the Contractor.

4.06 SLUMP TESTS

- A. Slump tests will be taken with each strength test and as directed by the Engineer in accordance with ASTM C143.

4.07 AIR CONTENT

- A. ASTM C 173, volumetric method for lightweight or normal weight concrete; ASTM C 231, pressure method for normal weight concrete; one for each strength test set.

4.08 CONCRETE TEMPERATURE

- A. ASTM C1064; one test hourly when air temperature is 40 degrees F and below and when 80 degrees F and above, and one test for each set of compressive strength specimens.

4.09 TEST OF HARDENED CONCRETE

- A. Acceptance shall be based on concrete cylinder tests in accordance with Part 3 Article, REJECTIONS. Contractor will pay for additional test by coring per ASTM C42 or load tests for that portion of job where questionable concrete has been placed. Such additional testing will be accepted in lieu of cylinder tests. Results of rebound hammer tests will not be accepted except in defining problem areas.

4.10 WATER LEAKAGE TESTS

- A. Purpose: Determine integrity of finished concrete and to show exposed wall surfaces are visually acceptable. Exposed shall mean all wall surfaces prior to backfilling, or application of any exterior coating system, and other permanently or temporarily exposed areas for all water holding structures.
- B. All Water-Holding Structures:
 - 1. Perform water leakage tests according to ACI 350.1 and as specified hereinafter.
 - 2. Perform leakage tests after concrete has cured a minimum of 7 to 14 days and obtained its design strength, and before backfill, application of any exterior coating system, or other work which will cover concrete wall surfaces is begun.
 - 3. Make other equipment, i.e., stop gates, sluice gates, valves, etc., or temporary bulkheads water-tight prior to test.
 - 4. As an alternative to having watertight bulkheads, gates, or valves, accurately measure the leakage through gates, valves, and

bulkheads with methods acceptable to Engineer. An assumed leakage through gates and valves based on manufacturer's recommendations is not acceptable.

5. Fill with water to maximum liquid level prior to leak testing, and maintain level for 48 hours for moisture absorption by concrete.
6. Close all valves and gates to the structure and measure the change in water surface for a 24-hour period.
7. During test period, examine exposed portions of structure for dampness or leaks and mark visible leaks or damp spots.

C. Test Evaluation Criteria:

1. For water-holding structures comprised entirely of new construction, an acceptable test shall have a drop in water surface in 24-hour period with basin full less than 1/10 of 1 percent of normal volume of liquid contained in water-holding structure, after accounting for evaporation and precipitation in open basins; and damp spots or seepage are not present on walls or other areas exposed to view prior to any backfilling.
2. Determine evaporation by floating an evaporation pan in structure during test period.

D. Excessive Leakage and Leakage Test Failure: If drop in water surface exceeds test evaluation criteria or if damp spots or seepage is visible in exposed surfaces prior to any backfilling, the leak test shall be considered as failing.

E. Repairs:

1. If leakage is excessive, or if damp spots or observed seepage is present on exposed surfaces, drain water-holding structure, repair all leaks and damp spots previously marked, and make necessary repairs, and retest basin.
2. Repair in accordance with these Specifications and as approved by Engineer.

F. Retest:

1. Refill water-holding structure and test for leakage until structure meets test criteria.

2. Successful Test: If liquid level criteria is met and damp spots and seepage problems are corrected, the retest will be considered acceptable.
- G. Cost of all leakage tests, repairs, and retests shall be borne by the Contractor, at no extra cost to the Owner.

END OF SECTION 03 30 00

PART 1 GENERAL**1.01 WORK INCLUDED**

- A. This section includes work necessary to furnish and install, complete, structural steel.

1.02 GENERAL REQUIREMENTS

- A. Like items of materials provided hereunder shall be the end products of one manufacturer to achieve standardization for appearance, maintenance, and replacement.
- B. See CONDITIONS OF THE CONTRACT and Division 01 00 00, GENERAL REQUIREMENTS which contain information and requirements that apply to the work specified herein and are mandatory for this project.

1.03 RELATED WORK SPECIFIED IN OTHER SECTIONS

- A. Section 01 40 00, QUALITY CONTROL for independent testing agency procedures and administrative requirements.
- B. Section 03 30 00, CONCRETE for non-shrink grout and other concrete work.
- C. Section 05 31 20, STEEL DECKING for field installation of shear connectors.
- D. Section 05 50 00, MISCELLANEOUS METAL ITEMS for loose steel bearing and embedded plates, anchor bolts, and miscellaneous steel framing.
- E. Section 09 90 00, PAINTING for surface preparation and priming requirements.

1.04 SUBMITTALS

- A. General: Submit each item in this section according to the Conditions of the Contract and Section 01 33 00, SUBMITTALS.
- B. Product data for each type of product specified including name and address of manufacturer(s), product specifications, manufacturer's testing procedures and standards, and preparation and installation instructions.
- C. Shop drawings detailing fabrication of structural steel components in compliance with AISC recommendations and specifications referenced herein:

1. Details showing members and their connections with all necessary information such as dimensions, anchor bolt layouts, etc.
 2. Include details of cuts, connections, splices, camber, holes, and other pertinent data.
 3. Indicate welds by standard AWS symbols, distinguishing between shop and field welds, and show size, length, and type of each weld.
 4. Indicate type, size, and length of bolts, distinguishing between shop and field bolts. Identify high strength bolted slip critical, direct tension, or tensioned shear/bearing connections.
- D. Qualification data for firms and persons specified in the "Quality Assurance" Article hereinafter to demonstrate their capabilities and experience. Include lists of completed projects with project names and addresses, names and addresses of engineers, architects, and owners, and other information specified.
- E. Mill test reports signed by manufacturers certifying that their products, including the following, comply with requirements:
1. Structural steel, including chemical and physical properties.
 2. Bolts, nuts, and washers, including mechanical properties and chemical analysis.
 3. Shop primers.
 4. Non-shrink grout.
 5. Direct-tension indicators.
 6. Shear stud connectors.
- F. Submit results and reports for all Contractor provided quality control testing.

1.05 QUALITY ASSURANCE

- A. Installer Qualifications: Engage an experienced installer with a minimum of 10 years experience, who has completed structural steel work similar in material, design, and extent to that indicated for this project and with a record of successful in-service performance.
- B. Fabricator Qualifications: Engage a firm experienced in fabricating structural steel similar to that indicated for this Project and with a record of successful in-service performance, as well as sufficient production capacity to fabricate structural steel without delaying the work.

1. Fabricator must participate in the AISC Quality Certification Program and be designated an AISC - Certified Plant as follows:
 - a. Category: Category 1, conventional steel structures.
 - b. Fabricator shall be registered with and approved by authorities having jurisdiction.
 - c. As an alternate to Category 1 certifications, other fabricators will be allowed providing they can demonstrate a minimum of 10 years experience fabricating similar steel structures.
- C. Comply with applicable provisions of the following specifications and documents:
 1. AISC's "Specification for Structural Steel Buildings ".
 2. AISC's "Code of Standard Practice for Structural Steel Buildings and Bridges".
 3. ASTM A6 "Specification for General Requirements for Rolled Steel Plates, Shapes, Sheet Piling, and Bars for Structural Use".
 4. Research Council on Structural Connections' (RCSC) "Specification for Structural Joints Using ASTM A325 or A490 Bolts".
 5. Other ASTM standards as referenced herein.
- D. Welding Standards: Comply with applicable provisions of AWS D1.1 "Structural Welding Code—Steel", latest edition. Present evidence that each welder has satisfactorily passed AWS qualification tests for welding processes involved and, if pertinent, has undergone recertification.
- E. Field Quality Control Testing and Special Inspection(s): The Contractor shall provide the services of an independent Special Inspector certified by the appropriate jurisdiction to perform the types of field quality control tests and inspections specified. Field quality control testing and Special Inspection requirements shall be as specified hereinafter in Part 3, EXECUTION. Costs of field quality control testing and Special Inspections shall be borne by the Contractor.

PART 2 PRODUCTS

2.01 MATERIALS

- A. Structural Wide Flange (W-shapes) and WT-shapes Sections: ASTM A992.
- B. Structural M-shapes or S-shapes Sections: ASTM A36.

- C. Angles, Channels, Plates, Bars and Other Structural Steel Shapes (as indicated on the Drawings): ASTM A36. Dual 36 ksi / 50 ksi; certified grade is acceptable.
- D. Cold-Formed Structural Steel Tubing: ASTM A500, Grade B.
- E. Hot-Formed Structural Steel Tubing: ASTM A501.
- F. Structural Steel Pipe: ASTM A53, Type E or S, Grade B.
 - 1. Weight Class: STD, or as indicated on the Drawings.
 - 2. Finish: Black, except where indicated to be galvanized.
- G. Shear Connectors: ASTM A108, Grade 1015 through 1020, headed-stud type, cold-finished carbon steel, AWS D1.1, Type B.
- H. Anchor Rods, Bolts, Nuts, and Washers:
 - 1. Unheaded and Threaded Rods: ASTM A36.
 - 2. Hooked, headed, and Threaded Rods: ASTM F1554, Grade 36.
 - 3. Headed Bolts: ASTM A307, Grade A (ASTM F568, Property Class 4.6); carbon-steel, hex-head bolts; and carbon-steel nuts.
 - 4. Washers: ASTM A36.
 - 5. Finish: Mechanically deposited zinc-coating, ASTM B695, Class 55.
- I. Non-high Strength Bolts, Nuts, and Washers: ASTM A307, Grade A (ASTM F568, Property Class 4.6); carbon-steel, hex-head bolts; carbon-steel nuts; and flat, unhardened steel washers.
 - 1. Finish: Mechanically deposited zinc-coating, ASTM B695, Class 55.
 - 2. Bolt Length: As required with unhardened washers.
- J. High-Strength Bolts, Nuts, and Washers: ASTM A325, Type 1, heavy hex steel structural bolts, heavy hex carbon-steel nuts, and hardened carbon-steel washers.
 - 1. Finish: Mechanically deposited zinc-coating, ASTM B695, Class 55.
 - 2. Bolt Length: As required with hardened washers and load indicator washers.
 - 3. Hardened Washers: ASTM F436, match bolt type and finish.

- K. Welding Electrodes: Use E70XX electrodes. Comply with AWS D1.1 requirements.
- L. Direct Tension Indicators (Load Indicator Washers): ASTM F959, Type 325.
 - 1. Finish: Mechanically deposited zinc-coating, ASTM B695, Class 55.
 - 2. Provide at all connections using high strength bolts for testing of high strength bolt connections.
- M. Welded Anchor Studs: Provide headed concrete anchor studs (HAS), or deformed bar anchors (DBA), or threaded anchor studs (TAS), as shown on the Drawings.
- N. Non-shrink Grout: Non-shrink, non-metallic type as specified in Section 03 30 00, CONCRETE.

2.02 SHOP PRIMER MATERIAL

- A. Primer: Anti-corrosive epoxy primer or fabricator's standard lead- and chromate-free, non-asphaltic, rust-inhibiting primer, depending on specific area where steel is to be located. Compatible with specified painting system in Section 09 90 00, PAINTING.

2.03 SHOP FABRICATION

- A. Fabricate and assemble structural steel in shop to greatest extent possible. Fabricate structural steel according to AISC specifications referenced in this section and in approved shop drawings.
 - 1. Camber structural steel members where indicated.
 - 1. Identify high-strength structural steel according to ASTM A6 and maintain markings until steel has been erected.
 - 2. Mark and match-mark materials for field assembly.
 - 3. Fabricate for delivery a sequence that will expedite erection and minimize field handling of structural steel.
 - 4. Complete structural steel assemblies, including welding of units, before starting shop-priming operations.
 - 5. Comply with fabrication tolerance limits of AISC's "Code of Standard Practice for Steel Buildings and Bridges" for structural steel.
- B. Thermal Cutting: Perform thermal cutting by machine to greatest extent possible. Plane thermally cut edges to be welded.

- C. Finishing: Accurately mill ends of columns and other members transmitting loads in bearing.
- D. Shear Connectors: Prepare steel surfaces as recommended by manufacturer of shear connectors. Use automatic end welding of headed-stud shear connectors according to AWS D1.1 and manufacturer's printed instructions.
- E. Holes: Provide holes required for securing other work to structural steel framing and for passage of other work through steel framing members, as shown on shop drawings. Cut, drill, or punch holes perpendicular to metal surfaces. Do not flame-cut holes or enlarge holes by burning. Drill holes in bearing plates.
- F. Weld threaded nuts to framing and other specialty items as indicated to receive other work.

2.04 SHOP CONNECTIONS

- A. Shop install and tighten non-high strength bolts, except where high strength bolts are indicated.
- B. Shop install and tighten high strength bolts according to RCSC's "Specification for Structural Joints Using ASTM A325 or A490 Bolts."
 - 1. Bolts: ASTM A325 high strength bolts, unless otherwise indicated.
 - 2. Connection Type: Snug tightened, unless noted as slip critical. Use special indicator washer location requirements of ASTM F959 at all bolt locations.
 - 3. Provide hardened washers. Install under turned element (bolt head or nut) and between turned element and indicator washer protrusions.
- C. Weld Connections: Comply with AWS D1.1 for procedures, appearance and quality of welds, and methods used in correcting welding work. Verify that weld sizes, fabrication sequence, and equipment used for architecturally exposed structural steel will limit distortions to allowable tolerances. Prevent surface bleeding of back-side welding on exposed steel surfaces. Grind smooth exposed fillet welds ½-inch and larger. Grind flush butt welds. Dress exposed welds.

2.05 HOT DIP GALVANIZING

- A. Steel members to be hot dip galvanized after fabrication shall be as shown on the Drawings, per ASTM A123. All structural steel fasteners shall be galvanized in accordance with ASTM A695, Class 55 minimum.

2.06 SHOP PRIMING

- A. Shop prime steel surfaces as specified in Section 09 90 00, PAINTING, except the following:
 - 1. Surfaces embedded in concrete or mortar. Extend priming of partially embedded members to a depth of 2 inches.
 - 2. Surfaces to be field welded.
 - 3. Galvanized surfaces.
- B. Surface Preparation: Clean surfaces to be painted. Remove loose rust, loose mill scale, and spatter, slag, or flux deposits. Prepare surfaces according to SSPC specifications per SSPC-SP 3 "Power Tool Cleaning."
- C. Priming: Immediately after surface preparation, apply primer according to manufacturer's instructions and at rate recommended by SSPC to provide a dry film thickness of not less than 1.5 mils, or as specified in Section 09 90 00, PAINTING, whichever is greater. Use priming methods that result in full coverage of joints, corners, edges, and exposed surfaces. Apply two coats of shop paint to inaccessible surfaces after assembly or erection. Change color of second coat to distinguish it from first.

2.07 SOURCE QUALITY CONTROL

- A. Correct deficiencies in or remove and replace structural steel that inspections and test reports indicate do not comply with specified requirements.
- B. Additional testing, at Contractor's expense, will be performed to determine compliance of corrected work with specified requirements.
- C. Shop-bolted connections will be tested and inspected according to RCSC's "Specification for Structural Joints Using ASTM A325 or A490 Bolts." Direct-tension indicator gaps will be verified to comply with ASTM F959, Table 2.
- D. In addition to visual inspection, shop-welded connections will be inspected and tested according to AWS D1.1 and the inspection procedures listed below, at testing agency's option:
 - 1. Liquid Penetrant Inspection: ASTM E165.
 - 2. Magnetic Particle Inspection: ASTM E709; performed on root pass and on finished weld. Cracks or zones of incomplete fusion or penetration will not be accepted.

3. Ultrasonic Inspection: ASTM E164.
- E. In addition to visual inspection, shop-welded shear connectors will be inspected and tested according to requirements of AWS D1.1 for stud welding and as follows:
1. Bend tests will be performed when visual inspections reveal either less than a continuous 360 degree flash or welding repairs to any shear connector.
 2. Tests will be conducted on additional shear connectors when weld fracture occurs on shear connectors already tested, according to requirements of AWS D1.1.

PART 3 EXECUTION

3.01 DELIVERY, STORAGE, AND HANDLING

- A. Deliver structural steel to project site in such quantities and at such times to ensure continuity of installation. Load and unload structural members in a manner such that they will be transported and moved without being excessively stressed, deformed, or otherwise damaged.
- B. Store materials to permit easy access for inspection and identification. Keep steel members off ground in a dry area by using pallets, platforms, or other supports. Protect steel members and packaged materials from erosion and deterioration. Handle all materials to avoid distortion or damage to members or supporting structures.
1. Store fasteners in a protected place. Clean and re-lubricate bolts and nuts that become dry or rusty before use.
 2. Do not store materials on structure in a manner that might cause distortion or damage to members or supporting structures. Repair or replace damaged materials or structures as directed.

3.02 SEQUENCING

- A. Supply anchorage items to be embedded in or attached to other construction without delaying the work. Provide setting diagrams, templates, instructions, and directions, as required, for installation.

3.03 EXAMINATION

- A. Before erection proceeds, and with the steel erector present, verify elevations of concrete and masonry bearing surfaces and locations of anchorages for compliance with requirements.

- B. Do not proceed with erection until unsatisfactory conditions have been corrected.

3.04 PREPARATION

- A. Furnish templates for installation of anchor rods, anchor bolts, and other embedments in concrete and masonry work.
- B. Provide temporary shores, guys, braces, and other supports during erection to keep structural steel secure, plumb, and in alignment against temporary construction loads and loads equal in intensity to design loads. Remove temporary supports when permanent structural steel, connections, and bracing are in place, unless otherwise indicated. Do not remove temporary shoring supporting composite deck construction until cast-in-place concrete has attained its design compressive strength.
- C. Where applicable, coordinate with temporary shoring requirements in Division 03 00 00, CONCRETE.

3.05 ERECTION

- A. Set structural steel accurately in locations and to elevations indicated and according to AISC specifications referenced in this Section.
- B. Anchor Bolts and Rods: Install anchor bolts and other connectors required for securing structural steel to in-place work. Provide templates and other devices for pre-setting bolts and other anchors to accurate locations.
- C. Base and Bearing Plates: Clean concrete and masonry bearing surfaces of bond-reducing materials and roughen surfaces prior to setting base and bearing plates. Clean bottom surface of base and bearing plates.
 - 1. Set base and bearing plates for structural members on wedges, shims, or setting nuts as required.
 - 2. Snug tighten anchor bolts after supported members have been positioned and plumbed. Do not remove wedges or shims but, if protruding, cut off flush with edge of base or bearing plate prior to packing with grout.
 - 3. Pack grout solidly between bearing surfaces and plates so no voids remain, as also specified in Section 03 30 00, CONCRETE. Finish exposed surfaces, protect installed materials, and allow to cure. Comply with manufacturer's instructions for proprietary grout materials and curing.
 - 4. Tighten anchor bolts after grout has cured for a minimum of 3 days.

- D. Maintain erection tolerances of structural steel within AISC's "Code of Standard Practice for Steel Buildings and Bridges."
- E. Align and adjust various members forming part of complete frame or structure before permanently fastening. Before assembly, clean bearing surfaces and other surfaces that will be in permanent contact. Perform necessary adjustments to compensate for minor discrepancies in elevations and alignment.
 - 1. Level and plumb individual members of structure. Set structural members accurately to lines and elevations shown.
 - 2. Establish required leveling and plumbing measurements on mean operating temperature of structure. Make allowances for difference between temperature at time of erection and mean temperature at which structure will be when completed and in service.
- F. Splice members only where indicated.
- G. Remove erection bolts on welded, architecturally exposed structural steel; fill holes with plug welds; and grind smooth at exposed surfaces.
- H. Do not use thermal or gas cutting during erection in the field.
- I. Do not enlarge unfair holes in members by burning or by using drift pins. Ream holes that must be enlarged to admit bolts.
- J. All field welding shall be done in accordance with AWS D1.1. Provide AWS D1.1 qualified welders, welding operators, and tackers. Grind exposed welds smooth. Removal of temporary welds is only required from finished, exposed areas.
- K. Repair damage to galvanized coatings using ASTM A780 zinc rich paint for galvanizing damaged by handling, transporting, cutting, welding, or bolting. Do not heat surfaces to which repair paint has been applied.

3.06 FIELD CONNECTIONS

- A. Install and tighten non-high strength bolts, except where high strength bolts are indicated. Tighten bolts to a snug tight fit where the plies in a joint are in firm contact.
- B. Install and tighten high strength bolts according to RCSC's "Specification for Structural Joints Using ASTM A325 or A490 Bolts."
 - 1. Washers: Provide direct tension indicator washers on all high strength bolt locations. Where possible, install washer under the bolt head and tighten the nut. If the washer must be installed adjacent to

the turned element, provide a flat washer between the direct tension indicator washer and the nut when the nut is turned for tightening.

2. Connection Type: Initially snug tightened, unless indicated as slip critical. After initial tightening procedure, fully tension bolts progressing from the most rigid part of a connection to the free edges.
- C. Weld Connections: Comply with AWS D1.1 for procedures, appearance and quality of welds, and methods used in correcting welding work. Comply with AISC specifications referenced in this Section for bearing, adequacy of temporary connections, alignment, and removal of paint on surfaces adjacent to field welds.

3.07 FIELD PAINTING

- A. Touchup: Immediately after erection, clean field welds, bolted connections, and abraded areas of slag or shop paint primer. Apply touchup paint primer by brush or spray of same thickness and material as that used in shop application.
- B. Finish Coats: As indicated on the Drawings and/or as specified in Section 09 90 00, PAINTING.

3.08 FIELD QUALITY CONTROL TESTING AND SPECIAL INSPECTIONS

- A. The Contractor shall engage an independent testing and inspecting agency to perform field inspections, quality control tests, Special Inspections, and to prepare test reports. Testing agency will conduct and interpret tests and state in each report whether tested work complies with or deviates from requirements.
- B. Correct deficiencies in or remove and replace structural steel that inspections and test reports indicate do not comply with specified requirements.
- C. Additional testing, at Contractor's expense, will be performed to determine compliance of corrected work with specified requirements.
- D. Field-bolted connections will be tested and inspected according to RCSC's "Specification for Structural Joints Using ASTM A325 or A490 Bolts." Direct-tension indicator gaps will be verified to comply with ASTM F959, Table 2.
- E. In addition to visual inspection, field-welded connections will be inspected and tested according to AWS D1.1 and the inspection procedures listed below, at testing agency's option:

1. Liquid Penetrant Inspection: ASTM E165.
 2. Magnetic Particle Inspection: ASTM E709; performed on root pass and on finished weld. Cracks or zones of incomplete fusion or penetration will not be accepted.
 3. Ultrasonic Inspection: ASTM E164.
- F. In addition to visual inspection, field-welded shear connectors will be inspected and tested according to requirements of AWS D1.1 for stud welding and as follows:
1. Bend tests will be performed when visual inspections reveal either less than a continuous 360 degree flash or welding repairs to any shear connector.
 2. Tests will be conducted on additional shear connectors when weld fracture occurs on shear connectors already tested, according to requirements of AWS D1.1.
- G. Special Inspection shall be in accordance with the 2021 International Building Code for items as shown on the Drawings.

END OF SECTION 05 12 00

PART 1 GENERAL**1.01 WORK INCLUDED**

- A. This section includes work necessary to furnish and install, complete, structural aluminum, including the fabrication and erection of framing and bracing members and connections.

1.02 GENERAL REQUIREMENTS

- A. Like items of materials provided hereunder shall be the end products of one manufacturer in order to achieve standardization for appearance, maintenance, and replacement.
- B. See CONDITIONS OF THE CONTRACT and Division 01 00 00, GENERAL REQUIREMENTS which contain information and requirements that apply to the work specified herein and are mandatory for this project.

1.03 RELATED WORK SPECIFIED IN OTHER SECTIONS

- A. Section 01 40 00, QUALITY CONTROL for independent testing agency procedures and administrative requirements.
- B. Section 03 30 00, CONCRETE for non-shrink grout and other related concrete work.
- C. Section 05 50 00, MISCELLANEOUS METAL ITEMS for anchor bolts and miscellaneous fabricated aluminum items.
- D. Section 09 90 00, PAINTING for aluminum and dis-similar metals protection.

1.04 QUALITY ASSURANCE

- A. Reference Standards:
 - 1. Aluminum Association (AA):
 - a. ADM 1, The Aluminum Design Manual.
 - b. DAF-45, Designation System for Aluminum Finishes.
 - 2. American Institute of Steel Construction (AISC):
 - a. Manual of Steel Construction.
 - 3. ASTM International (ASTM):

- a. B209, Standard Specification for Aluminum and Aluminum-Alloy Sheet and Plate.
 - b. B221, Standard Specification for Aluminum and Aluminum-Alloy Extruded Bars, Rods, Wire, Profiles, and Tubes.
 - c. B247, Standard Specification for Aluminum and Aluminum-Alloy Die Forgings, Hand Forgings, and Rolled Ring Forgings.
 - d. B308, Standard Specification for Aluminum-Alloy 6061-T6 Standard Structural Profiles.
 - e. B429, Standard Specification for Aluminum-Alloy Extruded Structural Pipe and Tube.
 - f. F467, Standard Specification for Nonferrous Nuts for General Use.
 - g. F468, Standard Specification for Nonferrous Bolts, Hex Cap Screws, and Studs for General Use.
 - h. F593, Standard Specification for Stainless Steel Bolts, Hex Cap Screws, and Studs.
 - i. Other ASTM standards as referenced herein.
4. American Welding Society (AWS):
- a. D1.2, Structural Welding Code – Aluminum.
- B. Qualifications for Welding Aluminum: Qualify welding procedures and welding operators in accordance with AWS D1.2; welding operators shall have been qualified during the 12-month period prior to commencement of welding.

1.05 SUBMITTALS

- A. General: Submit each item in this section according to the Conditions of the Contract and Section 01 33 00, SUBMITTALS.
- B. Product data for each type of product specified including name and address of manufacturer(s), product specifications, manufacturer's testing procedures and standards, certificates of compliance with standards specified for all major components and fasteners incorporated into work, and preparation and installation instructions.
- C. Shop drawings detailing fabrication of structural aluminum components in compliance with AISC recommendations and specifications referenced herein:
 1. Details showing members and their connections with all necessary information such as dimensions, anchor bolt layouts, etc.
 2. Include details of cuts, connections, splices, camber, holes, and other pertinent data.

3. Indicate welds by standard AWS symbols, distinguishing between shop and field welds, and show size, length, and type of each weld.
 4. Indicate type, size, and length of bolts, distinguishing between shop and field bolts.
 5. Complete shop drawings for all of the work showing clearly all pieces, details, connections, materials, and shop-applied coatings.
 6. Prepare complete erection drawings showing the location and marks of all pieces.
- D. Qualification data for firms and persons specified in the "Quality Assurance" Article hereinbefore to demonstrate their capabilities and experience. Include lists of completed projects with project names and addresses, names and addresses of engineers, architects, and owners, and other information specified. Also provide copies of current welding certificates for each welder assigned to perform welding indicating compliance with testing specified by AWS.
- E. Mill test reports signed by manufacturers certifying that their products, including the following, comply with requirements:
1. Structural aluminum, including chemical and physical properties.

PART 2 PRODUCTS**2.01 ALUMINUM MATERIALS**

- A. Alloy 6061-T6; 35,000 psi tensile yield strength minimum:
1. ASTM B209 for sheets and plates.
 2. ASTM B210 for tubes.
 3. ASTM B221 and ASTM B308 for shapes including beams, channels, angles, and tees.
 4. ASTM B247 for forgings.
- B. Alloy 6063-T5 or T6; 15,000 psi (T5) and 25,000 psi (T6) tensile yield strength minimum:
1. ASTM B211 and ASTM B221 for bars, rods, and wires.
- C. Aluminum Bolts and Nuts: ASTM F467 and ASTM F468 of Alloy 2024-T4 (45,000 psi tensile strength minimum). Washers shall be of the same

material and alloy as found in bolts and nuts with which the washers are to be used.

- D. Bolts and Nuts for fastening aluminum to structural steel: Stainless steel complying with ASTM F593, Type 316 with a minimum yield strength of 30,000 psi and a minimum tensile strength of 75,000 psi. Washers shall be of the same material and alloy as found in bolts and nuts with which the washers are to be used.
- E. Electrodes for Welding Aluminum: AWS D1.2 filler Alloy 5356.
- F. Expansion Anchor Bolts and Adhesive Anchor Bolts for Fastening to Concrete: Stainless steel as specified in Section 05 50 00, MISCELLANEOUS METAL ITEMS.

2.02 DESIGN CRITERIA

- A. Where final design of members and connection for any portion of structure is not indicated, perform final design of such members and connections.
- B. Final designs of members and connections shall conform to AA ADM 1 and to details and requirements shown on Drawings.

2.03 FABRICATION

- A. Fabrication of bolted and welded connections of aluminum work shall be in accordance with AA ADM 1.
- B. Contractor shall be solely responsible for correctness of all shop and field fabrication and fit, and shall verify field conditions and dimensions prior to fabrication.
- C. Fabricate aluminum work and assemble in shop to greatest extent possible, make splices only where indicated or approved in writing by the engineer.
- D. Provide connections as indicated on the Drawings. Where not indicated, design and provide connections in accordance with requirements of this Section. One-sided or other types of eccentric connections are not acceptable unless indicated on the Drawings or approved on shop drawings.
- E. Drill or punch holes at right angles to surface of metal. Do not make or enlarge holes by burning. Provide holes clean and free of torn or ragged edges. Use tools which will make a 1/16-inch bevel to remove outside burrs resulting from drilling or punching operations.

- 1. Punch or drill for field connections and for attachment of work by other trades

- F. Cope at 45 degrees corners of stiffener plates at junction of member flanges with webs.
- G. Welding: Weld connections to members in shop and bolt connections in field. Perform welding using electrodes of filler Alloy 5356, perform welding in accordance with AWS D1.2, use only welding procedures and welding operators qualified in accordance with requirements of Article "Quality Assurance" hereinbefore.
- H. Form to shapes indicated with straight lines, true angles, and smooth curves. Grind smooth all rough welds and sharp edges. Round all corners to approximately 1/8-inch radius.
- I. Finish shall be anodized as follows:
 - 1. Architectural Class I coating per AA DAF-45: Clear anodized AA-M10C22A41 or AA-M12C22A41.

PART 3 EXECUTION

3.01 DELIVERY, STORAGE, AND HANDLING

- A. Deliver structural aluminum to project site in such quantities and at such times to ensure continuity of installation. Load and unload structural members in a manner such that they will be transported and moved without being excessively stressed, deformed, or otherwise damaged.
- B. Store materials to permit easy access for inspection and identification. Keep aluminum members off ground in a dry area by using pallets, platforms, or other supports. Protect aluminum members and packaged materials from erosion and deterioration. Handle all materials to avoid distortion or damage to members or supporting structures.
 - 1. Store fasteners in a protected place. Clean and re-lubricate bolts and nuts that become dry or rusty before use.
 - 2. Do not store materials on structure in a manner that might cause distortion or damage to members or supporting structures. Repair or replace damaged materials or structures as directed.

3.02 SEQUENCING

- A. Supply anchorage items to be embedded in or attached to other construction without delaying the work. Provide setting diagrams, templates, instructions, and directions, as required, for installation.

3.03 EXAMINATION

- A. Before erection proceeds, verify elevations of concrete and masonry bearing surfaces and locations of anchorages for compliance with requirements.
- B. Do not proceed with erection until unsatisfactory conditions have been corrected.

3.04 PREPARATION

- A. Furnish templates for installation of anchor rods, anchor bolts, and other embedments in concrete and masonry work.
- B. Provide temporary shores, guys, braces, and other supports during erection to keep structural aluminum secure, plumb, and in alignment against temporary construction loads and loads equal in intensity to design loads. Remove temporary supports when permanent structural members, connections, and bracing are in place, unless otherwise indicated. Do not remove temporary shoring supporting concrete construction until cast-in-place concrete has attained its design compressive strength.
- C. Where applicable, coordinate temporary shoring requirements with Division 03 00 00, CONCRETE.

3.05 ERECTION

- A. Contractor shall be solely responsible for safety. Construction means and methods and sequencing of work shall be the responsibility and prerogative of the Contractor. Contractor shall take into consideration that full structural capacity of many structural members is not realized until structural assembly is complete; e.g. until decks and diagonal bracing or rigid connections are installed:
 - 1. Partially complete structural members shall not be loaded without an investigation by the Contractor
 - 2. Until all elements of the permanent structure and lateral bracing system are complete, provide temporary bracing designed, finished, and installed by the Contractor
- B. Bolting:
 - 1. Protect bolt threads from damage.
 - 2. Rest bolt heads and nuts squarely against surfaces.
 - 3. Where bolt heads or nuts rest on beveled surfaces having slope greater than 1 in 20 with planes normal to bolt axis, provide beveled washers to give full bearing to head and nut.

4. Correct poor matching of holes by drilling next larger size and using larger diameter bolt.
5. Unless shown otherwise on the Drawings, connect aluminum members to:
 - a. Aluminum members using $\frac{3}{4}$ -inch diameter aluminum bolts of Alloy 2024-T4.
 - b. Structural steel using $\frac{3}{4}$ -inch diameter stainless steel bolts.
 - c. Concrete or masonry using stainless steel expansion anchor bolts or adhesive anchor bolts as specified in Section 05 50 00, MISCELLANEOUS METAL ITEMS.
 - d. Provide dissimilar materials protection as specified hereinafter.
- C. Welding: Field welding of aluminum is not allowed unless indicated on the Drawings.
- D. Correct fabrication errors and damaged members in shop; do not use a cutting torch in shop or in field to cut any members, to correct fabrication errors, or to cut openings.
- E. Provide templates for anchors, bolts, and other items to be installed in other work.
- F. Field Assembly: Tolerances shall comply with the latest edition of AISC "Manual of Steel Construction". Before members are assembled, thoroughly clean all bearing surfaces and surfaces that will be in permanent contact. After assembly, carefully align all members of each frame or assembly and accurately adjust until final, correct, and true location is achieved. As work progresses, securely fasten in place:
 1. Provide full length members without splices.
 2. Securely tighten and leave in place all erection bolts used in welded construction, unless removal is required.
- G. Set beam and column base plates accurately, as indicated on the Drawings with non-shrink grout, in accordance with Section 03 30 00, CONCRETE:
 1. If not indicated otherwise, provide minimum of 1-inch grout thickness under base plates.
 2. Set and anchor each base plate to proper line and elevation:
 - a. Use aluminum wedges, shims, or setting nuts for leveling and plumbing columns and beams, and then tighten anchor bolts.

- b. Fill space between bearing surface and bottom of base plate with non-shrink grout, fill space until voids are completely filled and base plates are fully bedded on wedges, shims, and grout.
 - c. Do not remove wedges or shims and where they protrude, cut off flush with edge of base plate.
- H. Temporary Protection: Suitably protect aluminum surfaces against lime mortar stains, discoloration, surface abrasion and other construction abuses. Remove protection prior to installation.
- I. Contact with Dissimilar Materials: Where aluminum surfaces will be embedded in concrete, built into masonry, or in contact with steel (stainless or carbon), concrete, or masonry, or other dissimilar materials, coat the aluminum surfaces in accordance with System No. 27 in Section 09 90 00, PAINTING. Where aluminum surfaces will be bolted with stainless or carbon steel bolts, provide mylar, polyethylene, or Engineer approved isolation sleeves and washers.

END OF SECTION 05 14 00

PART 1 GENERAL**1.01 WORK INCLUDED**

- A. This section includes the work necessary to furnish and install, complete, fabricated metalwork and castings as shown or as required to secure various parts together and provide a complete installation.

1.02 GENERAL

- A. Like items of materials provided hereunder shall be the end products of one manufacturer to achieve standardization for appearance, maintenance, and replacement.
- B. See CONDITIONS OF THE CONTRACT and Division 01 00 00, GENERAL REQUIREMENTS, which contain information and requirements that apply to the work specified herein and are mandatory for this project.

1.03 SUBMITTALS

- A. Submittals shall be made in accordance with Section 01 33 00, SUBMITTALS. In addition, the following specific information shall be provided.
 - 1. Shop drawings, including calculations where required, showing the details of fabrication and installation for miscellaneous metalwork.
 - 2. Product data for wedge, expansion, and epoxy adhesive anchors. Furnish International Conference of Building Officials (ICBO) or other similar building code organizations' recommendations regarding safe allowable design loads.

1.04 REFERENCE STANDARDS

- A. AWS D1.1 "Structural Welding Code-Steel", AWS D1.2 "Structural Welding Code-Aluminum", AWS D1.6 "Structural Welding Code-Stainless Steel", American Welding Society.
- B. "Book of Fastener Standards," Industrial Fastener Institute.
- C. "Standards and Specifications" of the American Institute of Steel Construction.
- D. "Codes and Industry Standards" of the Aluminum Association current Aluminum Design Manual series.
- E. Other standards as referenced herein.

1.05 DELIVERY, STORAGE, AND HANDLING**A. Preparation for Shipment:**

1. Insofar as practical, factory assemble items specified herein.
2. Package and clearly tag parts and assemblies that are of necessity shipped unassembled, in a manner that will protect materials from damage, and facilitate identification and field assembly.

B. General Storage and Handling: Accept metal fabrications on-site in labeled shipments and inspect for damage. Protect metal fabrications from damage on-site by exposure to weather or by ground contact, deformation, and other types of damage.**C. Storage of Epoxy Adhesive:**

1. Store epoxy cartridges on pallets or shelving in a covered storage area.
2. Control temperature above 60 degrees F and dispose of cartridges if shelf life has expired. If stored at temperatures below 60 degrees F, test adhesive prior to use to determine if adhesive meets specified requirements.

1.06 GENERAL FABRICATION**A. Fabrication shall be coordinated with connecting work.****B. The fabrication shall be done in units as large as practicable for finishing, handling and installation. Fabricate items with joints tightly fitted and secured.****C. All welding shall conform to the requirements of the American Welding Society.****D. Connections:**

1. Shop connections shall be welded after removing all scale, and ground smooth.
2. Field connections shall be bolted, unless otherwise specified or detailed.
3. Punch or drill holes shall not be cut with a torch.
4. Joints exposed to weather shall be formed so as not to trap water.

5. Butt joints shall use the mill square end and be smoothed.
6. Corners shall use a cope and weld technique.

PART 2 PRODUCTS

2.01 GENERAL

- A. Like items of materials provided hereunder shall be the end products of one manufacturer to achieve standardization for appearance, maintenance, and replacement.
- B. Where applicable, the structure and appurtenant facilities have been designed around the first named manufacturer's equipment. Metalwork and castings furnished by all qualified interested manufacturers will be considered, provided that necessary structural, electrical, and mechanical changes required are submitted in conformance with the requirements of CONDITIONS OF THE CONTRACT and Division 01 00 00, GENERAL REQUIREMENTS. The Contractor shall bear all costs for necessary changes for a complete and satisfactory installation.
- C. Furnish miscellaneous items:
 1. Miscellaneous metalwork and castings as shown, or as required to secure various parts together and provide a complete installation.
 2. Items specified herein are not intended to be all inclusive. Provide metalwork and castings shown, specified, or which can reasonably be inferred as necessary to complete the project.
- D. Unless otherwise indicated, materials shall meet the latest issue of ASTM Specifications as follows:

<u>Item</u>	<u>ASTM Specification</u>
Steel Shapes, Channels, Angles, and Plates:	A36, A992 for "W" and "WT" shapes/sections
Steel Pipe Columns:	A501 or A53, Type E or S, Grade B
Structural Steel Tubing:	A500, Grade B
Sheet Steel	A653, Grade 33 structural quality
Stainless Steel:	
Bars and Shapes:	A276, Type 316

Steel Plate, Sheet and Strip:	A240, Type 316
Bolts:	A193, Type 316, B8MN, B8M2 or B8M3
Nuts:	A194, Type 316, B8MN, B8M2 or B8M3
Aluminum, Structural Shapes and Plates:	Alloy 6061-T6, meeting referenced specifications and ASTM sections found in Aluminum Association current Construction Manual Series
Connection Bolts for Steel Members: Use Compressible Washer Type Direct Tension Indicators at all Connections; Use Hardened Washers also Under Head and Nut:	A325-F, F959, F436 (washers)
Anchor Bolts and Nuts:	
Carbon Steel:	A307-A and A563
Stainless Steel:	A193, Type 316
Galvanized Steel Bolts and Nuts:	A153, Zinc Coating for A307 and A563
Flat Washers (Unhardened)	F844, Use A153 for Zinc Coating
Threaded Bars:	A36
Connection Bolts for Wood Members:	
Dry Environment:	A307-A or B Uncoated
Wet Use or Exterior Use:	A307-A or B with A153 Galvanizing
Connection Bolts for:	
Aluminum:	Alloy 2024-T4; or use appropriate Stainless Steel
Cast Iron:	A48, Class 30

2.02 ANCHOR BOLTS

- A. Anchor bolts for equipment and machinery, where permanently anchored into concrete (non-submerged use), shall be stainless steel unless otherwise shown. The diameter, length, and any bend dimensions shall be as required by the equipment or machinery manufacturer. Unless otherwise required, use 3/4-inch minimum diameter and other geometry shown on the

Drawings. Furnish a minimum of two nuts and a washer of the same material for each bolt. Provide sleeves as required or as shown for location adjustment.

- B. Anchor bolts for equipment, as hereinafter defined, machinery or other connections that are to be for submerged use shall be as specified for non-submerged use except that the bolts shall be Type 316 stainless steel. Coating of anchor bolt threads is not required. Where threads are covered with fusion bonded coating, provide nut of proper size to fit and provide connection of equal strength to embedded bolt.
- C. Submerged use is defined as any connection to concrete from a point 1 foot 6-inches above the maximum water surface in any water holding structures and any connections below that point.
- D. Anchor bolts for other uses to anchor fabricated metal work or structural building components, or structural frame components shall be Type 316 stainless steel. Minimum size shall be 3/4-inch diameter by 12-inches long, unless otherwise shown. Furnish two nuts and one washer per bolt of the same material as the bolt, unless otherwise shown.

2.03 STAINLESS STEEL FASTENERS LUBRICANT (ANTI-SEIZING)

- A. Where stainless steel nuts and machined bolts, anchor bolts, concrete anchors, and all other threaded fasteners are used, Contractor shall apply an anti-seizing lubricant to the threads prior to making up the connections. The lubricant shall contain substantial amounts of molybdenum disulfide, graphite, mica, talic, or copper, such as Loctite anti-seize lubricant as manufactured by Henkel Corporation; Permatex anti-seize lubricant; or equal.

2.04 POST INSTALLED ANCHORING SYSTEMS FOR CONCRETE

- A. Wedge Anchors:
 - 1. Wedge anchors shall be 100 percent 316 stainless steel and shall not be used below a point of 1-foot 6-inches above the peak (maximum) water surface in water holding structures. See epoxy adhesive anchors or coated anchor bolts specified elsewhere in this Specification.
 - 2. Wedge anchors shall be Type 316 stainless steel, manufactured by ITW Red Head Trubolt; Hilti Kwik-Bolt, KB-TZ, manufactured by Hilti, Inc.; or equal. Furnish sizes shown on Drawings.

B. Expansion Anchors:

1. Expansion anchors shall not be used except in dry areas where future corrosion is not a problem. In wet or damp areas, provide wedge anchors as specified hereinbefore, or in submerged conditions, epoxy adhesive anchors as specified hereinafter.
2. Self-drilling anchors, snap-off type or flush type. Provide anchors for use with hot-dipped galvanized bolts. Non-drilling anchors shall be flush type for use with a bolt or stud type with projecting threaded stud. Multi-Set II Drop-in as manufactured by ITW Red Head; Hilti HDI+ Drop-In Anchors as manufactured by Hilti, Inc.; or equal.

C. Epoxy Adhesive Anchors:

1. Provide for anchoring metal components at or below a point 1-foot 6-inches above maximum water surface elevation in water holding structures, in buried in earth conditions, and in very wet or humid locations.
2. Anchor rod shall be Type 316 stainless steel threaded rod free of grease, oil, or other deleterious material with a 45-degree chisel point. Where indicated, use typical reinforcing where attaching to existing concrete.
3. Epoxy Adhesive:
 - a. Meet ASTM C881, Type I, Grade 3, Class A, B, or C.
 - b. Two-component, 100 percent solids, non-sag, paste, insensitive to moisture, designed to be used in adverse freeze/thaw environments and gray in color.
 - c. Cure Temperature, Pot Life, and Workability: Compatible for intended use and environmental conditions.
4. Mixed Epoxy Adhesive:
 - a. Non-sag paste consistency with ability to remain in a 1-inch diameter overhead drilled hole without runout, holding the following properties:
 - 1) Slant Shear Strength, ASTM C881 and C882, No Failure in Bond Line, Dry/Moist Conditions: 5,000 psi.
 - 2) Compressive Strength, ASTM D695: 13,000 psi minimum.
 - 3) Tensile Strength, ASTM D638: 6,500 psi.
 - 4) Heat Deflection Temperature, ASTM D648: 135 degrees F, minimum.

5. Epoxy Adhesive Packaging:

- a. Disposable, self-contained cartridge system capable of dispensing both epoxy components in the proper mixing ratio, and fit into a manually or pneumatically operated caulking gun.
- b. Dispense components through a mixing nozzle that thoroughly mixes components and places epoxy at base of predrilled hole.
- c. Mixing Nozzles: Disposable, manufactured in several sizes to accommodate sizes of anchor rods.
- d. Cartridge Markings: Include manufacturer's name, mix ratio by volume, product expiration date, and appropriate ANSI handling precautions.

6. Manufacturers:

- a. Hilti Inc., Hybrid HIT-RE 500 V3 Adhesive Anchoring System.
- b. ITW Red Head, Epcon C6+ Epoxy Anchor System.
- c. Adhesives Technology Corporation, Ultrabond HS-1CC Epoxy.
- d. Or equal.

2.05 MISCELLANEOUS STRUCTURAL STEEL SUPPORTS AND PIPING SUPPORTS

- A. Provide all structural steel supports and miscellaneous piping system supports of the sizes and weights shown. All connections shall be welded, unless otherwise shown. All steel shall be painted, unless shown otherwise on the Drawings.
- B. Provide Series 300 stainless steel where indicated on the Drawings.
- C. For piping supports also refer to Section 40 05 10, PIPING – GENERAL.

2.06 BOLTS AND FASTENERS

- A. Bolts and fasteners not permanently embedded in concrete shall be Type 316 stainless steel as hereinbefore specified.
- B. Bolts for flanges of piping, valves, and other similar connections shall be Type 316 stainless steel.

2.07 PIPE SLEEVES

- A. See Section 40 05 10, PIPING - GENERAL.

2.08 ALUMINUM ITEMS

- A. General: Aluminum 6061 and 6063 alloy extruded bar, rod, shapes, type and wire shall conform to the latest edition of Federal Specification QQ-A-200 and ASTM B221. Aluminum 6061 alloy seamless drawn tubing shall conform to the latest edition of Federal Specification WW-T-700 and ASTM B210. Aluminum finish shall be anodized and conform to American Architectural Manufacturers Association (AAAMA) A41, prepared with M or C pretreatment.
- B. Anchor Bolts, Nuts and Washers: Aluminum anchor bolts, nuts and washers shall conform to the applicable requirements of the Aluminum Association Aluminum Design Manual and Specifications for Aluminum Structures. Where anchor bolts are embedded into the concrete, use Type 316 stainless steel bolts as specified hereinbefore.

2.09 LOOSE LINTELS AND ANGLE FRAMING

- A. Provide all steel lintels and framing required for the support of masonry and other construction not attached to structural steel framing or where not specified elsewhere. Hot dip galvanize after fabrication.

2.10 NEOPRENE GASKET

- A. ASTM D1056-2A1-E, soft, closed-cell, neoprene gasket material, suitable for exposure to sewage and sewage gases, unless otherwise shown.
 - 1. Furnish without skin coat on either side.
 - 2. Thickness: As shown or minimum 1/4-inch.
 - 3. Provide sufficient gasket material for sealing penetrations through headworks channel grating and around the screen enclosures.
- B. Provide minimum 1 gallon of manufacturer's recommended adhesive.
- C. Manufacturer:
 - 1. Rubatex Division of Great American Industries, Rubatex No. R-4261-N.
 - 2. Equivalent by Atlantic Gasket Corporation.
 - 3. Or equal.

2.11 MISCELLANEOUS FABRICATED METALS

- A. The following additional items are listed as a guide. Some items on the list may not be required, and list may not be all-inclusive. Submittal data for materials and products must be approved before they are incorporated in the work.
1. Pipe supports, hangers, and/or sway braces.
 2. Steel bases and anchors.
 3. Guard posts (pipe bollards), fabricated from Schedule 40 steel pipe and prime painted after fabrication.
 4. Aluminum or steel stairway members.
 5. Lifting eyes.

2.12 SHOP PAINTING

- A. Clean ferrous metal items not galvanized and apply shop coat of metal primer per Section 09 90 00, PAINTING.

PART 3 EXECUTION**3.01 FABRICATION AND GENERAL WORKMANSHIP**

- A. Workmanship and finish of all metalwork specified under this section shall be the highest grade and equal to the best practice of modern shops for the respective work and shall meet the requirements for "Architecturally Exposed Steel" as defined by the American Institute of Steel Construction (AISC). Exposed surfaces shall have smooth finish and sharp, well-defined lines. Provide all necessary rabbets, lugs, and brackets so that the work can be assembled in a neat, substantial manner. Conceal fastenings where practical. Drill metalwork and countersink holes as required for attaching hardware or other materials. Fabricate with materials as specified. Weld connections, except where bolting is directed. Items requiring special fabrication methods are mentioned herein. Fabrication of all other items shall be of equal quality. Methods of fabrication not otherwise specified or shown shall be adequate for the stresses and as directed by the Engineer.
- B. Grind all exposed edges of welds smooth. All sharp edges shall be rounded to a 1/8-inch minimum radius; all burrs, jagged edges, and surface defects shall be ground smooth.
- C. Welds and adjacent areas shall be prepared such that there is (1) no undercutting or reverse ridges on the weld bead, (2) no weld spatter on or adjacent to the weld or any other area to be painted, and (3) no sharp peaks

or ridges along the weld bead. All embedded pieces of electrode or wire shall be ground flush with the adjacent surface of the weld bead.

- D. Aluminum: Fabricate aluminum as shown, and in accordance with the Aluminum Association Standards and the manufacturer's recommendations as approved. Grind smooth sheared edges exposed in the finished work.

3.02 WELDING

- A. The technique of welding employed, appearance, quality of welds made, and the methods of correcting defective work shall conform to codes for Arc and Gas Welding in Building Construction of the AWS and AISC. Surfaces to be welded shall be free from loose scale, rust, grease, paint, and other foreign material, except that mill scale which will withstand vigorous wire brushing may remain. A light film of linseed oil may likewise be disregarded. No welding shall be done when the temperature of the base metal is lower than zero degrees F. Finished members shall be true to line and free from twists.
- B. Prepare welds and adjacent areas such that there is no undercutting or reverse ridges on the weld bead, no weld spatter on or adjacent to the weld or any other area to be painted, and no sharp peaks or ridges along the weld bead. Grind embedded pieces of electrode or wire flush with adjacent surface of weld bead.
- C. Aluminum: Aluminum shall be welded with Gas Metal Arc (MIG) or Gas Tungsten Arc (TIG) processes in accordance with the manufacturer's recommendations as approved, and in accordance with the recommendations of the American Welding Society contained in the Welding Handbook, as last revised. Grind smooth all exposed aluminum welds.

3.03 EXAMINATION

- A. Examine surfaces and structures to receive the work of this section. Do not proceed until unsuitable conditions have been corrected. Starting work constitutes acceptance of conditions as suitable to the proper execution of the work.
- B. Take measurements at the site and fabricate work to suit. No changes will be made in the structure to accommodate this work.

3.04 DELIVERY, STORAGE AND HANDLING

- A. Deliver, store, and handle equipment in a manner to prevent damage, deterioration and warping. Provide packaging such as cardboard or other

containers, separators, banding, spreaders, and paper wrappings to protect all items.

- B. The Contractor shall thoroughly inspect product upon receipt and report damaged material immediately to delivering carrier and note such damage on the carrier's freight bill of lading.
- C. Store units in a protected dry area, at least 6 inches or more off the ground or floor and at least 1/4" between individual pieces. Follow special storage and handling requirements of manufacturer. Protect exposed finish surfaces of prefinished items.

3.05 GENERAL INSTALLATION

- A. Comply with manufacturer's instructions and recommendations. Coordinate with installation of concrete floors or walls to receive accessory units. Where applicable, anchor units securely to supporting structural substrates, adequate to withstand lateral and thermal stresses, as well as inward and outward loading pressures.
- B. Clean exposed metal surfaces according to manufacturer's instructions. Touch up damaged metal coatings.
- C. Moving parts shall operate freely and shall not rattle or catch when moved.

3.06 INSTALLATION OF FABRICATED METALWORK

- A. Install in accordance with the shop drawings, the Drawings and these Specifications. Perform field welding and erection work by skilled mechanics. Install fabricated metalwork plumb or level as applicable, accurately fitted, and free from distortions or defects. The completed installations shall, in all cases, be rigid, substantial, and neat in appearance. Erect structural steel in accordance with the applicable portions of AISC Code of Standard Practice, except as modified. Install commercially manufactured products in accordance with manufacturer's recommendations as approved.
- B. Aluminum: Erection of aluminum shall be in accordance with the Aluminum Association. Mill markings shall not be removed from concealed surfaces. Exposed surfaces not otherwise coated shall have the inked or painted identification marks removed after the material has been inspected and approved by the Engineer.
- C. Make provisions for erection stresses. Install temporary bracing to maintain alignment until permanent bracing and/or attachments are installed.

3.07 ANCHOR BOLTS

- A. All anchor bolts shall be accurately located and held in place with templates at the time the concrete is poured.

3.08 POST INSTALLED CONCRETE ANCHORS

- A. Installation shall not begin until the concrete or masonry receiving the anchors has attained its design strength. Anchor shall not be installed closer than six times its diameter to either an edge of the concrete or masonry, or to another anchor, unless specifically detailed otherwise on the Drawings. Install in strict conformance with manufacturers written instructions. Use manufacturer's recommended drills and equipment.
- B. Do not install epoxy adhesive anchors when temperature of concrete is below 35 degrees F or above 110 degrees F.

3.09 STAINLESS STEEL FASTENERS LUBRICANT (ANTI-SEIZING)

- A. Apply specified anti-seizing lubricant to threads prior to making up connections.

3.10 GALVANIZING AND REPAIR

- A. Galvanizing of steel plates, shapes, bars (and products fabricated from these items), and strip 1/8-inch thick or thicker, shall conform to ASTM A123. Pipe, welded or seamless steel, shall conform to ASTM A53. Material thinner than 1/8-inch shall either be galvanized before fabrication in conformance with the requirements of ASTM A525, Coating Designation G 210; or after fabrication, in conformance with the requirements of ASTM A123, except that the weight of zinc coating shall average not less than 1.2 ounces per square foot of actual surface area with no individual specimen having a weight of less than 1.0 ounce per square foot. Unless otherwise provided, galvanizing shall be done before or after fabrication, for material which is thinner than 1/8-inch, at the option of the Contractor. Galvanizing will not be required for stainless steel, monel metal, and similar corrosion resistant parts.
- B. All welded areas shall be thoroughly cleaned prior to galvanizing to remove all slag or other material that would interfere with the adherence of the zinc. When it is necessary to straighten any sections after galvanizing, such work shall be performed without damage to the zinc coating.
- C. Fabrication shall include all operations such as shearing, cutting, punching, forming, drilling, milling, bending, welding, and riveting.

- D. Components of bolted assemblies shall be galvanized separately before assembly.
- E. The minimum pitch diameter of the threaded portion of all bolts, anchor bars, or studs shall conform to ANSI B1.1, having a Class 2A tolerance before galvanizing. After galvanizing, the pitch diameter of the nuts or other internally threaded parts may be tapped over ANSI B1.1, Class 2B tolerance, by the following maximum amounts:
- | | |
|----------------------------|---------------------|
| 3/8-inch through 9/16-inch | 0.016-inch oversize |
| 5/8-inch through 1-inch | 0.023-inch oversize |
| 1-1/8-inch and larger | 0.033-inch oversize |
- F. Galvanized surfaces which are specifically to be painted shall be prepared in the field approximately 48 to 72 hours before painting in accordance with Section 09 90 00, PAINTING.
- G. All edges of tightly contacting surfaces, where galvanized is required, shall be completely sealed by welding before galvanizing.
- H. Galvanized surfaces that are abraded or damaged at any time after the application of the zinc coating shall be repaired by solvent cleaning the damaged area (Steel Structures Painting Council SP 1) and hand or power tool (Steel Structures Painting Council SP 2 or SP 3) the damaged areas removing all loose and cracked coating; after which the cleaned areas shall be re-galvanized. Re-galvanize coatings 2 ounces or heavier with a suitable low-melting zinc base alloy per the recommendations of the American Hot Dip Galvanizers Association to the thickness and quality specified for the original zinc coating. Conform to ASTM A123, ASTM A153, or ASTM A767 as appropriate. Re-galvanize coatings less than 2 ounces in accordance with ASTM A780.
- I. Paint should be applied to a cleaned surface. Abrasive blasting is required for inorganic zinc silicate.

3.11 ELECTROLYTIC PROTECTION

- A. Where aluminum is in contact with dissimilar metals, or to be embedded in masonry or concrete, protect surfaces in accordance with Section 09 90 00, PAINTING. Allow paint to dry before installation of the material. Protect painted surfaces during installation; should coating become marred, prepare and touch up surface per paint manufacturer's instructions.
- B. Where aluminum is to be bolted using stainless or carbon steel, provide mylar, polyethylene or Engineer approved isolation sleeves and washers.

- C. Where titanium equipment is in contact with concrete, masonry, or dissimilar metals, provide full-face neoprene insulation gasket, 3/32-inch minimum thickness and 70 durometer hardness.

3.12 PAINTING

- A. Thoroughly clean all ferrous metal items not galvanized and shop coat with an appropriate metal primer. Preparation of surfaces and application of primer shall be in accordance with the paint manufacturer's printed directions and recommendations as approved; and in accordance with Section 09 90 00, PAINTING, utilizing the appropriate painting system.

END OF SECTION 05 50 00

PART 1 GENERAL**1.01 WORK INCLUDED**

- A. This section includes designing, furnishing, and installing all aluminum handrails, guardrails, railings, and supports, complete.

1.02 GENERAL

- A. Like items of materials provided hereunder shall be the end products of one manufacturer to achieve standardization for appearance, maintenance, and replacement.
- B. See CONDITIONS OF THE CONTRACT, and Division 01 00 00, GENERAL REQUIREMENTS, which contains information and requirements that apply to the work specified herein and are mandatory for this project.

1.03 DEFINITIONS AND AGENCY ABBREVIATIONS

- A. Handrails: Synonymous with terms; i.e., guardrail, railing system, ramp-rail system, and stair-rail system. Handrails are comprised of a framework of vertical, horizontal, or inclined members, grillwork or panels, accessories, or combination thereof.
- B. Toeboards: Vertical barrier at floor level usually erected on handrails along exposed edges of floor or wall openings, platforms, ramps, or stairs to prevent miscellaneous items from falling through.
- C. ICC: International Code Council.
- D. ICBO: International Conference of Building Officials.
- E. IBC: International Building Code, latest edition, published by ICC.
- F. Special Inspection: As governed by the IBC.

1.04 SUBMITTALS

- A. Shop Drawings:
 - 1. Indicate handrail profiles, sizes, connections, anchorage, splices, dowel lengths, size and type of fasteners, and accessories. Provide project-specific scale plans and elevations of handrails.
 - 2. Manufacturer's literature and catalog data of handrail and components.

3. Design Data: Calculations or test data using design performance loads specified hereinafter and include the following:
 - a. Bending stress in, and deflection of, posts in accordance with ASTM E985.
 - b. Stress in post base connection.
 - c. Calculation of anchorage forces and comparison of these forces to ICC International Building Code recommendations regarding safe allowable design loads of anchorages.
 - d. For concrete anchor spacings less than 12-anchor diameters and edge distances less than 6-anchor diameters, make a reduction in allowable pullout and shear values. Use published ICC Report values for anchors without Special Inspection; or provide independent laboratory inspection services for ICC Report values with Special Inspection.
- B. Samples:
 1. Railing sections, 6 inches long showing different connections and proposed finish.
 2. Each fitting including wall brackets, castings, rail expansion joints, and toeboard fittings.
- C. Quality Control Submittals:
 1. Manufacturer's assembly and installation instructions.
 2. Manufacturer's Certificate of Proper Installation in accordance with Section 01 66 40, MANUFACTURERS' SERVICES.
 3. Manufacturer's written recommendations describing procedure for maintaining handrails including cleaning materials, application methods, and precautions to be taken in the use of cleaning materials.
 4. Test Reports: Test data may supplement load calculations providing data covers the complete handrail system, including anchorage:
 - a. Test data for handrail and components showing load and deflection due to load, in enough detail to prove handrail is strong enough and satisfies national, state, local standards, regulations, code requirements, and OSHA 29 CFR Subpart D and specifically 29 CFR 1910.23 and 1910.29, using design loads specified. Include test data for the following:
 - 1) Railing and post connections.

- 2) Post and base connections.
- 3) Railing wall connections.
- 4) Railing expansion joint connections.
- b. Deflection Criteria: In accordance with ASTM E985 and design loads specified.
- c. Aluminum Rail Piping: Test data showing yield strength of pipe as-delivered equals or exceeds 35,000 psi.
- d. Concrete Anchors: Calculations and test data for review prior to use, on anchors other than those specified.

1.05 QUALITY ASSURANCE

- A. Qualifications: Calculations required for design data stamped by a registered engineer licensed in the United States.
- B. Handrails, railings, and associated fittings, hardware, and specialties shall meet minimum requirements of national, state, and local standards, regulations, and code requirements, including OSHA and the current edition of the IBC, as they specifically apply to this project.
- C. Perform work of this section according to the Aluminum Association (AA) ADM 1, Aluminum Design Manual and ASTM E985.

1.06 ENVIRONMENTAL REQUIREMENTS

- A. Thermal Movements: Allow for thermal movement resulting from the following maximum range in ambient temperature in the design, fabrication, and installation of handrails to prevent buckling, opening up of joints, over stressing of components, connections and other detrimental effects. Base design calculations on actual surface temperatures of materials due to both solar heat gain and night time sky heat loss. The temperature change is the difference between high or low temperature and installation temperature.
 - 1. Temperature Change Range: 70 degrees F, ambient; 100 degrees F, material surfaces.

PART 2 PRODUCTS

2.01 DESIGN PERFORMANCE

- A. Structural Performance of Handrails: Design, test, fabricate, and install handrails to withstand the following structural loads without exceeding the allowable design working stress or allowable deflection. Apply each load to produce maximum stress and deflection in each of the respective components comprising handrails.

1. Top Rail of Handrails: Capable of withstanding the following load cases applied:
 - a. Concentrated load of 200 pounds applied at any point and in any direction in accordance with ICC IBC.
 - b. Uniform load of 50 pounds per linear foot applied horizontally in accordance with ICC IBC.
 - c. Concentrated load need not be assumed to act concurrently with uniform loads in accordance with ICC IBC.
2. In-Fill Area of Railing Systems:
 - a. Capable of withstanding a horizontal concentrated load of 200 pounds applied to one square foot at any point in the system including panels, intermediate rails, balusters, or other elements composing the in-fill area.
 - b. Horizontal concentrated load need not be assumed to act concurrently with loads on top rails of handrails.
3. Mid-rails with corner returns shall withstand a 300-pound concentrated vertical load applied at any point or direction without damage and loosening of pipe, fittings, or attachment hardware.
4. Concrete Anchors for Handrail Wall Brackets: Anchors with a strength required by calculations with concrete strength assumed at 4,000 psi and not exceeding ICC IBC allowable loads for actual spacing, edge distance, and embedment.
5. Concrete Anchors: In accordance with ICC IBC allowable load values for size, length, embedment, spacing, and edge distance to match required loads shown in calculations.

2.02 ALUMINUM HANDRAILS

A. General:

1. Furnish pre-engineered and pre-fabricated three rail handrail system or components as shown on the Drawings and as specified herein. Meet load and deflection criteria specified hereinbefore.
2. Handrail system shall provide for field cutting of all posts to fit, prior to installation or attachment to, base connections.
3. Provide toeboards at all handrails except where concrete curbs or gates are furnished.
4. Pop rivets and glued railing construction are not permitted.

- B. Manufacturers (listed or alternate manufacturers must meet performance and material specifications herein):
1. Thompson Fabricating LLC, Tarrant, AL.
 2. Superior Aluminum Products, Inc.
 3. Or approved equal.
- C. Rails, Posts, and Formed Elbows: Extruded Alloy 6105-T5, 6061-T6, or 6063-T6, minimum tensile strength of 38,000 psi and minimum yield strength of 35,000 psi, with special close tolerances for tight fit and excellent appearance. Use the same alloy throughout the project for railings to provide a uniform appearance.
1. Miscellaneous Aluminum Parts: Alloy 6063-T6 or 6061-T6 extruded aluminum of adequate strength for all loads.
 2. Post and Railing: Nominal 1-1/2-inch diameter post and rail system.
 - a. Rails: 1.900-inch outside diameter by 0.145-inch wall thickness, Schedule 40.
 - b. Posts: 1.900-inch outside diameter by 0.200-inch wall thickness, Schedule 80.
 - c. Provide solid dowel interconnectors of 6105-T5, 6061-T6, or 6063-T6 aluminum to fit tight inside the posts where required.
 - d. Post Spacing: Maximum 6.0-feet horizontal spacing.
- D. Fittings:
1. Top Mount Post Base:
 - a. Cast aluminum to allow for cutting posts to accurate length in the field and to allow for tight fit of post base to top of concrete.
 - b. Four holes in base for concrete anchors. For narrow walls or curbs, furnish two holes in base for concrete anchors with required edge distance.
 - c. Manufacturer and Products: Thompson Fabricating; Part No. TBF-3.4 and Part No. TBF-3.2 for narrow walls and curbs.
 2. Handrail and Post Fittings: Extruded, machined bar stock, permanent mold castings, or die castings of sufficient strength to meet load requirements. Fittings shall match color and finish of pipe in handrails. Sand cast parts are not permitted.
 3. Side Mounted Handrail Bracket: Extruded aluminum, Alloy 6063-T6 with two separate pieces, each with two holes for bolts or concrete anchors.

- a. Manufacturer and Product: Thompson Fabricating; Part No. TSM-1.5.
4. Concrete Anchors for Securing Bases and Brackets to Concrete: Type 304 or Type 316 stainless steel 1/2-inch by 5-1/2-inch concrete wedge anchors as specified in Section 05 50 00, MISCELLANEOUS METAL ITEMS.
5. Handrail Connections for Metal Stairway Stringers:
 - a. Extruded aluminum bracket, Alloy 6063-T6.
 - b. Brackets Bolts: 1/2-inch diameter Type 304 or Type 316 stainless steel bolts.
 - c. Offset adjustable stair fitting of cast Al-mag, Part No. ABF.
 - d. Manufacturer and Products: Thompson Fabricating; Part Nos. SMB-2 or SMB-3, ABF.
6. Handrail Connections for Metal Beams:
 - a. Extruded aluminum bracket, Alloy 6063-T6.
 - b. Bracket Bolts: 1/2-inch diameter Type 304 stainless steel bolts.
 - c. Manufacturer and Products: Thompson Fabricating; Part Nos. SMB-2 or SMB-3. Use Part No. TSM-1.5 (one piece with four holes for bolts) if bracket is attached to flat side of a channel.
7. Handrail Wall Brackets: Cast Al-mag aluminum bracket, adjustable wall fittings, with provision for three 3/8-inch Type 304 stainless steel bolts or concrete wedge anchors.
 - a. Manufacturer and Product: Thompson Fabricating; Part No. AWF.
8. Miscellaneous Rail to Post Fittings:
 - a. Cast Aluminum Tee Fittings: Part Nos. TF-1 and TX-1.
 - b. Cast Aluminum Ell Fittings: Part Nos. TE-1, TE-2, and TE-3.
 - c. Aluminum Splice Lock: Part No. SL-1.
 - d. Aluminum Expansion Joint Splice: Part No. ES-1.
 - e. Formed Aluminum Wall Flange: Part No. CF-2.
 - f. Manufacturer: Thompson Fabricating.
9. Toeboards and Accessories:
 - a. Material: Molded or extruded 6063 or 6061 aluminum, minimum size and mounting as shown on the Drawings.
 - b. Manufacturer: Thompson Fabricating.

10. Handrail Gate and Hardware: Furnish 6063-T6, 6105-T5, or 6061-T6 extruded aluminum gate as shown on the Drawings. Hardware manufacturers and products include:
 - a. Thompson Fabricating Company, Factory Industrial Gate aluminum hinges and stainless steel latch.
 - b. Julius Blum and Company, Inc.; No. 782/783 gate hinges with springs, and No. 784 gate latch and stop.
 11. Safety Chains: Provide safety chains of Type 316 stainless steel, coil proof straight link type, 1/4-inch diameter, with snap hooks on one end. Provide Type 316 stainless eye bolts for attachment of chains to handrail post on one end and attachment to other post with snap hooks, as shown on the Drawings. Provide three chains, each 4 inches longer than the anchorage spacing, for each guarded area.
 12. Castings for Handrails: Cast Al-mag with sufficient strength to meet load and test requirements. Anodizable grade finish with excellent resistance to corrosion when subject to exposure of sodium chloride solution intermittent spray and emersion.
- E. Chain-Link Railing Infill: Where indicated on the Drawings, infill railings with 9-gauge aluminum chain link fabric with clear anodized finish
- F. Concrete Embedded Metal Anchorages: In accordance with Section 05 50 00, MISCELLANEOUS METAL ITEMS.
- G. Finishes:
1. Handrail Pipe and Post: In accordance with American Architectural Manufacturer's Association (AAMA) 611 Class I, with Aluminum Association designation AA-M32-C22-A41.
 2. Cast Fittings and Toeboards: In accordance American Architectural Manufacturer's Association (AAMA) 611 Class I, with Aluminum Association designation AA-M10-C22-A41.
 3. Anodize exposed pre-fabricated components, except stainless steel fasteners, after fabrication.

2.03 ANCHOR BOLTS, FASTENERS, AND CONCRETE ANCHORS

- A. Locknuts, Washers, and Screws:
1. Elastic Locknuts, Steel Flat Washers, RHMS Round Head Machine Screws: Type A 304 or A 316 stainless steel.
 2. Flat Washers: Molded nylon.

3. Manufacturer: McMaster-Carr Supply Company, or equal.
- B. Bolts and Nuts for Bolting Handrail to Metal Beams: ASTM A193 and ASTM A194, Type A 316 stainless steel with minimum yield strength for bolts of 95,000 psi, unless otherwise shown.
- C. Concrete Anchors:
 1. Anchor Bolts: Stainless steel Type 316, with minimum yield strength of 30,000 psi, 1/2-inch minimum diameter with hex nuts, or size as shown.
 2. Wedge Anchors: Type 316 stainless steel, minimum 1/2-inch diameter by 5-1/2-inches long, or size as shown.
 3. Use ICC IBC approved service load allowable values for size, length, embedment, spacing, and edge distance to match required loads shown in calculations.
- D. Epoxy Adhesive Anchors: Heavy-duty 1/2-inch diameter minimum, for exterior use only in accordance with Section 05 50 00, MISCELLANEOUS METAL ITEMS, as an alternative to mechanical concrete anchors. Design and provide the number required. Do not use where fire or elevated temperatures above 110 degrees F may exist.

2.04 FABRICATION OF ALUMINUM HANDRAILS

- A. Perform all work according to approved shop drawings by workmen experienced in the fabrication and erection of aluminum railing systems of type and quantity specified.
- B. Shop Assembly: Fit and shop assemble components in largest practical sizes for delivery to site. Clearly mark components for reassembly in the field and coordinated installation.
 1. Post Spacing: Maximum 6 foot horizontal spacing.
 2. Railing Posts Bolted to Metal or Concrete:
 - a. Furnish longer than needed posts and field cut to exact dimensions required to satisfy any vertical variations on actual structure. In lieu of field cutting, provide an approved fitting with sufficient post overlap, containing provisions for vertical adjustment.
 - b. Field fit-up is required. Do not use shims or grout under baseplates. Misfits shall be rejected.

3. Aluminum handrails shall be free of burrs, nicks, and sharp edges when fabrication is complete. Welding is not permitted.
 4. Form bends to maintain cylindrical cross section of pipe throughout entire bend without buckling, cracking, or otherwise deforming exposed surfaces of pipe.
 5. Exposed mechanical fastenings shall be flush countersunk screws or bolts, unobtrusively located, consistent with design of component, except where specifically noted otherwise.
- C. Shop/Factory Finishing: Use same alloy for uniform appearance throughout fabrication for railings. Handrail and post fittings shall match the fittings with the color and finish of pipe in handrail. Sand cast parts are not permitted.
- D. Tolerances:
1. Shop assemble rails, posts, and formed elbows with a close tolerance for tight fit.
 2. Fit dowels tightly inside posts.

PART 3 EXECUTION**3.01 DELIVERY, STORAGE, AND HANDLING**

- A. Handrails shall be adequately packaged and cushion wrapped to prevent scratching and denting during shipment, storage, and installation. Leave protective wrapping intact, insofar as possible, until railing is completely installed.
- B. Aluminum Handrails:
1. Shop assemble into practical modules of lengths not exceeding 24 feet for shipment. Deliver toeboards loose for field assembly.
 2. All clear anodized handrail pipe and posts shall be delivered with protective plastic wrap. Wrap shall only be removed after erection.

3.02 GENERAL EXECUTION PROVISIONS

- A. Provide railing posts longer than needed and field cut to exact dimensions required to satisfy vertical variations on the actual structure. Install railing with a base that provides plus or minus 1/4-inch vertical adjustment inside the base fitting. If adjustment is required in the field and exceeds plus or minus 1/4-inch, reduce post length not to exceed beyond bottom of lowest setscrew or bolt in base fitting.

- B. Field fabrication of aluminum railing systems is not permitted.
- C. Modification to structure will not be permitted where handrail is attached.
- D. Mount handrails only on completed walls or structures. Do not support handrails temporarily by means not satisfying structural performance requirements.

3.03 HANDRAIL INSTALLATION

- A. Assembly and Installation: Perform in accordance with manufacturer's written recommendations for installation and as shown on the Drawings. Install components plumb and level, accurately fitted, and free from distortion or defects. Conceal bolts and screws whenever possible. Where not concealed, use flush countersunk fastenings.
- B. Protection from Entrapped Water:
 - 1. Make provisions in exterior and interior installations subject to high humidity to drain water from railing system.
 - 2. For posts mounted in concrete, and bends and elbows occurring at low points, drill weep holes of 1/4-inch diameter at lowest possible elevations, one hole per post or rail. Drill hole in the plane of the rail.
- C. Expansion Joints:
 - 1. Provide at maximum intervals of 54 feet on center and at structural joints.
 - 2. Slip joint with internal sleeve extending 2 inches beyond each side of joint. Provide 1/2-inch slip joint gap to allow for expansion.
 - 3. Fasten to one side using 3/8-inch diameter setscrew. Place setscrew at bottom of pipe.
 - 4. Locate joints within 12 inches of posts. Locate expansion joints in rails that span expansion joints in structural walls and floors supporting the posts.
- D. Setting Posts:
 - 1. Embedded:
 - a. Clean dust and foreign matter from sleeves or blockouts.
 - b. Moisten interior of hole and surrounding surface with clean water. Fill hole with non-shrink grout as specified in Section 03 30 00, CONCRETE prior to installing post.

- c. Brace railing until grout sets.
 - d. For posts installed outside and exposed to freezing temperatures, drill weep hole through post approximately 1/2-inch above the level of the grout inside the post and in plane of the rail to prevent entrapment and freezing of water inside post.
- 2. Surface Mounted:
 - a. Bolt post baseplate connectors firmly in place.
 - b. Shims, wedges, grout, and similar devices for handrail post alignment will not be permitted.
 - c. Furnish in longer length than needed. Accurately field measure for correct length, cut and secure to the post baseplate connector.
- E. Posts and Rails:
 - 1. Set posts plumb and aligned to within 1/8-inch in 12 feet.
 - 2. Set rails horizontal or parallel to slope of steps to within 1/8-inch in 12 feet.
 - 3. Install posts and rails in the same plane. Remove projections or irregularities and provide a smooth surface for sliding hands continuously along top rail. Use offset rail for use on stairs and platforms if post is attached to web of stringers or structural platform supports.
 - 4. Support 1-½-inch rails directly above stairway stringers with offset fittings.
- F. Handrail Wall Brackets:
 - 1. Support wall rails on brackets spaced maximum 5 feet on centers for aluminum as measured on the horizontal projection.
- G. Toeboard:
 - 1. Provide at all handrails except where 4-inch or higher concrete curbs are installed, or at gates or safety chain areas.
 - 2. Accurately measure in field for correct length, after handrail post installation, cut and secure to posts.
 - 3. Dimension between bottom of toeboard and walking surface shall not to exceed 1/4-inch.

- 4. Aluminum Toeboards: Provide expansion and contraction connections between each post.
- H. Railing Gates: Install in accordance with manufacturer's installation instructions.
- I. Chain-Link Infill: Attach fabric on the interior side of the posts with aluminum hog rings as recommended by fabric manufacturer. Make sure all cut fabric wires are bent over and connected to adjacent wires.
- J. Safety Chains: Install in accordance with details shown on the Drawings.

3.04 FIELD FINISHING

- A. Corrosion Protection: Prevent galvanic action and other forms of corrosion caused from direct contact with concrete and dissimilar metals by coating metal surfaces in accordance with Section 09 90 00, PAINTING. Where aluminum is to be bolted with stainless or carbon steel bolts provide mylar, polyethylene or Engineer approved isolation sleeves and washers.

3.05 CLEANING

- A. Wash railing system thoroughly using clean water and soap. Rinse with clean water.
- B. Do not use acid solution, steel wool, or other harsh abrasive.
- C. If stain remains after washing, restore in accordance with manufacturer's recommendations, or replace stained handrails with new handrails meeting specified finish.

END OF SECTION 05 52 00

PART 1 GENERAL**1.01 WORK INCLUDED**

- A. This section includes furnishing and installing all fabricated metal grating and grating supports and stair treads, complete.
- B. Fiberglass grating is specified in Section 06 50 00, MISCELLANEOUS FIBERGLASS ITEMS.
- C. Related work specified in other sections includes:
 - 1. Section 05 12 00, STRUCTURAL STEEL.
 - 2. Section 05 14 00, STRUCTURAL ALUMINUM.
 - 3. Section 05 52 00, HANDRAILS AND RAILINGS.

1.02 GENERAL REQUIREMENTS

- A. See CONDITIONS OF THE CONTRACT, and Division 01 00 00, GENERAL REQUIREMENTS, which contains information and requirements that apply to the work specified herein and are mandatory for this project.
- B. Like items of materials provided hereunder shall be the end products of one manufacturer or supplier to achieve standardization for operation, maintenance, spare parts, appearance, and replacement.

1.03 QUALITY ASSURANCE

- A. Quality Requirements: Fabrication, installation, standard clearances, banding and tolerances shall be in accordance with the National Association of Architectural Metal Manufacturers (NAAMM) Metal Bar Grating (MBG) standards; MBG 531 "Metal Bar Grating Manual", MBG 532 "Heavy-Duty Metal Bar Grating Manual", MBG 533 "Welding Standards for Fabrication of Steel, Stainless Steel, and Aluminum Bar Grating, and MBG 534 "Metal Bar Grating Engineering Design Manual".

1.04 SUBMITTALS

- A. Product Data:
 - 1. Catalog information and catalog cuts, along with span and deflection tables demonstrating compliance with these specifications.
 - 2. Manufacturer's specifications, including coatings.
 - 3. Special handling and storage requirements.

4. Installation instructions.
- B. Shop Drawings:
1. Grating: Show dimensions, weight, and size, and location of connections to adjacent grating, supports, and other work. Also show all required opening locations and sizes for piping or other penetrations in the grating.
 2. Grating Anchorage: Show structural calculations and details of anchorage to supports to prevent displacement from traffic impact.
 3. Grating Supports: Show dimensions, weight, size, location, and anchorage to supporting structure. Also indicate required bearing length and allowable clearing tolerances.
- C. Quality Control Submittals:
1. Factory test reports.
 2. Manufacturer's certification of compliance for specified products.
 3. Manufacturer's report that swaged cross bars, if used on grating, meet the requirements of these Specifications.

PART 2 PRODUCTS

2.01 GENERAL

- A. Materials shall meet the following ASTM Specifications:
1. Stainless Steel:
 - a. Bolts: A193, Type 316.
 - b. Nuts: A194, Type 316.
 - c. Bars and Shapes: A276, Type 316.
 - d. Plate, Sheet, Strip: A167, Type 316.
 2. Anchor Bolts and Nuts:
 - a. Stainless: A193, Type 316.
 3. Flat Washers (Unhardened): F844, use A153 for zinc coating.

B. Design and Fabrication:

1. Meet minimum dimensional requirements as shown on the Drawings, as specified herein, and/or as needed to meet specific loading design criteria.
2. Field measure areas to receive grating, verify dimensions of new fabricated supports, and fabricate to dimensions required for specified clearances.
3. Section Length: Sufficient to prevent its falling down through clear opening when oriented in the span direction when one end is touching either the concrete or the vertical leg of grating support.
4. Minimum Depth of Grating: As shown on the Drawings for foot traffic grating. As shown on the Drawings or as required to meet specific loading criteria for vehicular traffic grating.
5. Minimum bearing of main bars on each support and end clearance of installed grating sections shall be as specified in the references included under Article QUALITY ASSURANCE hereinbefore.
6. Metal Cross Bar Spacing: 2-inch maximum center to center, unless otherwise shown or specified.
7. Cross Bars:
 - a. Flush with top of main bar and extend downward a minimum of 50 percent of the main bar depth for pressure locked or dove tail type design grating.
 - b. Swaged or Squeezed Cross Bars:
 - 1) Within 1/4-inch of top of grating with 1/2-inch minimum vertical dimension after swaging, and minimum before swaging dimension of 5/16-inch square.
 - 2) Cross Bar Dimension After Swaging: Minimum 1/8-inch wider than the opening at minimum of two corners at each side of each square opening in main bar.
 - 3) Tightly fit main bars and cross bars allowing no differential movement.
8. Do not use weld type cross bars.
9. Banding:
 - a. Same material as grating.

- b. Band grating edges and openings in grating shall be as specified in the references listed under Article QUALITY ASSURANCE hereinbefore.
 - 10. Metals for Embedment, or Seat Angles for Partial Embedment in Concrete: Type 316 stainless steel, unless otherwise shown or specified.
- C. Grating Accessories: Anchor bolts, bolts, inserts, threaded anchor studs, wedge anchors, expansion anchors, adhesive anchors and as necessary for anchorage of grating to supports, as specified in Section 05 50 00, MISCELLANEOUS METAL ITEMS and below:
 - 1. Stainless steel Type 316.
 - 2. Fastener Capability: Firmly secure grating section to supports.
 - 3. Fastener Clips and Bolts: In accordance with grating manufacturer's recommendations, except minimum of four fasteners per grating section and removable from above grating walkway surface.
 - 4. Provide stainless steel Type 316 threaded anchor studs, as fasteners for grating attachment to metal supports either not embedded or partially embedded in concrete, as manufactured by:
 - a. Stanley Engineering Fastening, Nelson Stud Welding and fastening.
 - b. Atlantic Bolt Inc.
 - c. Or equal.
- D. Grating Supports:
 - 1. Seat angles and beams where shown.
 - 2. Stainless steel Type 316.
 - 3. Coordinate dimensions and fabrication with grating to be supported.
- E. Slip-Resistant Surface for Foot Traffic Grating:
 - 1. Bar Grating Steel or Aluminum: Uniform disbursement of custom alloy slip resistant particles to substrate by a CNC laser welding deposition process as manufactured by:
 - a. Borden Gratings ALGRIP surface.
 - b. Grating Pacific AlGrip surface.
 - c. Or equal.

2.02 FOOT TRAFFIC GRATING

- A. Use aluminum grating at all locations, unless shown otherwise on the Drawings. Uniform service load for foot traffic grating shall be 100 pounds per square foot minimum with a concentrated load force of 300 pounds per foot width, unless otherwise shown.
- B. Maximum Deflection: 1/4-inch, unless otherwise shown.
- C. Banding: 3/16-inch minimum, in accordance with NAAMM 531.
- D. Provide Algrip slip resistant surface on all metal foot traffic grating.
- E. Aluminum Bar Type Grating:
 - 1. Pressure locked or dove tail, rectangular bar design, as manufactured by:
 - a. Borden Gratings Type F (19-P-2).
 - b. Grating Pacific Type 19-ADT-2.
 - c. Or equal.
 - 2. Swage or squeeze locked grating, rectangular bar type, as manufactured by:
 - a. Borden Gratings Type S/F.
 - b. Grating Pacific Type 19-SG-2.
 - c. Or equal.
- F. Stair Treads:
 - 1. Material and Type: Same as grating material and grating type as provided for connecting walkway or work surface.
 - 2. Provide nonslip abrasive nosing on each stair tread along one long edge.
 - 3. Provide a carrier plate or angle at each stair tread end for connection to stair stringers.
 - 4. Dimensions:
 - a. Length: As shown.
 - b. Width: As shown or manufacturer's standard as close as possible to width as shown.
 - 5. Manufacturers: Same as for grating.

2.03 LIGHT VEHICULAR TRAFFIC GRATING

- A. Design for vehicles with a maximum load of 2,200 pounds per wheel, minimum wheel base and axle width of 4.0 feet, and as shown on the Drawings.
- B. Space main bars at 1-3/16-inch center to center.
- C. Banding: 1/4-inch.
- D. Galvanized Steel Bar Type Grating:
 - 1. Hot dip galvanized after fabrication.
 - 2. Cross Bar Size and Shape: As shown on the Drawings.
 - 3. Manufacturers: Borden Gratings heavy weld Type HD19F; Grating Pacific Type 19-W-2; or equal.

2.04 HEAVY VEHICULAR TRAFFIC GRATING

- A. Design for modified AASHTO H20 loading per NAAMM MBG 532 and MBG 534.
- B. Banding: 1/4-inch.
- C. Galvanized Steel Bar Type Grating:
 - 1. Hot dip galvanized after fabrication.
 - 2. Heavy duty, main bars spaced at 1-7/8-inch maximum center to center, suitable modified for AASHTO H20 loading.
 - 3. Size and shape as shown on the Drawings.
 - 4. Manufacturers: Borden Gratings heavy weld Type HD30F; Grating Pacific Type 30-W-2; or equal.

2.05 FABRICATION

- A. General:
 - 1. Exposed surfaces shall be smooth finish with sharp, well-defined lines.
 - 2. Provide necessary rabbets, lugs, and brackets so work can be assembled in a neat, substantial manner.
 - 3. Conceal fastenings where practical.

4. Drill metalwork and countersink holes as required for attaching hardware or other materials.
 5. Weld connections are not permitted on grating except at banding bars.
- B. Aluminum Foot Traffic Grating:
1. Fabricate as shown and in accordance with manufacturer's recommendations as approved.
 2. Grind smooth sheared edges exposed in the finished work.
 3. Swage cross bars, if used, shall be provided with equipment strong enough to deform cross bars as specified herein.
 4. Eliminate any loose cross bar intersections on swaged grating.
- C. Galvanizing and Repair: Hot dip galvanized after fabrication as specified in Section 05 50 00, MISCELLANEOUS METAL ITEMS, Article Galvanizing and Repair.
- D. Foot Traffic Grating: Any single grating section or assembly shall not be less than 1 foot 6 inches or greater than 3 feet 0 inches in width or weigh more than 150 pounds, unless otherwise shown on the Drawings or on approved shop drawings.
- E. Light Vehicular Traffic Grating: Any single grating section or assembly shall not be less than 1 foot 6 inches or greater than 3 feet 0 inches in width (except 3/8-inch thick bearing bar grating), or weigh more than 150 pounds, unless otherwise shown on the Drawings or on approved shop drawings.
- F. Heavy Vehicular Traffic Grating: Minimum width of grating sections shall be 2 feet 0 inches regardless of length and weight.

PART 3 EXECUTION**3.01 DELIVERY, STORAGE, AND HANDLING**

- A. Preparation for Shipment:
1. Insofar as is practical, factory assemble items provided herein.
 2. Package and clearly tag parts and assemblies that are of necessity shipped unassembled in a manner that will protect the materials from damage, and facilitate identification and final assembly in the field.

- B. Storage and Handling: In accordance with manufacturer's recommendations.

3.02 PREPARATION

- A. Electrolytic Protection:

1. Where aluminum will be in contact with dissimilar metals, other than stainless steel, or is to be embedded in masonry or concrete, protect surfaces in accordance with System No. 27 as specified in Section 09 90 00, PAINTING. Where aluminum is to be in contact with stainless or carbon steel bolts, provide mylar, polyethylene or Engineer approved isolation sleeves and washers.
2. Allow paint to dry before installation of the material.
3. Protect painted surfaces during installation.
4. Should coating become marred, prepare and touch up surface per paint manufacturer's instructions.

3.03 INSTALLATION

- A. Provide equipment for lifting and placing as necessary.
- B. Install in accordance with approved shop drawings, as shown on the Drawings, and as specified. Field modifications are not allowed unless written authorization is received from the manufacturer and approved by the Engineer.
- C. Install plumb or level as applicable in locations as shown.
- D. Anchor grating securely to supports to prevent displacement from traffic impact.
- E. Completed installation shall be rigid and neat in appearance.
- F. Commercially Manufactured Products:
 1. Install in accordance with manufacturer's recommendations.
 2. Secure grating to support members with fasteners.
 3. Welding is not permitted.
 4. Fasteners: Field locate and install.
 5. Permit each grating section to be easily removed and replaced.

- G. Clearance Between Ends of Grating Sections and Vertical Surfaces of Supports or Concrete Walls: Not to exceed those hereinbefore specified.
- H. Replace grating sections not meeting specified or detailed dimensional requirements.

END OF SECTION 05 53 00

SECTION 07 11 13
BITUMINOUS

DIVISION 07 00 00 - THERMAL AND MOISTURE PROTECTION DAMPPROOFING

PART 1 GENERAL

1.01 WORK INCLUDED

- A. This section covers the work necessary to furnish and install, complete, all below-grade dampproofing.
- B. Dampproofing shall be provided on the exterior side of all buried concrete walls and where shown on the Drawings or specified elsewhere.
 - 1. Clarifier tank
 - 2. Splitter box
 - 3. Additive Alternate 1 SE Manhole

1.02 GENERAL

- A. See Volume 1 and Division 01 00 00, GENERAL REQUIREMENTS, which contain information and requirements that apply to the work specified herein and are mandatory for this project.

1.03 SUBMITTALS

- A. Submittals shall be made in accordance with Section 01 33 00, SUBMITTALS. In addition, the following specific information shall be provided:
 - 1. Manufacturer's Literature: Submit manufacturer's literature, specifications, and application instructions for dampproofing materials.
 - 2. Certificate: Submit manufacturer's certificate of conformance with these specifications.

PART 2 PRODUCTS

2.01 GENERAL

- A. The use of a manufacturer's name and catalog number is for the purpose of establishing the standard of quality desired only. Products of other manufacturers will be considered in accordance with the General Conditions.

SECTION 07 11 13
BITUMINOUS

DIVISION 07 00 00 - THERMAL AND MOISTURE PROTECTION DAMPPROOFING

2.02 DAMPPROOFING

- A. Asphalt compound of brush or spray consistency conforming to ASTM D1187, Type I and ASTM D1227, Type II, Class 1 or 2 with an ASTM D41 asphalt primer for cold applied fibrated emulsified asphalt, as manufactured by;
 - 1. W.R. Meadows, Inc. Seal-Mastic Type II.
 - 2. BASF/Master Builders Solutions MasterSeal 615.
 - 3. Henry Company HE789.
 - 4. Or equal.

PART 3 EXECUTION

3.01 PRODUCT DELIVERY, STORAGE, AND HANDLING

- A. Deliver materials in original sealed containers, clearly marked with manufacturer's name, brand name, and type of material.
- B. Store materials in area where temperatures are not less than 50 degrees F or over 85 degrees F, unless otherwise authorized by the manufacturer.

3.02 ENVIRONMENTAL REQUIREMENTS

- A. Do not start work until the following environmental requirements are met:
 - 1. Do not proceed with application of materials when ambient temperature is less than 50 degree F.
 - 2. Do not apply dampproofing in rainy conditions or within 3 days after surfaces become wet from rainfall or other moisture.
 - 3. Do not apply materials when low temperature of 40 degrees F or less is predicted within a period of 24 hours after application. Maintain ambient temperatures above 40 degrees F for 24 hours before and during application, and until material has cured.

3.03 INSPECTION

- A. Examine surfaces to receive dampproofing to assure conditions are satisfactory for application of materials.

SECTION 07 11 13
BITUMINOUS

DIVISION 07 00 00 - THERMAL AND MOISTURE PROTECTION DAMPPROOFING

3.04 SURFACE PREPARATION

- A. Clean surfaces to remove dust, dirt, oil, wax, efflorescence, and other foreign materials, in accordance with dampproofing manufacturer's instructions.
- B. Remove efflorescence by scrubbing surface with muriatic acid and thoroughly rinsing with water.
- C. Allow 3 days drying time following washing down of substrate surfaces.
- D. Fill all cracks, voids, and honeycombs with mortar to provide sound surface for dampproofing.

3.05 APPLICATION

- A. Apply dampproofing with a brush, or with manufacturer approved low pressure airless spray equipment with a coarse nozzle.
- B. Apply materials at rate and as recommended by the manufacturer and in two coats, to produce a smooth, uniform dry film with no voids or defects. Dull or porous spots shall be recoated with a third coat.
- C. Start application at top of wall and work down surface, keeping a wet edge at all times, forming a continuous, unbroken film, free from pinholes and other surface breaks. If not shown otherwise, apply dampproofing from 2 inches below finish grade elevation to top of footings.
- D. Dampproofing materials shall seal tightly around pipes and other items projecting through the dampproofing.

3.06 ADJUST AND CLEAN

- A. Clean spillage and overspray from adjacent surfaces as recommended by the manufacturer.

3.07 FIELD QUALITY CONTROL

- A. After dampproofing has dried, spray coat surfaces with water.
- B. Recoat surfaces that show water absorption, as recommended by the manufacturer. To prevent blistering, protect surfaces from heat and direct sunlight until dried, then backfill.

END OF SECTION 07 11 13

DIVISION 07 00 00 - THERMAL AND MOISTURE PROTECTION

PART 1 GENERAL

1.01 WORK INCLUDED

- A. This section includes the work necessary to furnish and install, complete, sealant and backing for all structure and building joints.
- B. This is a general specification and not all sealants or listed sealant locations may be included in this project.

1.02 GENERAL REQUIREMENTS

- A. See CONDITIONS OF THE CONTRACT and Division 01 00 00, GENERAL REQUIREMENTS, which contain information and requirements that apply to the work specified herein and are mandatory for this project.
- B. Performance: Provide elastomeric joint sealants that establish and maintain watertight and airtight continuous joint seals without staining or deteriorating joint substrates.

1.03 REFERENCE STANDARDS

- A. ASTM C834 - Standard Specification for Latex Sealants.
- B. ASTM C920- Standard Specification for Elastomeric Joint Sealants.
- C. ASTM C1193 -Standard Guide for Use of Joint Sealants.
- D. Other reference standards specified in this section.

1.04 SUBMITTALS

- A. Submittals shall be made in accordance with Section 01 33 00, SUBMITTALS.
- B. Submit the following:
 - 1. Product Data: Submit manufacturer's literature, specifications, surface preparation and application instructions for joint sealant materials.
 - 2. Samples: For each material proposed, submit sample of color intended, when required to match joint substrate or range of colors for selection.

3. Sealant Schedule: Submit sealant schedule indicating joint size and special conditions as well as manufacturer, type, and color of proposed product for each application.
4. Certificates of Compliance: Statement indicating proposed materials meet reference standards and specification requirements.

1.05 QUALITY ASSURANCE

- A. Installer Qualifications: An experienced installer who has specialized in installing joint sealants similar in material, design, and extent to those indicated for this project and whose work has resulted in joint sealant installations with a record of successful in-service performance.

1.06 ENVIRONMENTAL CONDITIONS

- A. Maintain temperature and humidity recommended by the sealant manufacturer during and after installation. Ambient temperature shall be between 40 and 120 degrees F unless otherwise authorized in writing by the manufacturer.

PART 2 PRODUCTS

2.01 GENERAL

- A. The use of a manufacturer's name and model or catalog number is for establishing the standard of quality and general configuration desired only. Products of other manufacturers will be considered in accordance with the General Conditions.
- B. Sealant material characteristics shall be uniform, homogenous, and free from lumps, skins, and coarse particles when mixed. All sealants shall be nonstaining and nonbleeding. Sealant hardness shall be 15 minimum and 50 maximum as measured by ASTM C661, unless specified otherwise hereinafter.
- C. At Contractor's option, immersible sealant may be substituted for non-immersible sealant of the same material.

2.02 MASTIC JOINT FILLER

- A. Mastic joint filler or asphalt fiber expansion joint material shall be a ½-inch, pre-molded, non-extruded, resilient type mastic joint filler conforming to ASTM D1751.

2.03 SEALANT MATERIALS

- A. Type 1 - Silicone, Nonsag, Not Immersible: Silicone base, single-component, chemical curing; meeting the requirements of ASTM C920, Type S, Grade NS, Class 50, Uses NT, M, A and G; capable of withstanding movement up to 50 percent of joint width. Use DOWSIL 790 manufactured by Dow Corporation; SCS2000 Silpruf manufactured by GE Silicones; or equal.
- B. Type 2 - Multi-Part Polyurethane, Self-Leveling, Immersible: Polyurethane base, multi-component, chemical curing; meeting the requirements of ASTM C920, Type M, Grade P, Class 25, Uses I, T, NT, A, and M; capable of being continuously immersed in water, and withstand movement of up to 25 percent of joint width. Use MasterSeal SL 2 manufactured by BASF/Master Builders Solutions; Iso-Flex 880 GB manufactured by LymTal International Inc.; Vulkem 445SSL manufactured by Tremco Commercial Sealants and Waterproofing; Sikaflex 2cSL manufactured by Sika Corporation; or equal.
- C. Type 3 - Multi-Part Polyurethane, Nonsag, Immersible: Polyurethane base, multi-component, chemical curing; meeting the requirements of ASTM C920, Type M, Grade NS, Class 25, Uses I, T, NT, M, and A; capable of being continuously immersed in water, and withstand movement of up to 25 percent of joint width. Use Iso-Flex 881 manufactured by LymTal International Inc.; Dymeric 240FC manufactured by Tremco Commercial Sealants and Waterproofing; Sikaflex 2cNS manufactured by Sika Corporation; MasterSeal NP 2 manufactured by BASF/Master Builders Solutions; or equal.
- D. Type 4 - Multi-Part Polyurethane, Nonsag, Not Immersible: Polyurethane base, multi-component, chemical curing; meeting the requirements of ASTM C920, Type M, Grade NS, Class 25, Uses NT, T, A, G, and M; withstand movement of up to 25 percent of joint width; color as selected. Use MasterSeal NP 2 manufactured by BASF/Master Builders Solutions; Dynatrol II manufactured by Pecora Corporation; Dymeric 240FC manufactured by Tremco Commercial Sealants and Waterproofing; Isoflex 881 manufactured by LymTal International Inc.; Sikaflex 2cNS manufactured by Sika Corporation; or equal.
- E. Type 5 - One-Part Polyurethane, Immersible: Polyurethane base, single-component, chemical curing; conforming to ASTM C920, Type S, Grade NS or Type P as required by installation, Class 25, Uses I, NT, T, M, and A; capable of being continuously immersed in water, and withstand movement of up to 25 percent of joint width. For nonsag type, use MasterSeal NP 1 manufactured by BASF/Master Builders Solutions; Sikaflex 1a manufactured by Sika Corporation; Vulkem 116 or Dymonic 100

SECTION 07 90 00
CAULKING AND

DIVISION 07 00 00 - THERMAL AND MOISTURE PROTECTION **SEALANTS**

manufactured by Tremco Commercial Sealants and Waterproofing; or equal. For self-leveling type, use Vulkem 45SSL manufactured by Tremco Commercial Sealants and Waterproofing; Sikaflex 1cSL manufactured by Sika Corporation; or equal.

- F. Type 6 - One-Part Polyurethane, Not Immersible: Polyurethane base, single-component, chemical curing; meeting the requirements of ASTM C920, Type S, Grade NS, Class 35, Uses NT, T, M, and A; withstand movement of up to 35 percent of joint width. Use Dynatrol I manufactured by Pecora Corporation; Dymonic 100 manufactured by Tremco Commercial Sealants and waterproofing; MasterSeal NP 1 manufactured by BASF/Master Builders Solutions; Sikaflex 1a by Sika Corporation; or equal.
- G. Type 10 - Sanitary Sealant/Caulk: Silicone sealant similar to Type 1 above, except Class 25, formulated to resist mold growth and repeated exposure to high humidity while retaining adhesion, flexibility, and color. Color as shown on the Drawings or as selected from manufacturer's full range of color choices. Use Dow Corporation DOWSIL 786; GE Silicones SCS1700 Sanitary Sealant; or equal.
- H. Type 11 - Fire-Resistant Penetration Seal: Medium density fire-resistant foam that retains stability at high temperatures. Use 3-6548 Silicone RTV Fire Stop Sealant or Foam manufactured by Dow Corning Corporation; Fire Barrier Sealant 1003SL and Foam FIP 1-Step manufactured by 3M Corporation; Specified Technologies SmokeBlock 200 fire blocking foam and SmokeBlock SB100 fire blocking caulk; or equal.

2.04 BACKUP MATERIAL

- A. Non-gassing, extruded, closed-cell round polyethylene foam rod compatible with sealant used. Comply with ASTM C1330 Type B or C, or ASTM D5249 Type 1 or 3, and as recommended by sealant manufacturer. Size as shown or as recommended by sealant material manufacturer. Provide for all joints greater than 3/16-inch wide. Use MasterSeal 920/921 manufactured by BASF/Master Builders Solutions; Sika Backer Rod manufactured by Sika Corporation; CERA-ROD or KOOL-ROD manufactured by W. R. Meadows; or equal.

2.05 BOND BREAKER

- A. Pressure sensitive tape recommended by sealant manufacturer to suit application.

2.06 JOINT CLEANER

- A. Noncorrosive and non-staining type, recommended by sealant manufacturer; compatible with joint forming materials.

2.07 PRIMER

- A. Non-staining type recommended by sealant manufacturer to suit application.

2.08 SEALANT COLOR

- A. Unless specifically noted, sealant color shall generally match or complement the color of the principal material adjoining the area of application, or as selected by Owner or Engineer.

2.09 TAPE SEALANT

- A. Closed cell polyvinyl chloride (PVC), polyurethane, or neoprene/EPDM-SBR foam, in black color, coated on both sides with a modified acrylic pressure-sensitive adhesive, in 3/4-inch width by length as required by sufficient thickness, as recommended by manufacturer, for particular application, meeting the following requirements:
 - 1. Tensile Strength (ASTM D412): 70 psi min.
 - 2. Elongation (ASTM D412): 125 percent min.
 - 3. Compression Set (ASTM D1056): 35 percent max.
 - 4. Compression Deflection (ASTM D1667) at 25 percent Deflection: 2.5 psi.
 - 5. Low Temperature Flexibility, 5 hours at -40 degrees F: No cracking.
 - 6. Staining (ASTM D925) on Most Substrates: None.
 - 7. Water Absorption by Weight at 35 percent Compression: 3 percent max.
 - 8. Density per Cubic Foot (ASTM D1667): 11 pounds min.

PART 3 EXECUTION

3.01 DELIVERY, STORAGE, AND HANDLING

- A. Deliver sealants to the jobsite in sealed containers, each bearing manufacturer's name and product designation, including type, class, grade and use.
- B. Store and protect sealant products from damage, deterioration, and contamination in accordance with manufacturer's written recommendations.

3.02 GENERAL INSTALLATION REQUIREMENTS

- A. Use of more than one material for the same joint is not allowed unless approved by the sealant manufacturer.
- B. Install joint sealants in accordance with ASTM C1193.
- C. Sealants shall be self-leveling (S/L, or Grade P) for horizontal and sloping joints with a maximum slope of 1 percent. Nonsag sealants (N/S, or Grade NS) shall be used for steeper sloped joints, vertical joints, and overhead joints.
- D. The one-part polyurethane (Types 5 and 6), silicone (Type 1), and acrylic (Type 9) sealants can be used in joints to maximum 1-inch width. Multi-part polyurethane (Types 2, 3, and 4) can be used in joints to 2-inch maximum width. For joints wider than 2-inch, consult manufacturer for proper product application. Follow sealant manufacturer's recommendations.
- E. Sealants used in water holding structures must be approved for use in domestic wastewater applications.

3.03 PREPARATION

- A. Verify that joint dimensions, and physical and environmental conditions, are acceptable to receive sealant.
- B. All surfaces to be sealed shall be clean, dry, sound, and free of dust, loose mortar, oil, and other foreign materials. Clean and prime joints as required by manufacturer.
 - 1. Mask adjacent surfaces where necessary to maintain neat edge.
 - 2. Starting of work will be construed as acceptance of all subsurfaces.
 - 3. Apply primer to dry surfaces as recommended by sealant manufacturer.

- C. Verify that joint backing/shaping materials and release tapes are compatible with sealant.
- D. Examine joint dimensions and size materials to achieve required width/depth ratios, neck dimensions, and surface bond area as recommended by the manufacturer, except where specific dimensions are indicated on the Drawings.

3.04 CAULKING AND SEALANT INSTALLATION

- A. Use joint filler to achieve required joint depths, to allow sealants to perform properly.
 - 1. Install backup material as recommended by sealant manufacturer.
 - 2. Where possible, provide full length sections without splices; minimize number of splices.
- B. Use bond breaker where recommended by sealant manufacturer.
- C. Apply sealant free of air pockets, foreign embedded matter, ridges, and sags.
- D. Seal all joints around window, door, and louver frames; control and/or expansion joints; and elsewhere as indicated.
- E. Apply all materials following manufacturer's recommendation and instructions, filling joint completely from back to top, without voids.
- F. Apply sealant within recommended temperature ranges. Consult manufacturer when sealant cannot be applied within recommended temperature ranges.
- G. Locate tape sealant where indicated on Drawings and install in strict accordance with manufacturer's instructions.
- H. Drive caulking compound into the grooves with a caulking gun with sufficient pressure to force out air and to fill grooves solidly using a nozzle of proper size to fit width of grooves. Exposed surface of compound shall be tooled free of wrinkles and uniformly smooth. Leave all adjoining surfaces free of caulking material.
- I. Joints: Tool slightly concave after sealant is installed. When tooling white or other light color sealant, use a water wet tool. Finish joints free of air pockets, foreign embedded matter, ridges, and sags.

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3.05 MASTIC JOINT FILLER

- A. Preformed joint filler shall be installed in accordance with manufacturer's specifications.

3.06 CLEANING

- A. Clean surfaces next to the sealed joints of smears or other soiling resultant of sealing application.
- B. Replace any damaged surfaces resulting from joint sealing or cleaning activities.

3.07 JOINT SEALANT APPLICATION SCHEDULE

- A. This schedule lists the sealant types acceptable for each joint location. Use as few different sealant types as possible to meet the requirements of this project.

<u>Joint Location Description</u>	<u>Sealant Type(s)</u>
1. Not Immersed Expansion/Contraction and Control Joints at:	
Concrete Walls	3, 4, 5, 6
Concrete Floor Slabs	2, 5
Masonry Walls	3, 4, 5, 6
2. Not Immersed Material Joints at:	
Metal Door, Window, and Louver Frames (Exterior)	1, 5, 6
Metal Door, Window, and Louver Frames (Interior)	1, 5, 6
Wall Penetrations (Exterior)	1, 5, 6
Wall Penetrations (Interior)	1, 5, 6
Floor Penetrations	5, 6
Ceiling/Roof Penetrations	1, 3, 4, 5, 6

<u>DIVISION 07 00 00 - THERMAL AND MOISTURE PROTECTION</u>	SECTION 07 90 00 CAULKING AND SEALANTS

	Sheet Metal Flashings	1, 3, 5
3.	Other Joints:	
	Threshold Sealant Bed	5
	Immersed Concrete (Vertical and Sloped)	3, 5
	Immersed Concrete (Horizontal)	2, 5
	Openings Around Pipes, Conduits, and Ducts Through Fire Rated Construction	11
	Concrete Form Snap-Tie Holes	4, 6
	Between Counter Tops and Backsplashes	10
	Around Plumbing Fixtures	10

END OF SECTION 07 90 00

PART 1 GENERAL**1.01 WORK INCLUDED**

- A. General: This section covers surface preparation, furnishing, and application of industrial and architectural paint and special protective coatings, complete.
- B. The intention of these Specifications is for new interior and exterior masonry, concrete, metal, and submerged metal surfaces to be painted, whether specifically mentioned or not, except as specified otherwise. Prime and coat structural steel surfaces as specified. Provide a holiday-free monolithic coating membrane layer. Exterior and interior concrete surfaces will be painted as specified.
- C. Prepare manufactured items and materials that are “factory” galvanized and/or coated as specified hereinafter for the exposure condition of the item and for architectural purposes, unless otherwise specified.

1.02 REFERENCE STANDARDS

- A. General: The latest revision of the following standards shall apply, at a minimum, to the coating materials, testing, and installation except where more stringent standards are applicable. In case of conflict, the most stringent requirements shall apply.
- B. American National Standards Institute (ANSI):
 - 1. MIL-STD-101C, Color Code for Pipelines and Compressed Gas Cylinders.
 - 2. A13.1, Scheme for the Identification of Piping Systems.
 - 3. Z535, Safety Color Code - Complete Set.
- C. American Society for Testing and Materials (ASTM):
 - 1. ASTM D16, Standard Terminology for Paint, Related Coatings, Materials, and Applications.
 - 2. ASTM D1000, Standard Test Methods for Pressure-Sensitive Adhesive Coated Tapes Used for Electrical and Electronic Applications.
 - 3. ASTM D1002, Standard Test Method for Apparent Shear Strength of Single-Lap-Joint Adhesively Bonded Metal Specimens by Tension Loading (Metal-to-Metal).

4. ASTM D1186, Standard Test Methods for Nondestructive Measurement of Dry Film Thickness of Nonmagnetic Coatings Applied to a Ferrous Base.
5. ASTM D1212, Standard Test Methods for Measurement of Wet Film Thickness of Organic Coatings.
6. ASTM D2200, Standard Practice for use of Pictorial Surface Preparation Standards and Guides for Painting Steel Surfaces (SSPC-VIS 1).
7. ASTM D2240, Standard Test Method for Rubber Property Durometer Hardness.
8. ASTM D3276, Standard Guide for Painting Inspectors (Metal Substrates).
9. ASTM D3359, Standard Test Methods for Measuring Adhesion by Tape Test.
10. ASTM D3363, Standard Test Method for Film Hardness by Pencil Test.
11. ASTM D4060, Standard Test Method for Abrasion Resistance of Organic Coatings by the Taber Abraser.
12. ASTM D4138, Standard Practices for Measurement of Dry Film Thickness of Protective Coating Systems by Destructive, Cross Sectioning Means.
13. ASTM D4258, Standard Practice for Surface Cleaning Concrete for Coating.
14. ASTM D4259, Standard Practice for Abrading Concrete.
15. ASTM D4261, Standard Practice for Surface Cleaning Concrete Masonry Units for Coating.
16. ASTM D4262, Standard Test Method for pH of Chemically Cleaned or Etched Concrete Surfaces.
17. ASTM D4263, Standard Test Method for Indicating Moisture in Concrete by the Plastic Sheet Method.
18. ASTM D4414, Standard Practice for Measurement of Wet Film Thickness by Notch Gages.

19. ASTM D4417, Standard Test Methods for Measurement of Surface Profile of Blast Cleaned Steel.
 20. ASTM D4541, Standard Test Method for Pull-Off Strength of Coatings Using Portable Adhesion Testers.
 21. ASTM D4787, Standard Practice for Continuity Verification of Liquid or Sheet Linings Applied to Concrete Substrates.
 22. ASTM D5064, Standard Practice for Conducting a Patch Test to Assess Coating Compatibility.
 23. ASTM D5162, Standard Practice for Discontinuity (Holiday) Testing of Nonconductive Protective Coating on Metallic Substrates.
- D. National Association of Corrosion Engineers-International (NACE):
1. NACE Standard SPO178, Design, Fabrication, and Surface Finish Practices for Tanks and Vessels to be Lined for Immersion Service.
 2. NACE Standard SPO188, Discontinuity (Holiday) Testing of New Protective Coatings on Conductive Substrates.
 3. NACE Standard SPO287, Field Measurement of Surface Profile of Abrasive Blast Cleaned Steel Surfaces Using a Replica Tape.
 4. NACE Standard SPO288, Recommended Practices for Inspection of Linings on Steel and Concrete.
- E. The Society for Protective Coatings (SSPC):
1. SSPC Surface Preparation Standards.
 2. SSPC-Vis 1, Guide and Reference Photographs for Steel Surfaces Prepared by Dry Abrasive Blast Cleaning.
 3. SSPC-SP COM, Surface Preparation Specifications Commentary.
 4. SSPC-PA 1, Shop, Field, and Maintenance Painting of Steel.
 5. SSPC-PA 2, Procedure for Determining Conformance to Dry Coating Thickness Requirements.
 6. SSPC-PA Guide 10, Guide to Safety and Health Requirements for Industrial Painting Projects.
 7. SSPC Guide 6, Guide for Containing Surface Preparation Debris Generated During Paint Removal Operations.

8. SSPC Guide 20, Guide for Applying Thick Film Coatings and Surfacing Over Concrete Floors.
9. SSPC TU 6, Chemical Stripping of Organic Coatings from Steel Structures.

1.03 DEFINITIONS

- A. Definitions of Painting Terms per ASTM D16, unless otherwise specified.

1.04 SUBMITTALS

- A. Provide catalog cuts and other information for all products proposed for use that show compliance of those materials with these Specifications. Contractor submittals shall be made in accordance with the General Conditions and Section 01 33 00, SUBMITTALS. Provide a complete submittal package for each coating system to be utilized to include, but not necessarily be limited to, the following:
 1. Data Sheets: Submit manufacturer's recommended coating system suitable for intended use per the Application Schedule included herein. For each coating system furnish the manufacturer's Technical Data Sheets, surface and application instructions, and colors available (where applicable) for each product used in the coating system.
- B. Factory Applied Coatings: Manufacturer's certification stating factory applied coating systems are recommended for intended exposure and meets or exceeds requirements specified herein.
- C. Coating Product Manufacturer's Certificate of Compliance. At completion of project, provide product manufacturer's letter certificate stating factory or field applied coating systems provided are recommended for intended exposure and meets or exceeds requirements specified herein and that they were installed in accordance with coating manufacturer recommendations and contract documents requirements by Applicator.
- D. Alternate Materials or Product Manufacturers Submittals: Alternate materials or product manufacturers shall be of same generic type of coating specified and provide equal to or greater quality, performance, chemical resistance, life, film thickness, solids by volume, and number of coats to be considered. Provide coating manufacturer letter stating that alternate material is equal to or better than specified product with supporting documentation of direct comparisons to verify equal to or better quality, chemical resistance, performance and life. Alternate coating systems to be considered must meet the same number of coats and minimum specified total dry film thickness.

- E. Submit quality control and testing procedures for field application of coatings.

1.05 QUALITY ASSURANCE

- A. Applicator shall have a minimum five years experience with specified or similar products and similar surface preparation requirements.
- B. Quality Control:
 - 1. If, in the coating manufacturer or Engineer's evaluation, surface preparation, application, or coating quality control testing are not as specified or there is excessive poor workmanship, number of defects, or damage, upon notification by Engineer, Contractor and Applicator shall immediately stop production. Stoppage of production and recoating shall be at the sole cost to the Contractor and Applicator.
 - 2. Failure to follow product manufacturer's written recommendations and these specifications shall be cause for stoppage of surface preparation and coating operations and rejection of all coated surfaces completed outside these parameters, at the sole cost to Contractor and Applicator.
 - 3. Surface preparation or coating application shall cease until quality control issues are resolved to the satisfaction of both the coating manufacturer and the Engineer. Surface preparation and repair procedures shall be mutually agreed upon between product manufacturer and Engineer before incorporation into work by the Contractor.
- C. Field Test Instruments: Provide field test equipment and instruments as specified hereinafter in Part 2 Products.
- D. Applicator Quality Control Plan:
 - 1. Provide a Quality Control Program that monitors surface preparation and coating application procedures in accordance with the product manufacturer's written instructions, NACE SPO288, ASTM D3276, these specifications, and other referenced Standards.
 - 2. Complete Applicator quality control inspections on all factory, field, and repair coatings. The Contractor is solely responsible for all inspection and quality control testing and record keeping for the project.
 - 3. Immediately report any problems or non-compliance of these specifications or coating manufacturer's instructions to the Engineer.

1.06 REGULATORY COMPLIANCE

- A. Perform surface preparation and coating in accordance with these specifications, and recommendations of the coating manufacturer's instructions and referenced standards.
- B. Contractor shall be solely and completely responsible for condition of the project site, including safety of all persons (including employees) and property during performance of the work. The Engineer and/or Owner will NOT monitor safety practices and will not assume responsibility for safety.
- C. Contractor shall monitor and be responsible for all health and regulatory compliance at the work site. The Engineer and/or Owner will NOT monitor health and compliance practices and will not assume responsibility for health and regulatory compliance issues.
- D. Meet federal, state, and local requirements for limiting the emission of volatile organic compounds (VOCs) and worker exposure. Paints and coatings shall contain no lead, zinc or strontium chromate, asbestos, or mercury materials or compounds.

1.07 ENVIRONMENTAL (WEATHER) REQUIREMENTS

- A. Do not prepare surfaces or apply coating in temperatures outside of manufacturer's recommended maximum or minimum allowable, or in dust, smoke-laden atmosphere, damp or humid weather, or under conditions that could cause ice build-up on the metal surface.
- B. Perform abrasive blast cleaning, apply and cure coating only when relative humidity is below 85 percent and when structure surface temperature is more than 5 degrees F above dew point and rising unless approved by coating manufacturer. If heating is required, use only indirect fired heaters that do not increase humidity levels in the work area.
- C. Coat surfaces the same day (within 8 hours maximum or sooner) of when abrasive blasted, before they start to rust. Re-blast surfaces that have started to rust or have been contaminated before coating.
- D. Do not spray apply coatings if the wind velocity is above coating manufacturer's limit or if spray application will cause over-spray damage to other structures.
- E. Dust and Contaminants: Schedule work and provide protection to avoid excessive dust and airborne contaminants.
- F. Ventilation: Provide ventilation as required to ensure that dust, contaminants, and vapor concentrations remain low and are safe.

1.08 OBSERVATION OF WORK

- A. All surface preparation work and individual coats are subject to observation by Engineer, Owner, and coating manufacturer's representatives. Provide access to the project site for Owner, Engineer, and coating manufacturer at all times during surface preparation, coating application, and to observe work.
- B. Provide Engineer a minimum twenty working days advance notice to start of shop or field surface preparation work and coating application work.
- C. Observation or testing by the Engineer, coating manufacturer, and/or Owner representative(s) or the waiver of observation or testing of any particular portion of the work shall not be construed to relieve the Contractor of his responsibility to correctly perform the work and testing required in accordance with these specifications and the coating manufacturer's recommendations.
- D. The Owner reserves the right to reject all work that does not meet the minimum requirements of this specification. This may be done either during or after completion of the surface preparation or coating work, during subsequent observations, warranty inspections, or at any time when discovered during the warranty period.
- E. The Contractor shall repair any defective or rejected work in accordance with written recommendations of the particular coating or lining manufacturer as reviewed and approved by the Engineer. The Contractor shall remedy any defective or rejected work in a timely manner to the satisfaction of the Owner and Engineer at Contractor's sole cost.

1.09 PROJECT WARRANTY

- A. The Contractor, coating applicator, and coating manufacturer shall jointly and severally warrant to the Owner and guarantee the work under this section against defective workmanship and materials for a period of one year commencing on the date of final acceptance of the work.
- B. Repairs: Any defects in the coating system discovered during inspection or during the warranty inspection(s) shall be repaired and retested in a timely manner (repairs shall be started within 30 days and finished with complete cure within 60 days) by the Contractor and/or Applicator. Complete all repairs in accordance with the written coating manufacturer's instructions as reviewed and approved by the Engineer. The repairs shall be completed to the satisfaction of the Engineer and Owner. All surface preparation and coating repair or any damage to other work caused by such defect or repairing of the defects including but not limited to any additional costs to the Owner, additional expenses or design/construction services by the

Engineer, including additional testing and evaluation, full-time observation during repairs, and re-warranty inspections shall be at the sole cost to Contractor and/or Applicator.

PART 2 PRODUCTS**2.01 GENERAL**

- A. Provide new materials intended for this type of service in accordance with this specification and the referenced standards. Whenever the requirements of these specifications or Drawings exceed those of the codes or manufacturer's instructions, the requirements of these specifications or Drawings shall prevail. Where a higher quality or better grade of material or a higher standard of workmanship is required, the most stringent requirement shall apply.
- B. Products shall comply with federal, state, and local requirements limiting the emission of volatile organic compounds as well as any other applicable federal, state, or local regulations.

2.02 PRODUCT MANUFACTURERS

- A. Each coating system provided herein shall be the end product of one manufacturer in order to achieve standardization for appearance, maintenance, and compatibility.
- B. Field applied coating systems specified for each general type of coating (Supplier Code) shall be the end product of one manufacturer for all of the coating systems in that Supplier Code classification in order to achieve standardization for appearance, maintenance, and compatibility.
- C. Suppliers listed below can usually supply the types of materials specified in this section. Alternate suppliers will be considered, subject to approval of the Engineer. Contact the suppliers for information regarding the location of their representative nearest the project site.
- D. Industrial Coating Manufacturers Supplier Code A (able to supply most heavy-duty industrial coatings and architectural paints):
 - 1. AkzoNobel/Devroe High Performance Coatings.
 - 2. AkzoNobel/International Ceilcote Coatings.
 - 3. Carboline Global.
 - 4. Sherwin-Williams Company.
 - 5. Pacific Southwest Coatings/PPG Protective and Marine Coatings.

6. Tnemec Coatings.
- E. Fusion Bonded Coating Suppliers Code E:
1. Axalta Coating Systems Nap-Gard.
 2. 3M Scotchkote.
 3. Valspar (subsidiary of Sherwin-Williams Company).
 4. Western Coatings, Inc./Farwest Steel Corporation.
- F. Architectural Paint Manufacturers: Subject to compliance with requirements, provide products of one of the following:
1. Benjamin Moore Company.
 2. Behr Process Corporation.
 3. Pratt & Lambert Paints.
 4. Sherwin-Williams Company/Valspar.
 5. PPG Industries.

2.03 MATERIALS

- A. General:
1. Material Quality: Manufacturer's highest quality products for specific application and suitable for intended service.
 2. Materials Including Primer and Finish Coats: Produced by same manufacturer.
 3. Thinners, Cleaners, Driers, and Other Additives: As recommended by manufacturer of the particular coating.
- B. The use of a manufacturer's name and model or catalog number is solely for establishing the standard of quality and general configuration desired. Products of other manufacturers of equal or better standard and quality will be considered in accordance with the General Conditions.
- C. Products are listed below according to their approximate order of appearance in the systems. The letter designating the manufacturer code refers to the corresponding manufacturers names listed under PRODUCT MANUFACTURERS hereinbefore. Not all listed products may be included in the project.

Coating Product Generic Description and Manufacturer Supplier Code		
Product	Definition	Manufacturer Supplier Code
Tar Stop	Coating designed to prevent bleeding of black asphaltic varnish through finish paint; Shellac is a suitable alternate; not applicable for white and pastel colors	A
Surface Tolerant Epoxy	Surface tolerant, polyamide or polyamidoamine anticorrosive, converted epoxy primer containing rust-inhibitive pigments suitable for the intended service	A
Vinyl Ester	Premium, quality, high solids, (92%), thermosetting coating with exceptional corrosion resistance. Suitable for this intended service	A
Epoxy Primer	Polyamide, anticorrosive, converted epoxy primer containing rust-inhibitive pigments	A
Epoxy Modified Cementitious Mortar	Aggregate reinforced epoxy, for patching and filling voids and bugholes in concrete	A
Coal-Tar Epoxy	Amine or phenolic epoxy type; 70 percent volume solids minimum, suitable for immersion service	A
Organic Zinc Rich Primer	Converted epoxy, epoxy/phenolic or urethane type, minimum 10 pounds metallic zinc content per gallon	A
Rust-Inhibitive Primer	Single-package steel primers with anticorrosive pigment loading	A
Modified Aromatic Polyurethane Primer	Moisture cured self-priming, anticorrosive primer with micaceous iron oxide and zinc, suitable for immersion and atmospheric service.	A
Alkyd Enamel	Optimum quality, gloss finish, medium long oil	A
Wash Primer	Vinyl butyral acid	A
Epoxy Nonskid Finish	Polyamide or amine converted epoxies aggregated; aggregate may be packaged separately	A
Inorganic Zinc Primer	Solvent or water based, 14 pounds metallic zinc content per gallon minimum; follow manufacturer's recommendation for top-coating	A
Silicone/Silicone Acrylic	Elevated temperature silicone or silicone/acrylic based	A

Coating Product Generic Description and Manufacturer Supplier Code		
Product	Definition	Manufacturer Supplier Code
Cementitious Acrylic Emulsion	Two-component (liquid and aggregate) filler	A
Polyamide High Build Epoxy	Capability of 4 to 8 MDFT per coat. Must be compatible with wastewater basin coating requirements.	A
High Build Epoxy, High Solids	High build, high solids epoxy with percent of volume solids 75 to 80 percent minimum, suitable for immersion service Capability of 4 to 8 MDFT per coat	A
Polyamide Epoxy, High Solids	Percent of volume solids 80 percent minimum, suitable for immersion service	A
Polyurethane Enamel	Two-component, aliphatic or acrylic based polyurethane; high gloss finish suitable for the intended service	A
Hydrophobic Aromatic Polyurethane	Moisture-cured, hydrocarbon-modified coating	A
Acrylic/Latex Finish	High-gloss, single-component suitable for the intended service	A
Canvas Sealer	Single-package latex or alkyd primer for canvas surfaces; follow manufacturer's recommendations for surface preparation	A
Bituminous Paint	Single-component, coal-tar pitch based	A
Block Filler	Primer-sealer designed for rough masonry surfaces, 100 percent acrylic emulsion	A
Epoxy Leveler	Leveler or sealer designed for rough concrete or masonry surfaces, epoxy based.	A
Alkyd (Semigloss)	Semigloss alkyd	A
Acrylic Latex (Flat)	Flat latex	A
Water Base Epoxy	A two-component, polyamide epoxy emulsion	A
Sanding Sealer	Co-polymer oil, clear, dull luster	A
Stain, Concrete	Acrylic, water repellent, penetrating stain	A
Acrylic Sealer	Clear acrylic	A
Varnish	Nonpigmented vehicle based on a variety of resins (alkyd, phenolic, urethane) available in gloss, semigloss, and flat finishes	A

Coating Product Generic Description and Manufacturer Supplier Code		
Product	Definition	Manufacturer Supplier Code
DTM Acrylic	Acrylic coating suitable for direct to metal applications and over coating of existing coatings suitable for the intended service.	A
Fusion Bonded Coating	100 percent solids, thermosetting, fusion bonded, dry powder epoxy or polyurethane resin, suitable for the intended service	E
Fusion Bonded, PTFE Lube or Grease Lube	Polytetrafluoroethylene grease as manufactured by CONDAT; or PTFE grease as supplied by McMaster-Carr Company; or RL 736 as manufactured by Amrep, Inc.	
Modified Polyamine Epoxy	100 percent solids minimum, for severe wastewater environments including H2S gas	A
Novolac Epoxy	Two-component Novolac Epoxy, 100% solids, with excellent chemical resistance, self-leveling, moisture tolerant, suitable for vertical and horizontal surfaces, and intended for chemical resistance and containment structures.	A

2.04 EXTRA COATING MATERIAL FOR OWNER

- A. Spare Coating Materials: Provide at time of field coating final testing and acceptance, one unopened gallon can of each type and each color of field coating utilized. If plural component type coating, provide repair coating. Material shall be new and at beginning of shelf life.

2.05 COLORS:

A. General:

- Colors to be used are to be selected by the Owner from color samples to be supplied by the coating manufacturer, unless indicated otherwise.
- Any proprietary identification of colors is for identification only. Selected authorized manufacturer may supply matches.

B. Pipe Identification Painting:

- Color code exposed, non-submerged metal and plastic piping except electrical conduit. Paint fittings and valves the same color as pipe.

2. Piping Color Coding: In accordance with Pipe System and Color Code Schedule as shown in table hereinafter. Coat piping in solid colors and provide bands as specified hereinafter.
 3. Pipe Supports: Mild steel, painted light gray, Tnemec Company No. 32GR; Sherwin-Williams SW 6255; or equal. Stainless steel supports need not be painted.
- C. Equipment Colors:
1. Equipment includes the machinery or vessel itself plus the structural supports and fasteners and attached electrical conduits.
 2. Paint exposed, non-submerged portions of equipment the same color as the piping it serves per the piping color code, except as itemized below:
 - a. Dangerous Parts of Equipment and Machinery: OSHA Orange.
 - b. Fire Protection Equipment and Apparatus: OSHA Red.
 - c. Physical hazards in normal operating area and energy lockout devices, including, but not limited to, electrical disconnects for equipment and equipment isolation valves in air and liquid lines under pressure: OSHA Yellow.
- D. Pipe Identification Labels:
1. Identification labels shall bear full Pipe Description/Flow Stream Identifier name as shown on the Pipe System and Color Code Schedule included below. Install separate flow directional arrows with each label.
 2. Labels shall be self-adhesive vinyl, long lasting, resistant to moisture, oils, solvents, and weathering, meeting OSHA requirements. The label lettering colors and lettering heights shall be in accordance with the latest version of ANSI or ASME A13.1.
 3. Locate labels at connections to equipment, valves, branch fittings, at wall boundaries, and at intervals along piping not greater than 18 feet on center, with at least one label applied to each exposed run of pipe.
 4. Manufactured by Brady Worldwide, Inc.; Seton Signs, Labels, and Safety Solutions; or equal.
- E. Pipe Identification Tags for Smaller Piping: For piping 3/4-inch diameter or smaller, identify with appropriate aluminum, brass, or stainless steel

identification tags. Tags shall be minimum 2-inch diameter or 2-inch square shape with lettering etched and filled with enamel, as manufactured by Brady Worldwide, Inc.; Seton Signs, Labels, and Safety Solutions; or equal.

F. Pipe System and Color Code Schedule:

1. The color code scheme proposed below is approximate and must be verified with the Engineer prior to any painting.
2. If a pipe designation is not shown, Contractor shall assume that painting for color coding will be required and direction from the Engineer regarding pipe color and banding should be sought.

Pipe Designation	Pipe Description	Pipe Color	Bands
RAS	RETURN ACTIVATED SLUDGE	Brown	
WAS	WASTE ACTIVATED SLUDGE	Brown	
UW	NONPOTABLE PLANT WATER	Exterior: Desert tan (match other exterior piping)	
UW	NONPOTABLE PLANT WATER	Interior: dark blue	
SE	SECONDARY EFFLUENT	Grey	

2.06 COATING INSPECTION TEST EQUIPMENT

- A. Applicator or Contractor shall provide the following minimum equipment for Contractor's quality control testing as required depending on the coating type, the product manufacturers' recommended quality control procedures, and/or specific requirements of these specifications.
1. Provide the following environmental monitoring equipment items to measure ambient temperature:
 - a. Surface Temperature: Provide a minimum of two surface thermometers, magnet mounted dial type to measure surface temperature, PTC Instruments Surface Thermometer Model 315 F (0 to 150 degrees F); Dwyer Instruments Surface Mount Thermometer ST 250 (0 to 250 degrees F); or equal.
 - b. Provide ambient maximum and minimum temperature thermometer.
 2. Surface Cleanliness Testing: Clear tape.

3. Provide Wet Film Thickness Gauge (1 to 80 mils).
4. Provide a magnetic type dry film thickness gauge to test coating thickness specified in mils. CG204 as manufactured by Extech; Positest DFT as manufactured by DeFelsko Corporation; QNix as manufactured by Automation Dr. Nix; or equal.

PART 3 EXECUTION**3.01 GENERAL WORKMANSHIP**

- A. All materials and equipment associated with surface preparation and coating application as shown and specified herein shall be furnished and installed by, or under the direction of, the Contractor. All work shall be supervised by qualified persons who have read and understood the minimum requirements of these specifications. Any changes in design or method of installation of an item as specified shall be reviewed and approved by the Engineer prior to installation.
- B. All work shall be in accordance with these specifications and the printed directions and recommendations of the paint manufacturer whose product is to be applied. Where a higher standard of workmanship is required, the most stringent requirement shall apply.
- C. Nothing included or omitted in this specification shall relieve the Contractor of the obligation of providing a complete and satisfactory coating system.
- D. Any portion of the work that does not meet the minimum requirements of these specifications shall be corrected by the Contractor at no additional cost to the Owner.

3.02 PAINT DELIVERY, STORAGE, AND HANDLING

- A. Deliver new coating materials to project site in original unopened containers and cartons. Store products in a covered and protected area that is heated or cooled to maintain temperatures within the range recommended by paint manufacturer. Store materials in original packaging until time of use.
- B. Comply during storage, mixing, and application with all pertinent codes, fire regulations, and coating manufacturer's requirements.

3.03 FACTORY AND SHOP COATED ITEMS AND FABRICATED EQUIPMENT

- A. Unless otherwise indicated, all fabricated components and equipment shall be shop primed. At Contractor's option, equipment may be shop or field mid- or top-coated. Surface preparation and factory or shop coating application shall be in accordance with the requirements of this specification. Degree of surface preparation and coating type shall be per

the Application Schedule included herein or as specified in the specific equipment or item's specification sections. In case of conflict, the most aggressive surface preparation and the coating system with the highest protection level provided shall be required.

- B. Confirm that the equipment manufacturer's standard or recommended coating will provide equal to or better quality, chemical performance, and durability than the specific coating system specified herein. If equipment manufacturer's standard or recommended coating will not, then provide surface preparation and shop or factory coating equal to or better than that specified for that specific area per the Application Schedule. Shop-applied primer or coats shall be the same type as the specified coating system and shall be applied at the minimum dry film thickness recommended by the coating manufacturer.
- C. Factory or shop applied primer and coating shall be compatible with field applied coatings submitted and being used for this project. Equipment manufacturer or shop or factory coating applicator shall provide product data sheets identifying the shop or factory primer and top coats to the on-site coating applicator, and provide information to Contractor to substantiate that coatings are compatible and to identify recoat windows.
- D. Shipping: Where pre-coated items are to be shipped to the site, protect coating from damage. Coated items may be rejected for excessive damage as determined by the Engineer. All rejected items shall be immediately removed from the project site and replaced at sole cost to the Contractor.
- E. Shop Coating Field Repairs: Damaged, deteriorated or poorly applied shop primed and coated items that do not meet the requirements specified herein shall be removed and the surfaces recoated. If the shop applied prime and finish coats meet the requirements specified herein, the field coating required shall consist of touch-up coating and then applying any finish coats necessary to achieve the specified film thickness and continuity.

3.04 SURFACES NOT REQUIRING PAINTING

- A. Unless otherwise stated or shown, the following areas or items will not require painting or coating:
 - 1. New building interior concrete floors and exterior slabs and equipment pads.
 - 2. Reinforcing steel.
 - 3. Nonferrous and corrosion resistant ferrous alloys such as copper, bronze, monel, aluminum, chromium plate, atmospherically exposed weathering steel, and stainless steel, except where:

- a. Required for electrical insulation between dissimilar metals.
 - b. Aluminum and stainless steel are embedded in or in contact with concrete or masonry.
 - c. Color coding of equipment and piping is required.
4. Portions of ferrous material embedded in concrete. This does not apply to back faces of bare items or equipment mounted to concrete or masonry surfaces, which shall be galvanized or coated prior to erection.
 5. Nonmetallic materials such as glass, PVC, wood, porcelain, and plastic except as required for architectural painting, color coding, or UV protection. Plastic piping must be color code painted unless specifically stated otherwise.
 6. Fiberglass reinforced plastic (FRP) with an integral ultra-violet resistant colored gel coat except as required for painting or color coding interior or exterior of building.
 7. Prefinished hardware and hardware accessories, electrical fixtures, and plumbing fixtures.
 8. Exposed, non-submerged electrical conduits attached to unpainted concrete or masonry surfaces. Where the conduit is attached to painted surface, it shall be painted the same color as that surface.
 9. Items specified to be galvanized after fabrication, unless specified otherwise elsewhere, or subject to immersion. Galvanized surfaces shall not be immersed without top coating(s). Submerged galvanized surfaces shall be coated with the same coating system as required for other ferrous materials in that area.

3.05 PROTECTION OF ITEMS NOT TO BE PAINTED

- A. Unless otherwise stated or shown, protect the areas or items that will not require surface preparation or coating in the following manner:
 1. Remove, mask, or otherwise protect hardware, lighting fixtures, switchplates, aluminum or stainless steel surfaces, machined surfaces, couplings, shafts, bearings, tags or nameplates on machinery, and other surfaces not intended to be painted.
 2. Protect working parts of mechanical and electrical equipment from damage during surface preparation and painting process. Mask openings in motors to prevent abrasives, paint, and other materials from entering the motors.

3. Cap or seal all open piping, valves, and conduits, prior to beginning any surface preparation or coating work to prevent entry of foreign material into the piping, valves, or conduit systems.
4. Protect nearby structures, equipment, vehicles, building, etc. from surface preparation and coating operations. Immediately remove coatings that are applied or fall on structures or items not intended to be coated.

3.06 SURFACE CLEANING AND BLASTING METHODS

- A. General: Provide materials, equipment, procedures, and safety equipment for personnel in accordance with current SSPC specifications. Degree of cleanliness is as follows:
 1. Solvent Cleaning: SP-1.
 2. Hand Tool Cleaning: SP-2.
 3. Power Tool Cleaning: SP-3.
 4. White Metal Blast Cleaning: SP-5.
 5. Commercial Blast Cleaning: SP-6.
 6. Brush-Off Blast Cleaning: SP-7.
 7. Pickling SP-8.
 8. Near-White Blast Cleaning: SP-10.
 9. Power Tool Cleaning to Bare Metal: SP-11.
 10. High Pressure Water Jetting: SP-12.
 11. Surface Preparation of Concrete: SP-13.
- B. The words "solvent cleaning", "hand tool cleaning", "wire brushing", and "blast cleaning", or similar words of equal intent in these Specifications or in paint manufacturer's specifications refer to the applicable SSPC Specifications.

3.07 PREPARATION OF SURFACES

- A. General:
 1. Inspect and provide substrate surfaces prepared in accordance with these specifications and the printed directions and recommendations

of the coating manufacturer according to the type of surface and type of coating to be applied.

2. Equipment, procedures, and degree of cleaning shall meet minimum requirements as specified under the Application Schedule. Minimum degree of surface preparation (SSPC Grade) is as specified herein and takes precedence over the coating manufacturer's recommendations unless the coating manufacturer's recommendations are more stringent.
3. Minimum surface profile shall be according to specified thickness or coating manufacturer recommendations for each coating type, whichever is greater.
4. Ensure surface is completely dry before beginning surface preparation in accordance with coating manufacturer's recommendations.

B. Metal Surfaces:

1. Equipment, procedures, and degree of cleaning shall meet minimum specified requirements per SSPC. Correct all metal surface and fabrication defects revealed by surface preparation.
2. Welds and Surface Defects:
 - a. Prepare and correct defects such that there is no undercutting or reverse ridges on weld bead, no weld spatter on or adjacent to weld or any other area to be painted, or no sharp peaks or ridges along weld bead.
 - b. Remove all weld flux and grind embedded pieces of electrode or wire flush with adjacent surface of weld bead. Grind porous welds down to solid weld material. Round or chamfer sharp edges and grind smooth burrs, jagged edges, and surface defects.
 - c. Complete all welding, burning, cutting, grinding, and other such work prior to field surface preparation and coating. Abrasive blast after all cutting, welding and/or grinding is completed to provide suitable anchor profile.
3. Pre-blast Cleaning Requirements (Decontamination):
 - a. Remove oil, grease, welding fluxes, and other surface contaminants per SSPC SP-1 prior to abrasive blast cleaning.

- b. Cleaning Methods: Steam, open flame, high pressure (3,000 psi or greater) hot water or cold water with appropriate detergent additives followed with clean water rinsing.
 - c. Clean small isolated areas as above or solvent clean with suitable solvents or degreasers and clean cloths.
- 4. Abrasive Blast Cleaning Requirements:
 - a. Complete the surface preparation and lining or coating application in a continuous operation. Complete prime coat or lining during the same day (within 8 hours maximum) of when the surface preparation is completed.
 - b. Complete surface blasting with proper equipment to obtain minimum SSPC SP degree of cleanliness specified herein.
 - c. Provide type and size of abrasive to produce minimum surface depth, sharpness, and angular profile that meets coating manufacturer's recommendations for particular primer or coating to be used.
 - d. Blasted surface shall be visually inspected for surface imperfections. Imperfections, which can be detrimental to application of the coating, shall be re-blasted or removed by filing or grinding and then re-blasted.
- 5. Post-Blast Cleaning and Other Cleaning Requirements:
 - a. Clean surfaces of dust and residual particles from cleaning operations by dry (no oil or water vapor) air blast cleaning.
 - b. Keep surfaces clean and protect from moisture, weather, dust, dirt, sandblast debris, and other contamination. The structure surfaces shall be completely clean, dust free, and dry before application of coating or lining. Paint surfaces the same day they are blasted. Re-blast surfaces that have started to rust before they are painted.
- C. Galvanized Surfaces:
 - 1. Repair hot-dipped galvanized surfaces in accordance with ASTM A780. Remove oil and grease by wiping or scrubbing with suitable solvents per SSPC SP-1. Remove soil, cement splatter, white rust, and other surface contaminants with appropriate hand or power tools in accordance with SSPC SP-2 and SSPC SP-3.

2. Damaged locations, exposed threads, and cut edges (galvanized steel, galvanized piping, electrical conduit, metal pipe sleeves, etc.) shall be solvent cleaned per SSPC SP-1 and primed with an organic zinc rich primer. Thickness of prime coat should be equal or more than original galvanized coating. Use of aerosol bottles of zinc paint is not acceptable.
3. For Immersion Service or Color Coding or Coordination: Clean and prepare galvanized surfaces by light abrasive whip blast (SSPC SP-7, Brush Blast) to abrade surface. Do not remove galvanizing. Wipe down with coating manufacturer's recommended wash primer to prepare galvanized surfaces for top coating. Coat with specified mid and top finish coats for that specific environment and exposure.
4. Obtain coating manufacturer's recommendations for additional surface preparation that may be required based on type of topcoat and exposure.

D. Concrete Surfaces:

1. Prepare concrete surfaces in accordance with coating manufacturer's directions, these specifications, and SSPC SP-13 to achieve a minimum surface smoothness, texture, and profile for the specific level or grade recommended by the coating manufacturer for each concrete coating system.
2. Do not begin until 30 days minimum after concrete has been placed. New or repair concrete and cementitious based materials shall be allowed to cure before coating per coating manufacturer's written recommendations. Do not treat concrete with hardeners or sealers where special coatings are to be applied. Unless otherwise required for proper adhesion, ensure surfaces are dry prior to painting.
3. Provide water barrier coating on backside of concrete walls and floors to be coated to minimize hydrostatic pressure from groundwater or coat interior surfaces of water bearing structures to minimize hydrostatic pressure on interior room concrete walls or floors. All leaks and infiltration shall be eliminated and repaired per coating manufacturer recommendations.
4. Remove grease, oil, dirt, chalk, form release agents, salts or other chemicals, loose materials, or other foreign matter by solvent, detergent, or other suitable cleaning methods per ASTM D4258.
5. Remove and level all mortar splatter and concrete protrusions and round or trim sharp edges by grinding, chipping, wire brushing, or other methods approved by coating manufacturer.

6. Concrete surface shall be smooth with no sharp edges, cavities, bug holes, etc. and profile shall have a texture feel of rough sandpaper to the degree in accordance with the coating manufacturer's recommendations.
 7. Fill and patch bug-holes, pits, air pockets, voids, and prepare cracks with coating manufacturer's recommended filler/surfacer and crack repair materials. Secure coating manufacturer's recommendations for additional preparation and apply leveler material if required for excessive bug holes exposed after abrasive blasting.
 8. Prepare surface and terminate coatings and fill or bevel at angles and edges in accordance with coating manufacturer's recommendations and special details for each type of coating.
- E. Plastic Surfaces: Hand sand plastic surfaces to be coated with a medium grit sandpaper to provide tooth for the coating system. Large areas may be power sanded or brush-off blasted, provided sufficient controls are employed so surface is roughened without removing excess material. Lightly sand between coats.
- F. Masonry Surfaces:
1. Prepare porous concrete masonry unit surfaces in accordance with coating manufacturer's directions and SSPC SP-13. Complete and cure masonry construction for 14 days or more before starting surface preparation work.
 2. Remove oil, grease, dirt, salts or other chemicals, loose materials, or other foreign matter by solvent, detergent washing, or other suitable cleaning methods. Clean masonry surfaces of mortar and grout spillage and other surface deposits using nonmetallic fiber brushes and commercial muriatic acid followed by rinsing with clean water, brush-off blasting, or water blasting.
 3. Do not damage masonry mortar joints or adjacent surfaces. Leave surfaces clean and dry, unless otherwise required for proper adhesion, dry prior to painting.
 4. Masonry Surfaces to be Painted: Uniform texture and free of surface imperfections that would impair the intended finished appearance.
 5. Clear Coated Masonry Surfaces: Free of discolorations and uniform in texture after cleaning.

3.08 COATING APPLICATION**A. General:**

1. Apply coatings in accordance with these specifications, the paint manufacturers' printed recommendations, and project specific details. The more stringent requirements shall apply.
2. Utilize materials, application equipment, tools, pressure settings, and techniques in accordance with coating manufacturer recommendations for each specific type of coating and surface. Ensure that minimum and maximum allowable recoat times are not exceeded and that material is used before it's pot life is exceeded.
3. Apply coating at wet film thickness as recommended by manufacturer so as to provide a uniform coverage as required to meet the specified minimum dry film thickness. Apply uniform monolithic coating, free of defects, holidays, pinholes, skips, or misses, with no runs, sags, and drips.
4. The surface area covered per gallon of coating for various types of surfaces shall not exceed those coverage rates recommended by the coating manufacturer:
 - a. Adjust application method rate for thinned coatings to provide same thickness or coverage as for unthinned materials.
 - b. On rough or pitted metal or concrete and masonry surfaces, application rates will vary according to surface texture; do not exceed the manufacturer's printed coverage rates.
 - c. On porous surfaces, decrease the coverage rate or apply additional coat of paint to achieve the desired protective and decorative coating finish and color.
5. Keep surface clean and free of any moisture, sand, grit, dirt, or other contamination. Reclean if required before coating application.
6. Apply only to surfaces within minimum and maximum range temperature as recommended by the product manufacturer.
7. Thinning of Coatings:
 - a. Thin coating immediately prior to use where necessary to meet weather, temperature, application method, and surface conditions as recommended by the coating manufacturer.

- b. Provide only the type of thinner as recommend by the coating manufacturer for each type of coating. Thin only in amount as allowed by the coating manufacturer.
- B. Special Requirements:
 - 1. Coat surfaces with a one coat/multiple pass spray technique to build the specified millage. Apply and build coating as recommended by the product manufacturer to not cause out-gassing. Coat high profile areas with multiple passes from different directions, backroll if recommended by the coating manufacturer. If necessary, film thickness may be increased as needed per the coating manufacturer's recommendations.
 - 2. Inaccessible Locations or Bolted Connections:
 - a. Coat units or surfaces to be bolted together or joined closely to structures or to one another prior to assembly or installation with prime and mid-coats, which will be accessible for topcoating after assembly.
 - b. Apply total (full) number of specified coats and thicknesses to surfaces which are inaccessible after assembly prior to erection or assembly.
 - c. Touch-up of all surfaces shall be completed after assembly and installation.
 - d. Apply complete top finish coat to all items accessible after assembly and installation.
 - 3. Uncoated Equipment Bases and Supports: Prior to setting or connecting equipment in place, coat underside or backside of all ungalvanized or uncoated equipment bases and supports with a prime and mid-coat of epoxy except for bases to be encased in grout.
- C. Coordination of Work with Other Specification Sections: Some paint systems require specific application details that are included in other sections of the Contract Documents or the coating manufacturer instructions. These specific detail requirements shall be considered as part of this work.
- D. Film Thickness:
 - 1. Coverage is listed as either total minimum dry film thickness in mils (MDFT) or the maximum spreading rate in square feet per gallon (SFPG). Per coat (PC) determinations are listed as MDFTPC or SFPGPC.

2. Conduct testing per SSPC-PA 2 with the exception that the averaging method is not allowed. Dry film thickness mils specified herein is the absolute minimum allowed. Conduct additional dry film measurements in any area if requested by Engineer.
 3. Number of Coats: Minimum specified required irrespective of the coating thickness. Additional coats may be required to obtain the minimum required paint thickness, depending on method of application, differences in manufacturers' products, and atmospheric conditions.
 4. Film Build per Coat or Coating System:
 - a. Do not exceed coating manufacturer's recommendations. Measure with wet film gauge to ensure proper thickness during application.
 - b. Where dry film thickness measurements are below the specified minimum, provide additional coat(s) of paint as necessary to meet the thickness required in accordance with the coating manufacturer directions.
 - c. Give particular attention to edges, angles, flanges, bolts, nuts, rivets, and other similar areas where insufficient film thicknesses are likely to be present to ensure proper millage and coverage in these areas.
- E. Coating System Curing:
1. Obtain full cure of mortar, sealants, seam sealers, and cementitious coating systems before top coating. Consult product manufacturer's written instructions for these requirements.
 2. If required by weather conditions or project schedule, provide and continuously operate heating equipment during both coating and cure period in accordance with the coating manufacturer's instructions. Use only indirect heat source types approved by the coating manufacturer.
 3. Allow sufficient time between coats to allow thorough drying of previous coat before application of finish coats.
 4. For coatings subject to immersion, obtain full cure for completed system before any exposure to liquid or water. Consult coatings manufacturer's written instructions for these requirements. Do not immerse coatings for any purpose until completion of the curing cycle.

F. Galvanized Metal:

1. Concealed galvanized surfaces (behind building panels or walls) do not require coating unless specifically indicated herein, or in other sections of these Contract Documents.
2. Galvanized surfaces shall be top coated where required for color coding as specified.
3. All submerged galvanized surfaces shall be top coated with coatings specified for that immersion condition. Do not immerse galvanized surfaces without top coating.
4. Prepare surface and apply wash primer or coating manufacturer's recommended prime coat. Upon written recommendation of the coating manufacturer, recommended primer will replace the specification required coating system's indicated primer.
5. Apply coating system (intermediate/finish coats) appropriate for the intended exposure according to the Application Schedule.

G. Porous Surfaces, Such as Concrete or Masonry:

1. Filler/Surfacer: Use coating manufacturer's recommended product to fill air holes, bug holes, and other surface defects prior to additional coats.
2. Prime Coat: May be thinned to provide maximum penetration and adhesion.
 - a. Type and Amount of Thinning: Determined by paint manufacturer and dependent on surface density and type of coating.
 - b. Do not exceed coating manufacturer's unthinned square foot coverage rate per gallon.
3. Surfaces Specified to Receive Water Base Coating: Damp, but free of running water, just prior to application of coating.

3.09 CONVENTIONAL AND CATALYZED COATINGS**A. Multiple-Component Coating Mixing:**

1. Provide unopened product containers to designated mixing area. Prepare using the contents of the container for each component as packaged and recommended by the coating manufacturer. Mix in

clean containers of adequate capacity. No partial batches will be permitted.

2. Provide heating or cooling of materials if required to meet minimum or maximum temperature requirements of the manufacturer during mixing and application.
3. No unauthorized thinners or other materials shall be mixed into the paint. Do not thin more than recommended by the coating manufacturer.

B. Conventional and Catalyzed Coating Application:

1. Apply coatings in accordance with these specifications and the paint manufacturer's printed recommendations and specific details for each type of coating. The more stringent requirements shall apply.
2. Apply with equipment, tools, pressure settings, and application techniques in accordance with the coating manufacturer's instructions for each type of surface and coating in accordance with SSPC-PA 1. Apply at a uniform thickness and at the rate specified by the manufacturer to achieve the minimum dry film thickness required for each coat. Apply in a manner to provide a uniform continuous coating film free of defects or holidays.
3. Brush and/or Roller Application: Top quality, proper style and size brushes and rollers shall be used. The brushing or rolling shall be done so that a smooth coat as nearly uniform in thickness as possible is obtained. Brush or roller strokes shall be made to smooth the film without leaving deep or detrimental marks. Surfaces not accessible to brushes or rollers may be painted by spray, by dauber or sheepskins, and paint mitt.
4. Spray Application:
 - a. The equipment used shall be suitable for the intended purpose, shall be capable of properly atomizing the coating to be applied, and shall be equipped with suitable pressure regulators and gauges.
 - b. Coating shall be applied in a uniform layer with a minimum 50 percent overlap pattern in accordance with the coating manufacturer's application instructions. All runs and sags should be brushed out immediately or the coating shall be removed and the surface recoated.

- c. High build coatings should be applied by a crosshatch method of spray application to ensure proper film thickness of the coating.
- d. Areas inaccessible to spray shall be brushed; if also inaccessible to brush, daubs or sheepskins shall be used, as authorized by the manufacturer.
- e. Special care shall be taken with thinners and paint temperatures so that coating of the correct formula reaches the receiving surface.

3.10 FIELD COATING OF SHOP PRIMED AND FACTORY COATED ITEMS

A. General:

- 1. Schedule inspection with Applicator and Engineer at project site before field priming or top-coating of shop or factory finished items previously delivered to the project site. Conduct dry film, solvent wipe, and adhesion testing before top-coating.
- 2. Field coating of shop primed or factory finished items shall be completed during the recoat window for shop or factory coating. If the shop or factory coating window is exceeded, obtain recommendations from the field coating material manufacturer for surface preparation requirements.
- 3. If in the opinion of the Engineer or the top-coating manufacturer, any shop or factory prime or finish coats have been improperly prepared and applied, are in an excessively damaged condition, if the surface preparation or coating materials used are contrary to those specified herein, or are not compatible with the specified field coats, then the factory or shop applied materials shall be completely removed and the factory coated item recoated at the sole cost to the Contractor.

B. Surface Preparation and Coating Application:

- 1. Prior to application of field finish coats, clean shop primed or coated surfaces with solvent wipe (SSPC SP-1) so they are free of dirt, oil, and grease. Hand or power sand areas of chipped, peeled, or abraded coating, feathering the edges (SSPC SP-11, or SP-2 and SP-3). Areas of rust bleeding, rust penetration, or damaged shop coated items shall be spot blasted to SSPC SP-5 (White Metal Blast) or power-tooled cleaned to bare metal SSPC SP-11.
- 2. Follow with a spot primer using the specified primer before the application of succeeding coats.

3. If the coating window is missed or if recommended by the coating manufacturer, lightly abrasive blast shop primed or coated items scheduled to receive field applied finish coats to remove glossy coating and provide a rough profile. Apply mist or tie coat of specified primer, minimum 1-mil dry film thickness, if recommended by the field applied coating manufacturer depending on the type of coating and surface condition.
 4. Repair abraded areas on factory finished items as recommended by the coating manufacturer, as reviewed and approved by the Engineer. Apply spot primer, touch-up, and additional coats as required according to the field coating manufacturer's written recommendations. Carefully blend repaired areas into original finish.
- C. Applicator Quality Control Inspection: Applicator shall conduct dry film measurements, holiday testing, and adhesion testing on cured coatings as specified.

3.11 EXISTING COATED SURFACES TO BE PAINTED

- A. Unless otherwise specified, existing or recently constructed coating systems damaged by new construction shall be repaired and coated in accordance with the appropriate coating system specified for that area as new work.

3.12 APPLICATOR FIELD INSPECTION TESTING

- A. Surface Preparation Inspection:
1. Abrasive blasted surface shall be visually inspected for degree of surface preparation and surface imperfections. Imperfections, which can be detrimental to application of the coating, shall be re-blasted or removed by filing or grinding.
 2. Degree of surface preparation shall be visually inspected and compared to test coupons or visual standards (SSPC VIS 1) to verify grade of cleanliness.
- B. Surface Cleanliness:
1. Visually inspect and conduct pressure sensitive tape method (ISO 8502-3) to determine surface cleanliness. Reclean if there is visible dust or other contamination on scotch tape, and retest.
 2. Visually inspect surface and rag test for rust blush. Conduct clean white rag test to determine if any rust present. Re-blast any surfaces where rust found.

- C. Solvent Wipe Test:
1. Conduct rub test with clean rag and MEK solvent to confirm that coating is cured adequately and is the correct type. Complete in accordance with the coating manufacturer's recommended procedures.
 2. Do not coat over alkyd prime coats with epoxy based coating systems. Return improperly coated items and/or field abrasive blast to completely remove alkyd coatings if found on equipment or items with specified epoxy based coating systems, and recoat with the correct epoxy or specified type of coating.
- D. Coating Application:
1. Conduct wet film measurements during coating application.
 2. Calculate volume of coating utilized and surface area coated and visually inspect to ensure proper and complete coverage has been attained.
- E. Film Thickness:
1. Conduct dry film thickness measurements of the cured coatings in accordance with the coating manufacturer's written directions and these specifications.
 2. Test frequency and procedures for dry film thickness testing of coatings with a magnetic film thickness gauge shall be in accordance with SSPC-PA 2, with the exception that the minimum coating thickness allowed shall be the MDFT specified.
- F. Number of Coats: Minimum specified required irrespective of coating thickness. Additional coats may be required to obtain minimum required paint thickness, depending on method of application, differences in manufacturers' products, and atmospheric or structure surface conditions.
- G. Application Thickness: Do not exceed coating manufacturer's recommendations. Measure using a wet film thickness gauge and/or calculation of square foot coated and material used to ensure proper coating thickness during application.
- H. Coating Adhesion: Test factory and field applied coatings per ASTM D4541 Pull-Off Test and the coating manufacturer's directions. Provide correct size dollies for each pipe size or structure shape and size. Minimum acceptance values for adhesion for factory, field, and repair coatings for steel and concrete surfaces shall be as specified hereinbefore, or printed

acceptance values according to the manufacturer's data sheets, whichever is higher.

3.13 FIELD COATING REPAIR

- A. Materials and Surfaces Not Scheduled to be Coated: Repair or replace damaged surfaces and materials not scheduled to be coated.
- B. Repairs, General: Complete repairs and surface preparation in accordance with these specifications and the manufacturer's recommended procedures. Confirm that repair materials are compatible with damaged or existing coatings.
- C. Spot Repair of Damaged Existing Coatings, Pinholes, and Holidays: Prepare the surface as specified hereinbefore for "Existing Surfaces to Be Painted", or as required per the specific coating type. Apply one spot coat of the specified primer to bare areas overlapping the prepared existing coating. Apply specified finish coat(s).
- D. Other Repair of Damaged Coatings, Pinholes, and Holidays:
 - 1. At completion of the work, inspect, touch-up, and restore coatings where damaged. Touch-up of minor damage is acceptable where the result is not visually different from the surrounding surfaces. Where touch-up results in visually different conditions, either in texture, color, sheen or appearance, recoat the entire surface.
 - 2. Remedy all defective work in a timely manner to the satisfaction of the Engineer and Owner, at the sole cost to the Contractor.
 - 3. If an item has an improper finish color, or insufficient film thickness, clean surface and topcoat with the specified paint material to obtain the specified color and coverage.
 - 4. Obtain specific surface preparation and coating repair information from the coating manufacturer for coatings that have exceeded the maximum recoat time (window).
 - 5. Hand or power sand visible areas of chipped, peeled, or abraded paint, and feather the edges. Follow with primer and finish coat. Depending on the extent of repair and appearance, a finish sanding and topcoat may be required in accordance with the coating manufacturer recommendations.
 - 6. Evidence of runs, bridges, shiners, laps, or other imperfections is cause for rejection and repair.

7. Apply finish coats, including touchup and damage repair coats, in a manner which will present a uniform texture and color matched appearance.

E. Unsatisfactory Application:

1. The coating shall be a uniform continuous (monolithic) film of correct coverage and appearance per coat, free of imperfections or defects. Evidence of holidays, defects, pinholes, misses, runs, bridges, shiners, laps, or other imperfections shall be cause for rejection. Coating materials shall be uniform in color with no evidence of off-ratio application, disbondment, delamination, or blisters.
2. Where stains, contamination, or undercoats show through the final coat, correct defects and cover with additional coats until the coating is of uniform coverage, finish, color, and appearance.
3. Engineer may reject coated and lined items for excessive damage, poor workmanship, contamination, or inadequate surface preparation. Items determined by the Engineer or coating manufacturer's representative to have excessive problems shall be corrected in a timely manner at the sole cost to the Contractor.

F. Defective Work:

1. If defective work or unsatisfactory application is discovered during initial surface preparation or coating application work, Contractor final inspections, during warranty inspections, or anytime during the warranty period, it shall be corrected at the sole cost to the Contractor including all additional costs incurred by the Owner, Engineer, or Engineer Representative.
2. All additional Owner and Engineer costs required to identify the scope and size of defective work and determine necessary corrective actions, shall be at the sole cost to Contractor. This shall include but not be limited to additional costs for time and expenses, laboratory analyses, additional testing, equipment rental, coating manufacturer site evaluation, recommendation time and laboratory costs, coordination and communication, review and evaluation of repair recommendations, full time observation during the defective work repair, and additional warranty inspection(s) of repair work.

3.14 PRESERVATION, RESTORATION, AND CLEANUP

- A.** Confine operations to construction easements, work areas described, or as approved by the Owner or Engineer. Protect existing structures, equipment,

vehicles, and utilities and keep the work area neat and orderly. Keep the work site free from accumulation of waste materials or rubbish.

- B. Control all contamination from surface preparation and coating application. Damage due to surface preparation, coating operations, or overspray on buildings, vehicles, trees, or other surfaces not specified to be coated shall be the sole responsibility of the Contractor.
- C. Prevent contamination of the project site or surrounding areas. Do not dump coating materials, spent abrasive, paint debris, waste oil, rubbish, or other similar materials on the ground or in any water way. Use caution to prevent soil, stream, or groundwater contamination. Contractor shall be liable for containment and cleanup or any contamination of any aquifer, stream, or soil at their sole expense.
- D. Upon completion of the work, remove all materials, scraps, and debris from project area and from the interior of all structures, pipes, tanks, devices and equipment. Remove staging, scaffolding, and containers from the site or destroy in a legal manner. Leave the work site free of rubbish or excess materials of any kind.
- E. The Contractor is solely responsible for containment, packaging, treatment, transportation, and disposal of all debris generated during this work and shall be responsible for all associated costs.
- F. Any damage to structures, equipment, utilities, vehicles, nearby facilities, or to the project site resulting from Contractor related work activities shall be promptly corrected by the Contractor. Repairs shall be completed in a timely manner to restore items to preconstruction condition to the Owner's satisfaction by the Contractor at their sole expense.

3.15 PROTECTIVE COATING SYSTEMS APPLICATION SCHEDULE

- A. Unless otherwise shown or specified, paint surfaces in accordance with the following Application Schedule. In the event of discrepancies or omissions in the following, request clarification from the Engineer before starting work in question. The schedule below is not intended to be all-inclusive and some systems may not apply to this project.
- B. System No. 2 Coal Tar Epoxy, Submerged Metal-Domestic Sewage or Other Non-potable Water:
 - 1. Use where called out on the Drawings.

System No. 2 Surface Prep.	Paint Material	Min. Coats, Cover
Abrasive Blast, or Centrifugal Wheel Blast (SP 5 White Metal)	Prime in accordance with manufacturer's recommendations-epoxy primer	1 coat, 2 to 4 MDFT
	Coal Tar Epoxy	2 Coats, 16 MDFT

C. System No. 3 Concrete Encased or Buried Metal-Other:

1. Use on the following items or areas:
 - a. Metal surfaces encased in concrete such as wall pipes, pipes, pipe sleeves, access manholes, gate guides and thimbles, and structural steel excluding reinforcing steel.
 - b. All metal encased in concrete, unless already factory coated with a suitable coating.
2. Other areas where specified or noted on the Drawings.

System No. 3 Surface Prep.	Paint Material	Min. Coats, Cover
Abrasive Blast, or Centrifugal Wheel Blast (SP 6 Commercial)	Prime in accordance with manufacturer's recommendations-epoxy primer	1 Coat, 2 to 4 MDFT
	Coal Tar Epoxy	2 coats, 16 MDFT

D. System No. 4 Submerged and Exterior Exposed Metal-Domestic Sewage or Other Non-potable Water – Highly Corrosive

1. Use on the following items or areas:
 - a. Clarifier and Clarifier Splitter Box
 - 1) Metal surfaces new and existing below and above the normal operating water level.
 - b. Submerged Surfaces of metallic items such as wall pipes, pipes, pipe sleeves, access manholes, gate guides and thimbles; structural steel that is embedded in concrete.

- c. All exterior metal surfaces located inside of basins and wet wells, unless factory-finished with a suitable approved coating.
 - d. Other areas where noted on the Drawings.
2. Do not use on exposed stainless steel, aluminum, or galvanized steel ductwork.

System No. 4 Surface Prep.	Paint Material	Min. Coats, Cover
Near-White Blast Cleaning (SSPC-SP 10) Minimum angular anchor profile of 1.5 mils Uniformly scarified between coats	Polyamidoamine Epoxy Series N 69 Hi-Build Epoxoline II or approved equal	1 Stripe Coat, 4-6 mils on all edges or hard to reach areas, brushed or rolled 2 coats, 4-6 mil DFT/coat

E. System No. 5 Exposed Metal-Mildly Corrosive:

- 1. Use on the following items or areas: Exposed metal surfaces, located inside or outside of structures and exposed to weather or in a humid atmosphere, such as pump stations, treatment plant buildings, pipe galleries, vaults, and similar areas and the following specific surfaces:
 - a. All (exterior surfaces) of exposed interior metallic piping, valves, fittings, and appurtenances in vaults, treatment plant buildings, or pump stations (except hot temperature piping).
 - b. Exterior surfaces of piping, pipe supports, and appurtenances.
 - c. Metal doors and frames, vents, louvers, exterior metal ductwork, flashings, sheet metalwork, and miscellaneous architectural metal trim located inside and outside of pipe galleries, treatment buildings, or vaults.
 - d. Instrumentation and control systems exposed enclosures for process use in humid areas of pipe galleries, treatment buildings, or vaults.
 - e. Steel roof joists and structural steel located in or above wet or damp areas if not specified to be coated with a more corrosion resistant coating because of exposure.

2. Apply surface preparation and primer and mid-coat to surfaces prior to installation. Finish coats need only be applied to interior surfaces exposed after completion of construction.
3. Do not use on exposed stainless steel, aluminum, or galvanized steel ductwork.
4. Other areas where specified or noted on the Drawings.

System No. 5 Surface Prep.	Paint Material	Min. Coats, Cover
Abrasive Blast, or Centrifugal Wheel Blast (SP 10 Near White)	Polyamide, Anticorrosive Epoxy Primer	1 coat, 2.5 to 3.5 MDFT
	Polyamide, Anticorrosive Epoxy Mid-Coat	1 coat, 3 to 4 MDFT
	Polyurethane Enamel	1 or 2 coats (as required to hide mid-coat), 3 to 4 MDFT

F. System No. 10 Galvanized Metal Conditioning:

1. Use on the following items or areas:
 - a. Galvanized surfaces requiring top coating.
 - b. All galvanized materials shall be top coated prior to immersion service.
 - c. After application of System No. 10, apply finish coats as required for exposure or color coding.
 - d. Concealed galvanized surfaces do not require painting unless in wet or submerged environments.
2. Other areas where specified or noted on the Drawings.

System No 10 Surface Prep.	Paint Material	Min. Coats, Cover
Solvent Clean (SP 1) Followed by Hand Tool (SP 2) or Power Tool (SP 3) Abrasive Sweep Blast for All Wet or Immersed Galvanized Surfaces	Wash Primer (vinyl butyral acid) or Coating Manufacturer's Recommendation	1 coat, 0.4 MDFT
		Apply Finish Coats as Required For Exposure

G. System No. 11 Galvanized Metal Repair:

1. Prepare surface with System No. 10 as recommended by coating manufacturer; use on the following items or areas:
 - a. Galvanized surfaces that are abraded, chipped, or otherwise damaged.
 - b. Topcoat if required for color coding or exposure.
2. Other areas where specified or noted on the Drawings.

System No. 11 Surface Prep.	Paint Material	Min. Coats, Cover
Solvent Clean (SP 1) Followed by Hand Tool (SP 2), Power Tool (SP 3), or Brush-off Blast (SP 7)	Organic Zinc Rich Primer	1 coat, 3 MDFT

H. System No.12 Rigid Epoxy System-Concrete:

1. Use on the following items or areas:
 - a. Clarifier walls above the water line and 1 ft below the water line. Use in the launder troughs.
 - b. Clarifier Splitter Box above water line and 6 inches below the gate fully open position.
 - c. Other areas where specified or noted on the Drawings

System No. 12 Surface Prep.	Paint Material	Min. Coats, Cover
Concrete surface prep per NACE #6/ SSPC SP-13 to minimum ICRI CSP-5	Epoxy Cementitious Mortar Series N218 Mortarclad Or approved equal	As required to fill voids and level surface
Uniformly scarify between coats	Polyamine Epoxy Series G435 Or approved equal	1 or more coats to achieve 20 – 30 mils DFT

I. System No. 24 Exposed Fiberglass, PVC:

1. Use on the following items or areas:
 - a. Exposed fiberglass or PVC pipe, ducts, or equipment requiring color coding or cosmetic painting.
 - b. Exposed chemical feed pumps requiring color coding or cosmetic painting.
 - c. As required to protect fiberglass or PVC where exposed to sunlight, including shaded areas.
2. Other fiberglass or PVC items required to be color coded or otherwise specified or shown to be painted.

System No. 24 Surface Prep.	Paint Material	Min. Coats, Cover
Plastic	Polyurethane Enamel	2 coats, 4 mils MDFTPC

J. System No. 25 Interior FRP, PVC:

1. Use on the following items or areas:
 - a. Exposed fiberglass or PVC pipe or other items required to be color coded.
2. As required to be color coded or otherwise specified or shown to be painted.

System No. 25 Surface Prep.	Paint Material	Min. Coats, Cover
Plastic	Acrylic Latex	2 coats, 320 SFPGPC

K. System No. 27 Aluminum, Stainless Steel, and Dissimilar Metal Insulation:

1. Use on the following items or areas:
 - a. All concrete embedded aluminum or stainless steel surfaces.
 - b. Aluminum surfaces fastened to steel or concrete or masonry.
 - c. Aluminum access hatch frames.
 - d. Aluminum grating frames.
 - e. Aluminum slide gate frame surfaces in contact with concrete.

- f. Other areas where specified or noted on the Drawings.

System No. 27 Surface Prep.	Paint Material	Min. Coats, Cover
Solvent Clean (SP 1)	Wash Primer	1 coat, 0.4 MDFT
	Bituminous Paint, Coal Tar Epoxy, or Epoxy	1 or 2 coats, 10 MDFT

L. System No. 29 Fusion Bonded Coating:

1. Use on the following items:
 - a. Metallic fittings, valves, appurtenances, fasteners, bolts, nuts, and washers as specified or noted on the Drawings.
 - b. Stainless steel anchor bolts used in submerged or wet areas, to maintain electrical isolation.
2. Other items where specified or noted on the Drawings.

System No. 29 Surface Prep.	Paint Material	Min. Coats, Cover
Abrasive Blast, or Centrifugal Wheel Blast (SP 10) or Acid Pickling (SP 8)	Fusion Bonded 100 percent Solids Epoxy or Polyurethane	1 or 2 coats, 12 to 16 MDFT

3.16 ARCHITECTURAL PAINT SYSTEMS APPLICATION SCHEDULE

- A. Provide the following paint systems for the various substrates indicated, unless scheduled or shown otherwise in this section or the Drawings. Paint numbers are based on Benjamin Moore Company's specification manual. Equivalent paint systems from other manufacturers may be used. Note that some architectural systems in this schedule may not be used on this project.
- B. Specification Code A: Exposed architectural steel, metal trim, metal doors and frames, railings, grilles, and iron work – Interior and Exterior, Dry or Relatively Non-Corrosive. For shop primed work, omit first coat. Remove all rust and scale.
 1. 1st coat: Corotech Metal Rust Inhibitive Primer V110 (3.0 to 4.0 MDFT).
 2. 2nd coat: Corotech Acrylic Enamel V330 (2.0 MDFT).

3. 3rd coat: Corotech Acrylic Enamel V330 (2.0 MDFT).
- C. Specification Code C: Concrete and concrete masonry units:
1. 1st coat: Corotech Epoxy Pre-Primer V 155 (2.5 MDFT).
 2. 2nd coat: Corotech Acrylic Epoxy V450 (1.3 MDFT).
 3. 3rd coat: Corotech Acrylic Epoxy V450 (1.3 MDFT).
- D. Specification Code D: Painting of Mechanical and Electrical Items (NOTE - Paint grilles at exterior):
1. Interior Areas: All piping, lighting panels, conduits, ducts, etc., exposed in finished areas of the building to be painted the same color as the adjacent walls or ceilings, except piping to be color coded.
 2. Exterior Areas: All piping, stacks, grilles, or other items of electrical or mechanical equipment, exposed on the exterior of the building, and not factory finished, to be painted as directed by the Engineer.
 3. Paint as specified in Division 23 00 00, 26 00 00, or Division 40 00 00. If not specified in these divisions, paint per System No. 5 as specified hereinbefore.

END OF SECTION 09 90 00

PART 1 GENERAL**1.01 WORK INCLUDED**

- A. This section covers the work necessary to furnish and install, complete, the identifying devices. This includes all identification, information, emergency, warning, and hazardous material signs and their mounting requirements.

1.02 GENERAL

- A. Like items of materials specified hereunder shall be the end products of one manufacturer to achieve standardization for appearance, maintenance, and replacement.
- B. See CONDITIONS OF THE CONTRACT and Division 01 00 00, GENERAL REQUIREMENTS, which contain information and requirements that apply to the work specified herein and are mandatory for this project.
- C. Signs shall be furnished and erected at the locations shown or specified herein, complete with all hardware and accessories.
- D. All signs required by this section shall be provided by manufacturing firms regularly engaged in the production of signs of this type. Lettering and graphics shall be clean, neatly aligned and highly legible. Signs with rough edges, flaws, misaligned letters or other indications of poor workmanship will be rejected.

1.03 SUBMITTALS

- A. Submittals shall be made in accordance with Section 01 33 00, SUBMITTALS in Division 01 00 00, GENERAL REQUIREMENTS. In addition, the following specific information shall be provided:
 - 1. Shop Drawings: Provide drawings and manufacturer's literature showing layouts, dimensions, letter sizes and styles, colors, and mounting details.
 - 2. Layout and installation details.

PART 2 PRODUCTS**2.01 GENERAL**

- A. The use of a manufacturer's name and model or catalog number is for establishing the standard of quality and general configuration desired only. Products of other manufacturers will be considered in accordance with the General Conditions.

2.02 SIGNS

- A. Safety (Warning, Caution, Danger) Signs (Type A):
1. Baked enamel finished 20-gauge (minimum) steel or 18-gauge (minimum) aluminum signs, as manufactured by Seton Corporation; Nutheme Safety Signs and Labels; or equal. Provide reflective signs for outdoor locations and non-reflective signs for interior locations.
 2. Text, colors, and sizes as indicated on the Safety Sign Schedule hereinafter and conforming to OSHA requirements.
- B. Safety Sign Schedule: See schedule below for sign details. Detail number refers to the Standard Details shown on the Drawings.

SAFETY SIGN TYPE	DETAIL NUMBER	TEXT	QUANTITY
WARNING	10134	THIS EQUIPMENT STARTS AND STOPS AUTOMATICALLY	At all equipment that is started remotely or automatically (3 minimum)
CAUTION	10136	NONPOTABLE WATER - NOT SAFE FOR DRINKING	At all new hose valves or yard hydrants

2.03 IDENTIFICATION LABELS

- A. Piping identification labels shall be provided as specified in Section 09 90 00, PAINTING.
- B. Equipment Labels: Equipment labels shall contain black lettering on a yellow or orange background. The labels shall be 2 inches minimum and 4 inches maximum high by 8 inches minimum and 12 inches maximum long. The lettering shall be bold face and 3/4-inch minimum high. The label shall be plastic or aluminum material, minimum 1/16-inch thickness, that is suitable for use on wet, oily, exposed, abrasive, and corrosive areas. Alternatively, the labels may be fiberglass with fiberglass encased lettering. Leave a 1-inch margin on each end of the label for mounting. Fiberglass labels shall be grommeted at each end for mounting. All labels shall have the same size base dimensions. The label wording shall be as shown hereinafter. The labels shall be Style No. AV0175 by Seton Corporation; equivalent as manufactured by Brady Worldwide Inc.; or equal.
- C. Provide labels for equipment, valves, gates, instrumentation, and clarifier drive as follows:

1. RAS/WAS Pump 1
2. RAS/WAS Pump 2
3. RAS/WAS Pump 3
4. RAS Flow Meter 1
5. RAS Flow Meter 2
6. RAS Flow Meter 3
7. Clarifier 1 Gate
8. Clarifier 2 Gate
9. Clarifier 3 Gate
10. Clarifier 3 Drive
11. Clarifier 3 Control Panel (coordinate supply of this label with Westech)

PART 3 EXECUTION**3.01 DELIVERY, STORAGE, AND HANDLING**

- A. Deliver and store materials in manufacturer's original, unopened, undamaged containers. Protect materials from moisture and dust by storing in clean, dry, location remote from construction operations area.
- B. Handle materials in such a manner as to prevent damage to products or finishes.

3.02 INSTALLATION

- A. Installation of identifying devices shall be as recommended by the manufacturer and located in accordance with the Drawings, as specified herein, or as directed by the Engineer and/or the Owner's representative. Contractor shall furnish such incidental materials and labor as required for proper, secure mounting that is level and plumb.
- B. Use manufacturer's installation templates and attachment devices. Install signs after doors and other substrate surfaces are finished.
- C. Do not install tape adhesive when ambient temperature is lower than recommended by manufacturer. Maintain this minimum temperature during and after installation of signs using adhesive.

3.03 SIGNS

- A. General: Locate and securely mount signs where indicated on Drawings, or specified hereinbefore and/or hereinafter. Fasten to walls or posts with stainless steel screws or other fasteners.
- B. Safety Signs:
 - 1. Install safety signs on steel or aluminum posts, walls, doors, piping, or equipment in a location that will allow high visibility but a minimum restriction of the working area around walkways and equipment. Signs shall be installed without damaging structures or equipment such that they are removable with ordinary hand tools without leaving scars on the structure or equipment. Fasteners shall be stainless steel.
 - 2. Install signs with the legend STARTS AND STOPS AUTOMATICALLY near equipment and motors that are remote or automatically controlled. Install NONPOTABLE WATER - NOT FOR DRINKING signs near each indoor and outdoor hose valve or hose bibb. Install other safety signs as directed by the Engineer or Owner's representative. Obtain the approval of the Engineer for the location of each sign and the mounting method to be used before installation.
 - 3. Where appropriate, mount each sign on a 2-inch diameter galvanized steel pipe post using two 1/4-inch aluminum or stainless steel bolts. Install facing foot traffic at locations and in manner indicated on Drawings or in ANSI D6.1.

3.04 EQUIPMENT LABELS

- A. Install the equipment labels on the equipment or concrete equipment base. The labels shall be securely fastened to the equipment or base with 1/8- to 1/4-inch diameter stainless steel bolts or anchor bolts. The nameplate anchors shall be readily removable and replaceable with a wrench, pliers, or screwdriver.

3.05 CLEANING AND PROTECTION

- A. After installation, clean soiled sign surfaces according to the manufacturer's written instructions. Protect signs from damage until final acceptance by the Owner.

END OF SECTION 10 14 00

DIVISION 23 00 00 – HEATING, VENTILATING, AND AIR CONDITIONING (HVAC)

PART 1 GENERAL

1.01 WORK INCLUDED

- A. This section covers the testing, adjusting, and balancing requirements necessary for HVAC work on this project. This includes the following major areas of work:
 - 1. Balancing Air Systems:
 - a. Constant volume air systems.

1.02 GENERAL

- A. Also see the GENERAL CONDITIONS, Division 01 00 00, GENERAL REQUIREMENTS, and Section 22 01 00, GENERAL REQUIREMENTS OF PLUMBING AND HVAC which contain information and requirements that apply to the work specified herein and are mandatory for this project.
- B. It shall be the responsibility of the mechanical sub-contractor to examine and refer to all architectural, structural, and/or electrical Drawings and specifications for construction conditions which may affect the scope of HVAC work. Inspect the building site and existing facilities for verification of present conditions. Make proper provisions for these conditions in performance of the work and cost thereof.
- C. Mechanical work for this project shall include all items, articles, materials and the associated labor mentioned, scheduled or shown in these specifications and in the accompanying Drawings. Furnish and install all equipment, materials and any required incidental items required by good practice to complete the systems described on the Drawings or in the project specifications.

1.03 DEFINITIONS

- A. The following definitions apply to the HVAC testing, adjusting, and balancing work on this project. Also see the Drawings and other specifications sections.
 - 1. AABC: Associated Air Balance Council.
 - 2. NEBB: National Environmental Balancing Bureau.
 - 3. TAB: Testing, adjusting, and balancing.
 - 4. TABB: Testing, Adjusting, and Balancing Bureau.

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- 5. TAB Specialist: An independent entity meeting the qualifications to perform TAB work.
- 6. TDH: Total dynamic head.

1.04 SUBMITTALS

- A. Submittals shall be provided as specified in Section 01 33 00, SUBMITTALS and Section 22 01 00, GENERAL REQUIREMENTS OF PLUMBING AND HVAC.
- B. Provide plan and procedures to be used for testing, adjusting, and balancing work. Include a complete set of report forms intended for use on this project.
- C. Certified TAB Reports: Submit two copies of reports prepared, as specified in this Section, on approved forms certified by TAB firm.

1.05 QUALITY ASSURANCE

- A. TAB Specialists Qualifications: Certified by AABC, NEBB, TABB, or as approved by the Engineer prior to bidding.
- B. Certify TAB field data reports and perform the following:
 - 1. Review field data reports to validate accuracy of data and to prepare certified TAB reports.
 - 2. Certify that the TAB team complied with the approved TAB plan and the procedures specified and referenced in this Specification.
- C. TAB Report Forms: Use standard TAB contractor's forms.
- D. Instrumentation Type, Quantity, Accuracy, and Calibration: Comply with requirements in ASHRAE 111, Section 4, "Instrumentation."
- E. ASHRAE/IES 90.1 Compliance: Applicable requirements in ASHRAE/IES 90.1, Section 6.7.2.3 - "System Balancing."

1.06 COORDINATION

- A. Coordinate the efforts of factory authorized service representatives for systems and equipment, HVAC controls installers, and other mechanics to operate HVAC systems and equipment to support and assist TAB activities.
- B. Perform TAB after leakage and pressure tests on air distribution systems have been satisfactorily completed.

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PART 2 PRODUCTS

PART 3 EXECUTION

3.01 EXAMINATION

- A. Examine the Contract Documents to become familiar with the project requirements and to discover conditions in systems' designs that may preclude proper TAB of systems and equipment.
- B. Examine installed systems for balancing devices, such as and fittings, and manual volume dampers. Verify that locations of these balancing devices are applicable for intended purpose and are accessible.
- C. Examine the approved submittals for HVAC systems and equipment.
- D. Examine HVAC equipment and verify that bearings are greased, belts are aligned and tight, filters are clean, and equipment with functioning controls is ready for operation in a safe and normal condition.
- E. Examine heat transfer coils for correct piping connections and for clean and straight fins.
- F. Report deficiencies discovered before and during performance of TAB procedures. Observe and record system reactions to changes in conditions. Record default set points if different from indicated values.

3.02 PREPARATION

- A. Perform system readiness checks of HVAC systems and equipment to verify system readiness for TAB work. Include, at a minimum, the following:
 - 1. Airside:
 - a. Duct systems are clean and complete with terminals installed and connected.
 - b. Volume dampers are open and functional.
 - c. Clean filters are installed.
 - d. Fans are operating, free of vibration, and rotating in correct direction.
 - e. Automatic temperature control systems are operational.
 - f. Windows and doors are installed.
 - g. Suitable access to balancing devices and equipment is provided.

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3.03 GENERAL PROCEDURES FOR TESTING AND BALANCING

- A. After testing and balancing, patch probe holes in ducts with plastic plugs.
- B. Mark equipment and balancing devices, including damper control positions, valve position indicators, fan speed control levers, and similar controls and devices, with paint or other suitable, permanent identification material to show final settings.

3.04 GENERAL PROCEDURES FOR BALANCING AIR SYSTEMS

- A. Prepare test reports for both fans and outlets. Obtain manufacturer's outlet factors and recommended testing procedures. Cross check the summation of required outlet volumes with required fan volumes.
- B. Prepare schematic diagrams of systems' "as-built" duct layouts.
- C. Determine the best locations in main and branch ducts for accurate duct airflow measurements.
- D. Check airflow patterns from the outdoor air louvers and dampers and the return and exhaust air dampers through the supply fan discharge and mixing dampers.
- E. Locate start-stop and disconnect switches, electrical interlocks, and motor starters.
- F. Verify that motor starters are equipped with properly sized thermal protection.
- G. Check dampers for proper position to achieve desired airflow path.
- H. Check for airflow blockages.
- I. Check condensate drains for proper connections and functioning.
- J. Check for proper sealing of air handling unit components.
- K. Verify that air duct system is sealed as specified in Section 23 31 13, METAL DUCTS.

3.05 PROCEDURES FOR CONSTANT VOLUME AIR SYSTEMS

- A. Adjust fans to deliver total indicated airflows within the maximum allowable fan speed listed by fan manufacturer.

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1. Measure total airflow:
 - a. Set outside air, return air, and relief air dampers for proper position that simulates minimum outdoor air conditions.
 - b. Where duct conditions allow, measure airflow by Pitot-tube traverse. If necessary, perform multiple Pitot-tube traverses to obtain total airflow.
 - c. Where duct conditions are not suitable for Pitot-tube traverse measurements, a coil traverse may be acceptable.
 - d. If a reliable Pitot-tube traverse or coil traverse is not possible, measure airflow at terminals and calculate the total airflow.
 2. Measure fan static pressures as follows:
 - a. Measure static pressure directly at the fan outlet or through the flexible connection.
 - b. Measure static pressure directly at the fan inlet or through the flexible connection.
 - c. Measure static pressure across each component that makes up the air handling system.
 - d. Report artificial loading of filters at the time static pressures are measured.
 3. Do not make fan speed adjustments that result in a motor overload condition. Consult equipment manufacturers about fan speed safety factors. Modulate dampers and measure fan motor amperage to ensure that no overload occurs. Measure amperage in full-cooling, full-heating, economizer, and any other operating mode to determine the maximum required brake horsepower.
- B. Adjust volume dampers for main duct, submain ducts, and major branch ducts to indicated airflows.
1. Measure airflow of submain and branch ducts.
 2. Adjust submain and branch duct volume dampers for specified airflow.
 3. Re-measure each submain and branch duct after all have been adjusted.
- C. Adjust air inlets and outlets for each space to indicated airflows.
1. Set airflow patterns of adjustable outlets for proper distribution without drafts.

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2. Measure inlets and outlets airflow.
3. Adjust each inlet and outlet for specified airflow.
4. Re-measure each inlet and outlet after they have been adjusted.

3.06 PROCEDURES FOR CONDENSING UNITS

- A. Verify proper rotation of fans.
- B. Record compressor data.
 1. not required.
 2. Balance each air outlet.

3.07 TOLERANCES

- A. Set HVAC system's airflow rates within the following tolerances:
 1. Supply, Return, and Exhaust Fans and Equipment with Fans: Plus or minus 10 percent.
 2. Air Outlets and Inlets: Plus or minus 10 percent.
- B. Maintaining pressure relationships as designed shall have priority over the tolerances specified above.

3.08 FINAL REPORT

- A. General: Prepare a certified written report; tabulate and divide the report into separate sections for tested systems and balanced systems.
 1. Include a certification sheet at the front of the report's binder, signed and sealed by the certified testing and balancing engineer.
 2. Include a list of instruments used for procedures, along with proof of calibration.
 3. Certify validity and accuracy of field data.
- B. Final Report Contents: In addition to certified field report data, include the following:
 1. Fan curves.

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2. Manufacturers' test data.
 3. Field test reports prepared by system and equipment installers.
 4. Other information relative to equipment performance; do not include shop drawings and product data already submitted.
- C. General Report Data: In addition to form titles and entries, include the following data:
1. Title page.
 2. Name and address of the TAB specialist.
 3. Project name.
 4. Project location.
 5. Engineer's name and address.
 6. Contractor's name and address.
 7. Report date.
 8. Signature of TAB supervisor who certifies the report.
 9. Table of Contents with the total number of pages defined for each section of the report. Number each page in the report.
 10. Summary of contents including the following:
 - a. Indicated versus final performance.
 - b. Notable characteristics of systems.
 - c. Description of system operation sequence if it varies from the Contract Documents.
 11. Nomenclature sheets for each item of equipment.
 12. Data for terminal units, including manufacturer's name, type, size, and fittings.
 13. Notes to explain why certain final data in the body of reports vary from indicated values.
 14. Test conditions for fan performance forms including the following:

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- a. Settings for outdoor, return, and exhaust air dampers.
 - b. Conditions of filters.
 - c. Face and bypass damper settings at coils.
 - d. Settings for supply air, static pressure controller.
 - e. Other system operating conditions that affect performance.
- D. Air Handling Unit Test Reports: For air handling units with coils, include the following:
 - 1. Unit Data:
 - a. Unit identification.
 - b. Location.
 - c. Make and type.
 - d. Model number and unit size.
 - e. Manufacturer's serial number.
 - f. Unit arrangement and class.
 - g. Discharge arrangement.
 - h. Sheave make, size in inches, and bore.
 - i. Center-to-center dimensions of sheave and amount of adjustments in inches.
 - j. Number, make, and size of belts.
 - k. Number, type, and size of filters.
 - 2. Motor Data:
 - a. Motor make, and frame type and size.
 - b. Horsepower and rpm.
 - c. Volts, phase, and hertz.
 - d. Full load amperage and service factor.
 - e. Sheave make, size in inches, and bore.
 - f. Center-to-center dimensions of sheave and amount of adjustments in inches.
 - 3. Test Data (Indicated and Actual Values):
 - a. Total airflow rate in cfm.
 - b. Total system static pressure in inches wg.
 - c. Fan rpm.
 - d. Discharge static pressure in inches wg.
 - e. Filter static pressure differential in inches wg.
 - f. Preheat coil static pressure differential in inches wg.
 - g. Cooling coil static pressure differential in inches wg.
 - h. Heating coil static pressure differential in inches wg.
 - i. Outdoor airflow in cfm.

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- j. Return airflow in cfm.
 - k. Outdoor air damper position.
 - l. Return air damper position.
- E. Fan Test Reports: For supply, return, and exhaust fans, include the following:
- 1. Fan Data:
 - a. System identification.
 - b. Location.
 - c. Make and type.
 - d. Model number and size.
 - e. Manufacturer's serial number.
 - f. Arrangement and class.
 - g. Sheave make, size in inches, and bore.
 - 2. Motor Data:
 - a. Motor make, and frame type and size.
 - b. Horsepower and rpm.
 - c. Volts, phase, and hertz.
 - d. Full load amperage and service factor.
 - e. Sheave make, size in inches, and bore.
 - f. Number, make, and size of belts.
 - 3. Test Data (Indicated and Actual Values):
 - a. Total airflow rate in cfm.
 - b. Total system static pressure in inches wg.
 - c. Fan rpm.
 - d. Discharge static pressure in inches wg.
 - e. Suction static pressure in inches wg.
- F. Air Terminal Device Reports:
- 1. Unit Data:
 - a. System and air handling unit identification.
 - b. Location and zone.
 - c. Apparatus used for test.
 - d. Area served.
 - e. Make.
 - f. Number from system diagram.
 - g. Type and model number.

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- h. Size.
- 2. Test Data (Indicated and Actual Values):
 - a. Airflow rate in cfm.
 - b. Air velocity in fpm.
 - c. Preliminary airflow rate as needed in cfm.
 - d. Preliminary velocity as needed in fpm.
 - e. Final airflow rate in cfm.
 - f. Final velocity in fpm.
- G. Instrument Calibration Reports:
 - 1. Report Data:
 - a. Instrument type and make.
 - b. Serial number.
 - c. Application.
 - d. Dates of use.
 - e. Dates of calibration.

3.09 DUCT TESTING

- A. Duct testing is required for supply, return or exhaust ductwork that will operate at 3 inches WC static pressure or greater.
- B. Leakage test procedures shall follow the outlines and classifications in the SMANCA HVAC Air Duct Leakage Test Manual.
- C. The Owner and/or Engineer shall select sections of ductwork from each air handling system for duct leakage testing. The sample shall include at least five transverse joints, typical seams, and access door connections. The sample will include all medium pressure supply ductwork between the air handling unit to within 2-feet of the connection to variable air volume terminal units.
- D. The air handling systems shall be tested at 3 inches w.g. and shall meet leakage Class 3.
- E. If a section fails to meet allotted leakage level, the mechanical subcontractor shall modify the ductwork to bring it into compliance and shall retest the section until acceptable leakage is demonstrated. One retest shall will be provided by the TAB contractor. The mechanical subcontractor shall pay the TAB contractor for any additional retesting required.

**SECTION 23 05 93
TESTING, ADJUSTING, AND
BALANCING FOR HVAC**

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- F. All testing and necessary repairs shall be completed prior to concealment of the ductwork

END OF SECTION 23 05 93

DIVISION 23 00 00 – HEATING, VENTILATING, AND AIR CONDITIONING (HVAC)**PART 1 GENERAL****1.01 WORK INCLUDED**

- A. This section covers work for furnishing and installing metal ducts and appurtenances for HVAC systems on this project, complete. This includes the following items:
 - 1. Rectangular ducts and fittings.
 - 2. Round ducts and fittings.
 - 3. Sheet metal materials.
 - 4. Sealants and gaskets.
 - 5. Hangers and supports.
 - 6. Seismic restraint devices.

1.02 GENERAL REQUIREMENTS

- A. Also see the GENERAL CONDITIONS, Division 01 00 00, GENERAL REQUIREMENTS, and Section 22 01 00, GENERAL REQUIREMENTS OF PLUMBING AND HVAC which contain information and requirements that apply to the work specified herein and are mandatory for this project.
- B. Like items of equipment or materials provided hereunder shall be the end products of one manufacturer to achieve standardization for appearance, maintenance, and replacement, and shall include all necessary appurtenances for a complete and working system. The equipment or materials shall be the product of a manufacturer regularly engaged in the production of equipment or materials for the specified use. The manufacturer shall have the sole responsibility for the proper functioning and coordination of the equipment or materials as furnished.
- C. The Contractor or their sub-contractors shall provide all required miscellaneous equipment and materials, as shown on the Drawings and in accordance with these Specifications. The Contractor or their sub-contractors shall furnish all equipment and material items, whether specified or not, as necessary to provide a complete, operable HVAC system.

1.03 SUBMITTALS

- A. Submit product data and shop drawings on all metal duct and accessories used on this project.

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1.04 QUALITY ASSURANCE

- A. Perform work according to Sheet Metal and Air Conditioning Contractors' National Association (SMACNA) 1966, "HVAC Duct Construction Standards – Metal and Flexible".
- B. Construct work according to NFPA 90A, "Standard for the Installation of Air Conditioning and Ventilating Systems"

1.05 PERFORMANCE REQUIREMENTS

- A. Structural Performance: Duct hangers and supports shall withstand the effects of gravity and seismic loads and stresses within limits and under conditions described in SMACNA's "HVAC Duct Construction Standards - Metal and Flexible", SMACNA's "Seismic Restraint Manual: Guidelines for Mechanical Systems", and ASCE/SEI 7.
- B. Airstream Surfaces: Surfaces in contact with the airstream shall comply with the requirements of ANSI/ASHRAE 62.1.

1.06 PROJECT CONDITIONS

- A. Unless stated otherwise, the environment and air streams can include varying concentrations of the following chemical components:
 - 1. Grease.
 - 2. Condensation.

PART 2 PRODUCTS

2.01 RECTANGULAR DUCT AND FITTINGS

- A. General Fabrication Requirements: Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible" based on the indicated static pressure class hereinafter in Part 3, EXECUTION, unless otherwise indicated.
- B. Transverse Joints: Select joint types and fabricate according to SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Figure 2-1, "Rectangular Duct/Transverse Joints," for static pressure class, applicable sealing requirements, materials involved, duct support intervals, and other provisions in SMACNA's "HVAC Duct Construction Standards - Metal and Flexible."
- C. Longitudinal Seams: Select seam types and fabricate according to SMACNA's "HVAC Duct Construction Standards - Metal and Flexible,"

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Figure 2-2, "Rectangular Duct/Longitudinal Seams," for static pressure class, applicable sealing requirements, materials involved, duct-support intervals, and other provisions in SMACNA's "HVAC Duct Construction Standards - Metal and Flexible."

- D. Elbows, Transitions, Offsets, Branch Connections, and Other Duct Construction: Select types and fabricate according to SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Chapter 4, "Fittings and Other Construction," for static pressure class, applicable sealing requirements, materials involved, duct support intervals, and other provisions in SMACNA's "HVAC Duct Construction Standards - Metal and Flexible."

2.02 ROUND DUCTS AND FITTINGS

- A. General Fabrication Requirements: Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Chapter 3, "Round, Oval, and Flexible Duct," based on the indicated static pressure class hereinafter in Part 3, EXECUTION, unless otherwise indicated.
- B. Transverse Joints: Select joint types and fabricate according to SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Figure 3-1, "Round Duct Transverse Joints," for static pressure class, applicable sealing requirements, materials involved, duct support intervals, and other provisions in SMACNA's "HVAC Duct Construction Standards - Metal and Flexible."
 - 1. Transverse Joints in Ducts Larger Than 24-inch Diameter: Flanged.
- C. Tees and Laterals: Select types and fabricate according to SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Figure 3-5, "90 Degree Tees and Laterals," and Figure 3-6, "Conical Tees," for static pressure class, applicable sealing requirements, materials involved, duct support intervals, and other provisions in SMACNA's "HVAC Duct Construction Standards - Metal and Flexible."

2.03 SHEET METAL MATERIALS

- A. General Material Requirements: Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible" for acceptable materials, material thicknesses, and duct construction methods unless otherwise indicated. Sheet metal materials shall be free of pitting, seam marks, roller marks, stains, discolorations, and other imperfections.
- B. Galvanized Sheet Steel: Comply with ASTM A653.

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1. Galvanized Coating Designation: G90 zinc coating according to ASTM A90.
 2. Quality: Lock forming.
- C. Tie Rods: Galvanized steel, 1/4-inch minimum diameter for lengths 36 inches or less; 3/8-inch minimum diameter for lengths longer than 36 inches.
- D. Fasteners: Rivets, bolts, or sheet metal screws.

2.04 SEALANTS AND GASKETS

- A. General Sealant and Gasket Requirements: Surface burning characteristics for sealants and gaskets shall be a maximum flame spread index of 25 and a maximum smoke developed index of 50 when tested according to UL 723; certified by an NRTL.
- B. Water Based Joint and Seam Sealant (to be used for any exposed ducts):
1. Application Method: Brush on.
 2. Solids Content: Minimum 65 percent.
 3. Shore A Hardness: Minimum 20.
 4. Water resistant.
 5. Mold and mildew resistant.
 6. VOC: Maximum 75 grams/Liter (less water).
 7. Maximum Static Pressure Class: 10-inch w.g., positive and negative.
 8. Service: Indoor or outdoor.
 9. Substrate: Compatible with galvanized sheet steel (both PVC coated and bare), stainless steel, or aluminum sheets.
- C. Flanged Joint Sealant: Comply with ASTM C920.
1. General: Single component, acid curing, silicone, elastomeric.
 2. Type: S.
 3. Grade: NS.

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4. Class: 25.
 5. Use: O.
- D. Round Duct Joint O-Ring Seals:
1. Seal shall provide a maximum leakage class of 3 cfm/100 square feet at 1-inch w.g. and shall be rated for 10-inch w.g. static pressure class, positive or negative.
 2. EPDM O-ring to seal in concave bead in coupling or fitting spigot.
 3. Double-lipped, EPDM O-ring seal, mechanically fastened to factory fabricated couplings and fitting spigots.

2.05 HANGERS AND SUPPORTS

- A. Hanger Rods for Corrosive Environments: Electrogalvanized, all-thread rods or galvanized steel rods with threads painted with zinc chromate primer after installation.
- B. Strap and Rod Sizes: Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Table 5-1, "Rectangular Duct Hangers Minimum Size," and Table 5-2, "Minimum Hanger Sizes for Round Duct."
- C. Steel Cables for Galvanized Steel Ducts: Galvanized steel complying with ASTM A603.
- D. Steel Cable End Connections: Cadmium plated steel assemblies with brackets, swivel, and bolts designed for duct hanger service; with an automatic locking and clamping device.
- E. Duct Attachments: Sheet metal screws, blind rivets, or self-tapping metal screws; compatible with duct materials.
- F. Trapeze and Riser Supports:
 1. Supports for Galvanized Steel Ducts: Galvanized steel shapes and plates.

PART 3 EXECUTION**3.01 GENERAL DUCT INSTALLATION**

- A. The Drawings' plans, schematics, and diagrams indicate the general location and arrangement of the duct system. Indicated duct locations, configurations, and arrangements were used to size ducts and calculate

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friction loss for air handling equipment sizing and for other design considerations. Install duct systems as indicated unless deviations to layout are approved on shop drawings and coordination drawings.

- B. Install and seal ducts according to SMACNA's "HVAC Duct Construction Standards - Metal and Flexible" unless otherwise indicated.
- C. Install ducts in maximum practical lengths.
- D. Install ducts with fewest possible joints.
- E. Install factory fabricated or shop fabricated fittings for changes in direction, size, and shape and for branch connections.
- F. Unless otherwise indicated, install ducts vertically and horizontally, and parallel and perpendicular to building lines.
- G. Install ducts close to walls, overhead construction, columns, and other structural and permanent enclosure elements of the building.
- H. Install ducts with a clearance of 1-inch, plus allowance for insulation thickness where applicable.
- I. Route ducts to avoid passing through transformer vaults and electrical equipment rooms and enclosures. Do not route ducts directly over electrical panels or enclosures; observe all clearance requirements of the National Electrical Code, latest edition.
- J. Where ducts pass through non-fire rated interior partitions and exterior walls and are exposed to view, cover the opening between the partition and duct or duct insulation with sheet metal flanges of same metal thickness as the duct. Overlap openings on four sides by at least 1-1/2 inches. Seal around ductwork with a sealant as specified in Section 07 90 00, CAULKING AND SEALANTS.
- K. Where ducts pass through fire rated interior partitions and exterior walls, install fire dampers. Comply with requirements in Section 23 33 00, AIR DUCT ACCESSORIES for fire and smoke dampers.
- L. Protect duct interiors from moisture, construction debris and dust, and other foreign materials. Comply with SMACNA's "IAQ Guidelines for Occupied Buildings Under Construction," Appendix G, "Duct Cleanliness for New Construction Guidelines."

3.02 INSTALLATION OF EXPOSED DUCTWORK

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- A. Protect ducts exposed in finished spaces from being dented, scratched, or damaged.
- B. Trim duct sealants flush with metal. Create a smooth and uniform exposed bead. Use only a water based sealant system on exposed ducts. Do not use a two part tape sealing system.
- C. Grind welds to provide smooth surface free of burrs, sharp edges, and weld splatter. When welding stainless steel with a No. 3 or 4 finish, grind the welds flush, polish the exposed welds, and treat the welds to remove discoloration caused by welding.
- D. Maintain consistency, symmetry, and uniformity in the arrangement and fabrication of fittings, hangers and supports, duct accessories, and air outlets.
- E. Repair or replace damaged sections and finished work that does not comply with these requirements.

3.03 DUCT SEALING

- A. Seal ducts at a minimum to the following seal classes according to SMACNA's "HVAC Duct Construction Standards - Metal and Flexible":
 - 1. Outdoor, Supply Air Ducts: Seal Class A.
 - 2. Outdoor, Exhaust Ducts: Seal Class C.
 - 3. Outdoor, Return Air Ducts: Seal Class C.
 - 4. Unconditioned Space, Supply Air Ducts in Pressure Classes 2-Inch w.g. and Lower: Seal Class B.
 - 5. Unconditioned Space, Supply Air Ducts in Pressure Classes Higher Than 2-Inch w.g.: Seal Class A.
 - 6. Unconditioned Space, Exhaust Ducts: Seal Class C.
 - 7. Unconditioned Space, Return Air Ducts: Seal Class B.
 - 8. Conditioned Space, Supply Air Ducts in Pressure Classes 2-Inch w.g. and Lower: Seal Class C.
 - 9. Conditioned Space, Supply Air Ducts in Pressure Classes Higher Than 2-Inch w.g.: Seal Class B.
 - 10. Conditioned Space, Exhaust Ducts: Seal Class B.

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11. Conditioned Space, Return Air Ducts: Seal Class C.

B. Leakage Tests:

1. Test 100 percent of installed ductwork for leakage in accordance with "System Pressure Testing for Leaks," published by United Sheet Metal Division of United McGill Corporation. Use prescribed test kit containing test blower, two U-tube manometers and calibrated curve attached to the orifice tube assembly.
2. Pressurize installed duct system in 2-inch water gauge over design operating pressure. Total allowable leakage shall not exceed one percent of air handling capacity of system. If system is tested in sections, add leakage rates for individual sections to determine leakage for the whole system.
3. Correct leaks found in excess of allowable limits. Retest.
4. Have test results available for review on a progressive and final basis. Include test results in project closing file.
5. For bidding purposes, assume that all leakage tests will be witnessed by the Engineer. Notify the Engineer of testing schedule a minimum of 7 days in advance.
6. Disassemble, reassemble, and seal segments of systems to accommodate leakage testing and for compliance with test requirements.
7. Test for leaks before applying external insulation.

3.04 HANGER AND SUPPORT INSTALLATION

- A. Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Chapter 5, "Hangers and Supports."
- B. Building Attachments: Concrete inserts, powder actuated fasteners, or structural steel fasteners appropriate for construction materials to which hangers are being attached.
 1. Where practical, install concrete inserts before placing concrete.
 2. Install powder actuated concrete fasteners after concrete is placed and completely cured.
 3. Use powder actuated concrete fasteners for standard weight aggregate concretes or for slabs more than 4 inches thick.

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- 4. Do not use powder actuated concrete fasteners for lightweight aggregate concretes or for slabs less than 4 inches thick.
- 5. Do not use powder actuated concrete fasteners for seismic restraints.
- C. Hanger Spacing: Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Table 5-1, "Rectangular Duct Hangers Minimum Size," and Table 5-2, "Minimum Hanger Sizes for Round Duct," for maximum hanger spacing; install hangers and supports within 24 inches of each elbow and within 48 inches of each branch intersection.
- D. Hangers Exposed to View: Provide threaded rod and angle or channel supports.
- E. Threaded Rods: Provide double nuts and washers.
- F. Support vertical ducts with steel angles or channel secured to the sides of the duct with welds, bolts, sheet metal screws, or blind rivets; support at each floor and at a maximum interval of 16 feet.
- G. Install upper attachments to structures. Select and size upper attachments with pull-out, tension, and shear capacities appropriate for supported loads and building materials where used.

3.05 SEISMIC RESTRAINT DEVICE INSTALLATION

- A. Install ducts with hangers and braces designed to support the duct and to restrain against seismic forces required by applicable building codes. Comply with SMACNA's "Seismic Restraint Manual: Guidelines for Mechanical Systems" and ASCE/SEI 7.

3.06 CONNECTIONS

- A. Make connections to equipment with flexible connectors complying with Section 23 33 00, AIR DUCT ACCESSORIES.
- B. Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible" for branch, outlet and inlet, and terminal unit connections.

3.07 DUCT CLEANING

- A. Clean duct system before testing, adjusting, and balancing.
- B. Use service openings for entry and inspection.

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1. Create new openings and install access panels appropriate for duct static-pressure class if required for cleaning access. Provide insulated panels for insulated or lined duct. Patch insulation and liner as recommended by duct liner manufacturer. Comply with Section 23 33 00, AIR DUCT ACCESSORIES for access panels and doors.
2. Disconnect and reconnect flexible ducts as needed for cleaning and inspection.
3. Where applicable, remove and reinstall ceiling to gain access during the cleaning process.

C. Particulate Collection and Odor Control:

1. When venting vacuuming system inside the building, use HEPA filtration with 99.97 percent collection efficiency for 0.3-micron-size (or larger) particles.
2. When venting vacuuming system to outdoors, use filter to collect debris removed from HVAC system, and locate exhaust downwind and away from air intakes and other points of entry into building.

D. Clean the following components by removing surface contaminants and deposits:

1. Air outlets and inlets (registers, grilles, and diffusers).
2. Supply, return, and exhaust fans including fan housings, plenums (except ceiling supply and return plenums), scrolls, blades or vanes, shafts, baffles, dampers, and drive assemblies.
3. Air handling unit internal surfaces and components including mixing box, coil section, condensate drain pans, filters and filter sections, and condensate collectors and drains.
4. Coils and related components.
5. Return air ducts, dampers, actuators, and turning vanes except in ceiling plenums and mechanical equipment rooms.
6. Supply air ducts, dampers, actuators, and turning vanes.
7. Dedicated exhaust and ventilation components and makeup air systems.

E. Mechanical Cleaning Methodology:

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1. Clean metal duct systems using mechanical cleaning methods that extract contaminants from within duct systems and remove contaminants from building.
2. Use vacuum collection devices that are operated continuously during cleaning. Connect vacuum device to downstream end of duct sections so areas being cleaned are under negative pressure.
3. Use mechanical agitation to dislodge debris adhered to interior duct surfaces without damaging integrity of metal ducts, duct liner, or duct accessories.
4. Antimicrobial Agents and Coatings: Apply EPA registered antimicrobial agents if fungus is present. Apply antimicrobial agents according to manufacturer's written instructions after removal of surface deposits and debris.

3.08 START UP

- A. Air Balance: Comply with the requirements of Section 23 05 93, TESTING, ADJUSTING, AND BALANCING FOR HVAC.

3.09 DUCT SCHEDULE

- A. Fabricate ducts with **galvanized steel** sheet except as otherwise indicated on the Drawings and as follows hereinafter.
- B. Supply Ducts:
 1. Ducts Connected to Fan Coil Units, Furnaces, Heat Pumps, and Terminal Units:
 - a. Pressure Class: Positive 2-inch w.g.
 - b. Minimum SMACNA Seal Class: C.
 - c. SMACNA Leakage Class for Rectangular: 16.
 - d. SMACNA Leakage Class for Round and Flat Oval: 8.
 2. Ducts Connected to Constant Volume Air Handling Units:
 - a. Pressure Class: Positive 2-inch w.g.
 - b. Minimum SMACNA Seal Class: C.
 - c. SMACNA Leakage Class for Rectangular: 16.
 - d. SMACNA Leakage Class for Round and Flat Oval: 8.
- C. Return Ducts:

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1. Ducts Connected to Fan Coil Units, Furnaces, Heat Pumps, and Terminal Units:
 - a. Pressure Class: Positive or negative 2-inch w.g.
 - b. Minimum SMACNA Seal Class: C.
 - c. SMACNA Leakage Class for Rectangular: 16.
 - d. SMACNA Leakage Class for Round and Flat Oval: 8.
 2. Ducts Connected to Air Handling Units:
 - a. Pressure Class: Positive or negative 2-inch w.g.
 - b. Minimum SMACNA Seal Class: C.
 - c. SMACNA Leakage Class for Rectangular: 16.
 - d. SMACNA Leakage Class for Round and Flat Oval: 8.
- D. Exhaust Ducts:
1. Ducts Connected to Fans Exhausting (ASHRAE 62.1, Class 1 and 2) Air:
 - a. Pressure Class: Negative 2-inch w.g.
 - b. Minimum SMACNA Seal Class: C if negative pressure, and A if positive pressure.
 - c. SMACNA Leakage Class for Rectangular: 16.
 - d. SMACNA Leakage Class for Round and Flat Oval: 8.
 2. Ducts Connected to Air Handling Units:
 - a. Pressure Class: Positive or negative 3-inch w.g.
 - b. Minimum SMACNA Seal Class: B if negative pressure, and A if positive pressure.
 - c. SMACNA Leakage Class for Rectangular: 8.
 - d. SMACNA Leakage Class for Round and Flat Oval: 4.
- E. Intermediate Reinforcement:
1. Galvanized Steel Ducts: Galvanized steel.
- F. Elbow Configuration:
1. Rectangular Duct: Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Figure 4-2, "Rectangular Elbows."
 - a. Velocity 1000 fpm or Lower:

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- 1) Radius Type RE 1 with minimum 0.5 radius to diameter ratio.
 - 2) Mitered Type RE 4 without vanes.
 - b. Velocity 1000 to 1500 fpm:
 - 1) Radius Type RE 1 with minimum 1.0 radius to diameter ratio.
 - 2) Radius Type RE 3 with minimum 0.5 radius to diameter ratio and two vanes.
 - 3) Mitered Type RE 2 with vanes complying with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Figure 4-3, "Vanes and Vane Runners," and Figure 4-4, "Vane Support in Elbows."
 - c. Velocity 1500 fpm or Higher:
 - 1) Radius Type RE 1 with minimum 1.5 radius to diameter ratio.
 - 2) Radius Type RE 3 with minimum 1.0 radius to diameter ratio and two vanes.
 - 3) Mitered Type RE 2 with vanes complying with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Figure 4-3, "Vanes and Vane Runners," and Figure 4-4, "Vane Support in Elbows."
2. Rectangular Duct: Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Figure 4-2, "Rectangular Elbows."
 - a. Radius Type RE 1 with minimum 1.5 radius to diameter ratio.
 - b. Radius Type RE 3 with minimum 1.0 radius to diameter ratio and two vanes.
 - c. Mitered Type RE 2 with vanes complying with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Figure 4-3, "Vanes and Vane Runners," and Figure 4-4, "Vane Support in Elbows."
3. Round Duct: Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Figure 3-4, "Round Duct Elbows."
 - a. Minimum Radius to Diameter Ratio and Elbow Segments: Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Table 3-1, "Mitered Elbows." Elbows with less than a 90 degree change of direction have proportionately fewer segments.

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- 1) Velocity 1000 fpm or Lower: 0.5 radius to diameter ratio and three segments for 90 degree elbow.
 - 2) Velocity 1000 to 1500 fpm: 1.0 radius to diameter ratio and four segments for 90 degree elbow.
 - 3) Velocity 1500 fpm or Higher: 1.5 radius to diameter ratio and five segments for 90 degree elbow.
- b. Round Elbows, 12 Inches and Smaller in Diameter: Stamped or pleated.
 - c. Round Elbows, 14 Inches and Larger in Diameter: Standing seam.

G. Branch Configuration:

1. Rectangular Duct: Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Figure 4-6, "Branch Connection."
 - a. Rectangular Main to Rectangular Branch: 45 degree entry.
 - b. Rectangular Main to Round Branch: Spin in.
2. Round Duct: Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Figure 3-5, "90 Degree Tees and Laterals," and Figure 3-6, "Conical Tees." Saddle taps are permitted in existing duct.
 - a. Velocity 1000 fpm or Lower: 90 degree tap.
 - b. Velocity 1000 to 1500 fpm: Conical tap.
 - c. Velocity 1500 fpm or Higher: 45 degree lateral.

END OF SECTION 23 31 13

DIVISION 23 00 00 – HEATING, VENTILATING, AND AIR CONDITIONING (HVAC)**PART 1 GENERAL****1.01 WORK INCLUDED**

- A. This section includes the work required to furnish and install, complete, intake and exhaust fixed/stationary metal air louvers.
- B. The extent of the work for louvers is indicated on the Drawings and in applicable schedules, and by the requirements of this section.

1.02 GENERAL AND PERFORMANCE REQUIREMENTS

- A. See general requirements.
- B. System Performance Requirements: Provide aluminum louver units that comply with requirements shown on the Drawings and specified, as demonstrated by testing manufacturer's stock systems according to test methods indicated.
- C. Design Concept: Drawings indicate size, profiles, dimensional, and performance requirements of louvers required. Louvers by various manufacturers may be considered provided deviations do not change the design concept and these specifications are met.
- D. Like items of equipment or materials provided hereunder shall be the end products of one manufacturer to achieve standardization for appearance, maintenance, and replacement, and shall include all necessary appurtenances for a complete and working system. The equipment or materials shall be the product of a manufacturer regularly engaged in the production of equipment or materials for the specified use. The manufacturer shall have the sole responsibility for the proper functioning and coordination of the equipment or materials as furnished.
- E. The Contractor or their sub-contractors shall provide all required miscellaneous equipment and materials, as shown on the Drawings and in accordance with these Specifications. The Contractor or their sub-contractors shall furnish all equipment and material items, whether specified or not, as necessary to provide a complete, operable HVAC system.

1.03 SUBMITTALS

- A. Submittals shall include the following:
 - 1. Product data, including construction details and fabrication methods; profiles, gauges, and dimensions of individual components; data on hardware, accessories, and finishes; capacities, ratings, and

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performance characteristics; and recommendations for maintenance and cleaning of exterior surfaces.

2. Shop drawings including installation details, elevations, anchors, full size details of typical composite members, reinforcement, hardware, and accessories.
3. Sample Wiring Diagrams: Submit manufacturer's electrical requirements for power supply wiring to equipment. Submit manufacturer's ladder type wiring diagrams for interlock and control wiring. Clearly differentiate between portions of wiring that are factory installed and portions to be field installed.
4. Operation and Maintenance Data: Submit operation and maintenance instructions, including lubrication instructions, motor and drive replacement, and spare parts lists. Include this data, product data, shop drawings in maintenance manuals.
5. Certification by an independent testing laboratory showing that louvers comply with performance requirements indicated.

1.04 QUALITY AND REFERENCE STANDARDS

- A. Manufacturer's specifications, recommendations, and installation instructions. All louvers shall be factory engineered to withstand seismic loads specified on the Drawings. Minimum design loads shall be calculated in accordance with ASCE 7.
- B. Manufacturer's Qualifications: Firms regularly engaged in manufacture of air outlets and inlets of types and capacities required, whose products have been in satisfactory use in similar service for not less than 5 years.
- C. American Society of Heating, Refrigerating, and Air Conditioning Engineers (ASHRAE) Compliance: Test and rate air outlets and inlets in accordance with ASHRAE 70 "Method of Testing the Performance of Air Outlets and Air Inlets".
- D. Air Movement and Control Association International (AMCA) Compliance: Test and rate louvers in accordance with AMCA 500-L "Laboratory Methods of Testing Louvers for Rating". Perform all work according to AMCA Certification for water penetration, air performance, and wind driven rain according to AMCA 500-L.
- E. AMCA Seal: Provide louvers bearing AMCA Certified Rating Seal. AMCA certified ratings seal applies to air performance and water penetration ratings.

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- F. National Fire Protection Association (NFPA) Compliance: Install air outlets and inlets in accordance with NFPA 90A "Standard for the Installation of Air Conditioning and Ventilating Systems".
- G. The Aluminum Association (AA): AA DAF-45 "Designation System for Aluminum Finishes".
- H. Louvers Requiring Electrical Connection: Listed and classified by UL or another testing firm acceptable to authority having jurisdiction as suitable for intended purpose.
- I. Other reference standards noted in this specification section.

PART 2 PRODUCTS**2.01 GENERAL**

- A. The use of a manufacturer's name and model or catalog number is for establishing the standard of quality and general configuration desired only. Products of other manufacturers will be considered in accordance with the General Conditions.
- B. System Description: Aluminum framed, shop fabricated and factory finished fixed louvers. Furnish systems with related flashings, anchorages, and attachment devices. System assembly shall be shop unitized without damage to components or deterioration of seals; and shall accommodate movement within the system, movement between the system and peripheral construction, dynamic loading and release of loads, and deflection of structural support framing.
- C. Design Conditions: Exterior louvers and fasteners shall be designed to resist a minimum wind load of 30 psf. All louvers shall be rated and tested per AMCA 500-L. In addition, exterior units shall have no more than 0.01 ounces per square foot water penetration at the scheduled airflow volume, or at a free velocity of 900 feet per minute, whichever is greater. All units shall permit passage of air at maximum velocity without blade vibration or noise.

2.02 GENERAL MATERIALS AND ACCESSORIES

- A. Manufacturers: Subject to compliance with requirements, provide products of one of the following. The first manufacturer listed is used as the basis of the design in schedules on the Drawings.
 - 1. Ruskin Company.

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2. Greenheck Fan Corporation.
 3. Construction Specialties Inc.
 4. Nailor Industries Inc.
 5. Or equal.
- B. Aluminum Extrusions: ASTM B221 6063-T5 or 6063-T6 alloy and temper recommended for strength, corrosion resistance, and application of finish, minimum 0.081-inch wall thickness or as specified hereinafter.
- C. Sheet Aluminum: ASTM B209 3003, 5005, or 5052 alloy; H15 or H34 temper.
- D. Fasteners: Aluminum, non-magnetic stainless steel, epoxy adhesive, or other materials warranted to be noncorrosive and compatible with louver members, trim, hardware, anchors, and other components.
1. Where fasteners screw-anchor into aluminum less than 0.125-inch thick, reinforce the interior with aluminum or nonmagnetic stainless steel to receive screw threads or provide standard noncorrosive pressed-in splined grommet nuts.
 2. Do not use exposed fasteners.
- E. Anchors, Clips, and Louver Accessories: Aluminum, non-magnetic stainless steel or zinc-coated steel complying with ASTM B633 and with sufficient strength to withstand design pressure indicated.
- F. Fabrication: Fabricate to comply with indicated standards and as further specified hereinafter. Include complete system for assembly of components and anchorage.
- G. Factory Finishes: Comply with National Association of Architectural Metal Manufacturers (NAAMM) "Metal Finishes Manual" for application and designations of finishes. Designations prefixed by "AA" conform to system established by Aluminum Association for designating aluminum finishes. Provide either 0.7 mil factory anodized finish or factory fluoropolymer coating finish as specified further below:
1. Anodized Finish: Clear anodized per AAMA 611 "Voluntary Specification for Anodized Architectural Aluminum", AA-M12C22A41 or similar, Architectural Class I, minimum 0.7 mils.

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2. Fluoropolymer Finish: High performance organic fluoropolymer coating system, 70 percent polyvinylidene fluoride (PVDF, sometimes called Kynar 500 or Hylar 5000) resin complying with AAMA 2605, minimum one prime coat and two finish coats at 1.2 mils minimum total dry film thickness. Finish coat(s) shall be applied following a thorough cleaning, pretreatment and prime coating of the aluminum extrusions. Cleaning shall include complete submersion in an acid cleaner, an alkali cleaner, an acid deoxidation, an amorphous chrome phosphate conversion coating and an acidulated final rinse. Extrusions shall be dried before application of primer coat. Dry film thickness of the primer coat shall be approximately 0.2 to 0.3 mil after baking at 350 degrees F for 10 to 15 minutes and cooled at ambient temperature. Kynar top coat(s) shall be applied to provide a top coat dry film thickness of approximately 0.8 to 1.2 mils when baked at 450 degrees F for 10 minutes.

H. Sealants: As specified in Section 07 90 00, CAULKING AND SEALANTS.

2.03 FIXED/STATIONARY AIR LOUVERS

- A. Performance: Provide louvers that have minimum free area, and maximum pressure drop of each type as listed in manufacturer's current data, complying with the size (panel depth and face dimensions), type, and capacity listed in Louver Schedule on the Drawings.
- B. Substrate Compatibility: Provide louvers with frame and sill styles that are compatible with adjacent substrate, and that are specifically manufactured to fit into construction openings with accurate fit and adequate support, for weatherproof installation. Refer to the Drawings and other related specifications for types of substrate which will contain each type of louver.
- C. Materials: Architectural fixed louver assembly constructed of aluminum extrusions as specified hereinbefore. Weld units or use stainless steel fasteners. Provide with Z-shaped, sloped baffle style, stormproof blades spaced on 3-inch to 6-inch centers with 35-degree to 45-degree pitch angle; concealed intermediate mullions with profile to suit louver frame; extruded head and sill flashings to required shape of single length in one piece for each location; and interior duct collar if shown on the Drawings. Blades for exterior louvers shall be drainable style. Reinforce blades with intermediate stiffeners as required. Mullions shall be provided where indicated, or for all louvers greater than 5 feet in width, same material and finish as louvers.
- D. Louver Bird and Insect Screens: On inside face of exterior louvers, provide 1/2-inch to 3/4-inch square mesh anodized aluminum wire (minimum 0.06-inch diameter or 0.04-inch to 0.06-inch expanded, flattened) bird screens, and

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18 by 16 mesh aluminum insect screens, mounted in removable extruded aluminum frame.

- E. Accessories: Provide the following accessories when called out on the Drawings.
1. Aluminum Blank-off Panels: 0.040-inch aluminum sheet, factory installed with removable fasteners and neoprene gaskets.
 2. Insulated Aluminum Blank-off Panels: 0.040-inch aluminum sheet, 2-inch aluminum skin insulated core, factory installed with removable fasteners and neoprene gaskets.
 3. Hinged Frame: Continuous piano hinge attached to angle or channel subframe.
 4. Filter Racks: Formed channel racks to accept standard 1-inch or 2-inch thick filters. Unused bottom portion shall be blanked off with aluminum blank-off panels as specified hereinbefore.
 5. Extended Sills: Extruded aluminum, Alloy 6063-T6. Minimum nominal thickness shall be 0.081-inch.

PART 3 EXECUTION**3.01 DELIVERY, STORAGE, AND HANDLING**

- A. Deliver louvers and all accessories, cartoned or packaged, to prevent damage and deterioration.
1. Properly identify each item.
 2. Provide cardboard, separators, banding, spreaders, and paper wrappings to protect units from damage during and after installation.
 3. Accept louvers on-site in manufacturer's packaging. Inspect for damage. Replace damaged units with new, undamaged units.
- B. Store louvers and accessories upright according to manufacturer's instructions, in protected dry area, at least 1-inch off ground or floor and at least 1/4-inch between individual pieces.
1. Follow special storage and handling requirements of manufacturer.
 2. Protect exposed finish surfaces of prefinished items with masking tape.

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- 3. Store in designated areas as close as possible to point of installation. Protect from weather, dirt, fumes, water, construction debris, and physical damage.
- C. Comply with manufacturer's rigging and installation instructions for unloading equipment and moving to final location.

3.02 EXAMINATION AND PREPARATION

- A. Examine surfaces and structures to receive the work of this section. Verify that structure walls, openings and other similar items affecting the work in this section are in place and positioned correctly. Verify that rough or masonry opening is correct and the sill plate is level. Do not proceed until unsuitable conditions have been corrected. Starting work constitutes acceptance of conditions as suitable to the proper execution of the work.
- B. Take measurements at the site and fabricate work to suit. Verify that field measurements are as indicated on shop drawings, and opening sizes and tolerances are acceptable. No changes will be made in the structure to accommodate this work.
- C. Clean opening thoroughly prior to installation. Prepare surfaces using methods recommended by the manufacturer for achieving the best result for the substrate under the project conditions.

3.03 GENERAL LOUVER INSTALLATION

- A. Installation: Comply with reference standards, recognized industry practice, the Drawings, and manufacturer's recommendations and instructions for installation of louvers and other components to ensure that products serve intended function. Set louvers plumb, level, and true to line, without warp or rack of frames, and at indicated alignment with adjacent work. Anchor securely in place, permitting sufficient adjustment to accommodate construction tolerances and other irregularities. Provide alignment attachments and shims to permanently fasten system to building structure.
- B. Set sill members in a bed of compound or with joint fillers or gaskets to provide weathertight construction. Coordinate installation with wall flashings and other components of the work. Install and align components to drain condensation, water penetrating joints, and moisture migrating within louvers to the exterior.
- C. Clean aluminum promptly after installation. Avoid damage to finishes. Remove excess sealant compounds, dirt, and other substances. Repair finishes damaged by cutting, welding, soldering, and grinding. Restore finishes so no evidence remains of corrective work. Return items that

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cannot be refinished in the field to the factory, make required alterations, and refinish entire unit or provide new units.

- D. Aluminum and any other metal surfaces in contact with concrete, cement plaster, or stucco; or any dissimilar metals in contact with each other; shall be coated with manufacturer's specified isolation paint, sealant, or isolation tape, cut to neat line.
- E. Louvers shall be erected securely, plumb, level, square, and in proper alignment with other work in accordance with manufacturer's installation instructions. Use concealed anchorages where possible. Provide brass or lead washers fitted to screws where required to protect metal surfaces and to make a weather tight connection. Provide perimeter reveals and openings of uniform width for sealants and joint fillers, as indicated.
- F. Installation shall be weathertight. Set with joint fillers or gaskets to provide weathertight construction. Coordinate installation with other components of the work such as attachment and seal of perimeter air and vapor retarder materials. Provide thermal isolation where components penetrate or disrupt building insulation. Pack fibrous insulation in shim spaces at perimeter of assembly to maintain continuity of thermal barrier.

3.04 PROTECTION, ADJUSTMENT, AND CLEANING

- A. Protect installed louvers and accessories against damage from other construction work. Protect aluminum surfaces from contact with contaminating substances resulting from construction operations. In addition, monitor surfaces adjacent to and below exterior concrete and masonry surfaces during construction for presence of dirt, scum, alkaline deposits, stains, or other contaminants. If contaminating substances do contact louver surfaces, remove contaminants immediately according to manufacturer's written recommendations.
- B. Restore louvers and accessories damaged during installation and construction so no evidence remains of corrective work. If results of restoration are unsuccessful, as determined by Engineer/Architect, remove damaged units and replace with new units. Touch up minor abrasions in finishes with air-dried coating that matches color and gloss of, and is compatible with, factory-applied finish coating.
- C. After erection, the Contractor shall protect exposed portions from damage by machines, plaster, line, paint, acid cement, or other harmful compounds. The Contractor shall be responsible for removal of protective materials and cleaning with plain water, water with soap, or household detergent.

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- D. Clean exposed surfaces of louvers and accessories that are not protected by temporary covering, to remove fingerprints and soil during construction period. Do not let soil accumulate until final cleaning. Upon completion and before final acceptance, clean exposed surfaces of louvers and frames thoroughly with water and a mild soap or detergent not harmful to finishes. Thoroughly rinse surfaces and dry. Remove any smears and other unsightly marks.

END OF SECTION 23 33 30

SECTION 23 34 23
HVAC POWER VENTILATORS

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PART 1 GENERAL

1.01 WORK INCLUDED

- A. This section covers work for furnishing and installing power ventilators for HVAC systems on this project, complete. This includes the following items:
 - 1. Centrifugal roof ventilators.

1.02 GENERAL REQUIREMENTS

- A. Like items of equipment or materials provided hereunder shall be the end products of one manufacturer to achieve standardization for appearance, maintenance, and replacement, and shall include all necessary appurtenances for a complete and working system. The equipment or materials shall be the product of a manufacturer regularly engaged in the production of equipment or materials for the specified use. The manufacturer shall have the sole responsibility for the proper functioning and coordination of the equipment or materials as furnished.
- B. The Contractor or their sub-contractors shall provide all required miscellaneous equipment and materials, as shown on the Drawings and in accordance with these Specifications. The Contractor or their sub-contractors shall furnish all equipment and material items, whether specified or not, as necessary to provide a complete, operable HVAC system.

1.03 SUBMITTALS

- A. Submit product data on all power ventilator equipment and accessories used on this project. Include dimensional drawings with mounting details, connection details, and wiring diagrams.

1.04 QUALITY ASSURANCE AND ASSEMBLY REQUIREMENTS

- A. Electrical Components, Devices, and Accessories: Listed and labeled as defined in National Fire Protection Association (NFPA) 70, by a qualified testing agency, and marked for intended location and application.
- B. UL Compliance: UL listed and labeled, designed, manufactured, and tested in accordance with UL 705, "Power Ventilators".

1.05 OPERATION AND MAINTENANCE MANUALS

- A. Operation and Maintenance (O&M) Manuals and Maintenance Summary Sheets for the equipment specified herein shall be furnished as specified in Section 01 77 00, CONTRACT CLOSEOUT in Division 01 00 00, GENERAL REQUIREMENTS.

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- B. The O&M manuals shall contain full descriptions of all equipment specified herein, motor data, spare parts lists, and detailed instructions for all operation and maintenance tasks to be performed by the operator.
- C. A spare manual shall be shipped with the equipment to allow for proper installation and operation of the equipment prior to the release of all final Installation, Operation, and Maintenance manuals.

1.06 EXTRA MATERIALS

- A. Furnish to the Owner extra materials described below that match products installed and that are packaged with a protective covering for storage and identified with labels describing the contents. The quantities listed shall be in addition to any materials that were replaced prior final testing, adjusting, and balancing services.
 - 1. Fan Belts: Furnish two sets of belts for each belt-driven ventilator or fan.

1.07 PROJECT CONDITIONS

- A. Unless stated otherwise, the environment and air streams can include varying concentrations of the following chemical components:
 - 1. Sodium Permanganate
 - 2. Condensation.

1.08 WARRANTY

- A. Special Warranty: Manufacturer's standard form in which manufacturer agrees to repair or replace components of equipment that fail in materials or workmanship within specified warranty period.
 - 1. Warranty Period for Power Ventilators: Two years from the date of Substantial Completion.

PART 2 PRODUCTS

2.01 CENTRFUGAL ROOF VENTILATORS

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - 1. Loren Cook Company.
 - 2. Acme Engineering and Manufacturing Corp.

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3. Aerovent.
 4. Greenheck Fan Corporation.
 5. Or equal.
- B. Housing: Heavy gauge, removable, spun aluminum, dome top and outlet baffle; square, one piece, aluminum base with venturi inlet cone.
1. Upblast Units: Provide spun aluminum discharge baffle to direct discharge air upward, with rain and snow drains.
 2. Hinged Subbase: Galvanized steel hinged arrangement permitting service and maintenance.
- C. Fan Wheels: Aluminum hub and wheel with backward inclined blades , direct driven.
- D. Accessories: As scheduled on the Drawings; options include the following:
1. Disconnect Switch: Nonfusible type, with thermal overload protection mounted outside fan housing, factory wired through an internal aluminum conduit.
 2. Bird Screens: Removable, 1/2-inch mesh, aluminum or brass wire.
 3. Dampers: Counterbalanced, parallel blade, backdraft dampers mounted in curb base; factory set to close when fan stops.
- E. Roof Curbs: Galvanized steel; mitered and welded corners; 1-1/2-inch thick, rigid, fiberglass insulation adhered to inside walls; and 1-1/2-inch wood nailer. Size as required to suit roof opening and fan base.
1. Configuration: Self-flashing without a cant strip, with mounting flange.
 2. Pitch Mounting: Manufacture curb for roof slope.
 3. Metal Liner: Galvanized steel.
 4. Mounting Pedestal: Galvanized steel with removable access panel.
 5. Vented Curb: Unlined with louvered vents in vertical sides.
 6. Hinged Curb Kit: Provide to allow the fan to be tilted to access inlet dampers and to inspect the fan wheel.

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F. Capacities and Characteristics: See Schedule on the Drawings.

2.02 CENTRIFUGAL WALL VENTILATORS

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

1. Loren Cook Company.
2. Acme Engineering and Manufacturing Corp.
3. Aerovent.
4. Greenheck Fan Corporation.
5. Or equal.

B. Housing: Heavy gauge, removable, spun aluminum, dome top and outlet baffle; venturi inlet cone.

C. Fan Wheel: Aluminum hub and wheel with backward inclined blades, direct driven.

D. Accessories: As scheduled on the Drawings; options include the following:

1. Disconnect Switch: Nonfusible type, with thermal overload protection mounted outside fan housing, factory wired through an internal aluminum conduit.
2. Bird Screens: Removable, 1/2-inch mesh, aluminum or brass wire.
3. Dampers: Counterbalanced, parallel blade, backdraft dampers mounted in wall sleeve; factory set to close when fan stops.

E. Capacities and Characteristics: See Schedule on the Drawings.

2.03 MOTORS

A. Comply with NEMA designation and temperature rating appropriate for the specific application and location. Motors shall be high efficiency type.

B. Motor Sizes: Minimum motor size shall be as indicated in the Schedule(s) on the Drawings. If not indicated, and even if indicated, motor size shall be large enough so that the driven load will not require the motor to operate in a service factor range above 1.00.

C. Enclosure Type: Totally enclosed, fan cooled.

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PART 3 EXECUTION

3.01 INSTALLATION

- A. Equipment Mounting:
- B. Secure roof mounted fans to roof curbs with cadmium plated hardware.
- C. Install units with clearances for service and maintenance.

3.02 CONNECTIONS

- A. Install ducts adjacent to power ventilators to allow service and maintenance.
- B. Ground equipment according to Section 26 05 26, GROUNDING AND BONDING.
- C. Connect wiring according to Section 26 05 19, LOW VOLTAGE ELECTRICAL POWER CONDUCTORS AND CABLES.

3.03 FIELD QUALITY CONTROL

- A. Tests and Inspections:
 - 1. Verify that shipping, blocking, and bracing are removed.
 - 2. Verify that each unit is secure on mountings and supporting devices and that connections to ducts and electrical components are complete. Verify that proper thermal overload protection is installed in motors, starters, and disconnect switches.
 - 3. Verify that cleaning and adjusting are complete.
 - 4. Disconnect fan drive from motor, verify proper motor rotation direction, and verify fan wheel free rotation and smooth bearing operation. Reconnect fan drive system, align and adjust belts, and install belt guards.
 - 5. Adjust belt tension.
 - 6. Adjust damper linkages for proper damper operation.
 - 7. Verify lubrication for bearings and other moving parts.
 - 8. Verify that manual and automatic volume control and fire and smoke dampers in connected ductwork systems are in fully open position.

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9. Disable automatic temperature control operators, energize motor and adjust fan to indicated rpm, and measure and record motor voltage and amperage.
 10. Shut unit down and reconnect automatic temperature control operators.
 11. Remove and replace malfunctioning units and retest as specified above.
- B. Test and adjust controls and safeties. Replace damaged and malfunctioning controls and equipment.
- C. Prepare test and inspection reports.

3.04 ADJUSTING

- A. Adjust damper linkages for proper damper operation.
- B. Replace fan and motor pulleys as required to achieve design airflows.
- C. Lubricate all bearings.

END OF SECTION 23 34 23

SECTION 23 81 26

SPLIT-SYSTEM AIR-CONDITIONERS

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PART 1 GENERAL

1.01 SUMMARY

- A. Section includes split-system air-conditioning and heat-pump units consisting of separate evaporator-fan and compressor-condenser components.

1.02 SUBMITTALS

- A. See general requirements.

1.03 QUALITY ASSURANCE

- A. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.
- B. ASHRAE Compliance:
 - 1. Fabricate and label refrigeration system to comply with ASHRAE 15, "Safety Standard for Refrigeration Systems."
 - 2. ASHRAE Compliance: Applicable requirements in ASHRAE 62.1, Section 4 - "Outdoor Air Quality," Section 5 - "Systems and Equipment," Section 6 - "Procedures," and Section 7 - "Construction and System Start-up."
- C. ASHRAE/IESNA Compliance: Applicable requirements in ASHRAE/IESNA 90.1.

1.04 WARRANTY

- A. Special Warranty: Manufacturer's standard form in which manufacturer agrees to repair or replace components of split-system air-conditioning units that fail in materials or workmanship within specified warranty period.
 - 1. Warranty Period:
 - a. For Compressor: Five years from date of Substantial Completion.
 - b. For Parts: One year from date of Substantial Completion.
 - c. For Labor: One year from date of Substantial Completion.

1.05 PRODUCTS

1.06 MANUFACTURERS

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A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

1. Lennox
2. Daikin
3. Goodman
4. York / JCI
5. Carrier
6. Trane

1.07 INDOOR UNITS (5 TONS OR LESS)

A. Concealed Evaporator-Fan Components:

1. Chassis: Galvanized steel with flanged edges, removable panels for servicing, and insulation on back of panel.
2. Insulation: Faced, glass-fiber duct liner.
3. Refrigerant Coil: Copper tube, with mechanically bonded aluminum fins and thermal-expansion valve. Comply with ARI 206/110.
4. Electric Coil: Helical, nickel-chrome, resistance-wire heating elements; with refractory ceramic support bushings, automatic-reset thermal cutout, built-in magnetic contactors, manual-reset thermal cutout, airflow proving device, and one-time fuses in terminal box for overcurrent protection.
5. Fan: Forward-curved, double-width wheel of galvanized steel; directly connected to motor.
6. Fan Motors:
 - a. Comply with NEMA designation, temperature rating, service factor, enclosure type, and efficiency requirements specified in
 - b. Multitapped, multispeed with internal thermal protection and permanent lubrication.
 - c. Wiring Terminations: Connect motor to chassis wiring with plug connection.

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7. Airstream Surfaces: Surfaces in contact with the airstream shall comply with requirements in ASHRAE 62.1.
 8. Filters: Permanent, cleanable.
 9. Condensate Drain Pans:
 - a. Fabricated with one percent slope minimum in at least two planes to collect condensate from cooling coils (including coil piping connections, coil headers, and return bends) and humidifiers, and to direct water toward drain connection.
 - 1) Length: Extend drain pan downstream from leaving face to comply with ASHRAE 62.1.
 - 2) Depth: A minimum of 2-inches deep.
 - b. Single-wall, galvanized-steel sheet.
 - c. Drain Connection: Located at lowest point of pan and sized to prevent overflow. Terminate with threaded nipple on one end of pan.
 - 1) Minimum Connection Size: NPS 1.
 - d. Pan-Top Surface Coating: Asphaltic waterproofing compound.
 - e. Units with stacked coils shall have an intermediate drain pan to collect condensate from top coil.
- B. Floor-Mounted, Evaporator-Fan Components:
1. Cabinet: Enameled steel with removable panels on front and ends in color selected by Architect.
 - a. Discharge Grille: Steel with surface-mounted frame.
 - b. Insulation: Faced, glass-fiber duct liner.
 - c. Drain Pans: Galvanized steel, with connection for drain; insulated.
 2. Refrigerant Coil: Copper tube, with mechanically bonded aluminum fins and thermal-expansion valve. Comply with ARI 206/110.
 3. Electric Coil: Helical, nickel-chrome, resistance-wire heating elements; with refractory ceramic support bushings, automatic-reset thermal cutout, built-in magnetic contactors, manual-reset thermal cutout, airflow proving device, and one-time fuses in terminal box for overcurrent protection.

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4. Fan: Direct drive, centrifugal.
5. Fan Motors:
 - a. Comply with NEMA designation, temperature rating, service factor, enclosure type, and efficiency requirements specified in Section 230513 "Common Motor Requirements for HVAC Equipment."
 - b. Multitapped, multispeed with internal thermal protection and permanent lubrication.
6. Air Filtration Section:
 - a. General Requirements for Air Filtration Section:
 - 1) Comply with NFPA 90A.
 - 2) Minimum Arrestance: According to ASHRAE 52.1 and MERV according to ASHRAE 52.2.
 - 3) Filter-Holding Frames: Arranged for flat or angular orientation, with access doors on both sides of unit. Filters shall be removable from one side or lifted out from access plenum.
 - b. Disposable Panel Filters:
 - 1) Factory-fabricated, viscous-coated, flat-panel type.
 - 2) Thickness: 2-inches.
 - 3) Merv according to ASHRAE 52.2: 6.
 - 4) Media: Interlaced glass fibers sprayed with nonflammable adhesive.
 - 5) Frame: Galvanized steel, with metal grid on outlet side, steel rod grid on inlet side, and hinged; with pull and retaining handles.
 - 6) Wall-Mounted, Evaporator-Fan Components:
7. Cabinet: Enameled steel with removable panels on front and ends in color selected by Architect, and discharge drain pans with drain connection.
8. Refrigerant Coil: Copper tube, with mechanically bonded aluminum fins and thermal-expansion valve. Comply with ARI 206/110.
9. Electric Coil: Helical, nickel-chrome, resistance-wire heating elements; with refractory ceramic support bushings, automatic-reset thermal cutout, built-in magnetic contactors, manual-reset thermal

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cutout, airflow proving device, and one-time fuses in terminal box for overcurrent protection.

10. Fan: Direct drive, centrifugal.
11. Fan Motors:
 - a. Comply with NEMA designation, temperature rating, service factor, enclosure type, and efficiency requirements specified in Section 230513 "Common Motor Requirements for HVAC Equipment."
 - b. Multitapped, multispeed with internal thermal protection and permanent lubrication.
 - c. NEMA Premium (TM) efficient motors as defined in NEMA MG 1.
 - d. Controllers, Electrical Devices, and Wiring: Comply with requirements for electrical devices and connections specified in electrical Sections.
12. Airstream Surfaces: Surfaces in contact with the airstream shall comply with requirements in ASHRAE 62.1.
13. Condensate Drain Pans:
 - a. Fabricated with one percent minimum slope in at least two planes to collect condensate from cooling coils (including coil piping connections, coil headers, and return bends) and humidifiers, and to direct water toward drain connection.
 - 1) Length: Extend drain pan downstream from leaving face to comply with ASHRAE 62.1.
 - 2) Depth: A minimum of 1-inch deep.
 - b. Single-wall, galvanized-steel sheet.
 - c. Drain Connection: Located at lowest point of pan and sized to prevent overflow. Terminate with threaded nipple on one end of pan.
 - 1) Minimum Connection Size: NPS 1.
 - d. Pan-Top Surface Coating: Asphaltic waterproofing compound.
14. Air Filtration Section:
 - a. General Requirements for Air Filtration Section:

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- 1) Comply with NFPA 90A.
 - 2) Minimum Arrestance: According to ASHRAE 52.1 and MERV according to ASHRAE 52.2.
 - 3) Filter-Holding Frames: Arranged for flat or angular orientation, with access doors on both sides of unit. Filters shall be removable from one side or lifted out from access plenum.
- b. Disposable Panel Filters:
- 1) Factory-fabricated, viscous-coated, flat-panel type.
 - 2) Thickness: 2-inches.
 - 3) Merv according to ASHRAE 52.2: 6.
 - 4) Media: Interlaced glass fibers sprayed with nonflammable adhesive.
 - 5) Frame: Galvanized steel, with metal grid on outlet side, steel rod grid on inlet side, and hinged; with pull and retaining handles.

1.08 OUTDOOR UNITS (5 TONS OR LESS)

A. Air-Cooled, Compressor-Condenser Components:

1. Casing: Steel, finished with baked enamel in color selected by Architect, with removable panels for access to controls, weep holes for water drainage, and mounting holes in base. Provide brass service valves, fittings, and gage ports on exterior of casing.
2. Compressor: Hermetically sealed with crankcase heater and mounted on vibration isolation device. Compressor motor shall have thermal- and current-sensitive overload devices, start capacitor, relay, and contactor.
 - a. Compressor Type: Scroll.
 - b. Two-speed compressor motor with manual-reset high-pressure switch and automatic-reset low-pressure switch.
 - c. Refrigerant Charge: R-410A.
 - d. Refrigerant Coil: Copper tube, with mechanically bonded aluminum fins and liquid subcooler. Comply with ARI 206/110.
3. Heat-Pump Components: Reversing valve and low-temperature-air cutoff thermostat.
4. Fan: Aluminum-propeller type, directly connected to motor.

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5. Motor: Permanently lubricated, with integral thermal-overload protection.
6. Low Ambient Kit: Permits operation down to 45 deg F.
7. Mounting Base: Polyethylene.

1.09 ACCESSORIES

- A. Thermostat: Low voltage with subbase to control compressor and evaporator fan.
- B. Automatic-reset timer to prevent rapid cycling of compressor.
- C. Refrigerant Line Kits: Soft-annealed copper suction and liquid lines factory cleaned, dried, pressurized, and sealed; factory-insulated suction line with flared fittings at both ends.

1.10 CAPACITIES AND CHARACTERISTICS

- A. Cooling Capacity:
 1. See Drawings
- B. Heating Capacity:
 1. See Drawings

PART 2 EXECUTION

2.01 INSTALLATION

- A. Install units level and plumb.
- B. Install evaporator-fan components using manufacturer's standard mounting devices securely fastened to building structure.
- C. Install roof-mounted, compressor-condenser components on equipment supports specified in Section 077200 "Roof Accessories." Anchor units to supports with removable, cadmium-plated fasteners.
- D. Equipment Mounting:
 1. Install ground-mounted, compressor-condenser components on pre-cast mounting pads.

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- E. Install and connect precharged refrigerant tubing to component's quick-connect fittings. Install tubing to allow access to unit.

2.02 CONNECTIONS

- A. Piping installation requirements are specified in other Sections. Drawings indicate general arrangement of piping, fittings, and specialties.
- B. Where piping is installed adjacent to unit, allow space for service and maintenance of unit.
- C. Duct Connections: Duct installation requirements are specified other Sections. Drawings indicate general arrangement of ducting, fittings, and accessories.

2.03 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. Leak Test: After installation, charge system and test for leaks. Repair leaks and retest until no leaks exist.
 - 2. Operational Test: After electrical circuitry has been energized, start units to confirm proper motor rotation and unit operation.
 - 3. Test and adjust controls and safeties. Replace damaged and malfunctioning controls and equipment.
- C. Remove and replace malfunctioning units and retest as specified above.
- D. Prepare test and inspection reports.

2.04 DEMONSTRATION

- A. Train Owner's maintenance personnel to adjust, operate, and maintain units.

END OF SECTION 23 81 26

SECTION 26 00 10
GENERAL REQUIREMENTS OF ELECTRICAL,
COMMUNICATIONS AND ELECTRONIC
SAFETY AND SECURITY

DIVISION 26 00 00 – ELECTRICAL

PART 1 GENERAL

1.01 SUMMARY

- A. The requirements listed in this section are supplemental to the Division 01 General Requirements.
- B. It shall be the responsibility of the Electrical and Low-voltage Contractors to examine and refer to all Architectural, Civil, Structural, Mechanical, Plumbing and Landscape drawings and specifications for construction conditions which may affect the scope of Electrical, Communications, Electronic Safety and Security work. Inspect the building site and existing facilities for verification of present conditions. Make proper provisions for these conditions in performance of the work and cost thereof.
- C. Electrical, Communications, Electronic Safety and Security work for this project shall include all items, articles, materials and the associated labor mentioned, schedules or shown in these specifications and in the accompanying drawings.
- D. Furnish and install all equipment, materials and any required incidental items required by good practice to complete the systems described herein.
- E. Refer to Division 01 00 00 for all listed Alternates and provide separate pricing and work as indicated in Division 01 00 00 and Contract Documents.

1.02 DEFINITIONS - THROUGHOUT CONTRACT DOCUMENTS THESE WORDS AND PHRASES ARE USED:

- A. Contract documents - All drawings, specifications, addenda and change orders that document work to be done.
- B. Demolition – Carefully disconnect and remove items. All reasonable caution shall be taken to avoid damaging removed equipment and to retain its operability.
- C. Remove back to source - Remove all conduit and wire back to panelboard or last live device.
- D. Equivalent or equal - Product of like type and function that complies with all applicable provisions of drawings and specifications and which has been approved as substitute for specified item.
- E. Furnish - Purchase material as shown and specified, and place material to approved location on site or elsewhere as noted or agreed upon.

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- F. Install - Set in place and connect, ready for use and in complete and properly operating finished condition.
- G. Provide - Furnish and install with all products, labor, sub-contracts, and appurtenances required for a complete and properly operating, finished condition.
- H. Rough-in - Provide conduit raceway system with junction boxes, fittings, straps, BUSHINGS, etc., for future installation of wiring, devices, disconnects and breakers. Provision shall be made in panelboard (hardware, etc.) for future installation of breakers.
- I. Serviceable - Arranged so that component or product in question may be properly removed and replaced without disassembly, destruction or damage to surrounding installation.

1.03 CODES, STANDARDS AND REGULATIONS

- A. Codes - Perform all work in strict accordance with all applicable national, state and local codes; including, but not limited to latest legally enacted editions of the following codes:
 - 1. NFPA 70, National Electric Code – NEC
 - 2. NFPA 72, National Fire Alarm Code
 - 3. ANSI-C2, National Electrical Safety Code – NESC
 - 4. International Building Code – IBC
 - 5. International Fire Code – IFC
 - 6. International Energy Conservation Code – IECC
- B. Standards - Reference to standards infers that installation, equipment and material shall be within limits for which it was designed, tested and approved, in conformance with current publications and standards of following organizations:
 - 1. American National Standards Institute – ANSI
 - 2. American Society for Testing and Materials – ASTM
 - 3. American Society of Heating Refrigerating and Air Conditioning Engineers – ASHRAE (Standard 90-75)

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4. Institute of Electrical and Electronics Engineers – IEEE
 5. Insulated Cable Engineers Association – ICEA
 6. National Electrical Contractors Association – NECA
 7. National Electrical Manufacturers' Association – NEMA
 8. National Fire Protection Association – NFPA
 9. Occupational Safety and Health Administration – OSHA
 10. Underwriters' Laboratories, Inc. – UL
 11. Rules and Regulations of the State/Local Fire Marshal
 12. Standards and Requirement of the Serving Utilities
 13. State and Local Ordinances
- C. Regulations - Design has been performed in accordance with applicable regulations and guidelines noted below. Contractor shall carefully apply these regulations and bring any discrepancies to immediate attention of Engineer.
1. Americans with Disabilities Act – ADA

1.04 FEES AND PERMITS

- A. Electrical Contractor shall pay for all permits or fees in connection with electrical work. Fees shall include any or all user fees, government fees, system development fees, connection fees or other fees that are required to be paid before systems can be connected or used.
- B. Schedule all required electrical inspections with local electrical inspector. Notify engineer of all items of discrepancy noted by electrical inspector if those items affect cost or function of system, or if they conflict with electrical drawings and specifications.
- C. All Utility Cost and fees from the utility work shall be the responsibility of the Owner. Contractor to coordinate all utility requirements, standards and responsibilities with serving utility for a complete scope of work prior to bid.
- D. Deliver all inspection certificates to Engineer prior to final acceptance of work.

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1.05 INTENT OF SPECIFICATIONS AND DRAWINGS

- A. Plans and specifications are intended to result in complete electrical installation in full compliance with all applicable codes, standards and ordinances.
- B. Plans and specifications are to supplement each other, and any details contained in one shall be included as if contained in both.
- C. Electrical drawings shall serve as working drawings, but Architectural drawings shall take precedence if any dimensional discrepancies exist.
- D. Drawings are partly diagrammatic and do not show routing of conduits, exact location of products, or installation features in exact detail. Locations of devices, fixtures and equipment are approximate unless dimensioned.
- E. Riser diagrams and control schematics are not to scale and do not show physical arrangement of equipment. Do not use riser diagrams or schematics to obtain lineal conduit and cabling distances.
- F. Items are shown on drawings in locations to minimize interference with other equipment, structural members, etc. Exact finish locations are not indicated, however, and all work shall be done to avoid interference, preserve headroom and keep openings and passageways clear.
- G. In event that discrepancies of any kind exist or required items/details have been omitted, Contractor shall notify Engineer in writing of such discrepancy or omission at least ten days prior to bid date. Failure to do so shall be construed as willingness of Contractor to supply all necessary materials and labor required for proper completion of work.

1.06 CONTRACTOR'S RESPONSIBILITY

- A. Contractor shall be responsible for installation of complete and functional piece of work in accordance with true intent of contract documents. Provide all incidental items required for complete installation and satisfactory operation of all equipment, whether or not specifically noted in contract documents.
- B. **QUALIFICATIONS**
 - 1. Contractor shall employ on this project, capable, experienced and reliable foreman and such skilled workmen as may be required for various classes of work to be performed.

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2. Where special skills and certification are required, Contractor shall ensure that work is performed by individuals with required experience, skill and certification.
 3. If, in Engineer's opinion, Contractor's employees do not possess necessary qualifications to perform specialty work, Contractor will be required to obtain services of workmen who are approved by manufacturer and certified by applicable agency or group. These workmen, if required, shall be provided at no additional expense.
 4. Refer to other specification sections for additional required contractor qualifications and certification.
- C. LICENSING AND CERTIFICATION - All Division 26 00 00 work shall be accomplished by Electricians, licensed by state in which work is being done, certified as required, and skilled in their craft. Electrician may elect to hire subcontractors for portions of work (such as systems described in Divisions 27 00 00 and 28 00 00) who are not licensed electricians, but have required certificates and are licensed in their discipline by state in which work is being done.
- D. COORDINATION
1. Contractor shall consult all contract documents, shop drawings of other trades, and actual building dimensions to predetermine that his work and equipment will fit as planned. Do not scale drawings for fabrication. No extra payment will be issued for materials or items which do not fit because of Contractor's failure to verify as-built building dimensions.
 2. Contractor shall check location of fixtures, outlets, equipment, conduit, etc., to determine they clear all openings, structural members, piping, ducts and miscellaneous equipment having fixed locations.
 3. Changes in location of electrical work, necessary due to obstacles or installation of other trades shown on contract documents, shall be made by Electrical Contractor at no extra cost.
 4. Contractor shall coordinate with Plumbing and Mechanical Contractors to avoid installation of piping and ductwork above or below panels in violation of National Electrical Code.
 5. Lay out all work in advance and avoid conflict with other work in progress. Physical dimensions shall be determined from architectural and structural plans. Verify locations for junction boxes, disconnect

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switches, stub-ups, etc., for connection to equipment furnished by others, or in other Divisions of this work.

6. Contractor shall coordinate and plan work to proceed with work of other trades.
7. Contractor shall inform General Contractor of all required openings in building structure for installation of electrical equipment.
8. Contractor shall check dimensions of all electrical equipment installed, provided by himself or by others, so correct clearances and connections can be made.
9. Consulting all contract documents and shop drawings of other trades, contractor shall determine where electrical junction/pull boxes and equipment can be installed to maintain proper accessibility. Where accessibility cannot be maintained by judicious placement of boxes, Electrical Contractor shall coordinate with General Contractor to provide, fabricate, install, adjust, paint, etc. access doors through non-accessible floor, wall, and ceiling finishes to allow access to all electrical junction and pull boxes, electrical devices, electrical equipment, etc. at all required locations whether shown or not shown on plans. Electrical Contractor is responsible for determining size and location of the access doors. Report any conflicts to Engineer.

1.07 REVIEW

- A. All work and material is subject to review at any time by the Engineer or his representative. If the Engineer or his representative finds material that does not conform to these specifications or that is not properly installed or finished, correct the deficiencies in a manner satisfactory to the Engineer at the Contractor's expense.

1.08 TEMPORARY FACILITIES

A. ELECTRICAL UTILITIES

1. The Electrical Contractor shall provide temporary electrical power to the construction site as directed by the General Contractor. No connections to the owner's system shall be allowed without owner's written approval. Provide a separate utility service as required.
2. The Electrical Contractor shall provide temporary electrical power to job trailers as directed by the General Contractor.

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3. The Electrical Contractor shall provide temporary communications to job trailers as directed by the General Contractor.
4. All Costs associated with temporary power, communications and utility cost shall be paid by to the General Contractor.
5. The Electrical Contractor shall provide temporary construction lighting as directed by the General Contractor to provide a safe working environment.
6. All temporary services are to be removed in their entirety prior to occupancy as directed by the General Contractor.

B. OFFICES

1. The Electrical Contractor must have the permission of the Owner and General Contractor or Construction Manager to install a temporary office/job trailer on the project site.
2. Contractor shall completely remove his temporary installations when no longer needed and the premises shall be completely clean, disinfected, patched, and refinished to match adjacent areas.

C. LADDERS AND SCAFFOLDS

1. The Electrical and Low-voltage Contractors shall provide their own ladders, scaffolds, etc. of substantial construction for access to their work in various portions of the building as may be required. When no longer needed, they shall be removed by the Contractor.

D. PROTECTION DEVICES

1. The Electrical and Low-voltage Contractors shall provide and maintain their own necessary barricades, fences, signal lights, etc., required by all governing authorities or shown on the drawings. When no longer needed, they shall be removed by the Contractor.

E. TEMPORARY FIRE PROTECTION

1. The Electrical and Low-voltage Contractors shall provide all necessary first aid, hand fire extinguishers for Class A, B, C and special hazards as may exist in their own work area only in accordance with good and safe practice and as required by jurisdictional safety authority.

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1.09 RECORD DOCUMENTS (AS-BUILT DRAWINGS)

- A. See requirements regarding record documents in General Division and Division 01 00 00.
- B. At beginning of work, Contractor shall set aside one complete set of drawings which shall be maintained as complete "As-Built" set. Drawings shall be updated daily in neat and legible manner and shall not be used for any other purpose. Drawings, specification, addenda, change orders, etc. shall be maintained at job site and available for review at any time.
- C. Show dimensioned location and routing of all electrical work that will become permanently concealed, cast in concrete or buried underground.
- D. Show complete routing and sizing of any significant revisions to systems shown.
- E. Show provisions for future connection, referenced to building lines or approved benchmarks.
- F. Provide wiring diagrams for all individual communications systems as installed. Identify all components and show all wire and terminal numbers and connections.
- G. At completion of project, deliver drawings to Engineer for review.

1.10 WARRANTY

- A. The Contractor shall guarantee that all materials and labor installed are new and of first quality and that any material or labor found defective shall be replaced without cost to the Owner within two (2) years after substantial completion of the Contract or two (2) full seasons of heating and cooling operation, whichever is the greater. The guarantee shall list the date of the beginning of the two (2) year period, which shall be the date that the Substantial Completion Certificate is issued.
- B. Any damage to the building, caused by defective work or material of the Contractor within the above-mentioned period, shall be satisfactorily repaired without cost to the Owner.
- C. The guarantee does not include maintenance of equipment. The Owner shall accept full responsibility for proper operation and maintenance of equipment immediately upon substantial completion and occupancy of the building.

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- D. Final acceptance by the Owner will not occur until all operating instructions are mounted in Equipment Rooms and Operating Personnel thoroughly indoctrinated in the operation of all electrical equipment by the Contractor.
- E. No equipment installed as part of this project shall be used for temporary heat during construction.

PART 2 PRODUCTS

2.01 MATERIALS AND EQUIPMENT

- A. Manufacturer's trade names and catalog numbers listed are intended to indicate the quality of equipment or materials desired. Manufacturers not listed in the specification will be considered substitutions and must have prior approval.
- B. See Division 01 00 00 for Substitutions Procedures. Requests for substitution are to be submitted sufficiently ahead of the deadline, to give ample time for examination. Prior approval request for substitution must indicate the specific item or items to be furnished in lieu of those scheduled, together with complete technical and comparative data on scheduled items and items proposed for substitution.
- C. If the engineer approves any proposed substitution, the approved product will be listed in an addendum. Bidders shall not rely on approval made in any other manner.
- D. Electrical equipment may be installed with manufacturer's standard finish and color except where specific color, finish or choice is indicated. If the manufacturer has no standard finish, equipment shall have a prime coat and two finish coats of gray enamel.
- E. High altitude operation: Capacity of all equipment is to be sized and manufactured to perform at the elevation of the project site. If not specifically indicated in the equipment schedule or in the specifications provide all required accessories and equipment for proper operation at elevation of the project site.
- F. This Contractor shall be responsible for materials and equipment installed under this contract. Contractor shall also be responsible for the protection of materials and equipment of others from damage as a result of his work.
- G. Manufactured material and equipment shall be applied, installed, connected, erected, used, cleaned and conditioned as directed by manufacturer unless herein specified to the contrary.

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- H. This Contractor shall make the required arrangement with General Contractor or Construction Manager for the introduction into the building of equipment too large to pass through finished openings.
- I. Store materials and equipment indoors at the job site or, if this is not possible, store on raised platforms and protect from the weather by means of waterproof covers. Coverings shall permit circulation of air around the materials to prevent condensation of moisture. Screen or cap openings in equipment to prevent the entry of vermin.

2.02 SUBSTITUTION OF MATERIALS

- A. Where substituted equipment requires structural, architectural, mechanical, plumbing or electrical work that differs from basic design, cost of all changes, including re-design, shall be the responsibility of contractor using substitution.
- B. **APPROVED MANUFACTURERS**
 - 1. In general, one particular manufacturer and part number or series is listed to describe equipment. Equivalent equipment of other manufacturers listed for that item may be substituted without prior approval. It shall be Contractor's responsibility to ensure that item used for bidding purposes is truly equivalent to that specified. If it is not equivalent, it will be rejected at shop drawing review and Contractor shall supply specified item at his own cost.
 - 2. It is understood that manufacturers listed may not actually have equivalent product to that specified. If contractor/distributor has any questions regarding desired product characteristics and suitability of proposed substitution, he is encouraged to submit for prior approval. Also, any manufacturer not listed shall be submitted for prior approval.
- C. **PRIOR APPROVALS**
 - 1. Manufacturers not listed in specification or on schedule for a particular item are open for substitution prior to bid opening only.
 - 2. Manufacturers desiring approval shall submit catalog cuts that define quality of product and ability to perform as specified. It is understood that no two manufactures use identical methods or make identical products. Any and all deviations from that specified shall be clearly noted.

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3. Submittals shall arrive at Engineer at least ten (10) days prior to bid opening. All approvals will be listed in last addendum as being approved to bid. Items substituted, but not listed in contract documents, will not be considered if submitted on shop drawings.
4. Approval of substitute equipment is on basis of quality only. Materials supplier shall be responsible for his quotation reflecting proper selection of his particular equipment with regard to proper capacities, physical dimensions, requirements, intended function, finish, color, etc. Engineer will not give approval to specific model numbers or check capacities, dimensions, or requirements. Evaluation will be on basis of quality and equality to specified items.
5. Prior approval shall be obtained from engineer and no other entity (architect, owner, etc.) is authorized to give such approval.

D. SAMPLES

1. Where, in Engineer's opinion, product sample is required in order to determine appearance, quality, workmanship or operation, Contractor shall submit actual production samples of item in question.
2. Samples will be returned to Contractor. Approved samples may be used.
3. All costs incurred in providing and returning samples will be Contractor's responsibility.

2.03 PRODUCT AND SYSTEM SUBMITTALS

- A.** Submittals will be required for each piece of equipment, material or product as noted in the table below. All submittal shall be submitted, reviewed and all discrepancies addressed prior to ordering equipment or starting work. Any equipment ordered without having first completed the submittal process is done at the risk of the contractor. Any work performed prior to completing the submittal process is done at the risk of the contractor.

B. SUBMITTAL DEFINITIONS

1. **Product Data:** Provide manufacturers cut sheets that include general product information including but not limited to: Model Number, physical data, nominal capacities, rough-in requirements.
2. **Performance Data:** Provide detailed performance and capacities based on project specific requirements including but not limited to:

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voltage, phase, amperage, overcurrent protection, conductor size, conductor material, conduit size, color temperature, color rendering index, life expectancy, efficacy, efficiency, IP ratings, light distribution types and lighting control.

3. Shop Drawings: Provide detailed drawings of the equipment showing overall dimensions, location of electrical connection, location of anchorage points, location of electrical and control panels, and all operating, service and maintenance clearances.
4. Delegated Design: Provide detailed drawings prepared and stamped by a registered Professional Engineer that detail pertinent design criteria, the materials and products to be installed and the required installation locations.
5. Wiring Diagram: Provide diagrams that identify and detail required field wiring.
6. Color Chart: Provide a physical color chart of material samples required for selection of equipment colors.
7. Sustainability Compliance: Provide literature that indicated a products compliance with LEED or Green Globes. See Division 01 for additional information and requirements.

C. SUBMITTAL FORMATS

1. Include the following information with each submittal:
 - a. Project Name
 - b. Submittal Date
 - c. Name of Engineer
 - d. Name of General Contractor or Construction Manager
 - e. Name of Sub-Contractor
 - f. Name of firm or entity that prepared the submittal
 - g. Unique Submittal Number
 - h. Type of Submittal
 - i. Specification Section
 - j. Name or Mark of equipment or material and detail or drawings reference.
2. All Submittal with the exception of color charts or material samples shall be electronically transmitted PDFs. All submittals over 8 Mb shall be setup on a share file site and access granted through email with folder's link for download.

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D. SUBMITTAL REQUIREMENTS

1. Submittals shall be submitted as a complete specification section. The submittal must include all materials and equipment for that specification section. Submittals for individual materials of equipment will be rejected without review.
2. Submittals shall be complete, clearly show item used, size, dimensions, capacity, rough in, etc., as required for complete check and installation. Manufacturer's literature showing more than one item shall be clearly marked as to which item is being furnished or it will be rejected and returned without review.
3. Each submittal shall be thoroughly checked by the Contractor for compliance with the Contract Document requirements, accuracy of dimensions, relationship to the work of other trades, and conformance with sound, safe practices as to erection and installation. Each submittal shall then bear a stamp evidencing such checking and shall show corrections made, if any. Submittals requiring extensive corrections shall be revised before submission. Each submittal not stamped and signed by the General and Electrical Contractors evidencing such checking will be rejected and returned without review.
4. On each submittal, clearly indicate deviations from requirements in the Contract Documents, including minor variations and limitations; include relevant additional information and revisions, other than those requested on previous submittals. Indicate by highlighting on each submittal or noting on attached separate sheet.
5. Review of the shop drawings and literature by the engineer shall not relieve the contractor for responsibility for deviations for the drawings or specifications, nor shall it relieve the contractor from responsibility for errors in the shop drawings or literature. It is the responsibility of the contractor to provide materials and equipment which meet the specifications and job requirements.
6. Luminaires submittals shall include dimensions, quality, distribution, color rendering index, color temperature, optics, photometrics, all listings (UL, DLC, Energy Star, Made in America, etc.), IP ratings, voltage, wattage, warranty, installation methods, control methods, efficacy, efficiency, diffuser options, emergency operation and any required accessories. Provide IES and Revit files upon request.

E. ENGINEER'S REVIEW - Submittal review is for general design and arrangement only and does not relieve Contractor from any requirements of

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contract documents. Submittals will not be checked for quantity, dimension, fit or proper technical design of manufactured equipment. Where product or system performance deviations have not been specifically noted in submittal by Contractor, Engineer's review will not relieve Contractor's responsibility to provide complete and satisfactory working installation of equal quality and performance to specified system. Ordering, manufacture, shipment or installation of equipment prior to receipt of Engineer's written review is strictly at Contractor's risk and all costs associated with shipping, changes, replacement or restocking shall be Contractor's responsibility.

2.04 SUB-CONTRACTORS

- A. With shop drawing submittals, Contractor shall submit list of all sub-contractors to be used for the project.

2.05 OPERATION AND MAINTENANCE MANUALS

- A. Operation and Maintenance Manuals (O&M Manuals) shall contain:
 - 1. Names and contact information for the Project Engineer.
 - 2. Names and contact information for the General Contractor or Construction Manager.
 - 3. Names and contact information for sub-contractors.
 - 4. Installation, maintenance and operating instructions for each piece of equipment.
 - 5. Parts lists
 - 6. Wiring Diagrams
 - 7. Equipment Start-up and inspection certificates
 - 8. Test and Balance Reports
 - 9. Commissioning Reports
 - 10. Copies of Equipment Warranties
 - 11. Copies of Submittals
 - 12. Record Drawings.
 - 13. Training DVD's.

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- B. Prior to substantial completion submit an electronic copy of the O&M manual in PDF format to the Engineer and Owner for Review and approval. The PDF shall be one file with an index and hyperlinks to each section. Individual bound PDFs without automated navigation will be rejected. All O&M data shall be grouped by the equipment type and ordered by the specification numbering.
- C. Prior to final payment a final electronic copy of the O&M manual on an archival quality DVD as well as two printed copies shall be furnished to the owner. Printed copies shall have commercial quality 8-1/2" x 11" 3-ring binders with tabbed dividers for each section.

PART 3 EXECUTION

3.01 SITE EXAMINATION

- A. Prior to submitting bid, Contractor shall visit site of proposed work and familiarize himself with conditions affecting work. Allowance shall be made in bid for these conditions and no additional allowance shall be granted because of lack of knowledge of such conditions.
- B. Contractor shall verify all measurements at building site.

3.02 CUTTING AND PATCHING

- A. Obtain written permission of Engineer before cutting or piercing structural members.
- B. Sleeves through floors and walls shall be black iron pipe, flush with walls, ceilings or finished floors, sized to accommodate raceway. Grout all penetrations through concrete walls or floors. Holes through existing concrete and concrete block (CMU) shall be core drilled.

3.03 CLEAN-UP AND COMMISSIONING

- A. DURING CONSTRUCTION - Throughout construction, keep work area reasonably neat and orderly by periodic clean-ups.
- B. COMMISSIONING - As independent parts of construction are completed, they may be commissioned and utilized during construction. See various sections for restrictions.
- C. AT COMPLETION OF WORK
 - 1. Clean equipment of dirt and debris, including interior of panels, outlet boxes, etc. Remove labels from and clean all fixture lenses.

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2. Remove materials, scraps, etc., relative to this work and leave premises in clean and orderly condition. This includes all tunnels, attics, ceiling and crawl spaces.
3. Remove all temporary facilities and restore to conditions present prior to work.

3.04 PROJECT COMPLETION AND DEMONSTRATION

A. TESTING

1. Prior to final test, all switches, panelboards, devices, and fixtures shall be in place.
2. At completion of work, or upon request from Engineer, place entire electrical installation, and/or any portion thereof, in operation to demonstrate satisfactory operation.
3. All electrical systems shall be free from short circuits and unintentional grounds.
4. Furnish one (1) copy of certified test results to Engineer prior to final inspection and include one (1) copy in each Brochure of Equipment.

B. ADJUSTMENTS

1. Make all changes necessary to balance connected electrical loads on complete system. Arrange for balanced conditions of circuits under connected load demands, as contemplated by normal working conditions. Final load and balance test shall be demonstrated in presence of Engineer.
2. Immediately correct all deficiencies which are evidenced during tests and repeat tests until system is approved. Do not cover or conceal electrical installations until satisfactory tests are made and approved.

C. FINAL WALK-THRU

1. Conduct operating tests during final inspection. Demonstrate installation to operate satisfactorily in accordance with requirements of Contract Documents. Should any portion of installation fail to meet requirements of Contract Documents, repair or replace items failing to meet requirements until items can be demonstrated to comply.

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2. Have instruments available for measuring light intensities, voltage and current values and for demonstration of continuity, grounds, or open circuit conditions.
3. Furnish personnel to assist in taking measurements and making tests. In event that systems are not complete and fully operational at time of final inspection, all costs of any subsequent inspections shall be borne by Contractor at no additional cost to Owner.

3.05 OWNER ORIENTATION AND TRAINING

A. GENERAL

1. The system training is intended to familiarize the Owner's operating and maintenance staff with all systems requiring maintenance. Training is to be provided after the systems are in place and operational, after issues noted during commissioning have been resolved, and before final acceptance.
2. Provide second set of training sessions for automatic control systems about 6-9 months after the first sessions.
3. All Training shall be videotaped and reproduced on DVD's and given to the owner. Provide a copy for each O&M manual produced.
4. See Individual specification sections for additional training requirements.

B. ATTENDANCE

1. Training is to be provided by contractor's representatives that are familiar with the system's operation and maintenance requirements. Individual training sessions (modules) are to be provided for each type or group of systems, separated roughly by trade group that will be performing maintenance on the system.

C. SCHEDULE

1. Duplicate training sessions are to be provided for each training module, so that Owner's operating personnel can be split into two groups during training. Duplicate training sessions to be scheduled on different days. Length of training sessions will be determined by scope of training indicated below, and as coordinated with Owner after draft copy of training documents have been reviewed.

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D. TRAINING DOCUMENTATION

1. Contractor to submit draft copy of agenda and training documents to Owner for review at least two weeks prior to training date.
2. Provide a copy of the following items for each person that will be attending the training sessions. Coordinate required number with the Owner.
 - a. Training agenda.
 - b. Summary of new systems and existing systems affected by this project.
 - c. Summary of work performed under this project.
 - d. Control system drawings and sequences of operation.
 - e. List of important maintenance and trouble-shooting operations for all systems.
3. Provide minimum of 2 copies of following items:
 - a. Contract documents including all drawings, specifications, addendums, and change orders.

E. TRAINING SESSIONS

1. Assemble at location to be determined by the Owner.
2. Distribute training documentation as indicated above.
3. Provide classroom style training if required for orientation, discussion of new systems and existing systems affected by this project, and other issues appropriate for a classroom format.
4. Visit site and review locations, and perform detailed review of operation and maintenance requirements for current systems.
5. All training session shall be video recorded and distributed to the owner upon completion in DVD format, or owner desired format. Include all training videos in the O&M manual.

END OF SECTION 26 00 10

PART 1 GENERAL**1.01 WORK INCLUDED**

- A. This section covers the general provisions and basic materials and methods necessary for electrical work on this project, complete. The materials and methods covered in this section include:
 - 1. Equipment Cleanup.
 - 2. Cutting and Patching.
 - 3. Supports and Concrete Platforms, Foundations, and Pits.
 - 4. Electrical Equipment Coordination, Installation, and Provisions.
 - 5. Excavation, Trenching, and Backfilling.
 - 6. Connections to Special Equipment.
 - 7. Local Operator Stations.
 - 8. Common Electrical Installation Requirements.

1.02 GENERAL

- A. Also see the GENERAL CONDITIONS, Division 01 00 00, GENERAL REQUIREMENTS, and Section 26 00 10, GENERAL ELECTRICAL REQUIREMENTS which contain information and requirements that apply to the work specified herein and are mandatory for this project.
- B. Like items of equipment or materials provided hereunder shall be the end products of one manufacturer to achieve standardization for appearance, maintenance, and replacement, and shall include all necessary appurtenances for a complete and working system. The equipment or materials shall be the product of a manufacturer regularly engaged in the production of equipment or materials for the specified use. The manufacturer shall have the sole responsibility for the proper functioning and coordination of the equipment or materials as furnished.
- C. The Contractor or their sub-contractors shall provide all required miscellaneous equipment and materials, as shown on the Drawings and in accordance with these Specifications. The Contractor or their sub-contractors shall furnish all equipment and material items, whether specified or not, as necessary to provide a complete, operable electrical system.

1.03 SUBMITTALS

- A. Submittals shall be provided as specified in Section 01 33 00, SUBMITTALS and Section 26 00 10, GENERAL ELECTRICAL REQUIREMENTS.

1.04 QUALITY ASSURANCE

- A. All materials and equipment shall be new and of high quality, of the type best suited for the purpose intended, and be made by nationally recognized and substantially established manufacturers. The type and weight of material used for each purpose shall be as herein specified, and all material shall conform with the requirements of the latest standard specifications of the "ASTM" for that particular material.

PART 2 PRODUCTS

2.01 SUPPORTS AND CONCRETE PLATFORMS, FOUNDATIONS, AND PITS

- A. Unless otherwise specified or indicated, all floor mounted equipment (such as motor control centers) shall be anchored to two 4-inch by 2-inch minimum channel iron sills, by tack welding or bolting. Sills shall be furnished by the electrical sub-contractor to match the equipment provided and shall be installed so that equipment is 4 inches above floor level.
- B. Where a membrane waterproofed floor or concrete slab is under the equipment, there shall be provided a 4-inch high concrete platform poured separately on top of finished floor slab. This platform shall not extend more than 2 inches in all directions beyond the maximum dimensions of the equipment. The 4-inch channel sills specified above shall be furnished and installed in this platform.
- C. In addition to the above, the Contractor or the electrical sub-contractor shall provide all foundations and pits required for installation of work specified herein.
- D. All concrete work shall be as specified in Section 03 30 00, CONCRETE.

2.02 LOCAL OPERATOR STATIONS

- A. Wherever indicated in the Drawings or by other sections of this Project Manual, furnish and install local operator stations (LOSs) including installation hardware and all wiring. For Division 43 41 65, TYPE III CONCRETE CLARIFIER and Division 46 05 50, INSTALLATION OF OWNER FURNISHED CLARIFIER EQUIPMENT supplied LOSs, these shall be installed by the electrical sub-contractor including hardware

mounting and all wiring. Specifically, refer to the P&ID Drawings for more detail on LOS provisions.

PART 3 EXECUTION**3.01 ELECTRICAL EQUIPMENT COORDINATION, INSTALLATION, AND PROVISIONS**

- A. Coordinate the 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 slopes.
 - 4. So connecting raceways, cables, wireways, cable trays, and busways will be clear of obstructions and of the working and access space of other equipment.
- B. Wherever electrical switch gear, troughs, panelboards, etc., are indicated to be mounted on wall surfaces, the equipment shall be anchored to walls by means of toggle or expansion anchors of sufficient size to support the equipment. Equipment shall be attached to plywood by means of wood screws.
- C. Wherever indicated by the Drawings or by other sections of this Project Manual, furnish and install wiring troughs to facilitate connections to electrical equipment. Troughs shall be constructed of code gauge metal, prime coated inside and out and with a gray enamel finish coat. Covers shall be screw attachment type. Troughs shall be installed wherever two or more safety switches or motor starters occur at one location, fed from a common set of conductors, to allow tap connections to be made outside of the switch or starter cover.

3.02 CONNECTIONS TO SPECIAL EQUIPMENT

- A. Special equipment is hereby defined as all equipment that is not specified under Division 26 00 00, ELECTRICAL of this contract, but requires connections by the electrical sub-contractor, as indicated on the Drawings. Such connections shall be performed by the electrical sub-contractor. The electrical sub-contractor shall verify the locations of such connections by

securing from the Contractor and equipment suppliers' items such as templates, detail drawings, and roughing-in measurements.

- B. Unless otherwise specified, the Contractor or sub-contractor responsible for furnishing such equipment is also responsible for setting the equipment in place.
- C. All equipment included in Division 26 00 00, ELECTRICAL requiring connections by the Contractor or other sub-contractors shall be provided with proper openings, tapings, flanges, etc., ready for final connection.

3.03 EQUIPMENT CLEANUP

- A. Special care must be taken for the protection of panels, switches, starters, and other similar electrical items. All must be kept completely protected from weather elements, painting, dust and dirt, etc., until the facilities are substantially completed. Damage from rust, paint, scratches, etc., shall be corrected as directed by the Engineer.
- B. Clean all switchgear, motor controls, etc., and take special care to remove dirt, mortar, wire scraps, etc., from junction boxes and switchgear interiors.
- C. Clean light fixtures and lamps thoroughly, just prior to final inspection. Fixture globes, enclosures, shielding, etc., shall be cleaned by an approved method.
- D. Accessible elements of disconnecting and protective devices of equipment, coils of dry type transformers and the like shall be cleaned with compressed air (less than 15 psig) and the enclosures shall be vacuum cleaned prior to being energized.
- E. Protection of electrical equipment during painting of the facilities shall be the responsibility of the Contractor or their painting sub-contractor. This shall not relieve the electrical sub-contractor of the responsibility for checking to assure that adequate protection is being provided.

3.04 CUTTING AND PATCHING

- A. The Contractor will be required under their contract to leave all chases and openings in walls, floors, ceilings, partitions, etc., where shown on the Drawings or otherwise necessary to receive electrical work, but the electrical sub-contractor shall furnish the Contractor full information as to locations, dimensions, etc., of such chases and openings, including provision and proper setting of sleeves and other equipment in such time as to cause no delay to the work of the Contractor.

- B. Should any cutting of walls, floors, ceilings, partitions, etc., be required for proper installation of the work or apparatus of the electrical sub-contractor, or be made necessary on account of their failure to give the Contractor proper information at the time required, such cutting shall be done at the electrical sub-contractor's own expense, restoring the work to its original condition.
- C. All cutting and patching done by the electrical sub-contractor shall be subject to the direction and approval of the Engineer. This sub-contractor shall not endanger the stability of the structure by cutting, digging, or otherwise, and shall not be at any time cut or alter work of the Contractor or any other sub-contractor without the Engineer's consent.

3.05 EXCAVATION, TRENCHING, AND BACKFILLING

- A. The Division 26 00 00, ELECTRICAL sub-contractor shall perform all excavation required for underground power not installed by the applicable Power Company. Trenches shall be a minimum of 24 inches deep for power and other electrical lines, or as specified in other Sections, or as shown on the Drawings.
- B. Excavating, trenching, and backfilling shall be provided in accordance with Section 31 23 00, EARTHWORK FOR STRUCTURES and Section 31 23 33, TRENCH EXCAVATION AND BACKFILL FOR PIPELINES AND APPURTENANT STRUCTURES. Backfill material 4 inches below and above buried conduit shall be sand material.

3.06 COMMON REQUIREMENTS FOR ELECTRICAL INSTALLATION

- A. Comply with National Electrical Contractors Association (NECA) 1, Good Workmanship in Electrical Construction and the ANSI National Electrical Installation Standards.
- B. Unless shown otherwise on the Drawings, measure indicated mounting heights to bottom of unit for suspended items and to center of unit for wall mounted items.
- C. Headroom Maintenance: If mounting heights or other location criteria are not indicated on the Drawings, 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 right-of-way to piping systems installed at a required slope.

END OF SECTION 26 00 50

PART 1 GENERAL

1.01 SUMMARY

A. Section Includes:

1. Copper building wire rated 600 V or less.
2. Metal-clad cable, Type MC, rated 600 V or less.
3. Connectors, splices, and terminations rated 600 V and less.
4. VFD cables

B. Related Requirements:

1. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 00 00 Specification Sections, apply to this Section.

1.02 ACTION SUBMITTALS

A. Product Data: For each type of product.

PART 2 PRODUCTS

2.01 COPPER BUILDING WIRE

- A. Description:** Flexible, insulated and uninsulated, drawn copper current-carrying conductor with an overall insulation layer or jacket, or both, rated 600 V or less.
- B. Manufacturers:** Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
1. Alcan Products Corporation; Alcan Cable Division.
 2. Alpha Wire Company.
 3. Belden Inc.
 4. Cerro Wire LLC.
 5. Encore Wire Corporation.
 6. General Cable Technologies Corporation.

SECTION 26 05 19
LOW VOLTAGE ELECTRICAL

DIVISION 26 00 00 – ELECTRICAL **POWER CONDUCTORS AND CABLES**

7. Okonite Company.
 8. Service Wire Co.
 9. Southwire Incorporated.
 10. WESCO
- C. Standards:
1. Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and use.
 2. RoHS compliant.
 3. Conductor and Cable Marking: Comply with wire and cable marking according to UL's "Wire and Cable Marking and Application Guide."
- D. Conductors: Copper, complying with ASTM B 3 for bare annealed copper and with ASTM B 8 for stranded conductors.
- E. Conductor Insulation:
1. Type USE-2 and Type SE: Comply with UL 854.
 2. Type THHN and Type THWN-2: Comply with UL 83.
 3. Type THW-2: Comply with NEMA WC-70/ICEA S-95-658 and UL 83.
 4. Type XHHW-2: Comply with UL 44.

2.02 METAL-CLAD CABLE, TYPE MC

- A. Description: A factory assembly of one or more current-carrying insulated conductors in an overall metallic sheath.
- B. Approved for lighting whips 6' or less only.
- C. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
1. AFC Cable Systems.
 2. Alpha Wire Company.

SECTION 26 05 19
LOW VOLTAGE ELECTRICAL

DIVISION 26 00 00 – ELECTRICAL **POWER CONDUCTORS AND CABLES**

3. Belden Inc.
 4. Encore Wire Corporation.
 5. General Cable Technologies Corporation.
 6. Okonite Company.
 7. Service Wire Co.
 8. Southwire Incorporated.
 9. WESCO
- D. Standards:
1. Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and use.
 2. Comply with UL 1569.
- E. Conductor and Cable Marking: Comply with wire and cable marking according to UL's "Wire and Cable Marking and Application Guide."
- F. Conductors: Copper, complying with ASTM B 3 for bare annealed copper and with ASTM B 8 for stranded conductors.
- G. Ground Conductor: Insulated.
- H. Conductor Insulation:
1. Type TFN/THHN/THWN-2: Comply with UL 83.
- I. Armor: Steel, interlocked.
- J. Jacket: PVC applied over armor for mechanical connection or wet/damp environments

2.03 VARIABLE FREQUENCY CONTROLLER OUTPUT POWER CABLES

- A. 1000V UL Flexible Motor Supply Cable
- B. 3 conductors with one full conductor insulated ground (12AWG to 2AWG) or 3 symmetrical bare copper grounds (1AWG to 4/0AWG). If VFC output power cables are installed in parallel in the same raceway, auxiliary gutter, or cable tray, a single equipment grounding conductor that is sized in accordance with Table 250.122 of the NEC, shall be required in combination

with the equipment grounding conductors provided in the VFC output power cable and all be connected together.

- C. UL direct burial, Type XHHW-2, RHW-2 rated circuit conductors, PVC jacketed, shielded Type TC cable with XLPE insulation, 90 degree Celsius, Wet/Dry.

2.04 CONNECTORS AND SPLICES

- A. Description: Factory-fabricated connectors, splices, and lugs of size, ampacity rating, material, type, and class for application and service indicated; listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and use.
- B. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
 - 1. 3M Electrical Products
 - 2. AFC Cable Systems, Inc.
 - 3. Gardner Bender.
 - 4. Hubbell Power Systems, Inc.
 - 5. Ideal Industries, Inc.
 - 6. Ilsco; a branch of Bardes Corporation.
 - 7. NSi Industries LLC.
 - 8. O-Z/Gedney; a brand of the EGS Electrical Group.
 - 9. Service Wire Co.
 - 10. TE Connectivity Ltd.
 - 11. Thomas and Betts Corp

PART 3 EXECUTION

3.01 CONDUCTOR MATERIAL APPLICATIONS

- A. Feeders and Branch Circuits: Copper; solid for No. 10 AWG and smaller; stranded for No. 8 AWG and larger.

SECTION 26 05 19
LOW VOLTAGE ELECTRICAL

DIVISION 26 00 00 – ELECTRICAL **POWER CONDUCTORS AND CABLES**

3.02 CONDUCTOR INSULATION AND MULTICONDUCTOR CABLE APPLICATIONS AND WIRING METHODS

- A. Service Entrance: Type THHN/THWN-2, single conductors in raceway. Type SE or Type USE, multi-conductor cable.
- B. Feeders: Type THHN/THWN-2, single conductors in raceway. Metal-clad cable, Type MC. Nonmetallic-sheathed cable, Type NM.
- C. Branch Circuits: Type THHN/THWN-2, single conductors in raceway. Metal-clad cable, Type MC. Nonmetallic-sheathed cable, Type NM.
- D. Cord Drops and Portable Appliance Connections: Type SO, hard service cord with stainless-steel, wire-mesh, strain relief device at terminations to suit application.

3.03 INSTALLATION OF CONDUCTORS AND CABLES

- A. Conceal cables in finished walls, ceilings, and floors unless otherwise indicated.
- B. Complete raceway installation between conductor and cable termination points according to Section 26 05 33 "Raceways and Boxes for Electrical Systems" prior to pulling conductors and cables.
- C. 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 side-wall pressure values.
- D. Use pulling means, including fish tape, cable, rope, and basket-weave wire/cable grips, that will not damage cables or raceway.
- E. Install exposed cables parallel and perpendicular to surfaces of exposed structural members, and follow surface contours where possible.
- F. Support cables according to Section 26 05 29 "Hangers and Supports for Electrical Systems."
- G. Provide a dedicated neutral conductor for each 120 V branch circuit.

3.04 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-486B.

SECTION 26 05 19

LOW VOLTAGE ELECTRICAL

DIVISION 26 00 00 – ELECTRICAL **POWER CONDUCTORS AND CABLES**

- B. Make splices, terminations, 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 (150 mm) of slack.

3.05 IDENTIFICATION

- A. Identify and color-code conductors and cables according to Section 26 05 53 "Identification for Electrical Systems."
- B. Identify each spare conductor at each end with identity number and location of other end of conductor and identify as spare conductor.

3.06 SLEEVE AND SLEEVE-SEAL INSTALLATION FOR ELECTRICAL PENETRATIONS

- A. Install sleeves and sleeve seals at penetrations of exterior floor and wall assemblies. Comply with requirements in Section 26 05 44 "Sleeves and Sleeve Seals for Electrical Raceways and Cabling."

3.07 FIRESTOPPING

- A. Apply firestopping to electrical penetrations of fire-rated floor and wall assemblies to restore original fire-resistance rating of assembly.

END OF SECTION 26 05 19

PART 1 GENERAL

1.01 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 00 00 Specification Sections, apply to this Section.

1.02 SUMMARY

- A. RATIONALE – Grounding provides the foundation to the entire electrical system. This system is designed to:
 - B. Protect personnel.
 - C. Minimize damage to equipment and property in the event of high fault current situations,
 - D. Improve overall electrical system reliability, and
 - E. Minimize the effects of transient overvoltages.
 - F. Section includes grounding and bonding systems and equipment.
 - G. Section includes grounding and bonding systems and equipment, plus the following special applications:
 - 1. Underground distribution grounding.
 - 2. Foundation steel electrodes.

1.03 ACTION SUBMITTALS

- A. Product Data: For each type of product.

1.04 INFORMATIONAL SUBMITTALS

- A. Coordination Drawings: Plans showing dimensioned as-built locations of grounding features specified in "Field Quality Control" Article.
 - 1. Ground rods
 - 2. Concrete encased electrodes
- B. Qualification Data: For testing agency and testing agency's field supervisor.
- C. Field quality-control reports.

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- D. Photographs of ground rod installation prior to burial.
- E. Photographs of Cadweld connections to rebar and building steel.
- F. Photographs of connection to water service and all bonding jumpers.
- G. Certified test results from ground resistance measurements.

1.05 CLOSEOUT SUBMITTALS

- A. Operation and maintenance data.
 - 1. Plans showing as-built, dimensioned locations of grounding features specified in "Field Quality Control" Article, including the following:
 - a. Ground rods.
 - b. Concrete encased electrodes

PART 2 PRODUCTS

2.01 SYSTEM DESCRIPTION

- A. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.
- B. Comply with UL 467 for grounding and bonding materials and equipment.

2.02 CONDUCTORS

- A. Insulated Conductors: Copper wire or cable insulated for 600 V unless otherwise required by applicable Code or authorities having jurisdiction.
- B. Equipment and wiring device grounding conductor shall be as follows:
 - 1. Bare copper or have green insulation of same type as circuit conductors (larger wires may be permanently marked with green).
 - 2. Properly sized in accordance with the NEC.
- C. Bare Copper Conductors:
 - 1. Solid Conductors: ASTM B 3.
 - 2. Stranded Conductors: ASTM B 8.
 - 3. Tinned Conductors: ASTM B 33.

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4. Bonding Cable: 28 kcmil, 14 strands of No. 17 AWG conductor, 1/4 inch (6 mm) in diameter.
 5. Bonding Conductor: No. 4 or No. 6 AWG, stranded conductor.
 6. Bonding Jumper: Copper tape, braided conductors terminated with copper ferrules; 1-5/8 inches (41 mm) wide and 1/16 inch (1.6 mm) thick.
 7. Tinned Bonding Jumper: Tinned-copper tape, braided conductors terminated with copper ferrules; 1-5/8 inches (41 mm) wide and 1/16 inch (1.6 mm) thick.
- D. Grounding Bus: Predrilled rectangular bars of annealed copper, 1/4 by 4 inches (6.3 by 100 mm) in cross section, with 9/32-inch (7.14-mm) holes spaced 1-1/8 inches (28 mm) apart. Stand-off insulators for mounting shall comply with UL 891 for use in switchboards, 600 V and shall be Lexan or PVC, impulse tested at 5000 V.

2.03 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.
- E. Beam Clamps: Mechanical type, terminal, ground wire access from four directions, with dual, tin-plated or silicon bronze bolts.
- F. Cable-to-Cable Connectors: Compression type, copper or copper alloy.
- G. Cable Tray Ground Clamp: Mechanical type, zinc-plated malleable iron.
- H. Conduit Hubs: Mechanical type, terminal with threaded hub.
- I. Ground Rod Clamps: Mechanical type, copper or copper alloy, terminal with hex head bolt.

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- J. Lay-in Lug Connector: Mechanical type, copper rated for direct burial terminal with set screw.
- K. Service Post Connectors: Mechanical type, bronze alloy terminal, in short- and long-stud lengths, capable of single and double conductor connections.
- L. Signal Reference Grid Clamp: Mechanical type, stamped-steel terminal with hex head screw.
- M. Straps: Solid copper, copper lugs. Rated for 600 A.
- N. Tower Ground Clamps: Mechanical type, copper or copper alloy, terminal one-piece clamp.
- O. U-Bolt Clamps: Mechanical type, copper or copper alloy, terminal listed for direct burial.
- P. Water Pipe Clamps:
 - 1. Mechanical type, two pieces with zinc-plated bolts.
 - a. Material: Die-cast zinc alloy.
 - b. Listed for direct burial.

2.04 GROUNDING ELECTRODES

- A. Ground Rods: Copper-clad steel; 3/4 inch by 10 feet (19 mm by 3 m).
- B. Concrete encased electrodes: #5 A36 Rod or larger.

PART 3 EXECUTION

3.01 APPLICATIONS

- A. Conductors: Install solid conductor for No. 10 AWG and smaller, and stranded conductors for No. 8 AWG and larger unless otherwise indicated.
- B. Underground Grounding Conductors: Install bare tinned-copper conductor, No. 2/0 AWG minimum.
 - 1. Bury at least 24 inches (600 mm) below grade.
- C. Grounding Bus: Install in electrical equipment rooms, in rooms housing service equipment, and elsewhere as indicated.
 - 1. Install bus horizontally, on insulated spacers 2 inches (50 mm) minimum from wall, 6 inches (150 mm) above finished floor unless otherwise indicated.

D. Conductor Terminations and Connections:

1. Pipe and Equipment Grounding Conductor Terminations: Bolted connectors.
2. Underground Connections: Welded connectors except at test wells and as otherwise indicated.
3. Connections to Ground Rods at Test Wells: Bolted connectors.
4. Connections to Structural Steel: Welded connectors.
5. Any threaded bolt connectors shall be torqued in accordance with manufacturer's guidelines.

3.02 GROUNDING AT THE SERVICE

- A. Equipment grounding conductors and grounding electrode conductors shall be connected to the ground bus. Install a main bonding jumper between the neutral and ground buses.

3.03 GROUNDING UNDERGROUND DISTRIBUTION SYSTEM COMPONENTS

- A. Comply with IEEE C2 grounding requirements.
- B. Grounding Manholes and Handholes: Install a driven ground rod through manhole or handhole floor, close to wall, and set rod depth so 4 inches (100 mm) will extend above finished floor. If necessary, install ground rod before manhole is placed and provide No. 1/0 AWG bare, tinned-copper conductor from ground rod into manhole through a waterproof sleeve in manhole wall. Protect ground rods passing through concrete floor with a double wrapping of pressure-sensitive insulating tape or heat-shrunk insulating sleeve from 2 inches (50 mm) above to 6 inches (150 mm) below concrete. Seal floor opening with waterproof, nonshrink grout.
- C. Grounding Connections to Manhole Components: Bond exposed-metal parts such as inserts, cable racks, pulling irons, ladders, and cable shields within each manhole or handhole, to ground rod or grounding conductor. Make connections with No. 4 AWG minimum, stranded, hard-drawn copper bonding conductor. Train conductors level or plumb around corners and fasten to manhole walls. Connect to cable armor and cable shields according to written instructions by manufacturer of splicing and termination kits.
- D. Pad-Mounted Transformers and Switches: Install two ground rods and ground ring around the pad. Ground pad-mounted equipment and noncurrent-carrying metal items associated with substations by connecting them

to underground cable and grounding electrodes. Install tinned-copper conductor not less than No. 2 AWG for ground ring and for taps to equipment grounding terminals. Bury ground ring not less than 6 inches (150 mm) from the foundation.

3.04 EQUIPMENT GROUNDING

- A. Install insulated equipment grounding conductors with all feeders and branch circuits. Do not rely on conduit for the grounding path.
- B. Multiple circuits sharing a raceway may share a single grounding conductor if all of the following requirements are met:
 - 1. All circuits originate in the same panel.
 - 2. No more than three single pole circuits may share a ground conductor.
 - 3. Size the ground conductor for the largest circuit.
- C. Install insulated equipment grounding conductors with the following items, in addition to those required by NFPA 70:
 - 1. Feeders and branch circuits.
 - 2. Lighting circuits.
 - 3. Receptacle circuits.
 - 4. Single-phase motor and appliance branch circuits.
 - 5. Three-phase motor and appliance branch circuits.
 - 6. Flexible raceway runs.
 - 7. Armored and metal-clad cable runs.
- D. Air-Duct Equipment Circuits: Install insulated equipment grounding conductor to duct-mounted electrical devices operating at 120 V and more, including air cleaners, heaters, dampers, humidifiers, and other duct electrical equipment. Bond conductor to each unit and to air duct and connected metallic piping.
- E. Water Heater, Heat-Tracing, and Antifrost Heating Cables: Install a separate insulated equipment grounding conductor to each electric water heater and heat-tracing cable. Bond conductor to heater units, piping, connected equipment, and components.

- F. Poles Supporting Outdoor Lighting Fixtures: Do not install a grounding electrode and a separate insulated equipment grounding conductor at these locations. Bond the equipment grounding conductor installed with branch-circuit conductors to the grounding terminal at the pole base.

3.05 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 (50 mm) 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.
 - 2. For grounding electrode system, install at least 2 rods spaced at least one-rod length from each other and located at least the same distance from other grounding electrodes, and connect to the service grounding electrode conductor.
- 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.
- D. Grounding and Bonding for Piping:
 - 1. Metal Water Service Pipe: Install insulated copper grounding conductors, in conduit, from building's main service equipment, or grounding bus, to main metal water service entrances to building. Connect grounding conductors to main metal water service pipes; use a bolted clamp connector or bolt a lug-type connector to a pipe flange by using one of the lug bolts of the flange. Where a dielectric main water fitting is installed, connect grounding conductor on street

- side of fitting. Bond metal grounding conductor conduit or sleeve to conductor at each end.
2. Water Meter Piping: Use braided-type bonding jumpers to electrically bypass water meters. Connect to pipe with a bolted connector.
 3. Bond each aboveground portion of gas piping system downstream from equipment shutoff valve.
- E. Bonding Interior Metal Ducts: Bond metal air ducts to equipment grounding conductors of associated fans, blowers, electric heaters, and air cleaners. Install bonding jumper to bond across flexible duct connections to achieve continuity. Size bonding conductors and jumpers in accordance with NEC 250.122, using the rating of the circuit that is likely to energize the ducts.
- F. Ground Ring: Install a grounding conductor, electrically connected to each building structure ground rod and to each indicated item, extending around the perimeter of area or item indicated.
1. Install tinned-copper conductor not less than No. **2/0** AWG for ground ring and for taps to building steel.
 2. Bury ground ring not less than 24 inches from building's foundation.
- G. Ufer Ground (Concrete-Encased Grounding Electrode): Fabricate according to NFPA 70, and as detailed on drawings. If drawing does not provide Ufer ground detail install the grounding electrode as defined below:
1. Use a minimum of 20 feet (6 m) of bare copper conductor not smaller than No. 4 AWG.
 2. If concrete foundation is less than 20 feet (6 m) long, coil excess conductor within base of foundation.
 3. Bond grounding conductor to reinforcing steel in at least four locations and to anchor bolts. Extend grounding conductor below grade and connect to building's grounding grid or to grounding electrode external to concrete.
- H. Structural Steel: When available, bond structural steel to grounding electrode system, according to NFPA 70.

3.06 FIELD QUALITY CONTROL

- A. Perform tests and inspections.
- B. Tests and Inspections:

1. After installing grounding system 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 grounding system at each location where a maximum ground-resistance level is specified, at service disconnect enclosure grounding terminal, and at individual ground rods. Make tests at ground rods before any conductors are connected.
 - a. Measure ground resistance no fewer than two full days after last trace of precipitation and without soil being moistened by any means other than natural drainage or seepage and without chemical treatment or other artificial means of reducing natural ground resistance.
 - b. Perform tests by fall-of-potential method according to IEEE 81.
 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 25 ohms to ground.
- F. Excessive Ground Resistance: If resistance to ground exceeds specified values, notify Architect promptly and include recommendations to reduce ground resistance.

END OF SECTION 26 05 26

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PART 1 GENERAL

1.01 SUMMARY

A. Section Includes:

1. Steel slotted support systems.
2. Conduit and cable support devices.
3. Support for conductors in vertical conduit.
4. Structural steel for fabricated supports and restraints.
5. Mounting, anchoring, and attachment components, including powder-actuated fasteners, mechanical expansion anchors, concrete inserts, clamps, through bolts, toggle bolts, and hanger rods.
6. Fabricated metal equipment support assemblies.

B. Related Requirements:

1. Section 26 05 19 "Low Voltage Electrical Power Conductors and Cables" for products and installation requirements necessary for conductors and cables

1.02 ACTION SUBMITTALS

- A. Product Data:** For each type of product.

1.03 INFORMATIONAL SUBMITTALS

- A. Seismic Qualification Data:** Certificates, for hangers and supports for electrical equipment and systems, accessories, and components, from manufacturer.

1.04 COORDINATION

- A. Coordinate size and location of concrete bases.** Cast anchor-bolt inserts into bases. Concrete, reinforcement, and formwork requirements are specified together with concrete Specifications.
- B. Coordinate installation of roof curbs, equipment supports, and roof penetrations.**

PART 2 PRODUCTS

2.01 PERFORMANCE REQUIREMENTS

- A. Seismic Performance: Hangers and supports shall withstand the effects of earthquake motions determined according to ASCE/SEI 7.
 - 1. The term "withstand" means "the supported equipment and systems will remain in place without separation of any parts when subjected to the seismic forces specified and the supported equipment and systems will be fully operational after the seismic event."

2.02 SUPPORT, ANCHORAGE, AND ATTACHMENT COMPONENTS

- A. Steel Slotted Support Systems: Preformed steel channels and angles with minimum 13/32-inch- (10-mm-) diameter holes at a maximum of 8 inches (200 mm) o.c. in at least one surface.
 - 1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to the following:
 - a. Allied Tube & Conduit; a part of Atkore International.
 - b. B-line, an Eaton business.
 - c. ERICO International Corporation.
 - d. Flex-Strut Inc.
 - e. Gripple Inc.
 - f. G-Strut.
 - g. Thomas & Betts Corporation; A Member of the ABB Group.
 - h. Unistrut; Part of Atkore International.
 - 2. Standard: Comply with MFMA-4 factory-fabricated components for field assembly.
 - 3. Material for Channel, Fittings, and Accessories: Galvanized steel.
 - 4. Channel Width: Selected for applicable load criteria.
 - 5. Metallic Coatings: Hot-dip galvanized after fabrication and applied according to MFMA-4.
 - 6. Nonmetallic Coatings: Manufacturer's standard PVC, polyurethane, or polyester coating applied according to MFMA-4.
 - 7. Painted Coatings: Manufacturer's standard painted coating applied according to MFMA-4.

8. Protect finishes on exposed surfaces from damage by applying a strippable, temporary protective covering before shipping.
- B. Conduit and Cable Support Devices: Steel hangers, clamps, and associated fittings, designed for types and sizes of raceway or cable to be supported.
- C. Support for Conductors in Vertical Conduit: Factory-fabricated assembly consisting of threaded body and insulating wedging plug or plugs for nonarmored 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 made of malleable iron.
- D. Structural Steel for Fabricated Supports and Restraints: ASTM A 36/A 36M steel plates, shapes, and bars; black and galvanized.
- E. 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.
 2. Mechanical-Expansion Anchors: Insert-wedge-type, zinc-coated steel, for use in hardened portland cement concrete, with tension, shear, and pullout capacities appropriate for supported loads and building materials where used.
 3. Concrete Inserts: Steel or malleable-iron, slotted support system units are similar to MSS Type 18 units and comply with MFMA-4 or MSS SP-58.
 4. Clamps for Attachment to Steel Structural Elements: MSS SP-58 units are 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.

2.03 FABRICATED METAL EQUIPMENT SUPPORT ASSEMBLIES

- A. Description: Welded or bolted structural-steel shapes, shop or field fabricated to fit dimensions of supported equipment.

PART 3 EXECUTION**3.01 APPLICATION**

- A. Comply with the following standards for application and installation requirements of hangers and supports, except where requirements on Drawings or in this Section are stricter:
 - 1. NECA 1.
 - 2. NECA 101
 - 3. NECA 105.
 - 4. NECA 111.
- B. Comply with requirements for firestopping materials and installation for penetrations through fire-rated walls, ceilings, and assemblies.
- C. Comply with requirements for raceways and boxes specified in Section 260533 "Raceways and Boxes for Electrical Systems."
- D. Maximum Support Spacing and Minimum Hanger Rod Size for Raceways: Space supports for EMT, IMC, and RMC as required by NFPA 70. Minimum rod size shall be 1/4 inch (6 mm) in diameter.
- E. Multiple Raceways or Cables: Install trapeze-type supports fabricated with steel slotted support system, sized so capacity can be increased by at least 25 percent in future without exceeding specified design load limits.
 - 1. Secure raceways and cables to these supports with two-bolt conduit clamps.
- F. 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.

3.02 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, according to 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 SP-58, Type 19, 21, 23, 25, or 27), complying with MSS SP-69.
 - 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, transformers, and other devices on slotted-channel racks attached to substrate by means that comply with seismic-restraint strength and anchorage requirements.
- E. Drill holes for expansion anchors in concrete at locations and to depths that avoid the need for reinforcing bars.

3.03 INSTALLATION OF FABRICATED METAL SUPPORTS

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

- B. Field Welding: Comply with AWS D1.1/D1.1M.

3.04 CONCRETE BASES

- A. Construct concrete bases of dimensions indicated but not less than 4 inches (100 mm) larger in both directions than supported unit, and so anchors will be a minimum of 10 bolt diameters from edge of the base.
- B. Use 3000-psi (20.7-MPa), 28-day compressive-strength concrete.
- C. Anchor equipment to concrete base.
 - 1. Place and secure anchorage devices. Use supported equipment manufacturer's setting drawings, templates, diagrams, instructions, and directions furnished with items to be embedded.
 - 2. Install anchor bolts to elevations required for proper attachment to supported equipment.
 - 3. Install anchor bolts according to anchor-bolt manufacturer's written instructions.

END OF SECTION 26 05 29

PART 1 GENERAL

1.01 SUMMARY

- A. Section Includes:
 - 1. Metal conduits and fittings.
 - 2. Nonmetallic conduits and fittings.
 - 3. Metal wireways and auxiliary gutters.
 - 4. Nonmetal wireways and auxiliary gutters.
 - 5. Surface raceways.
 - 6. Boxes, enclosures, and cabinets.
 - 7. Handholes and boxes for exterior underground cabling.

1.02 ACTION SUBMITTALS

- A. Product Data: For surface raceways, wireways and fittings, floor boxes, hinged-cover enclosures, and cabinets.

1.03 INFORMATIONAL SUBMITTALS

- A. Seismic Qualification Data: Certificates, for enclosures, cabinets, and conduit racks and their mounting provisions, including those for internal components, from manufacturer.

PART 2 PRODUCTS

2.01 METAL CONDUITS AND FITTINGS

- A. Metal Conduit:
 - 1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to the following:
 - a. Allied Tube & Conduit; a part of Atkore International.
 - b. Electri-Flex Company.
 - c. O-Z/Gedney; a brand of Emerson Industrial Automation.
 - d. Patriot Aluminum Products, LLC.
 - e. Perma-Cote.
 - f. Picoma Industries, Inc.

- g. Plasti-Bond.
 - h. Republic Conduit.
 - i. Southwire Company.
 - j. Thomas & Betts Corporation; A Member of the ABB Group.
 - k. Western Tube and Conduit Corporation.
 - 2. Listing and Labeling: Metal conduits, tubing, and fittings shall be listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.
 - 3. GRC: Comply with ANSI C80.1 and UL 6.
 - 4. IMC: Comply with ANSI C80.6 and UL 1242.
 - 5. PVC-Coated Steel Conduit: PVC-coated rigid steel conduit.
 - a. Comply with NEMA RN 1.
 - b. Coating Thickness: 0.040 inch, minimum.
 - 6. EMT: Comply with ANSI C80.3 and UL 797.
 - 7. FMC: Comply with UL 1; zinc-coated steel.
 - 8. LFMC: Flexible steel conduit with PVC jacket and complying with UL 360.
- B. Metal Fittings: Comply with NEMA FB 1 and UL 514B.
- 1. Listing and Labeling: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.
 - 2. Fittings, General: Listed and labeled for type of conduit, location, and use.
 - 3. Conduit Fittings for Hazardous (Classified) Locations: Comply with UL 1203 and NFPA 70.
 - 4. Fittings for EMT:
 - a. Material: Steel.
 - b. Type: Setscrew.
 - 5. Expansion Fittings: PVC or steel to match conduit type, complying with UL 651, rated for environmental conditions where installed, and including flexible external bonding jumper.

6. Coating for Fittings for PVC-Coated Conduit: Minimum thickness of 0.040 inch, with overlapping sleeves protecting threaded joints.
- C. Joint Compound for IMC and GRC: Approved, as defined in NFPA 70, by authorities having jurisdiction for use in conduit assemblies, and compounded for use to lubricate and protect threaded conduit joints from corrosion and to enhance their conductivity.

2.02 NONMETALLIC CONDUITS AND FITTINGS

A. Nonmetallic Conduit:

1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to the following:
 - a. Arnco Corporation.
 - b. CANTEX INC.
 - c. CertainTeed Corporation.
 - d. Champion Fiberglass, Inc.
 - e. Condux International, Inc.
 - f. Electri-Flex Company.
 - g. FRE Composites.
 - h. Kraloy.
 - i. Lamson & Sessions.
 - j. Niedax Inc.
 - k. RACO; Hubbell.
 - l. Thomas & Betts Corporation; A Member of the ABB Group.

B. Listing and Labeling: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.

1. RNC: Type EPC-40-PVC or Type EPC-80-PVC, complying with NEMA TC 2 and UL 651 unless otherwise indicated.
2. LFNC: Comply with UL 1660.
3. Rigid HDPE, SDR 11: Comply with UL 651A.
4. Continuous HDPE, SDR 11: Comply with UL 651B.

C. Nonmetallic Fittings:

1. Fittings, General: Listed and labeled for type of conduit, location, and use.

2. Fittings for ENT and RNC: Comply with NEMA TC 3; match to conduit or tubing type and material.
3. Fittings for LFNC: Comply with UL 514B.
4. Solvents and Adhesives: As recommended by conduit manufacturer.

2.03 STANDARD CONDUIT SEALS

- A. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to the following:
 1. American Polywater Corporation
 2. Dura-Line, Inc.
 3. FS3, Inc.
- B. Description: Sealing compound for use in underground conduit to prevent water and gas infiltration in non-classified locations.
 1. Semi-permanent, re-enterable seal.
 2. Compatible with PVC, rigid steel, EMT, IMC, fiberglass and polyethylene conduits.
 3. Keeps water, acids, greases, gases, insects, rodents, etc., out of the conduit.
 4. Two-part high-expansion urethane foam with 98% closed cell content.
 5. Cured compressive strength of 300 lbs. (ASTM D790), tensile strength of 250 lbs. (ASTM D1623), and flexural strength of 450 lbs. (ASTM D790) and temperature range of -20° to 200°F.
 6. Cured sealant will be capable of holding 10 psi water pressure continuously.
 7. Meets NEC requirements for raceway seals per Articles 225.27, 230.8 and 300.5
 8. FST™ Sealant or equivalent.

2.04 CLASSIFIED LOCATION CONDUIT SEALS

- A. Available Manufacturers: Subject to compliance with requirements, manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
 - 1. Appleton Electric
 - 2. Cooper Crouse-Hinds
 - 3. Hubbell Killark
- B. Description: Sealing fittings for use between a classified and non-classified location.
 - 1. Explosion proof and dust-ignition proof, raintight construction.
 - 2. Smooth, rounded integral bushing to protect conductor insulation.
 - 3. Tapped and tapered threads for tight, rigid joints and ground continuity.
 - 4. Removable nipple in male sealing fitting that can be used interchangeably in top or bottom hub.
 - 5. Fiber filler to prevent sealing compound from leaking while being poured in its liquid state.
 - 6. Sealing cement which hardens to contain and restrict the passage of gasses and explosions in classified areas.

2.05 METAL WIREWAYS AND AUXILIARY GUTTERS

- A. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to the following:
 - 1. B-line, an Eaton business.
 - 2. Hoffman; a brand of Pentair Equipment Protection.
 - 3. MonoSystems, Inc.
- B. Description: Sheet metal, complying with UL 870 and NEMA 250, Type 1, Type 3R, Type 4 or Type 12 unless otherwise indicated, and sized according to NFPA 70.

1. Metal wireways installed outdoors shall be listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.
- C. Fittings and Accessories: Include covers, couplings, offsets, elbows, expansion joints, adapters, hold-down straps, end caps, and other fittings to match and mate with wireways as required for complete system.
- D. Wireway Covers: Screw-cover type unless otherwise indicated.
- E. Finish: Manufacturer's standard enamel finish.

2.06 NONMETALLIC WIREWAYS AND AUXILIARY GUTTERS

- A. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to the following:
 1. Allied Moulded Products, Inc.
 2. Hoffman; a brand of Pentair Equipment Protection.
 3. Lamson & Sessions.
- B. Listing and Labeling: Nonmetallic wireways and auxiliary gutters shall be listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.
- C. Description: PVC, extruded and fabricated to required size and shape, and having snap-on cover, mechanically coupled connections, and plastic fasteners.
- D. Fittings and Accessories: Couplings, offsets, elbows, expansion joints, adapters, hold-down straps, end caps, and other fittings shall match and mate with wireways as required for complete system.
- E. Solvents and Adhesives: As recommended by conduit manufacturer.

2.07 SURFACE RACEWAYS

- A. Listing and Labeling: Surface raceways and tele-power poles shall be listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.
- B. Surface Metal Raceways: Galvanized steel with snap-on covers complying with UL 5. Manufacturer's standard enamel finish in color selected by Engineer.

1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
 - a. Mono-Systems, Inc.
 - b. Panduit Corp.
 - c. Wiremold / Legrand.

2.08 J-HOOKS

- A. Description: Prefabricated sheet metal cable supports for low-voltage cables (lighting controls).
- B. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 1. Eaton, B-line.
 2. Panduit Corp.
 3. Wiremold / Legrand.
- C. Listed and labeled as defined in NFPA 70, by an NRTL, and marked for intended location and application.

2.09 BOXES, ENCLOSURES, AND CABINETS

- A. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to the following:
 1. Crouse-Hinds, an Eaton business.
 2. Erickson Electrical Equipment Company.
 3. Hoffman; a brand of Pentair Equipment Protection.
 4. Hubbell Incorporated.
 5. Hubbell Incorporated; Wiring Device-Kellems.
 6. Milbank Manufacturing Co.
 7. MonoSystems, Inc.
 8. Oldcastle Enclosure Solutions.

9. O-Z/Gedney; a brand of Emerson Industrial Automation.
 10. RACO; Hubbell.
 11. Stahlin Non-Metallic Enclosures.
 12. Thomas & Betts Corporation; A Member of the ABB Group.
- B. General Requirements for Boxes, Enclosures, and Cabinets: Boxes, enclosures, and cabinets installed in wet locations shall be listed for use in wet locations.
- C. Sheet Metal Outlet and Device Boxes: Comply with NEMA OS 1 and UL 514A.
- D. Cast-Metal Outlet and Device Boxes: Comply with NEMA FB 1, aluminum, Type FD, with gasketed cover.
- E. Nonmetallic Outlet and Device Boxes: Comply with NEMA OS 2 and UL 514C.
- F. Metal Floor Boxes. See drawings for differing floor box requirements based on location, floor material and box use.
1. All floor boxes shall be:
 - a. Fully adjustable.
 - b. Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.
 2. Specific conditions include:
 - a. Concrete floors (3" min. pour depth) - 4-gang floor box with corrosion resistant coating for on-grade use and up to 2" conduit feed.
 - b. Raised access floors - 4-gang floor box for up to 2" conduit feed.
 - c. Fire rated poke-through floor box for elevated concrete slabs:
 - 1) Small - 3" diameter core.
 - 2) Large - 8" diameter for up to 2" conduit feed.
 - d. Flush, round single surface floor box for concrete floors with up to 1" conduit feed.
 - e. Tombstone pedestal floor box with 1" conduit feed.

3. Include all interior box dividers, flanges, mounting hardware, wiring devices, faceplates, etc. to provide complete floor box outlet in accordance with drawings.
- G. Luminaire Outlet Boxes: Nonadjustable, designed for attachment of luminaire weighing 50 lb (23 kg). Outlet boxes designed for attachment of luminaires weighing more than 50 lb (23 kg) shall be listed and marked for the maximum allowable weight.
- H. Paddle Fan Outlet Boxes: Nonadjustable, designed for attachment of paddle fan weighing 70 lb (32 kg).
 1. Listing and labeling: Paddle fan outlet boxes shall be listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.
- I. Small Sheet Metal Pull and Junction Boxes: NEMA OS 1.
- J. Cast-Metal Access, Pull, and Junction Boxes: Comply with NEMA FB 1 and UL 1773, cast aluminum with gasketed cover.
- K. Box extensions used to accommodate new building finishes shall be of same material as recessed box.
- L. Device Box Dimensions: 4 inches square by 2-1/8 inches deep with single gang mud ring unless device(s) requires otherwise.
- M. Gangable boxes are allowed for 6-gang or larger.
- N. Hinged-Cover Enclosures: Comply with UL 50 and NEMA 250, Type 1, Type 3R, Type 4 or Type 12 with continuous-hinge cover with flush latch unless otherwise indicated.
 1. Metal Enclosures: Steel, finished inside and out with manufacturer's standard enamel.
 2. Nonmetallic Enclosures: Plastic.
 3. Interior Panels: Steel; all sides finished with manufacturer's standard enamel.
- O. Cabinets:
 1. NEMA 250, Type 1, Type 3R or Type 12 galvanized-steel box with removable interior panel and removable front, finished inside and out with manufacturer's standard enamel.

2. Hinged door in front cover with flush latch and concealed hinge.
3. Key latch to match panelboards.
4. Metal barriers to separate wiring of different systems and voltage.
5. Accessory feet where required for freestanding equipment.
6. Nonmetallic cabinets shall be listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.

2.10 HANDHOLES AND BOXES FOR EXTERIOR UNDERGROUND WIRING

A. General Requirements for Handholes and Boxes:

1. Boxes and handholes for use in underground systems shall be designed and identified as defined in NFPA 70, for intended location and application.
2. Boxes installed in wet areas shall be listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.

B. Polymer-Concrete Handholes and Boxes with Polymer-Concrete Cover: Molded of sand and aggregate, bound together with polymer resin, and reinforced with steel, fiberglass, or a combination of the two.

1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to the following:
 - a. Armorcast Products Company.
 - b. NewBasis.
 - c. Oldcastle Enclosure Solutions.
 - d. Oldcastle Precast, Inc.
 - e. Quazite (Hubbell).
2. Standard: Comply with ANSI/SCTE 77.
3. Load Ratings:
 - a. Tier 5 for non-traffic areas and sidewalk applications with a safety factor for occasional non-deliberate vehicular traffic.
 - b. Tier 15 for driveway, parking lot, and off-road applications subject to occasional non-deliberate heavy vehicular traffic.

- c. AASHTO H-20 for roadways and other deliberate vehicular traffic applications.
- 4. Configuration: Designed for flush burial with open bottom unless otherwise indicated.
- 5. Cover: Weatherproof, secured by tamper-resistant locking devices and having structural load rating consistent with enclosure and hand-hole location.
- 6. Cover Finish: Nonskid finish shall have a minimum coefficient of friction of 0.50.
- 7. Cover Legend: Molded lettering, "ELECTRIC" or "COM" as indicated on drawings.
- 8. Conduit Entrance Provisions: Conduit-terminating fittings shall mate with entering ducts for secure, fixed installation in enclosure wall.

PART 3 EXECUTION

3.01 RACEWAY APPLICATION

- A. Outdoors: Apply raceway products as specified below unless otherwise indicated:
 - 1. Exposed Conduit: GRC.
 - 2. Concealed Conduit, Aboveground: EMT.
 - 3. Underground Conduit: RNC, Type EPC-40-PVC or HDPE in fine bedded trench.
 - 4. Under roadways and paved or concrete walkways: Type EPC-80-PVC or HDPE in fine bedded trench.
 - 5. Connection to Vibrating Equipment (Including Transformers and Hydraulic, Pneumatic, Electric Solenoid, or Motor-Driven Equipment): LFMC.
 - 6. Boxes and Enclosures, Aboveground: NEMA 250, Type 3R.
- B. Indoors: Apply raceway products as specified below unless otherwise indicated:
 - 1. Exposed, Not Subject to Physical Damage: EMT.

2. Exposed, Not Subject to Severe Physical Damage: EMT.
 3. Exposed and Subject to Severe Physical Damage: GRC. Raceway locations include the following, if applicable:
 - a. Corridors used for traffic of mechanized carts, forklifts, and pallet-handling units.
 - b. Mechanical rooms.
 4. Concealed in Ceilings and Interior Walls and Partitions: EMT or as specified in Section 260519, "Low-Voltage Electrical Power Conductors and Cables".
 5. Connection to Vibrating Equipment (Including Transformers and Hydraulic, Pneumatic, Electric Solenoid, or Motor-Driven Equipment): FMC, except use LFMC in damp or wet locations.
 6. Damp or Wet Locations: GRC.
 7. Boxes and Enclosures: NEMA 250, Type 1, except use NEMA 250, Type 4 nonmetallic in institutional and commercial kitchens and damp or wet locations.
 8. Concealed in CMU block wall: Type EPC-40-PVC.
- C. Minimum Raceway Size: 1 inch trade size for telecom/data and 3/4 inch trade size for all other applications.
- 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. Comply with NEMA FB 2.10.
 2. PVC Externally Coated, Rigid Steel Conduits: Use only fittings listed for use with this type of conduit. Patch and seal all joints, nicks, and scrapes in PVC coating after installing conduits and fittings. Use sealant recommended by fitting manufacturer and apply in thickness and number of coats recommended by manufacturer.
 3. EMT: Use setscrew, steel fittings. Comply with NEMA FB 2.10.
 4. Flexible Conduit: Use only fittings listed for use with flexible conduit. Comply with NEMA FB 2.20.
- E. Install surface raceways only where specifically indicated on Drawings.

- F. Install nonmetallic conduit or tubing for protecting bare grounding conductors.
- G. Do not install nonmetallic conduit where ambient temperature exceeds 120 deg F (49 deg C).

3.02 LOW VOLTAGE CABLE INSTALLATION

- A. Any low voltage cables in exposed or finished areas shall be in raceway.
- B. In accordance with NEC 300.11 and NEC 800.24, any low voltage cables installed in accessible ceilings without conduit, including lighting control cables, shall be as follows:
 - 1. Cables shall not be draped over air ducts, pipes, or conduits, shall not rest on the ceiling grid or tiles, and shall not use ceiling grid support wires or rods.
 - 2. Cables shall be supported using j-hooks at intervals not to exceed 48". J-hooks shall be attached to the structure with dedicated support wires, and a j-hook shall be installed at each change in cabling direction.
 - 3. Written approval shall be obtained from the IT designer prior to any use of communications system cable/ladder tray or j-hooks. Whenever cable tray or communication system j-hooks are used, the lighting controls cabling shall be bundled with cable ties. Any non-metallic cable ties used to bundle the cables shall be plenum rated.

3.03 INSTALLATION

- A. Comply with requirements in Section 26 05 29 "Hangers and Supports for Electrical Systems" for hangers and supports.
- B. Comply with NECA 1 and NECA 101 for installation requirements except where requirements on Drawings or in this article are stricter. Comply with NFPA 70 limitations for types of raceways allowed in specific occupancies and number of floors.
- C. Do not install raceways or electrical items on any "explosion-relief" walls or rotating equipment.
- D. Do not fasten conduits onto the bottom side of a metal deck roof.
- E. 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.

- F. Whenever routed in parallel, maintain 12" minimum separation between communications conduits and power conduits. Where these conduits must intersect, cross at 90 degrees.
- G. Comply with requirements in Section 26 05 29 "Hangers and Supports for Electrical Systems" for hangers and supports.
- H. Install no more than the equivalent of three 90-degree bends in any conduit run except for control wiring conduits, for which fewer bends are allowed. Support within 12 inches of changes in direction.
- I. Make bends in raceway using large-radius preformed ells. Field bending shall be according to NFPA 70 minimum radii requirements. Use only equipment specifically designed for material and size involved.
- J. Conceal conduit and EMT within finished walls, ceilings, and floors unless otherwise indicated. Install conduits parallel or perpendicular to building lines.
- K. Support conduit within 12 inches of enclosures to which attached.
- L. Raceways Below Slab:
 - 1. Conduits are permitted under the slab in the base material only (not within the concrete slab).
 - 2. All routing must be approved by the structural engineer prior to rough-in.
 - 3. Arrange stub-ups so that curved portions of bends are not visible above finished slab.
 - 4. Change from RNC, Type EPC-40-PVC to PVC Coated GRC bend and thru slab stub before rising above floor.
- M. Stub-ups to Above Recessed Ceilings:
 - 1. Use EMT for raceways.
 - 2. Use a conduit bushing or insulated fitting to terminate stub-ups not terminated in hubs or in an enclosure.
- N. 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.

- O. Coat field-cut threads on PVC-coated raceway with a corrosion-preventing conductive compound prior to assembly.
- P. Raceway Terminations at Locations Subject to Moisture or Vibration: Use insulating bushings to protect conductors including conductors smaller than No. 4 AWG.
- Q. Install raceways square to the enclosure and terminate at enclosures with locknuts. Install locknuts hand tight plus 1/4 turn more.
- R. Do not rely on locknuts to penetrate nonconductive coatings on enclosures. Remove coatings in the locknut area prior to assembling conduit to enclosure to assure a continuous ground path.
- S. Cut conduit perpendicular to the length. For conduits 2-inch trade size and larger, use roll cutter or a guide to make cut straight and perpendicular to the length.
- T. Terminate threaded conduits into threaded hubs or with locknuts on inside and outside of boxes or cabinets. Install bushings on conduits up to 1-1/4-inch trade size and insulated throat metal bushings on 1-1/2-inch trade size and larger conduits terminated with locknuts. Install insulated throat metal grounding bushings on service conduits.
- U. Install pull wires in empty raceways. Use polypropylene or monofilament plastic line with not less than 200-lb (90-kg) tensile strength. Leave at least 12 inches of slack at each end of pull wire. Cap underground raceways designated as spare above grade alongside raceways in use.
- V. Surface Raceways:
 - 1. Install surface raceway with a minimum 2-inch radius control at bend points.
 - 2. Secure surface raceway with screws or other anchor-type devices at intervals not exceeding 48 inches and with no less than two supports per straight raceway section. Support surface raceway according to manufacturer's written instructions. Tape and glue are not acceptable support methods.
- W. Install raceway sealing fittings at accessible locations according to NFPA 70 and fill them with listed sealing compound. For concealed raceways, install each fitting in a flush steel box with a blank cover plate having a finish similar to that of adjacent plates or surfaces.
- X. Standard Conduit Seals:

1. Install devices to seal raceway interiors at accessible locations. Locate seals so no fittings or boxes are between the seal and the following changes of environments. Seal the interior of all raceways at the following points:
 - a. Where conduits pass from warm to cold locations, such as boundaries of refrigerated spaces.
 - b. Where an underground service raceway enters a building or structure.
 - c. Conduit extending from interior to exterior of building.
 - d. Conduit extending into pressurized duct and equipment.
 - e. Conduit extending into pressurized zones that are automatically controlled to maintain different pressure set points.
 - f. Where otherwise required by NFPA 70.
- Y. Expansion-Joint Fittings:
 1. Install in each run of aboveground RNC that is located where environmental temperature change may exceed 30 deg F (17 deg C) and that has straight-run length that exceeds 25 feet (7.6 m).
 2. Install type and quantity of fittings that accommodate temperature change listed for each of the following locations:
 - a. Outdoor Locations Not Exposed to Direct Sunlight: 125 deg F (70 deg C) temperature change.
 - b. Outdoor Locations Exposed to Direct Sunlight: 155 deg F (86 deg C) temperature change.
 - c. Indoor Spaces Connected with Outdoors without Physical Separation: 125 deg F (70 deg C) temperature change.
 - d. Attics: 135 deg F (75 deg C) temperature change.
 3. 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 for PVC conduits.
 4. Install expansion fittings at all locations where conduits cross building or structure expansion joints.
 5. Install each expansion-joint fitting with position, mounting, and piston setting selected according to manufacturer's written instructions for conditions at specific location at time of installation. Install conduit supports to allow for expansion movement.
- Z. Flexible Conduit Connections: Comply with NEMA RV 3. Use a maximum of 72 inches of flexible conduit for recessed and semi-recessed luminaires,

equipment subject to vibration, noise transmission, or movement; and for transformers and 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.
- AA. Mount boxes at heights indicated on Drawings. If mounting heights of boxes are not individually indicated, give priority to ADA requirements. Install boxes with height measured to center of box unless otherwise indicated.
- BB. Recessed Boxes in Masonry Walls: Saw-cut opening for box in center of cell of masonry block, and install box flush with surface of wall. Prepare block surfaces to provide a flat surface for a raintight connection between the box and cover plate or the supported equipment and box.
- CC. Horizontally separate boxes mounted on opposite sides of walls so they are not in the same vertical channel.
- DD. Locate boxes so that cover or plate will not span different building finishes.
- EE. Support boxes of three gangs or more from more than one side by spanning two framing members or mounting on brackets specifically designed for the purpose.
- FF. Fasten junction and pull boxes to or support from building structure. Do not support boxes by conduits.
- GG. Set metal floor boxes level and flush with finished floor surface.
- HH. Set nonmetallic floor boxes level. Trim after installation to fit flush with finished floor surface.

3.04 INSTALLATION OF UNDERGROUND CONDUIT

- A. Direct-Buried Conduit:
1. Excavation
 - a. Excavate trenches to indicated depths.
 - b. Excavate trenches to uniform widths to provide 12 inches on each side of conduits. Excavate trench walls vertically from trench bottom to 12 inches higher than top of conduits UNO.

- c. Excavate trenches sufficiently wide to maintain 12" minimum separation between communications conduits and all power conduits.
 - d. Excavate and shape trench bottoms to provide uniform bearing and support of conduits. Shape subgrade to provide continuous support for joints, fittings, and bodies of conduits. Remove projecting stones and sharp objects along trench subgrade. Excavate trenches 6 inches deeper than elevation required in rock or other unyielding bearing material to allow for bedding course.
 - e. Trenches in Tree- and Plant-Protection Zones:
 - 1) Hand-excavate to indicated lines, cross sections, elevations, and subgrades. Use narrow-tine spading forks to comb soil and expose roots. Do not break, tear, or chop exposed roots. Do not use mechanical equipment that rips, tears, or pulls roots.
 - 2) Do not cut main lateral roots or taproots; cut only smaller roots that interfere with installation of utilities.
2. Initial Backfill
- a. Place backfill on subgrades free of mud, frost, snow, or ice.
 - b. Place and compact bedding course on trench bottoms. Shape bedding course to provide continuous support for joints, fittings, and bodies of conduits.
3. Install manufactured duct elbows for stub-up at poles and equipment and at building entrances through floor unless otherwise indicated. Encase elbows for stub-up ducts throughout length of elbow.
4. Install manufactured rigid steel conduit elbows for stub-ups at poles and equipment and at building entrances through floor.
- a. Couple steel conduits to ducts with adapters designed for this purpose, and encase coupling with 3 inches of concrete for a minimum of 12 inches on each side of the coupling.
 - b. For stub-ups at equipment mounted on outdoor concrete bases and where conduits penetrate building foundations, extend steel conduit horizontally a minimum of 60 inches from edge of foundation or equipment base. Install insulated grounding bushings on terminations at equipment.
5. Backfill - After installing conduit, backfill and compact. Start at tie-in point, and work toward end of conduit run, leaving conduit at end of

run free to move with expansion and contraction as temperature changes during this process.

- a. Trenches under Footings: Backfill trenches excavated under footings and within 18 inches of bottom of footings with satisfactory soil; fill with concrete to elevation of bottom of footings.
 - b. Trenches under Roadways: Provide 4-inch thick, concrete-base slab support for conduits less than 30 inches below surface of roadways. After installing and testing, completely encase piping or conduit in a minimum of 4 inches of concrete before backfilling or placing roadway subbase course.
 - c. Initial Backfill: Place and compact initial backfill of subbase material, free of particles larger than 1 inch in any dimension, to a height of 12 inches over the conduits. Carefully compact initial backfill under conduit haunches and compact evenly up on both sides and along the full length of conduit to avoid damage or displacement of piping or conduit. Coordinate backfilling with utilities testing.
 - d. After placing controlled backfill to within 12 inches of finished grade, make final conduit connection at end of run and complete backfilling with normal compaction.
6. Underground Warning Tape: Comply with requirements in Section 260553 "Identification for Electrical Systems."
 7. Compaction - Firmly hand tamp backfill around conduit to provide maximum supporting strength. Coordinate all requirements with site civil specifications. Prior to commencing work, the more stringent requirement shall take precedence.
 - a. Compact each layer of initial and final backfill soil material at 95 percent.

3.05 INSTALLATION OF UNDERGROUND HANDHOLES AND BOXES

- A. Install handholes and boxes level and plumb and with orientation and depth coordinated with connecting conduits to minimize bends and deflections required for proper entrances.
- B. Unless otherwise indicated, support units on a level 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: In roadway or vehicle access areas, set so cover surface will be flush with finished grade. Set covers of other enclosures 1 inch above finished grade.

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- D. Where required, field-cut openings for 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.

3.06 SLEEVE AND SLEEVE-SEAL INSTALLATION FOR ELECTRICAL PENETRATIONS

- A. Install sleeves and sleeve seals at penetrations of exterior floor and wall assemblies. Comply with requirements in Section 260544 "Sleeves and Sleeve Seals for Electrical Raceways and Cabling."

3.07 FIRESTOPPING

- A. Install firestopping at penetrations of fire-rated floor and wall assemblies.

3.08 PROTECTION

- A. Protect coatings, finishes, and cabinets from damage and deterioration.
 - 1. Repair damage to galvanized finishes with zinc-rich paint recommended by manufacturer.
 - 2. Repair damage to PVC coatings or paint finishes with matching touchup coating recommended by manufacturer.

END OF SECTION 26 05 33

PART 1 GENERAL

1.01 SUMMARY

A. Section Includes:

1. Sleeves for raceway and cable penetration of non-fire-rated construction walls and floors.
2. Sleeve-seal systems.
3. Sleeve-seal fittings.
4. Grout.
5. Silicone sealants.

1.02 ACTION SUBMITTALS

A. Product Data: For each type of product.

PART 2 PRODUCTS

2.01 SLEEVES

A. Wall Sleeves:

1. Steel Pipe Sleeves: ASTM A 53/A 53M, Type E, Grade B, Schedule 40, zinc coated, plain ends.

B. Sleeves for Conduits Penetrating Non-Fire-Rated Gypsum Board Assemblies: Galvanized-steel sheet; 0.0239-inch (0.6-mm) minimum thickness; round tube closed with welded longitudinal joint, with tabs for screw-fastening the sleeve to the board.

C. Sleeves for Rectangular Openings:

1. Material: Galvanized sheet steel.
2. Minimum Metal Thickness:
 - a. For sleeve cross-section rectangle perimeter less than 50 inches (1270 mm) and with no side larger than 16 inches (400 mm), thickness shall be 0.052 inch (1.3 mm).
 - b. For sleeve cross-section rectangle perimeter 50 inches (1270 mm) or more and one or more sides larger than 16 inches (400 mm), thickness shall be 0.138 inch (3.5 mm).

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2.02 SLEEVE-SEAL SYSTEMS

- 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, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
 - a. Advance Products & Systems, Inc.
 - b. CALPICO, Inc.
 - c. Metraflex Company (The).
 - d. Pipeline Seal and Insulator, Inc.
 - e. Proco Products, Inc.
 - f. 3M
 2. Sealing Elements: EPDM rubber interlocking links shaped to fit surface of pipe. Include type and number required for pipe material and size of pipe.
 3. Pressure Plates: Stainless Steel.
 4. Connecting Bolts and Nuts: Stainless Steel of length required to secure pressure plates to sealing elements.

2.03 SLEEVE-SEAL FITTINGS

- A. Description: Manufactured plastic, sleeve-type, waterstop assembly made for embedding in concrete slab or wall. Unit shall have plastic or rubber waterstop collar with center opening to match piping OD.

2.04 GROUT

- A. Description: Non-shrink; recommended for interior and exterior sealing openings in non-fire-rated walls or floors.
- B. Standard: ASTM C 1107/C 1107M, Grade B, post-hardening and volume-adjusting, dry, hydraulic-cement grout.
- C. Design Mix: 5000-psi (34.5-MPa), 28-day compressive strength.
- D. Packaging: Premixed and factory packaged.

2.05 SILICONE SEALANTS

- A. Silicone Sealants: Single-component, silicone-based, neutral-curing elastomeric sealants of grade indicated below.
 - 1. Grade: Pourable (self-leveling) formulation for openings in floors and other horizontal surfaces that are not fire rated.
- B. Silicone Foams: Multicomponent, silicone-based liquid elastomers that, when mixed, expand and cure in place to produce a flexible, non-shrinking foam.

PART 3 EXECUTION

3.01 SLEEVE INSTALLATION FOR NON-FIRE-RATED ELECTRICAL PENETRATIONS

- A. Comply with NECA 1.
- B. Comply with NEMA VE 2 for cable tray and cable penetrations.
- C. Sleeves for Conduits Penetrating Above-Grade Non-Fire-Rated Concrete and Masonry-Unit Floors and Walls:
 - 1. Interior Penetrations of Non-Fire-Rated Walls and Floors:
 - a. Seal annular space between sleeve and raceway or cable, using joint sealant appropriate for size, depth, and location of joint.
 - b. Seal space outside of sleeves with mortar or grout. Pack sealing material solidly between sleeve and wall so no voids remain. Tool exposed surfaces smooth; protect material while curing.
 - 2. Use pipe sleeves unless penetration arrangement requires rectangular sleeved opening.
 - 3. Size pipe sleeves to provide 1/4-inch (6.4-mm) annular clear space between sleeve and raceway or cable unless sleeve seal is to be installed, **unless seismic criteria require different clearance**.
 - 4. Install sleeves for wall penetrations unless core-drilled holes or formed openings are used. Install sleeves during erection of walls. Cut sleeves to length for mounting flush with both surfaces of walls. Deburr after cutting.

SECTION 26 05 44

SLEEVES AND SLEEVE SEALS FOR

DIVISION 26 00 00 – ELECTRICAL ELECTRICAL RACEWAYS AND CABLING

5. Install sleeves for floor penetrations. Extend sleeves installed in floors 2 inches (50 mm) above finished floor level. Install sleeves during erection of floors.
- D. Sleeves for Conduits Penetrating Non-Fire-Rated Gypsum Board Assemblies:
 1. Use circular metal sleeves unless penetration arrangement requires rectangular sleeved opening.
 2. Seal space outside of sleeves with approved joint compound for gypsum board assemblies.
- E. Roof-Penetration Sleeves: Seal penetration of individual raceways and cables with flexible boot-type flashing units applied in coordination with roofing work, and in accordance with roof system manufacturer's warranty requirements.
- F. 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.
- G. Underground, Exterior-Wall and Floor Penetrations: Install cast-iron pipe sleeves. Size sleeves to allow for 1-inch (25-mm) annular clear space between raceway or cable and sleeve for installing sleeve-seal system.

3.02 SLEEVE-SEAL-SYSTEM INSTALLATION

- A. Install sleeve-seal systems in sleeves in exterior concrete walls and slabs-on-grade at raceway entries into building.
- B. Install 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.

3.03 SLEEVE-SEAL-FITTING INSTALLATION

- A. Install sleeve-seal fittings in new walls and slabs as they are constructed.
- B. Assemble fitting components of length to be flush with both surfaces of concrete slabs and walls. Position waterstop flange to be centered in concrete slab or wall.
- C. Secure nailing flanges to concrete forms.

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SLEEVES AND SLEEVE SEALS FOR

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- D. Using grout, seal the space around outside of sleeve-seal fittings.

END OF SECTION 26 05 44

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SLEEVES AND SLEEVE SEALS FOR
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PART 1 GENERAL

1.01 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 00 00 Specification Sections, apply to this Section.

1.02 SUMMARY

- A. Section Includes:
 - 1. Color and legend requirements for raceways, conductors, and warning labels and signs.
 - 2. Tapes and stencils.
 - 3. Signs.
 - 4. Cable ties.

PART 2 PRODUCTS

2.01 PERFORMANCE REQUIREMENTS

- A. Comply with ASME 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. Comply with NFPA 70E requirements for arc-flash warning labels.
- F. Adhesive-attached labeling materials, including label stocks, laminating adhesives, and inks used by label printers, shall comply with UL 969.

2.02 COLOR AND LEGEND REQUIREMENTS

- A. Raceways and Cables Carrying Circuits within Buildings. Identify the covers of each junction and pull box of the following systems with paint as follows:
 - 1. Battery or Generator Backed up Emergency System: Orange
 - 2. Fire Detection and Alarm System: Red

3. Systems with voltage greater than 600V: Yellow
 4. Direct current systems (Solar PV system): Green
 5. Affix label with black letters on color noted above indicating voltage and system or service type.
- B. Conductor Color-Coding for Phase and Voltage-Level Identification, 600 V or Less: Use colors listed below for ungrounded service, feeder and branch-circuit conductors.
1. Utilize factory applied, colored insulation for No. 8 AWG and smaller.
 2. If Authority Having Jurisdiction permits, for sizes larger than No. 8 AWG, where conductors with factory colored insulation are not commonly available, colored non-aging, plastic tape may be field applied. Apply in half-lapped turns for a minimum distance of 6 inches (150 mm) from terminal points and in boxes where splices or taps are made. Apply last two turns of tape with no tension to prevent possible unwinding. Locate bands to avoid obscuring factory cable markings.
 3. Colors for Three-Phase Wye, 208/120V Circuits:
 - a. Phase A: Black.
 - b. Phase B: Red.
 - c. Phase C: Blue.
 - d. Neutral: White.
 4. Colors for Single-Phase, 240/120V Circuits:
 - a. Phase A: Black.
 - b. Phase B: Red.
 - c. Neutral: White.
 5. Colors for Three-Phase, 480/277V Circuits:
 - a. Phase A: Brown.
 - b. Phase B: Orange.
 - c. Phase C: Yellow.
 - d. Neutral: Gray.

6. Colors for Three-Phase, Center-Tapped Delta, 240/120V Circuits:
 - a. Phase A: Black.
 - b. Phase B: Red.
 - c. Wild Leg: Orange.
 - d. Neutral: White.
 7. Color for Equipment Grounds: Bare copper or Green.
 8. Colors for Isolated Grounds: Green with white stripe.
 9. Lighting Circuit Switched Legs and 3-way/4-way Traveler: Color unique to those listed above.
- C. Warning Label Colors:
1. Identify system voltage with black letters on an orange background.
- D. Warning labels and signs shall include, but are not limited to, the following legends:
1. Multiple Power Source Warning: "DANGER - ELECTRICAL SHOCK HAZARD - EQUIPMENT HAS MULTIPLE POWER SOURCES."
 2. Workspace Clearance Warning: "WARNING - OSHA REGULATION - AREA IN FRONT OF ELECTRICAL EQUIPMENT MUST BE KEPT CLEAR FOR 36 INCHES (915 MM)."
 3. Arc Flash Warning: "WARNING – KEEP CLEAR. RISK OF ELECTRIC SHOCK OR ARC FLASH. PPE REQUIRED."
- E. Equipment Identification Labels:
1. Black letters on a white field, or white letters on a black field.
 2. Include equipment designation and circuit.
 3. Exterior equipment labels shall have a rivet or screw mounted label on the exterior door.
 4. 1" minimum height letters for service disconnect and emergency shut-off switches.
 5. 1/2" minimum height letters for panelboards, switchboards, relay enclosures and transformers.

6. 1/4" minimum height letters for disconnect switches and motor starters.
7. 1/8" minimum height letters for device cover plates (where required).

2.03 TAPES AND STENCILS

- A. Self-Adhesive Vinyl Tape: Colored, heavy duty, waterproof, fade resistant; not less than 3 mils (0.08 mm) thick by 1 to 2 inches (25 to 50 mm) wide; compounded for outdoor use.
- B. Floor Marking Tape: 2-inch- (50-mm-) wide, 5-mil (0.125-mm) pressure-sensitive vinyl tape, with yellow and black stripes and clear vinyl overlay.
- C. Underground-Line Warning Tape:
 1. Tape:
 - a. Recommended by manufacturer for the method of installation and suitable to identify and locate underground electrical and communications utility lines.
 - b. Printing on tape shall be permanent and shall not be damaged by burial operations.
 - c. Tape material and ink shall be chemically inert and not subject to degradation when exposed to acids, alkalis, and other destructive substances commonly found in soils.
 2. Color and Printing:
 - a. Comply with ANSI Z535.1, ANSI Z535.2, ANSI Z535.3, ANSI Z535.4, and ANSI Z535.5.
 - b. Inscriptions for Red-Colored Tapes: "ELECTRIC LINE, HIGH VOLTAGE".
 - c. Inscriptions for Orange-Colored Tapes: "TELEPHONE CABLE, CATV CABLE, COMMUNICATIONS CABLE, OPTICAL FIBER CABLE".
 3. Type:
 - a. Detectable three-layer laminate, consisting of a printed pigmented polyolefin film, a solid aluminum-foil core, and a clear protective film that allows inspection of the continuity of the conductive core; bright colored, continuous-printed on one side with the inscription of the utility, compounded for direct-burial service.
 - b. Width: 3 inches (75 mm).

- c. Overall Thickness: 5 mils (0.125 mm).
- d. Foil Core Thickness: 0.35 mil (0.00889 mm).
- e. Weight: 28 lb/1000 sq. ft. (13.7 kg/100 sq. m).
- f. Tensile according to ASTM D 882: 70 lbf (311.3 N) and 4600 psi (31.7 MPa).

2.04 SIGNS

A. Baked-Enamel Signs:

- 1. Preprinted aluminum signs, high-intensity reflective, punched or drilled for fasteners, with colors, legend, and size required for application.
- 2. 1/4-inch (6.4-mm) grommets in corners for mounting.
- 3. Nominal Size: 7 by 10 inches (180 by 250 mm).

B. Laminated Acrylic or Melamine Plastic Signs:

- 1. Engraved legend.
- 2. Thickness:
 - a. For signs up to 20 sq. in. (129 sq. cm), minimum 1/16 inch (1.6 mm) thick.
 - b. For signs larger than 20 sq. in. (129 sq. cm), 1/8 inch (3.2 mm) thick.
 - c. Engraved legend with black letters on white face
 - d. Punched or drilled for mechanical fasteners with 1/4-inch (6.4-mm) grommets in corners for mounting.
 - e. Framed with mitered acrylic molding and arranged for attachment at applicable equipment.

2.05 CABLE TIES

A. General-Purpose Cable Ties: Fungus inert, self-extinguishing, one piece, self-locking, and Type 6/6 nylon.

- 1. Minimum Width: 3/16 inch (5 mm).
- 2. Tensile Strength at 73 Deg F (23 Deg C) according to ASTM D 638: 12,000 psi (82.7 MPa).
- 3. Temperature Range: Minus 40 to plus 185 deg F (Minus 40 to plus 85 deg C).

4. Color: Black, except where used for color-coding.
- B. UV-Stabilized Cable Ties: Fungus inert, designed for continuous exposure to exterior sunlight, self-extinguishing, one piece, self-locking, and Type 6/6 nylon.
1. Minimum Width: 3/16 inch (5 mm).
 2. Tensile Strength at 73 Deg F (23 Deg C) according to ASTM D 638: 12,000 psi (82.7 MPa).
 3. Temperature Range: Minus 40 to plus 185 deg F (Minus 40 to plus 85 deg C).
 4. Color: Black.
- C. Plenum-Rated Cable Ties: Self-extinguishing, UV stabilized, one piece, and self-locking.
1. Minimum Width: 3/16 inch (5 mm).
 2. Tensile Strength at 73 Deg F (23 Deg C) according to ASTM D 638: 7000 psi (48.2 MPa).
 3. UL 94 Flame Rating: 94V-0.
 4. Temperature Range: Minus 50 to plus 284 deg F (Minus 46 to plus 140 deg C).
 5. Color: Black.

2.06 MISCELLANEOUS IDENTIFICATION PRODUCTS

- A. Paint: Comply with requirements in painting Sections for paint materials and application requirements. Retain 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.

PART 3 EXECUTION

3.01 COORDINATION

- A. Verify and coordinate identification names, abbreviations, colors, and other features with requirements in other Sections requiring identification applica-

tions, Drawings, Shop Drawings, manufacturer's wiring diagrams, and operation and maintenance manual. Use consistent designations throughout Project.

- B. Coordinate identification with Project Drawings, manufacturer's wiring diagrams, and operation and maintenance manual.
- C. Coordinate installation of identifying devices with location of access panels and doors.
- D. Install identifying devices before installing acoustical ceilings and similar concealment.

3.02 INSTALLATION

- A. Verify identity of each item before installing identification products.
- B. Apply identification devices to surfaces that require finish after completing finish work.
- C. Install signs with approved legend to facilitate proper identification, operation, and maintenance of electrical systems and connected items.
- D. Self-Adhesive Identification Products: Before applying electrical identification products, clean substrates of substances that could impair bond, using materials and methods recommended by manufacturer of identification product.
- E. Self-Adhesive Identification Products used on the exterior of the building: Before applying electrical identification products, clean substrates of substances that could impair bond, using materials and methods recommended by manufacturer of identification product. Labels shall have a rivet or screw mounted on each side of the label, located on the exterior door.
- F. Elevated Components: Increase sizes of labels, signs, and letters to those appropriate for viewing from the floor.
- G. Floor Marking Tape: Apply stripes to finished surfaces following manufacturer's written instructions.
- H. Underground Line Warning Tape:
 - 1. During backfilling of trenches, install continuous underground-line warning tape directly above cable or raceway at 6 to 8 inches (150 to 200 mm) below finished grade. Use multiple tapes where width of multiple lines installed in a common trench or concrete envelope exceeds 16 inches (400 mm) overall.

2. Install underground-line warning tape for direct-buried cables and cables in raceways.
- I. Laminated Acrylic or Melamine Plastic Signs:
 1. Attach signs and plastic labels that are not self-adhesive type with mechanical fasteners appropriate to the location and substrate.
- J. Cable Ties: General purpose, for attaching tags, except as listed below:
 1. Outdoors: UV-stabilized nylon.
 2. In Spaces Handling Environmental Air: Plenum rated.

3.03 IDENTIFICATION SCHEDULE

- A. Install identification materials and devices at locations for most convenient viewing without interference with operation and maintenance of equipment. Install access doors or panels to provide view of identifying devices.
- B. Identify conductors, cables, and terminals in enclosures and at junctions, terminals, pull points, and locations of high visibility. Identify by system and circuit designation.
- C. Accessible Fittings for Raceways and Cables within Buildings: Identify the covers of each junction and pull box of the following systems with self-adhesive labels containing the wiring system legend and system voltage. System legends shall be as follows:
 1. "EMERGENCY POWER."
 2. "FIRE ALARM."
 3. "HIGH VOLTAGE."
 4. "DIRECT CURRENT."
- D. Control-Circuit Conductor Identification: For conductors and cables in pull and junction boxes, manholes, and handholes, use write-on tags with the conductor or cable designation, origin, and destination.
- E. Control-Circuit Conductor Termination Identification: For identification at terminations, provide self-adhesive wraparound labels with the conductor designation.
- F. Conductors to Be Extended in the Future: Attach write-on tags to conductors and list source.

- G. Auxiliary Electrical Systems Conductor Identification: Identify field-installed alarm, control, and signal connections.
 - 1. Identify conductors, cables, and terminals in enclosures and at junctions, terminals, and pull points. Identify by system and circuit designation.
 - 2. Use system of marker tape designations that is uniform and consistent with system used by manufacturer for factory-installed connections.
 - 3. Coordinate identification with Project Drawings, manufacturer's wiring diagrams, and the Operation and Maintenance Manual.
- H. Locations of Underground Lines: Underground-line warning tape for power, lighting, communication, and control wiring and optical-fiber cable.
- I. Workspace Indication: Apply floor marking tape to finished surfaces. Show working clearances in the direction of access to live parts. Workspace shall comply with NFPA 70 and 29 CFR 1926.403 unless otherwise indicated. Do not install at flush-mounted panelboards and similar equipment in finished spaces.
- J. Instructional Signs: Self-adhesive labels, including the color code for grounded and ungrounded conductors.
- K. Warning Labels for Indoor Cabinets, Boxes, and Enclosures for Power and Lighting: Self-adhesive equipment labels.
 - 1. Apply to exterior of door, cover, or other access.
 - 2. For equipment with multiple power or control sources, apply to door or cover of equipment, including, but not limited to, the following:
 - a. Power-transfer switches.
 - b. Controls with external control power connections.
- L. Arc Flash Warning Labeling: Self-adhesive labels.
- M. 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.
- N. Emergency Operating Instruction Signs: Self-adhesive labels, Laminated acrylic or melamine plastic signs with white legend on a red background

with minimum 3/8-inch- (10-mm-) high letters for emergency instructions at equipment used for power transfer and load shedding.

O. Equipment Identification Labels:

1. Indoor Equipment: Engraved, laminated acrylic or melamine plastic label.
2. Outdoor Equipment: Engraved, Laminated acrylic or melamine label.
3. Equipment to Be Labeled:
 - a. Panelboards/Switchboards:
 - 1) Label shall be self-adhesive, engraved, laminated acrylic or melamine. Label shall include: Panel-board/switchboard name, voltage, amperage, number of phases and wires, source and available fault current with date calculated.
 - 2) Typewritten directory of circuits in the location provided by panelboard manufacturer. Spares shall be filled in by hand with pencil.
 - 3) On main distribution panel door / switchboard front provide a laminated one-line diagram of the electrical system and all panel configurations.
 - b. Enclosures and electrical cabinets.
 - c. Access doors and panels for concealed electrical items.
 - d. Switchgear.
 - e. Transformers: Label that includes tag designation shown on Drawings for the transformer, feeder, and panelboards or equipment supplied by the secondary.
 - f. Substations.
 - g. Emergency system boxes and enclosures.
 - h. Motor-control centers.
 - i. Enclosed switches.
 - j. Enclosed circuit breakers.
 - k. Enclosed controllers.
 - l. Variable-speed controllers.
 - m. Push-button stations.
 - n. Power transfer equipment.
 - o. Contactors.
 - p. Remote-controlled switches, dimmer modules, and control devices.
 - q. Battery-inverter units.
 - r. Battery racks.

- s. Power-generating units.
- t. Monitoring and control equipment.
- u. UPS equipment.
- v. Wiring devices: See specification section “Wiring Devices”.

END OF SECTION 26 05 53

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PART 1 GENERAL**1.01 SUMMARY****A. Section Includes:**

1. Time switches.
2. Outdoor photoelectric switches.
3. Indoor occupancy and vacancy sensors.
4. Switchbox-mounted occupancy sensors
5. Digital timer light switches.
6. High-bay occupancy sensors.
7. Outdoor motion sensors.
8. Lighting contactors.
9. Emergency shunt relays.
10. Lighting Control Relay Panels

B. Related Requirements:

1. Section 26 27 26 "Wiring Devices" for wall-box dimmers and manual light switches.

1.02 ACTION SUBMITTALS**A. Product Data:** For each type of product.**B. Shop Drawings:**

1. Show installation details for occupancy/vacancy and light-level sensors.
2. Interconnection diagrams showing field-installed wiring.
3. Include diagrams for power, signal, and control wiring.

1.03 CLOSEOUT SUBMITTALS**A. Operation and maintenance data.****B. Remote Configuration Tools.**

1.04 WARRANTY

- A. Manufacturer's Warranty: Manufacturer and Installer agree to repair or replace lighting control devices that fail(s) in materials or workmanship within specified warranty period.
 - 1. Warranty Period: Two year(s) from date of Substantial Completion.

PART 2 PRODUCTS**2.01 TIME SWITCHES**

- A. Manufacturers: Design is based on Intermatic ET1100 Series, but subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to the following:
 - 1. Cooper Industries, Inc.
 - 2. Intermatic, Inc.
 - 3. Leviton Manufacturing Co., Inc.
 - 4. Tork by NSi Industries LLC.
- B. Electronic Time Switches: Solid state, programmable, with alphanumeric display; complying with UL 917.
 - 1. Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.
 - 2. Contact Configuration: SPST, or as noted on plans.
 - 3. Contact Rating: 20A ballast load, 120/240V ac.
 - 4. Programs: Two on-off set points on a 24-hour schedule, allowing different set points for each day of the week and an annual holiday schedule that overrides the weekly operation on holidays.
 - 5. Circuitry: Allow connection of a photoelectric relay as substitute for on-off function of a program on selected channels.
 - 6. Astronomic Time: All channels.
 - 7. Automatic daylight savings time changeover.
 - 8. Battery Backup: Not less than seven days reserve, to maintain schedules and time clock.

2.02 OUTDOOR PHOTOELECTRIC SWITCHES

- A. Manufacturers: Design is based on Intermatic NightFox Series, but subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to the following:
1. Cooper Industries, Inc.
 2. Intermatic, Inc.
 3. Leviton Manufacturing Co., Inc.
 4. Tork by NSi Industries LLC.
- B. Description: Solid state, with SPST dry contacts rated for 1000W incandescent or 1800VA tungsten, to operate connected relay, contactor coils, or microprocessor input; complying with UL 773A, and compatible with ballasts and LED lamps.
1. Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.
 2. Light-Level Monitoring Range: 1.5 to 10 fc (16.14 to 108 lux), with an adjustment for turn-on and turn-off levels within that range, and a directional lens in front of the photocell to prevent fixed light sources from causing turn-off.
 3. Time Delay: Fifteen-second minimum, to prevent false operation.
 4. Surge Protection: Metal-oxide varistor.
 5. Mounting: Twist lock complies with NEMA C136.10, with base-and-stem mounting or stem-and-swivel mounting accessories as required to direct sensor to the north sky exposure.
 6. Failure Mode: Luminaire stays ON.

2.03 INDOOR OCCUPANCY AND VACANCY SENSORS

- A. Manufacturers: Design is based on WattStopper DT-300 and DT-200 Series, but subject to compliance with requirements, available manufacturers offering products that may be substituted into the Work include, but are not limited to the following:
1. Cooper Industries, Inc.
 2. Hubbell Building Automation, Inc.

3. Leviton Manufacturing Co., Inc.
4. Lithonia Lighting; Acuity Brands Lighting, Inc.
5. Lutron Electronics Co., Inc.
6. Philips Lighting Controls.
7. Sensor Switch, Inc.

B. General Requirements for Sensors:

1. Wall and Ceiling-mounted, solid-state indoor occupancy and vacancy sensors.
2. Dual technology (passive infrared and ultrasonic).
3. Separate power pack, unless installed on gyp. board ceilings or walls.
4. Hardwired (line or low-voltage) connection to switch.
5. Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.
6. Operation (as noted on plans):
 - a. Occupancy Sensor: Unless otherwise indicated, turn lights on when coverage area is occupied, and turn them off when unoccupied; with a time delay for turning lights off, adjustable over a minimum range of 1 to 15 minutes.
 - b. Vacancy Sensor: Unless otherwise indicated, lights are manually turned on and sensor turns lights off when the room is unoccupied; with a time delay for turning lights off, adjustable over a minimum range of 1 to 15 minutes.
7. Sensor Output: Sensor is powered from the power pack.
8. Power: Line voltage where installed on gyp. board ceilings or walls.
9. Power Pack: Dry contacts rated for 20A LED load at 120- and 277-V ac, for 13-A tungsten at 120-V ac, and for 1 hp at 120-V ac. Sensor has 24-V dc, 150-mA, Class 2 power source, as defined by NFPA 70.

10. Mounting:
 - a. Sensor: Suitable for mounting in any position on a standard outlet box.
 - b. Relay: Externally mounted through a 1/2-inch (13-mm) knock-out in a standard electrical enclosure.
 - c. Time-Delay and Sensitivity Adjustments: Recessed and concealed behind hinged door.
 11. Indicator: Digital display, to show when motion is detected during testing and normal operation of sensor.
 12. Bypass Switch: Override the "on" function in case of sensor failure.
 13. Automatic Light-Level Sensor: Adjustable from 2 to 200 fc (21.5 to 2152 lux); turn lights off when selected lighting level is present.
- C. Dual-Technology Type: Wall or Ceiling mounted (as noted on plans); detect occupants in coverage area using PIR and ultrasonic detection methods. The particular technology or combination of technologies that control on-off functions is selectable in the field by operating controls on unit.
1. Sensitivity Adjustment: Separate for each sensing technology.
 2. Detector Sensitivity: Detect occurrences of 6-inch- (150-mm-) minimum movement of any portion of a human body that presents a target of not less than 36 sq. in. (232 sq. cm), and detect a person of average size and weight moving not less than 12 inches (305 mm) in either a horizontal or a vertical manner at an approximate speed of 12 inches/s (305 mm/s).
 3. Ceiling Mounted Detection Coverage (Standard Room): Detect occupancy anywhere within a circular area of 1000 sq. ft. (93 sq. m) when mounted on a 96-inch- (2440-mm-) high ceiling.
 4. Wall Mounted Detection Coverage: Detect occupancy anywhere within a 180-degree pattern centered on the sensor over an area of 2000 square feet (220 square meters) when mounted 72 inches above finished floor.

2.04 SWITCHBOX-MOUNTED OCCUPANCY SENSORS, DUAL TECHNOLOGY

- A. Manufacturers: Design is based on WattStopper DW-100 Series, but subject to compliance with requirements, available manufacturers offering products that may be substituted into the Work include, but are not limited to the following:

1. Cooper Industries, Inc.
 2. Hubbell Building Automation, Inc.
 3. Leviton Manufacturing Co., Inc.
 4. Lithonia Lighting; Acuity Brands Lighting, Inc.
 5. Lutron Electronics Co., Inc.
 6. Philips Lighting Controls.
 7. Sensor Switch, Inc.
- B. Description: Switchbox-mounted, combination lighting-control sensor and conventional switch lighting-control unit using dual technology (passive infrared and ultrasonic).
1. Connections: Hard wired.
 2. Rated 1200 W at 120-V ac for tungsten lighting, 10 A at 120-V ac or 10 A at 277-V ac for fluorescent or LED lighting, and 1/6 hp at 120-V ac.
 3. Adjustable time delay of 5 to 20 minutes.
 4. Comply with NEMA WD 1, UL 20, and FS W-S-896.

2.05 DIGITAL TIMER LIGHT SWITCHES

- A. Manufacturers: Design is based on WattStopper TS-400 Series, but subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to the following:
1. Cooper Industries, Inc.
 2. Intermatic, Inc.
 3. Invensys Controls.
 4. Leviton Manufacturing Co., Inc.
 5. NSi Industries LLC.
 6. TE Connectivity Ltd.
 7. WattStopper; a Legrand® Group brand.

- B. Description: Combination digital timer and conventional switch lighting control unit. Switchbox-mounted, backlit LCD display, with selectable time interval in 10-minute increments.
1. Rated 960 W at 120-V ac for tungsten lighting, 10 A at 120-V ac or 10 amps at 277-V ac for LED, and 1/4 horsepower at 120-V ac.
 2. Voltage: Dual voltage - 120 and 277 V.
 3. Color: Match color of other wiring devices.
 4. Faceplate: Color matched to switch.

2.06 HIGH-BAY OCCUPANCY SENSORS

- A. Manufacturers: Design is based on WattStopper HBP-100 Series, but subject to compliance with requirements, available manufacturers offering products that may be substituted into the Work include, but are not limited to the following:
1. Cooper Industries, Inc.
 2. Hubbell Building Automation, Inc.
 3. Leviton Manufacturing Co., Inc.
 4. Lithonia Lighting; Acuity Brands Lighting, Inc.
 5. Lutron Electronics Co., Inc.
 6. Philips Lighting Controls.
 7. Sensor Switch, Inc.
- B. Description:
1. Rated for indoor use.
 2. Mounting heights between 15' and 40'.
 3. Adjustable time delay (15 seconds - 30 minutes; factory preset at 15 minutes).
 4. Low-voltage operation with power pack, or line-voltage operation with integral power pack.
 5. Operating conditions: Temperature 32-158°F (0-70°C); Humidity 20-90%, non-condensing.

- C. PIR Type: Ceiling mounted; detect occupants in coverage area by their heat and movement.
 - 1. Detector Sensitivity: Detect occurrences of 6-inch- (150-mm-) minimum movement of any portion of a human body that presents a target of not less than 36 sq. in. (232 sq. cm).
 - 2. Detection Coverage: Detect occupancy anywhere in a circular area of 40-foot diameter when mounted on a 20-foot-high ceiling.
 - 3. Detection Coverage: Detect occupancy anywhere in a circular area of 100-foot diameter when mounted on a 40-foot-high ceiling.
 - 4. Detection Coverage: Detect occupancy anywhere in a linear area of 60-foot long when mounted on a 40-foot-high ceiling.
- D. Remote Configuration Tool: Include remote configuration tool to allow for sensor setup and adjustment from the floor.

2.07 OUTDOOR MOTION SENSORS

- A. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to the following:
 - 1. WattStopper; a Legrand® Group brand.
 - 2. Cooper Industries, Inc.
 - 3. Hubbell Building Automation, Inc.
 - 4. Leviton Manufacturing Co., Inc.
 - 5. Lithonia Lighting; Acuity Brands Lighting, Inc.
 - 6. Sensor Switch, Inc.
- B. General Requirements for Sensors: Solid-state outdoor motion sensors.
 - 1. Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.
 - 2. PIR type, weatherproof. Detect occurrences of 6-inch- (150-mm-) minimum movement of any portion of a human body that presents a target of not less than 36 sq. in. (232 sq. cm). Comply with UL 773A.
 - 3. Switch Rating:

- a. Luminaire-Mounted Sensor: 1000-W incandescent, 500-VA fluorescent/LED.
 - b. Separately Mounted Sensor: Dry contacts rated for 20-A ballast load at 120- and 277-V ac, for 13-A tungsten at 120-V ac, and for 1 hp at 120-V ac. Sensor has 24-V dc, 150-mA, Class 2 power source, as defined by NFPA 70.
- 4. Switch Type: SP. with bypass switch to override the "on" function in case of sensor failure.
- 5. Voltage: Match the circuit voltage.
- 6. Detector Coverage:
 - a. Standard Range: 210-degree field of view, with a minimum coverage area of 900 sq. ft. (84 sq. m).
 - b. Long Range: 180-degree field of view and 110-foot (34-m) detection range.
- 7. Ambient-Light Override: Concealed, field-adjustable, light-level sensor from 10 to 150 fc (108 to 1600 lux). The switch prevents the lights from turning on when the light level is higher than the set point of the sensor.
- 8. Concealed, field-adjustable, "off" time-delay selector at up to 30 minutes.
- 9. Adaptive Technology: Self-adjusting circuitry detects and memorizes usage patterns of the space and help eliminate false "off" switching.
- 10. Operating Ambient Conditions: Suitable for operation in ambient temperatures ranging from minus 40 to plus 130 deg F (minus 40 to plus 54 deg C), rated as "raintight" according to UL 773A.
- C. Remote Configuration Tool: For any motion sensors mounted on poles or walls at more than 10-feet above grade, include remote configuration tool to allow for sensor setup and adjustment from the ground.

2.08 LIGHTING CONTACTORS

- A. Manufacturers: Design is based on ASCO 918 Series, but subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to the following:
 - 1. Allen-Bradley/Rockwell Automation.
 - 2. ASCO.

3. Eaton.
 4. General Electric Company.
 5. Square D.
- B. Description: Electrically operated and mechanically held, complying with NEMA ICS 2 and UL 508.
1. Current Rating for Switching: Listing or rating consistent with type of load served, including tungsten filament, inductive, and high-inrush ballast (ballast with 15 percent or less THD of normal load current).
 2. Fault Current Withstand Rating: Equal to or exceeding the available fault current at the point of installation.
 3. Enclosure: Comply with NEMA 250.
 4. Provide with Hand-Off-Auto switch and pilot devices as indicated on Drawings, matching the NEMA type specified for the enclosure.
 5. Provide solid-state control module as required for 2 or 3 wire control.

2.09 LIGHTING CONTROL RELAY PANEL

- A. Manufacturers: Design is based on WattStopper LC8 Series, but subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to the following:
1. Acuity Controls.
 2. Crestron
 3. Hubbell Automation.
 4. Leviton.
- B. Panel description:
1. UL Listed with 14,000 SCCR.
 2. Enclosure: NEMA 1 rated with hinged, lockable, surface or flush cover (as shown on plans).
 3. Interior: Barrier for separation of high voltage (class 1) and low voltage (class 2) wiring.

4. Relays: Up to (8) single-pole or (4) two-pole relays. Relays shall be electrically held relays with auxiliary contacts for pilot light switching. SPST and DPST relays with 20A contact ratings for:
 - a. Light fixture ballasts/drivers.
 - b. General purpose loads.
 - c. 1/2 HP motor at 120V.
 - d. 1 HP motor at 208, 240 or 480V.
 5. Back-lit Touchscreen User Interface:
 - a. Timeclock with 8 Channels of time control, up to 42 holidays and automatic daylight savings adjustment.
 - b. Non-volatile program memory to retain time keeping during power outages for at least 48 hours.
- C. External Control device interface:
1. 8 universal switch inputs that are low voltage, self-configuring and do not require programming to accept momentary on/ momentary off switch, push button switch (cycling), maintained switch or 24VDC signals from occupancy sensors, photocells or other interfacing devices.
 2. After-hour interior lighting shut off control shall provide a full duration override time of 1 to 240 minutes with a warning blink five minutes prior to shutting the lighting off. An impending shut off will be cancelled and the override period re-initialized by pressing the automatic control switch push button (WattStopper No. AS-100 or equivalent).
 3. Control exterior lighting via photocell input (do not use astronomical clock function).

2.10 CONDUCTORS AND CABLES

- A. Power Wiring to Supply Side of Remote-Control Power Sources: Not smaller than No. 12 AWG. Comply with requirements in Section 260519 "Low-Voltage Electrical Power Conductors and Cables."
- B. Classes 2 and 3 Control Cable: Multi-conductor cable with stranded-copper conductors not smaller than No. 18 AWG. Comply with requirements in Section 260519 "Low-Voltage Electrical Power Conductors and Cables." Consult manufacturer for Class 2 wiring requirements. Provide in a separate raceway if manufacturer does not allow cabling shared with Class 1 cabling.

- C. Class 1 Control Cable: Multi-conductor cable with stranded-copper conductors not smaller than No. 14 AWG. Comply with requirements in Section 260519 "Low-Voltage Electrical Power Conductors and Cables."

PART 3 EXECUTION

3.01 DEVICE LOCATIONS

- A. Device locations on plan drawings are approximate and are intended to indicate general area to be covered.
 - 1. All devices shall be installed in strict accordance with manufacturer's guidelines.
 - 2. Contractor shall provide additional devices and associated hardware as required to cover the entire area.
 - 3. Occupancy sensor locations shall be shifted as necessary to ensure the following:
 - a. Normal devices shall be installed only no higher than 120" AFF.
 - b. No device employing PIR sensing shall be installed in a location where obstacles may block the sensor's field of view.
 - c. Any device employing ultrasonic sensing shall be installed at a minimum of 6' away from any strong transfer of air such as supply diffusers.

3.02 INSTALLATION

- A. Comply with NECA 1.
- B. Examine all lighting control devices before installation. Reject lighting control devices that are wet, moisture damaged, or mold damaged.
- C. Coordinate layout and installation of ceiling-mounted devices with other construction that penetrates ceilings or is supported by them, including light fixtures, HVAC equipment, smoke detectors, fire-suppression systems, and partition assemblies.
- D. Install and aim sensors in locations to achieve not less than 90-percent coverage of areas indicated. Do not exceed coverage limits specified in manufacturer's written instructions.
- E. Mount electrically held lighting contactors with elastomeric isolator pads to eliminate structure-borne vibration unless contactors are installed in an enclosure with factory-installed vibration isolators.

- F. Provide detailed point to point wiring diagrams for every termination. Provide wire specifications and wire colors to simplify contactor termination requirements
- G. Install the work of this Section in accordance with manufacturer's printed instructions unless otherwise indicated.
- H. Calibrate all sensor time delays and sensitivity to guarantee proper detection of occupants and energy savings.
 - 1. Adjust time delay so that controlled area remains lighted for 5 minutes after occupant leaves area.
- I. Provide written or computer-generated documentation on the commissioning of the system including room by room description including:
 - 1. Sensor parameters, time delays and sensitivities.
 - 2. Sequence of operation, (e.g. manual ON, Auto OFF. etc.)
 - 3. Load Parameters (e.g. blink warning, etc.)

3.03 WIRING

- A. In general, all devices and equipment shall be wired in accordance with manufacturer's guidelines. Wireless devices shall only be used if specifically approved in writing by the Engineer.
- B. Wiring Method: Comply with Section 26 05 19 "Low-Voltage Electrical Power Conductors and Cables." Minimum conduit size is 3/4 inch.
- C. Low voltage cables do not require raceway where concealed in accessible ceilings. Cabling shall be cleanly organized and supported by J-Hooks or approved methods every 6 feet.
- D. Low voltage cables shall be installed in conduit/raceway where exposed.
- E. Wiring within Enclosures: Separate power-limited and nonpower-limited conductors according to conductor manufacturer's written instructions.
- F. Size conductors according to lighting control device manufacturer's written instructions unless otherwise indicated.
- G. Splices, Taps, and Terminations: Make connections only on numbered terminal strips in junction, pull, and outlet boxes; terminal cabinets; and equipment enclosures.

3.04 IDENTIFICATION

- A. Identify components and power and control wiring according to Section 260553 "Identification for Electrical Systems."
 - 1. Identify controlled circuits in lighting contactors.
 - 2. Identify circuits or luminaires controlled by photoelectric and occupancy sensors at each sensor.
- B. Label time switches and contactors with a unique designation.

3.05 FIELD QUALITY CONTROL

- A. Perform the following tests and inspections:
 - 1. Operational Test: After installing time switches and sensors, and after electrical circuitry has been energized, start units to confirm proper unit operation.
 - 2. Test and adjust controls and safeties. Replace damaged and malfunctioning controls and equipment.
- B. Lighting control devices will be considered defective if they do not pass tests and inspections.
- C. Prepare test and inspection reports.

3.06 ADJUSTING

- A. Occupancy Adjustments: When requested within 12 months from date of Substantial Completion, provide on-site assistance in adjusting lighting control devices to suit actual occupied conditions. Provide up to two visits to Project during other-than-normal occupancy hours for this purpose.
 - 1. For occupancy and motion sensors, verify operation at outer limits of detector range. Set time delay to suit Owner's operations.
 - 2. For daylighting controls, adjust set points and deadband controls to suit Owner's operations.
 - 3. Align high-bay occupancy sensors using manufacturer's laser aiming tool.

3.07 DEMONSTRATION

- A. Train Owner's maintenance personnel to adjust, operate, and maintain lighting control devices.

END OF SECTION 26 09 23

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PART 1 GENERAL**1.01 SUMMARY**

- A. Section Includes:
 - 1. Straight-blade convenience receptacles.
 - 2. TV outlets (power & signal)
 - 3. GFCI receptacles.
 - 4. Toggle switches.
 - 5. Wall-box dimmers.
 - 6. Wall plates.
 - 7. Finishes.

1.02 RELATED DOCUMENTS

- A. Refer to Section 26 09 23 "Lighting Control Devices" for occupancy/vacancy sensors, daylight sensors, low-voltage lighting control panels and devices, room controllers, etc.

1.03 DEFINITIONS

- A. Abbreviations of Manufacturers' Names:
 - 1. Cooper: Copper Wiring Devices; Division of Cooper Industries, Inc.
 - 2. Hubbell: Hubbell Incorporated: Wiring Devices-Kellems.
 - 3. Leviton: Leviton Mfg. Company, Inc.
 - 4. P&S: Pass & Seymour/Legrand.

1.04 ACTION SUBMITTALS

- A. Product Data: For each type of product.
- B. Dimmer switch and LED lamp manufacturers' literature showing compatibility between the two.

1.05 CLOSEOUT SUBMITTALS

- A. Operation and maintenance data.

PART 2 PRODUCTS**2.01 GENERAL WIRING-DEVICE REQUIREMENTS**

- A. Wiring Devices, Components, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.
- B. Comply with NFPA 70.
- C. Devices that are manufactured for use with modular plug-in connectors may be substituted under the following conditions:
 - 1. Connectors shall comply with UL 2459 and shall be made with stranding building wire.
 - 2. Devices shall comply with the requirements in this Section.
- D. Devices for Owner-Furnished Equipment:
 - 1. Receptacles: Match plug configurations including wire count, poles, twistlock, etc.
- E. Source Limitations: Obtain each type of wiring device and associated wall plate from single source from single manufacturer.

2.02 STRAIGHT-BLADE RECEPTACLES

- A. Duplex Convenience Receptacles, 125V, 20A: Comply with NEMA WD 1, NEMA WD 6 Configuration 5-20R, UL 498, and FS W-C-596.
 - 1. Products: Subject to compliance with requirements, available products that may be incorporated into the Work include, but are not limited to, the following:
 - a. Cooper; 5351 (single), 5362 (duplex).
 - b. Hubbell; HBL5361 (single), HBL5362 (duplex).
 - c. Leviton; 5361 (single), 5362 (duplex).
 - d. P&S; 5351 (single), CRB5362 (duplex).

2.03 TV OUTLET (POWER & SIGNAL)

- A. Recessed, 3-gang, in-wall enclosure with:
 - 1. 20A duplex receptacle in left, single-gang, opening.

2. Center, single-gang, low-voltage opening with 1-1/4" conduit and pullstring provision for signal cable. Route to accessible ceiling space and to floor box where applicable.
 3. Right, single-gang, low-voltage opening with 1" conduit and pullstring provision for signal cable. Route to accessible ceiling space.
- B. Products: Subject to compliance with requirements, available products that may be incorporated into the Work include, but are not limited to, the following:
1. Pass & Seymour; TV3WMTVSSW.

2.04 GFCI RECEPTACLES

- A. General Description:
1. 125V, 20A, straight blade, non-feed-through type.
 2. Comply with NEMA WD 1, NEMA WD 6 Configuration 5-20R, UL 498, UL 943 Class A, and FS W-C-596.
 3. Include indicator light that shows when the GFCI has malfunctioned and no longer provides proper GFCI protection.
 4. Self-testing:
 - a. Automatic test initiates within 5 seconds of power availability to the line or load terminals and repeats at least every 3 hours.
 - b. If auto-monitoring detects a problem, GFCI will trip with the inability to reset.
- B. Duplex GFCI Convenience Receptacles, 125V, 20A:
1. Products: Subject to compliance with requirements, available products that may be incorporated into the Work include, but are not limited to, the following:
 - a. Cooper; VGF20.
 - b. Hubbell; GFR5352L.
 - c. Leviton; GFNT2.
 - d. P&S; 2097.
- C. Weather Resistant, Self-Testing, Duplex GFCI Receptacles, 125V, 20A:
1. Products: Subject to compliance with requirements, available products that may be incorporated into the Work include, but are not limited to, the following:

- a. Cooper; WRSGF20.
- b. Hubbell; GFTWRST20.
- c. Leviton; GFWR2.
- d. P&S; 2097TRWR.

- 2. For use only with wet or damp location covers.

2.05 TOGGLE SWITCHES

- A. Comply with NEMA WD 1, UL 20, and FS W-S-896.

- B. Switches, 120/277V, 20A:

- 1. Products: Subject to compliance with requirements, available products that may be incorporated into the Work include, but are not limited to, the following:

- a. Single Pole:
- b. Cooper; AH1221.
 - 1) Hubbell; HBL1221.
 - 2) Leviton; 1221-2.
 - 3) P&S; CSB20AC1.
- c. Two Pole:
- d. Cooper; AH1222.
 - 1) Hubbell; HBL1222.
 - 2) Leviton; 1222-2.
 - 3) P&S; CSB20AC2.
- e. Three Way:
- f. Cooper; AH1223.
 - 1) Hubbell; HBL1223.
 - 2) Leviton; 1223-2.
 - 3) P&S; CSB20AC3.
- g. Four Way:
- h. Cooper; AH1224.
 - 1) Hubbell; HBL1224.
 - 2) Leviton; 1224-2.
 - 3) P&S; CSB20AC4.

- C. Lit-Handle Switches, 20A:

1. Products: Subject to compliance with requirements, available products that may be incorporated into the Work include, but are not limited to, the following:
 - a. Cooper; AH1221LT.
 - b. Hubbell; HBL1201IL.
 - c. Leviton; 1221-LH1.
 - d. P&S; PS20AC1-CSL.
 2. Description: Single pole, with lighted handle, illuminated when switch is "off".
- D. Pilot-Light Switches, 20A:
1. Products: Subject to compliance with requirements, available products that may be incorporated into the Work include, but are not limited to, the following:
 - a. Cooper; AH1221PL (single-pole), AH1222PL (two-pole).
 - b. Hubbell; HBL1221PL (single-pole), HBL1222PL (two-pole).
 - c. Leviton; 1221-PLR (single-pole), 1222-PLR (two-pole).
 - d. P&S; PS20AC1-RPL (single-pole), PS20AC2-RPL (two-pole).
 2. Description: Single pole or two-pole, with lighted handle, illuminated when switch is "on."
- E. Key-Operated Switches, 120/277V, 20A:
1. Products: Subject to compliance with requirements, available products that may be incorporated into the Work include, but are not limited to, the following:
 - a. Single Pole:
 - b. Cooper; AH1221L.
 - 1) Hubbell; HBL1221L.
 - 2) Leviton; 1121-2L.
 - 3) P&S; PS20AC1L.
 - c. Two Pole:
 - d. Cooper; AH1222L.
 - 1) Hubbell; HBL1222L.
 - 2) Leviton; 1122-2L.
 - 3) P&S; PS20AC2L.
 - e. Three Way:
 - f. Cooper; AH1223L.

- 1) Hubbell; HBL1223L.
 - 2) Leviton; 1123-2L.
 - 3) P&S; PS20AC3L.
 - g. Four Way:
 - h. Cooper; AH1224L.
 - 1) Hubbell; HBL1224L.
 - 2) Leviton; 1124-2L.
 - 3) P&S; PS20AC4L.
 2. Description: Single pole, with factory-supplied key in lieu of switch handle.
- F. Single-Pole, Double-Throw, Momentary-Contact, Center-off Switches: 120/277V, 15A; for use with mechanically held lighting contactors.
- a. Cooper; 1995, 1995L (keyed).
 - b. Hubbell; HBL1557, HBL1557L (keyed)
 - c. Leviton; 1257-W, 1257-L (keyed).
 - d. Pass & Seymour; 1251, 1251L (keyed).

2.06 DIGITAL TIMER LIGHT SWITCH

- A. Products: Subject to compliance with requirements, available products that may be incorporated into the Work include, but are not limited to, the following:
1. Watt Stopper; TS-200.
 2. Hubbell; TD300.
 3. P&S; RT-100
- B. Description: Switchbox-mounted, combination digital timer and conventional switch lighting-control unit, with backlit digital display, with selectable time interval from 5 minutes to 12 hours.
1. Rated 0-800W at 120V ac, and 0-1200W at 277V ac for tungsten, fluorescent, and LED loads.
 2. Optional beep warning every five seconds during last minute of countdown.
 3. Optional one second light flash warning at one minute before timer runs out.
 4. Time scrolling options for overriding the preset time.

5. Electroluminescent back-lit Liquid Crystal Display shows timer count-down.
 6. Integral relay for connection to BAS.
- C. Weather Resistant, Self-Testing, Duplex GFCI Receptacles, 125V, 15A:
1. Products: Subject to compliance with requirements, available products that may be incorporated into the Work include, but are not limited to, the following:
 - a. Cooper; TWRSGF15.
 - b. Hubbell; GFTWRST15.
 - c. Leviton; GFWT1.
 - d. P&S; 1597TRWR
 2. For use only with wet or damp location covers.
- D. TV Outlet (Power & Signal), recessed, 2-gang, in-wall enclosure with tamper resistant, duplex receptacle, 125V, 15A; comply with NEMA WD 1, NEMA WD 6 Configuration 5-15R, and UL 498; and 1" conduit with pull-string provision for signal cables.
1. Products: Subject to compliance with requirements, available products that may be incorporated into the Work include, but are not limited to, the following:
 - a. Cooper; 35MRW
 - b. Hubbell; RR1512.
 2. Description: Single RJ-45 jack for terminating Category 5e, twisted pair cable complying with Section 26 05 23 "Control-Voltage Electrical Power Conductors" and a single BNC connector for terminating coaxial cable."
 3. Comply with UL 1863.
- E. Toggle Switches, 120/277V, 15A:
1. Products: Subject to compliance with requirements, available products that may be incorporated into the Work include, but are not limited to, the following:
 - a. Single Pole:
 - b. Cooper; 1301-7 (standard), 7501 (decorator), 1301-7LT (lit handle).

- 1) Hubbell; RS115 (standard), RSD115 (decorator), RS115IL (lit handle).
 - 2) Leviton; 1451-2 (standard), 5601-2 (decorator), 1461-LC (lit handle).
 - 3) P&S; 660G (standard), TM870 (decorator), 660-SLG (lit handle).
- c. Two Pole:
- d. Hubbell; RS215 (standard), RSD215 (decorator), RS215IL (lit handle).
- 1) Leviton; CS215 (standard), 5602-2 (decorator).
 - 2) P&S; CS-B15AC2 (standard); 2622 (decorator).
- e. Three Way:
- f. Cooper; 1303-7 (standard), 7503 (decorator) 1303-7LT (lit handle).
- 1) Hubbell; RS315 (standard), RSD315 (decorator), RS315IL (lit handle).
 - 2) Leviton; 1453-2 (standard), 5603-2 (decorator), 1463-LC (lit handle).
 - 3) P&S; 663G (standard), TM873 (decorator), 663-SLG (lit handle).
- g. Four Way:
- h. Cooper; 1242-7 (standard), 7504 (decorator).
- 1) Hubbell; RS415 (standard), RSD415 (decorator), RS415IL (lit handle).
 - 2) Leviton; 54504-2 (standard), 5604-2 (decorator).
 - 3) P&S; 664G (standard), TM874 (decorator), 664-SLG (lit handle).
- F. Fan-Speed Controls:
1. Modular, 120-V, full-wave, solid-state units with integral, quiet on-off switches and audible frequency and EMI/RFI filters.
 2. Products: Subject to compliance with requirements, available products that may be incorporated into the Work include, but are not limited to, the following:
 - a. Cooper; RI061.
 - b. Leviton; RNL06-10Z.
 - c. P&S; DRSC53PV.

3. Comply with UL 1917.
4. Continuously adjustable rotary knob, 5A.

2.07 WALL-BOX DIMMERS

- A. General: These are stand-alone dimmer switches. See Section 26 09 23 “Lighting Control Devices” for dimmers that interface with daylight sensors, low-voltage lighting control panels, room controllers, etc.
- B. 0-10V Dimming for LED fixtures:
 1. Products: Subject to compliance with requirements, available products that may be incorporated into the Work include, but are not limited to, the following:
 - a. Philips; Sunrise series.
 - b. Watt Stopper; Radiant series.
 - c. Synergy; ISD-BC.
 - d. Lutron; Diva series.
 2. Slide dimmer with separate ON/OFF switch button. Lighting is switched ON or OFF at the level currently set by the slider.
 3. Designed for use with standard three-way and four-way switches for applications requiring control from multiple locations.
 4. Match dimmer to lamp(s) being dimmed in accordance with manufacturer’s guidelines.
- C. Dimmer Switches for screw-in LED lamps (LED lamps with integral drivers, designed to replace incandescent or screw-in compact fluorescent lamps):
 1. Modular, full-wave, solid-state units with integral, quiet on-off switches, with audible frequency and EMI/RFI suppression filters.
 2. Match dimmer to lamp(s) being dimmed in accordance with manufacturer’s guidelines.
 3. 600 W dimmers shall require no derating when ganged with other devices.

2.08 WALL PLATES

- A. Single and combination types shall match corresponding wiring devices.
 1. Plate-Securing Screws: Metal with head color to match plate finish.

2. Material for Finished Spaces: 0.05-inch- (1.2-mm-) thick, anodized aluminum.
3. Material for Unfinished Spaces: Galvanized steel.
4. Material for Damp Locations: Cast aluminum with spring-loaded lift cover, listed and labeled for use in wet and damp locations.

B. Damp/Wet Location Covers

1. General:
 - a. All wiring devices installed in damp or wet locations shall have cast metal covers.
 - b. Covers shall be UL listed and labeled for use in wet and damp locations.
 - c. Distinction between damp and wet locations shall be in accordance with NEC 406.9.
 - d. Cover shall be appropriate for the device orientation with the hinge on top.
 - e. Gasketing shall be provided to seal the cover to the box. Caulking shall be provided as required to seal any gaps between the cover and wall finish material.
2. Damp Location Covers:
 - a. Cast metal with spring-loaded lift cover to seal the device when it is NOT in use.
 - b. Leviton Series 6196 or equivalent.
3. Wet Location (Weatherproof-in-Use) Covers:
 - a. Heavy Duty, Lockable, cast metal cover to seal the device whether it is in use or not.
 - b. Intermatic Series WP1010MXD or equivalent.

2.09 FINISHES

A. Device Color:

1. Wiring Devices Connected to Normal Power System: Gray As selected by Engineer unless otherwise indicated or required by NFPA 70 or device listing.

B. Wall Plate Color: Match device color, unless noted otherwise.

PART 3 EXECUTION**3.01 INSTALLATION**

- A. Comply with NECA 1, including mounting heights listed in that standard, unless otherwise indicated.
- B. Coordination with Other Trades:
 - 1. Protect installed devices and their boxes. Do not place wall finish materials over device boxes and do not cut holes for boxes with routers that are guided by riding against outside of boxes.
 - 2. Keep outlet boxes free of plaster, drywall joint compound, mortar, cement, concrete, dust, paint, and other material that may contaminate the raceway system, conductors, and cables.
 - 3. Install device boxes in brick or block walls so that the cover plate does not cross a joint unless the joint is troweled flush with the face of the wall.
 - 4. Install wiring devices after all wall preparation, including painting, is complete.
 - 5. Coordinate receptacle configuration, location and mounting height with equipment/ function it serves.
- C. Conductors:
 - 1. Do not strip insulation from conductors until right before they are spliced or terminated on devices.
 - 2. Strip insulation evenly around the conductor using tools designed for the purpose. Avoid scoring or nicking of solid wire or cutting strands from stranded wire.
 - 3. The length of free conductors at outlets for devices shall meet provisions of NFPA 70, Article 300, without pigtails.
 - 4. Existing Conductors:
 - a. Cut back and pigtail, or replace all damaged conductors.
 - b. Straighten conductors that remain and remove corrosion and foreign matter.
 - c. Pigtailing existing conductors is permitted, provided the outlet box is large enough.

D. Device Installation:

1. Replace devices that have been in temporary use during construction and that were installed before building finishing operations were complete.
2. Keep each wiring device in its package or otherwise protected until it is time to connect conductors.
3. Do not remove surface protection, such as plastic film and smudge covers, until the last possible moment.
4. Connect devices to branch circuits using pigtails that are not less than 6 inches (152 mm) in length.
5. When there is a choice, use side wiring with binding-head screw terminals. Wrap solid conductor tightly clockwise, two-thirds to three-fourths of the way around terminal screw.
6. Use a torque screwdriver when a torque is recommended or required by manufacturer.
7. When conductors larger than No. 12 AWG are installed on 15- or 20-A circuits, splice No. 12 AWG pigtails for device connections.
8. Tighten unused terminal screws on the device.
9. When mounting into metal boxes, remove the fiber or plastic washers used to hold device-mounting screws in yokes, allowing metal-to-metal contact.
10. Damp Location Covers: Not permitted UNO. Install only where specified in interior locations.
11. Wet Location Covers: Install everywhere outside UNO.

E. Receptacle Orientation:

1. Install ground pin of vertically mounted receptacles up, and on horizontally mounted receptacles to the left.

F. Device Plates: Do not use oversized or extra-deep plates. Repair wall finishes and remount outlet boxes when standard device plates do not fit flush or do not cover rough wall opening.**G. Dimmers:**

1. Install dimmers within terms of their listing.

2. Verify that dimmers used for fan-speed control are listed for that application.
 3. Install unshared neutral conductors on line and load side of dimmers according to manufacturers' device listing conditions in the written instructions.
 4. Match dimmer to lamp(s) being dimmed in accordance with manufacturer's guidelines.
- H. Arrangement of Devices: Unless otherwise indicated, mount flush, with long dimension vertical and with grounding terminal of receptacles on top. Group adjacent switches under single, multi-gang wall plates.
- I. GFCI Receptacles: Install non-feed-through-type GFCI receptacles.

3.02 FIELD QUALITY CONTROL

- A. Test Instruments: Use instruments that comply with UL 1436.
- B. Test Instrument for Convenience Receptacles: Digital wiring analyzer with digital readout or illuminated digital-display indicators of measurement.
- C. Perform the following tests and inspections:
1. Tests for Convenience Receptacles:
 - a. Line Voltage: Acceptable range is 105 to 132V.
 - b. Percent Voltage Drop under 15-A Load: A value of 6 percent or higher is unacceptable.
 - c. Ground Impedance: Values of up to 2 ohms are acceptable.
 - d. GFCI Trip: Test for tripping values specified in UL 1436 and UL 943.
 - e. Using the test plug, verify that the device and its outlet box are securely mounted.
 - f. Tests shall be diagnostic, indicating damaged conductors, high resistance at the circuit breaker, poor connections, inadequate fault current path, defective devices, or similar problems. Correct circuit conditions, remove malfunctioning units and replace with new ones, and retest as specified above.
- D. Wiring device will be considered defective if it does not pass tests and inspections.

3.03 IDENTIFICATION

- A. Receptacles: Identify panelboard and circuit number from which the device is served.

1. Mark inside of box or coverplate with permanent marker. Test to ensure that marker lines are not visible on outside of cover when it is installed.
2. Mark outside of coverplate using labeler such as Brother PT-90 to produce 1/8" black letters (white letters if cover is dark) on clear tape.

3.04 WEATHER STRIPPING

A. Behind exterior wall devices

1. Install a precut foam insulation pad over the fixture and reinstall the cover.

END OF SECTION 26 27 26

PART 1 GENERAL**1.01 SUMMARY****A. Section Includes:**

1. Cartridge and plug fuses rated 600 V ac and less for use in the following:
 - a. Control circuits.
 - b. Motor-control centers.
 - c. Panelboards.
 - d. Switchboards.
 - e. Enclosed controllers.
 - f. Enclosed switches.
2. Spare-fuse cabinets.

1.02 ACTION SUBMITTALS**A. Product Data: For each type of product.**

1. Ambient Temperature Adjustment Information: If ratings of fuses have been adjusted to accommodate ambient temperatures, provide list of fuses with adjusted ratings.
 - a. For each fuse having adjusted ratings, include location of fuse, original fuse rating, local ambient temperature, and adjusted fuse rating.
 - b. Provide manufacturer's technical data on which ambient temperature adjustment calculations are based.
2. Dimensions and manufacturer's technical data on features, performance, electrical characteristics, and ratings.
3. Current-limitation curves for fuses with current-limiting characteristics.
4. Time-current coordination curves (average melt) and current-limitation curves (instantaneous peak let-through current) for each type and rating of fuse.

1.03 CLOSEOUT SUBMITTALS**A. Operation and maintenance data.**

1. Ambient temperature adjustment information.

2. Current-limitation curves for fuses with current-limiting characteristics.
3. Time-current coordination curves (average melt) and current-limitation curves (instantaneous peak let-through current) for each type and rating of fuse.

1.04 MAINTENANCE MATERIAL SUBMITTALS

- A. Furnish extra materials that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.
 1. Fuses: Equal to 10 percent of quantity installed for each size and type, but no fewer than three of each size and type.

1.05 PROJECT CONDITIONS

- A. Where ambient temperature to which fuses are directly exposed is less than 40 deg F (5 deg C) or more than 100 deg F (38 deg C), apply manufacturer's ambient temperature adjustment factors to fuse ratings.

PART 2 PRODUCTS

2.01 MANUFACTURERS

- A. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
 1. Bussmann
 2. Edison Fuse
 3. Ferraz Shawmut
 4. Littelfuse
- B. Obtain fuses, for use within a specific product or circuit, from a single source from a single manufacturer.

2.02 FUSES

- A. Cartridge fuse characteristics: Current-limiting, nonrenewable cartridge fuses with voltage ratings consistent with circuit voltages.
 1. Type RK-1: 250V and 600V, zero to 600A rating, 200 kAIC, dual-element time delay.

2. Type RK-5: 250V and 600V, zero to 600A rating, 200 kAIC, dual-element, time delay.
 3. Type CC: 600V, zero to 30A rating, 200 kAIC, fast acting.
 4. Type CD: 600V, 31 to 60A rating, 200 kAIC, fast acting.
 5. Type L: 600-V, 601 to 6000A rating, 200 kAIC, time delay.
- B. Plug fuse characteristics: Current-limiting with rejection base and voltage ratings consistent with circuit voltages.
1. Type S: 125V, zero to 15A rating, dual-element, time delay.
- 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.
- D. Comply with NEMA FU 1 for cartridge fuses.
- E. Comply with NFPA 70.
- F. Coordinate fuse ratings with utilization equipment nameplate limitations of maximum fuse size and with system short-circuit current levels.

2.03 SPARE-FUSE CABINET

- A. Characteristics: Wall-mounted steel unit with full-length, recessed piano-hinged door and key-coded cam lock and pull.
1. Size: Adequate for storage of spare fuses specified with 15 percent spare capacity minimum.
 2. Finish: Gray, baked enamel.
 3. Identification: "SPARE FUSES" in 1-1/2-inch- (38-mm-) high letters on exterior of door.
 4. Fuse Pullers: For each size of fuse, where applicable and available, from fuse manufacturer.

PART 3 EXECUTION**3.01 EXAMINATION**

- A. Examine fuses before installation. Reject fuses that are moisture damaged or physically damaged.
- B. Examine holders to receive fuses for compliance with installation tolerances and other conditions affecting performance, such as rejection features.
- C. Examine utilization equipment nameplates and installation instructions. Install fuses of sizes and with characteristics appropriate for each piece of equipment.
- D. Evaluate ambient temperatures to determine if fuse rating adjustment factors must be applied to fuse ratings.
- E. Proceed with installation only after unsatisfactory conditions have been corrected.

3.02 FUSE APPLICATIONS

- A. Apply fuses in the following circumstances:
 - 1. Service Entrance: Class L or Class RK-1, time delay.
 - 2. Feeders and Branch Circuits: Class L or Class RK-1, time delay.
 - 3. Motors, Welders, Transformers: Class RK-5, time delay.
 - 4. Control Circuits: Class CC, fast acting.
 - 5. Luminaires: In accordance with fixture manufacturer's guidelines.
 - 6. Fustats: Type S, time delay with rejection base.
- B. Size fuses as shown and specified, or as required by load being served. Where fusing in accordance with manufacturer's guidelines requires smaller fuses, provide necessary reducers with no additional cost to Owner.

3.03 INSTALLATION

- A. Install fuses in fusible devices. Arrange fuses so rating information is readable without removing fuse.
- B. Install spare-fuse cabinet. Verify exact location with Owner's maintenance representative prior to mounting.

3.04 IDENTIFICATION

- A. Install labels complying with requirements for identification specified in Section 26 05 53 "Identification for Electrical Systems" and indicating fuse replacement information inside of door of each fused switch and adjacent to each fuse block, socket, and holder.

END OF SECTION 26 28 13

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PART 1 GENERAL

1.01 SUMMARY

- A. Section Includes:
 - 1. Fusible switches.
 - 2. Nonfusible switches.
 - 3. Enclosed circuit breaker switches.
 - 4. Fustats
 - 5. Shunt trip switches.
 - 6. Enclosures.

1.02 DEFINITIONS

- A. NC: Normally closed.
- B. NO: Normally open.
- C. SPDT: Single pole, double throw.

1.03 ACTION SUBMITTALS

- A. Product Data: For each type of enclosed switch, accessory, and component indicated. Include nameplate ratings, dimensioned elevations, sections, weights, and manufacturers' technical data on features, performance, electrical characteristics, ratings, accessories, and finishes.
- B. Shop Drawings: For enclosed switches.
 - 1. Include plans, elevations, sections, details, and attachments to other work.
 - 2. Include wiring diagrams for power, signal, and control wiring.

1.04 INFORMATIONAL SUBMITTALS

- A. Seismic Qualification Certificates: For enclosed switches, accessories, and components, from manufacturer.
- B. Field quality-control reports.

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1.05 CLOSEOUT SUBMITTALS

- A. Operation and maintenance data.

1.06 WARRANTY

- A. Manufacturer's Warranty: Manufacturer and Installer agree to repair or replace components that fail in materials or workmanship within specified warranty period.

- 1. Warranty Period: Two years from date of Substantial Completion.

PART 2 PRODUCTS

2.01 PERFORMANCE REQUIREMENTS

- A. Seismic Performance: Enclosed switches shall withstand the effects of earthquake motions determined according to ASCE/SEI 7.
 - 1. The term "withstand" means "the unit will remain in place without separation of any parts from the device when subjected to the seismic forces specified and the unit will be fully operational after the seismic event."

2.02 GENERAL REQUIREMENTS

- A. Source Limitations: Obtain enclosed switches, overcurrent protective devices, components, and accessories, within same product category, from single manufacturer.
- B. Product Selection for Restricted Space: Drawings indicate maximum dimensions for enclosed switches, including clearances between enclosures, and adjacent surfaces and other items. Comply with indicated maximum dimensions.
- C. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by an NRTL, and marked for intended location and application.
- D. Comply with NFPA 70.

2.03 FUSIBLE SWITCHES

- A. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:

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1. Square D by Schneider Electric.
 2. Eaton Cutler-Hammer.
 3. ABB/General Electric Company.
- B. Type HD, Heavy Duty:
1. Single throw.
 2. Two or three pole.
 3. 240 or 600V ac as noted on plans.
 4. 1200 A and smaller.
 5. UL 98 and NEMA KS 1, horsepower rated, with clips or bolt pads to accommodate fuses indicated on plans, or as required by manufacture of the equipment being protected.
 6. Lockable handle (in the OFF position) with capability to accept three padlocks, and interlocked with cover in closed position.
 7. Ability to also lock switch handle in the ON position for exterior main disconnect.
- C. Accessories:
1. Equipment Ground Kit: Internally mounted and labeled for copper and aluminum ground conductors.
 2. Neutral Kit: Internally mounted; insulated, capable of being grounded and bonded; labeled for copper and aluminum neutral conductors.
 3. Class R Fuse Kit: Provides rejection of other fuse types when Class R fuses are specified.
 4. Lugs: Suitable for number, size, and conductor material.
 5. Service-Rated Switches: Labeled for use as service equipment.

2.04 ENCLOSED CIRCUIT BREAKER SWITCHES

- A. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:

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1. Square D by Schneider Electric.
2. Eaton Cutler-Hammer.
3. ABB/General Electric Company.

B. MOLDED CASE PROTECTIVE DEVICES

1. Protective devices shall be molded case circuit breakers with inverse time and instantaneous tripping characteristics.
2. Circuit breakers shall be operated by a toggle-type handle and shall have a quick-make, quick-break over-center switching mechanism that is mechanically trip-free. Automatic tripping of the breaker shall be clearly indicated by the handle position. Contacts shall be non-welding silver alloy and arc extinction shall be accomplished by means of DE-ION arc chutes. A push-to-trip button on the front of the circuit breaker shall provide a local manual means to exercise the trip mechanism.
3. Circuit breakers shall have a minimum symmetrical interrupting capacity as indicated on the drawings.
4. Circuit breakers shall have thermal-magnetic trip units and inverse time-current characteristics.

C. ACCESSORIES

1. Provide shunt trips, bell alarms and auxiliary switches as shown on the contract drawings.

2.05 NONFUSIBLE SWITCHES

- A. Manufacturers:** Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:

1. Square D by Schneider Electric.
2. Eaton Cutler-Hammer.
3. ABB/General Electric Company.

B. Type HD, Heavy Duty:

1. Single throw.

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2. Two or three pole.
3. 240 or 600V ac as noted on plans.
4. 1200 A and smaller.
5. UL 98 and NEMA KS 1, horsepower rated.
6. Lockable handle (in the OFF position) with capability to accept three padlocks, and interlocked with cover in closed position.

C. Accessories:

1. Equipment Ground Kit: Internally mounted and labeled for copper and aluminum ground conductors.
2. Neutral Kit: Internally mounted; insulated, capable of being grounded and bonded; labeled for copper and aluminum neutral conductors.
3. Lugs: Suitable for number, size, and conductor material.

2.06 FUSTAT

A. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:

1. Bussmann.
2. Littelfuse.

B. NEMA 1 rated and designed to mount on square, pressed steel box.

1. 15A and smaller.
2. 120V ac.
3. Type S fuse socket.
4. Toggle switch.
5. Pilot light.

2.07 SHUNT TRIP SWITCHES FOR ELEVATORS

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- A. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
 - 1. Mersen.
 - 2. Littelfuse.
- B. General Requirements: Comply with ASME A17.1, UL 50, and UL 98, with Class J fuse block and 200-kA interrupting and short-circuit current rating.
- C. Type HD, Heavy-Duty:
 - 1. Single throw.
 - 2. Three Pole.
 - 3. 240 or 600V ac as noted on plans.
 - 4. 30, 60, 100 or 200 A as noted on plans.
 - 5. UL 98 and NEMA KS 1, horsepower-rated
 - 6. Integral shunt trip mechanism.
 - 7. Clips or bolt pads to accommodate fuses sized as required by manufacture of the elevator equipment being provided.
 - 8. Lockable handle with capability to accept three padlocks; interlocked with cover in closed position.
- D. Control Circuit for fire safety interface relay: 24-Vdc or 120-V ac as coordinated with fire alarm contractor; obtained from integral control power transformer, with primary and secondary fuses of enough capacity to operate shunt trip, pilot, indicating and control devices.
- E. Accessories:
 - 1. Oiltight key switch for key-to-test function.
 - 2. Oiltight green ON pilot light.
 - 3. Isolated neutral lug; 100 or 200 percent rating.
 - 4. Mechanically interlocked auxiliary contacts that change state when switch is opened and closed. Contact shall be positively opened mechanically and shall not be dependent on springs or spring steel.

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5. Three-pole, double-throw, fire-alarm voltage monitoring relay complying with NFPA 72.
6. Neutral Kit: Internally mounted; insulated, capable of being grounded and bonded; labeled for copper and aluminum neutral conductors.
7. Class R Fuse Kit: Provides rejection of other fuse types when Class R fuses are specified.

2.08 ENCLOSURES

- A. Enclosed Switches: UL 489, NEMA KS 1, NEMA 250, and UL 50, to comply with environmental conditions at installed location.
- B. Enclosure Finish: The enclosure shall be finished with:
 1. Gray baked enamel paint, electrodeposited on cleaned, phosphatized steel (NEMA 250 Type 1).
 2. Gray baked enamel paint, electrodeposited on cleaned, phosphatized galvanized steel (NEMA 250 Types 3R, 12).
 3. Brush finish on Type 304 stainless steel (NEMA 250 Type 4-4X stainless steel).
 4. Copper-free cast aluminum alloy (NEMA 250 Types 7, 9).
- C. Conduit Entry: NEMA 250 Types 4, 4X, and 12 enclosures shall contain no knockouts. NEMA 250 Types 7 and 9 enclosures shall be provided with threaded conduit openings in both endwalls.
- D. Operating Mechanism: The switch operating handle shall be externally operable with the operating mechanism being an integral part of the box, not the cover. The cover interlock mechanism shall have an externally operated override. The override shall not permanently disable the interlock mechanism, which shall return to the locked position once the override is released. The tool used to override the cover interlock mechanism shall not be required to enter the enclosure in order to override the interlock.
- E. Enclosures designated as NEMA 250 Type 4, 4X stainless steel, 12, or 12K shall have a dual cover interlock mechanism to prevent unintentional opening of the enclosure cover when the switch is ON and to prevent turning the switch ON when the enclosure cover is open.
- F. NEMA 250 Type 7/9 enclosures shall be furnished with a breather and drain kit to allow their use in outdoor and wet location applications.

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PART 3 EXECUTION

3.01 ENCLOSURE ENVIRONMENTAL RATING APPLICATIONS

- A. Enclosed Switches: Provide enclosures at installed locations with the following environmental ratings.
 - 1. Indoor, Dry and Clean Locations: NEMA 250, Type 1.
 - 2. Outdoor Locations: NEMA 250, Type 3R.
 - 3. Kitchen/Wash-Down Areas: NEMA 250, Type 4X, stainless steel.
 - 4. Other Wet or Damp, Indoor Locations: NEMA 250, Type 4.
 - 5. Indoor Locations Subject to Dust, Falling Dirt, and Dripping Noncorrosive Liquids: NEMA 250, Type 12.
 - 6. Hazardous Areas Indicated on Drawings: NEMA 250, Type 7/Type 9 with cover attached by Type 316 stainless steel bolts.

3.02 INSTALLATION

- A. Coordinate layout and installation of switches and components with equipment served and adjacent surfaces. Maintain required workspace clearances and required clearances for equipment access doors and panels.
- B. Install individual wall-mounted switches with tops at uniform height unless otherwise indicated.
- C. Comply with mounting and anchoring requirements specified in Section 26 05 48.16 "Seismic Controls for Electrical Systems."
- D. Temporary Lifting Provisions: Remove temporary lifting of eyes, channels, and brackets and temporary blocking of moving parts from enclosures and components.
- E. Install fuses in fusible devices.
- F. Comply with NFPA 70 and NECA 1.

3.03 IDENTIFICATION

- A. Comply with requirements in Section 26 05 53 "Identification for Electrical Systems."

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1. Identify field-installed conductors, interconnecting wiring, and components; provide warning signs.
2. Label each enclosure with engraved metal or laminated-plastic nameplate.

3.04 FIELD QUALITY CONTROL

- A. Perform tests and inspections.
- B. Tests and Inspections for Switches:
 1. Visual and Mechanical Inspection:
 - a. Inspect physical and mechanical condition.
 - b. Inspect anchorage, alignment, grounding, and clearances.
 - c. Verify that the unit is clean.
 - d. Verify blade alignment, blade penetration, travel stops, and mechanical operation.
 - e. Verify that fuse sizes and types match the Specifications and Drawings.
 - f. Verify that each fuse has adequate mechanical support and contact integrity.
 - g. Inspect bolted electrical connections for high resistance using one of the two following methods:
 - 1) Verify tightness of accessible bolted electrical connections by calibrated torque-wrench method in accordance with manufacturer's published data or NETA ATS Table 100.12.
 - a) Bolt-torque levels shall be in accordance with manufacturer's published data. In the absence of manufacturer's published data, use NETA ATS Table 100.12.
 - h. Verify correct phase barrier installation.
 - i. Verify lubrication of moving current-carrying parts and moving and sliding surfaces.
- C. Enclosed switches will be considered defective if they do not pass tests and inspections.
- D. Prepare test and inspection reports.
 1. Test procedures used.

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2. Include identification of each enclosed switch tested and describe test results.
3. List deficiencies detected, remedial action taken, and observations after remedial action.

END OF SECTION 26 28 16

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PART 1 GENERAL**1.01 SUMMARY**

- A. This Section includes solid-state, pulse-width modulated (PWM), variable frequency controllers (VFCs) for speed control of three-phase, squirrel-cage induction motors.

1.02 SUBMITTALS

- A. Product Data: For each type of VFC.
- B. Shop Drawings: For each VFC.
 - 1. Include wiring diagrams.
- C. Field quality-control test reports.
- D. Operation and maintenance data.
- E. Load-current and overload-relay heater list.
- F. Load-current and list of settings of adjustable overload relays.

1.03 QUALITY ASSURANCE

- A. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, Article 100.
- B. Comply with NFPA 70.
- C. Product Selection for Restricted Space: Drawings indicate maximum dimensions for VFCs, minimum clearances between VFCs, and adjacent surfaces and other items. Comply with indicated maximum dimensions and clearances.

1.04 PROJECT CONDITIONS

- A. Environmental Limitations: Rate equipment for continuous operation, capable of driving full load without derating, under the following conditions, unless otherwise indicated:
 - 1. Ambient Temperature: 55 to 85 deg F Indoors, 32 to 125 deg F Outdoors.
 - 2. Humidity: Less than 90 percent (noncondensing).
 - 3. Altitude: Not exceeding 600 feet.

1.05 COORDINATION

- A. Coordinate features of VFCs, installed units, and accessory devices with pilot devices and control circuits to which they connect.
- B. Coordinate features, accessories, and functions of each VFC and each installed unit with ratings and characteristics of supply circuit, motor, required control sequence, and duty cycle of motor and load.

PART 2 PRODUCTS**2.01 MANUFACTURERS**

- 1. Eaton Corporation.
- 2. Rockwell Automation; Allen-Bradley Co.
- 3. Square D.
- 4. Or Approved Equal.

2.02 VARIABLE FREQUENCY CONTROLLERS

- A. Description: NEMA ICS 2, IGBT, PWM, VFC; listed and labeled as a complete unit and arranged to provide variable speed of an NEMA MG 1, Design B, 3-phase induction motor by adjusting output voltage and frequency.
 - 1. Provide unit suitable for operation of standard-efficiency motor as defined by NEMA MG 1.
- B. Design and Rating: Match load type such as pumps; and type of connection used between motor and load such as direct or through a power-transmission connection.
- C. Output Rating: 3-phase; 6 to 60 Hz, with voltage proportional to frequency throughout voltage range.
- D. Unit Operating Requirements:
 - 1. Input ac voltage tolerance of 480 V, plus or minus 10 percent.
 - 2. Input frequency tolerance of 50/60 Hz, plus or minus 6 percent.
 - 3. Minimum Efficiency: 96 percent at 60 Hz, full load.
 - 4. Minimum Displacement Primary-Side Power Factor: 96 percent.

5. Overload Capability: 1.1 times the base load current for 60 seconds; 2.0 times the base load current for 3 seconds.
 6. Starting Torque: 100 percent of rated torque or as indicated.
 7. Speed Regulation: Plus or minus 1 percent.
- E. Isolated control interface to allow controller to follow control signal over an 11:1 speed range.
1. Electrical Signal: 4 to 20 mA at 24 V.
- F. Internal Adjustability Capabilities:
1. Minimum Speed: 5 to 25 percent of maximum rpm.
 2. Maximum Speed: 80 to 100 percent of maximum rpm.
 3. Acceleration: 2 to a minimum of 22 seconds.
 4. Deceleration: 2 to a minimum of 22 seconds.
 5. Current Limit: 50 to a minimum of 110 percent of maximum rating.
- G. Self-Protection and Reliability Features:
1. Input transient protection by means of surge suppressors.
 2. Under- and overvoltage trips; inverter over temperature, overload, and overcurrent trips.
 3. Motor Overload Relay: Adjustable and capable of NEMA ICS 2, Class 10 performance.
 4. Notch filter to prevent operation of the controller-motor-load combination at a natural frequency of the combination.
 5. Instantaneous line-to-line and line-to-ground overcurrent trips.
 6. Loss-of-phase protection.
 7. Reverse-phase protection.
 8. Short-circuit protection.
 9. Motor over temperature fault.
 10. Line and Load Reactors.

- a. Each variable frequency controller shall be equipped with Engineer approved, 3-phase minimum 3% reactive impedance line and minimum 5% reactive impedance load reactors, amperes rated for operation to suit the service factor ampacity of the driven motor as shown on the Drawings.
- H. Automatic Reset/Restart: Attempts three restarts after controller fault or on return of power after an interruption and before shutting down for manual reset or fault correction. Bidirectional autospeed search shall be capable of starting into rotating loads spinning in either direction and returning motor to set speed in proper direction, without damage to controller, motor, or load.
- I. Power-Interruption Protection: To prevent motor from re-energizing after a power interruption until motor has stopped.
- J. Torque Boost: Automatically varies starting and continuous torque to at least 1.5 times the minimum torque to ensure high-starting torque and increased torque at slow speeds.
- K. Motor Temperature Compensation at Slow Speeds: Adjustable current fall-back based on output frequency for temperature protection of self-cooled, fan-ventilated motors at slow speeds.
- L. Status Lights: Door-mounted LED indicators or local operator station indicators shall indicate the following conditions:
 - 1. Power on – always door mounted
 - 2. Run – coordinate with drawings
 - 3. Fault – coordinate with drawings, drive fault or external fault.
- M. Panel-Mounted Operator Station or Local Operator station: Start-stop, Hand-Off-Auto, and Reset selector switches with manual speed control potentiometer and elapsed time meter.
- N. Indicating Devices: Meters or digital readout devices and selector switch, mounted flush in controller door and connected to indicate the following controller parameters:
 - 1. Output frequency (Hz).
 - 2. Motor speed (rpm).
 - 3. Motor status (running, stop, fault).
 - 4. Motor current (amperes).

5. Motor torque (percent).
6. Fault or alarming status (code).
7. PID feedback signal (percent).
8. DC-link voltage (VDC).
9. Set-point frequency (Hz).
10. Motor output voltage (V).

O. Control Signal Interface:

1. Electric Input Signal Interface: A minimum of 2 analog inputs (0 to 10 V or 0/4-20 mA) and 6 programmable digital inputs.
2. Remote Signal Inputs: Capability to accept any of the following speed-setting input signals from the BMS or other control systems:
 - a. 0-20 or 4-20 mA.
 - b. Potentiometer using up/down digital inputs.
 - c. Fixed frequencies using digital inputs.
 - d. RS485.
 - e. Keypad display for local hand operation.
3. Output Signal Interface:
 - a. A minimum of 1 analog output signal (0/4-20 mA), which can be programmed to any of the following:
 - 1) Output frequency (Hz).
 - 2) Output current (load).
 - 3) DC-link voltage (VDC).
 - 4) Motor torque (percent).
 - 5) Motor speed (rpm).
 - 6) Set-point frequency (Hz).
4. Remote Indication Interface: A minimum of 4 dry circuit relay outputs (120-V ac, 1 A) for remote indication of the following:
 - a. Motor running.
 - b. Set-point speed reached.
 - c. Fault and warning indication (over temperature, seal fail or overcurrent).
 - d. PID high- or low-speed limits reached.
 - e. VFC in "HAND" position.
 - f. VFC in "AUTO" position.

- P. Integral Disconnecting Means: NEMA KS 1, fusible switch with lockable handle.
- Q. Remote Indicating Circuit Terminals: Mode selection, controller status, and controller fault.

2.03 ENCLOSURES

- A. VFC's shall be self-contained units or installed in an enclosure, with its associated equipment, pre-designed by the manufacturer.

2.04 ACCESSORIES

- A. Devices shall be factory installed in controller enclosure, unless otherwise indicated.
- B. Push-Button Stations, Pilot Lights, and Selector Switches: NEMA ICS 2, heavy-duty type.
- C. Stop and Lockout Push-Button Station: Momentary-break, push-button station with a factory-applied hasp arranged so padlock can be used to lock push button in depressed position with control circuit open.
- D. Control Relays: Auxiliary and adjustable time-delay relays.
- E. Standard Displays:
 - 1. Output frequency (Hz).
 - 2. Set-point frequency (Hz).
 - 3. Motor current (amperes).
 - 4. DC-link voltage (VDC).
 - 5. Motor torque (percent).
 - 6. Motor speed (rpm).
 - 7. Motor output voltage (V).
- F. Historical Logging Information and Displays:
 - 1. Real-time clock with current time and date.
 - 2. Running log of total power versus time.
 - 3. Total run time.

- 4. Fault log, maintaining last four faults with time and date stamp for each.
- G. Current-Sensing, Phase-Failure Relays for Bypass Controller: Solid-state sensing circuit with isolated output contacts for hard-wired connection; arranged to operate on phase failure, phase reversal, current unbalance from 30 to 40 percent, or loss of supply voltage; with adjustable response delay.

2.05 FACTORY FINISHES

- A. Finish: Manufacturer's standard paint applied to VFCs before shipping.

PART 3 EXECUTION

3.01 APPLICATIONS

- A. Select features of each VFC to coordinate with ratings and characteristics of supply circuit and motor; required control sequence; and duty cycle of motor, controller, and load.
- B. Select horsepower rating of controllers to suit motor controlled.

3.02 INSTALLATION

- A. Install VFCs in locations shown in the Specification drawings
- B. Comply with mounting and anchoring requirements specified in Division 16 Section "Hangers and Supports for Electrical Systems."
- C. Controller Fuses: Install fuses in each fusible switch. Comply with requirements in Division 16 Section "Fuses."

3.03 IDENTIFICATION

- A. Identify VFCs, components, and control wiring with phenolic labels.
- B. Operating Instructions: Frame printed operating instructions for VFCs, including control sequences and emergency procedures. Fabricate frame of finished metal, and cover instructions with clear acrylic plastic. Mount on front of VFC or its enclosure.

3.04 CONTROL WIRING INSTALLATION

- A. Install wiring between VFCs and remote devices according to Division 26 Section "Conductors and Cables."
- B. Bundle, train, and support wiring in enclosures.

- C. Connect hand-off-automatic switch and other automatic-control devices where applicable.
 - 1. Connect selector switches to bypass only manual- and automatic-control devices that have no safety functions when switch is in hand position.
 - 2. Connect selector switches with control circuit in both hand and automatic positions for safety-type control devices such as low- and high-pressure cutouts, high-temperature cutouts, and motor overload protectors.

3.05 FIELD QUALITY CONTROL

- A. Prepare for acceptance tests as follows:
 - 1. Test insulation resistance for each enclosed controller element, bus, component, connecting supply, feeder, and control circuit.
 - 2. Test continuity of each circuit.
- B. Manufacturer's Field Service: Engage a factory-authorized service representative to perform the following:
 - 1. Inspect controllers, wiring, components, connections, and equipment installation. Test and adjust controllers, components, and equipment.
 - 2. Assist in field testing of equipment including pretesting and adjusting of solid-state controllers.
 - 3. Report results in writing.
- C. Perform the following field tests and inspections and prepare test reports:
 - 1. Perform each electrical test and visual and mechanical inspection, except optional tests, stated in NETA ATS. Certify compliance with test parameters.
 - 2. Correct malfunctioning units on-site, where possible, and retest to demonstrate compliance; otherwise, replace with new units and retest.

3.06 ADJUSTING

- A. Set field-adjustable switches and circuit-breaker trip ranges.

3.07 WARRANTY

- A. Provide 1 year warranty on all VFCs from date of substantial completion.

END OF SECTION 26 29 23

PART 1 GENERAL

1.01 SUMMARY

- A. Section includes field-mounted SPDs for low-voltage (120 to 600 V) power distribution and control equipment.

1.02 ACTION SUBMITTALS

- A. Product Data: For each type of product.
 - 1. Include rated capacities, operating characteristics, electrical characteristics, and furnished specialties and accessories.
 - 2. Copy of UL Category Code VZCA certification, as a minimum, listing the tested values for VPRs, *I_{NOMINAL}* ratings, MCOVs, type designations, OCPD requirements, model numbers, system voltages, and modes of protection.

1.03 INFORMATIONAL SUBMITTALS

- A. Field quality-control reports.
- B. Sample Warranty: For manufacturer's special warranty.

1.04 CLOSEOUT SUBMITTALS

- A. Maintenance data.

1.05 WARRANTY

- A. Manufacturer's Warranty: Manufacturer agrees to replace or replace SPDs that fail in materials or workmanship within specified warranty period.
 - 1. Warranty Period: Five years from date of Substantial Completion.

PART 2 PRODUCTS

2.01 GENERAL SPD REQUIREMENTS

- A. SPD with Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.
- B. Comply with NFPA 70.
- C. Comply with UL 1449.

D. MCOV of the SPD shall be the nominal system voltage.

2.02 EXTERIOR MOUNTED 'LIGHTNING ARRESTOR' SPD

A. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to the following:

1. Square D.
2. General Electric Company.
3. Eaton.

B. SPD:

1. Comply with UL 1449, Type 1.
2. Designed to be installed without OCPD.
3. NEMA 4X enclosure with nipple mount for installation on outside of exterior main disconnect switch.
4. 15" #14 AWG connection leads (cut as necessary to maintain shortest lead length possible).

C. Characteristics and protection modes and UL 1449 VPR for grounded wye circuits with 480Y/277 V, three-phase, four-wire circuits shall be as follows:

1. Maximum Continuous Operating Voltage (MCOV):
 - a. Line to Neutral: 420 V.
 - b. Line to Line: 840 V.
2. Peak Voltage Let-Through (Vpk):
 - a. Line to Neutral: 1500 V.
 - b. Line to Line: 2500 V.
3. Peak Surge Current Rating per Phase: 40 kA.
4. Nominal Current Rating (I-nom): 10 kA
5. Short Circuit Current Rating (SCCR): 200 kA.

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- D. Characteristics and protection modes and UL 1449 VPR for grounded wye circuits with 208Y/120 V, three-phase, four-wire circuits shall be as follows:
1. Maximum Continuous Operating Voltage (MCOV):
 - a. Line to Neutral: 180 V.
 - b. Line to Line: 360 V.
 2. Peak Voltage Let-Through (Vpk):
 - a. Line to Neutral: 700 V.
 - b. Line to Line: 1200 V.
 3. Peak Surge Current Rating per Phase: 40 kA.
 4. Nominal Current Rating (I-nom): 10 kA
 5. Short Circuit Current Rating (SCCR): 200 kA.
- E. Characteristics and protection modes and UL 1449 VPR for 240/120 V, single-phase, three-wire circuits shall be as follows:
1. Maximum Continuous Operating Voltage (MCOV):
 - a. Line to Neutral: 150 V.
 - b. Line to Line: 300 V.
 2. Peak Voltage Let-Through (Vpk):
 - a. Line to Neutral: 700 V.
 - b. Line to Line: 1200 V.
 3. Peak Surge Current Rating per Phase: 36 kA.
 4. Nominal Current Rating (I-nom): 10 kA
 5. Short Circuit Current Rating (SCCR): 25 kA.

2.03 SERVICE ENTRANCE AND TRANSFER SWITCH SUPPRESSOR

- A. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to the following:
1. Advanced Protection Technologies Inc. (APT).
 2. Current Technology Inc.

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3. Eaton.
 4. General Electric Company.
 5. Leviton Manufacturing Co., Inc.
 6. Liebert; a brand of Vertiv.
 7. Square D.
- B. SPDs: Comply with UL 1449, Type 1.
1. Permanently connected, hard-wired SPD that can be installed in both locations noted:
 - a. Between the secondary of the service transformer and the line side of the main service equipment overcurrent protective device.
 - b. On the load side of the main service equipment.
 2. SPDs with the following features and accessories:
 - a. Internal thermal protection that disconnects the SPD before damaging internal suppressor components.
 - b. Indicator light display for protection status.
- C. Features and Accessories:
1. Internal thermal protection that disconnects the SPD before damaging internal suppressor components.
 2. Indicator light display for protection status.
 3. Surge counter.
- D. Peak Surge Current Rating: The minimum single-pulse surge current withstand rating per phase shall not be less than 200 kA. The peak surge current rating shall be the arithmetic sum of the ratings of the individual MOVs in a given mode.
- E. Characteristics and protection modes and UL 1449 VPR for grounded wye circuits with 480Y/277 V, three-phase, four-wire circuits shall be as follows:
1. Maximum Continuous Operating Voltage (MCOV):
 - a. Line to Neutral: 420 V.
 - b. Line to Line: 840 V.

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2. Peak Voltage Let-Through (Vpk):
 - a. Line to Ground: 1200 V.
 - b. Line to Neutral: 1200 V.
 - c. Line to Line: 2000 V.
 3. Nominal Current Rating (I-nom): 20 kA
 4. Short Circuit Current Rating (SCCR): 100 kA.
- F. Characteristics and protection modes and UL 1449 VPR for grounded wye circuits with 208Y/120 V, three-phase, four-wire circuits shall be as follows:
1. Maximum Continuous Operating Voltage (MCOV):
 - a. Line to Neutral: 180 V.
 - b. Line to Line: 360 V.
 2. Peak Voltage Let-Through (Vpk):
 - a. Line to Ground: 700 V.
 - b. Line to Neutral: 700 V.
 - c. Line to Line: 1000 V.
 3. Nominal Current Rating (I-nom): 20 kA
 4. Short Circuit Current Rating (SCCR): 100 kA.
- G. Characteristics and protection modes and UL 1449 VPR for 240/120 V, single-phase, three-wire circuits shall be as follows:
1. Maximum Continuous Operating Voltage (MCOV):
 - a. Line to Neutral: 150 V.
 - b. Line to Line: 300 V.
 2. Peak Voltage Let-Through (Vpk):
 - a. Line to Ground: 700 V.
 - b. Line to Neutral: 700 V.
 - c. Line to Line: 1000 V.
 3. Nominal Current Rating (I-nom): 20 kA
 4. Short Circuit Current Rating (SCCR): 25 kA.

2.04 PANEL SUPPRESSORS

- A. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to the following:
 - 1. Advanced Protection Technologies Inc. (APT).
 - 2. Current Technology Inc.
 - 3. Eaton.
 - 4. General Electric Company.
 - 5. Leviton Manufacturing Co., Inc.
 - 6. Liebert; a brand of Vertiv.
 - 7. Square D.
- B. SPDs: Comply with UL 1449, Type 2.
 - 1. Permanently connected, hard-wired SPD intended for installation on the load side of the main service equipment overcurrent protective device.
 - 2. Include LED indicator lights for power and protection status.
 - 3. Internal thermal protection that disconnects the SPD before damaging internal suppressor components.
- C. Peak Surge Current Rating: The minimum single-pulse surge current withstand rating per phase shall not be less than 100 kA. The peak surge current rating shall be the arithmetic sum of the ratings of the individual MOVs in a given mode.
- D. Characteristics and protection modes and UL 1449 VPR for grounded wye circuits with 480Y/277 V, three-phase, four-wire circuits shall be as follows:
 - 1. Maximum Continuous Operating Voltage (MCOV):
 - a. Line to Neutral: 420 V.
 - b. Line to Line: 840 V.
 - 2. Peak Voltage Let-Through (Vpk):
 - a. Neutral to Ground: 1200 V.

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- b. Line to Ground: 1200 V.
 - c. Line to Neutral: 1200 V.
 - d. Line to Line: 2000 V.
 - 3. Nominal Current Rating (I-nom): 20 kA
 - 4. Short Circuit Current Rating (SCCR): 100 kA.
- E. Characteristics and protection modes and UL 1449 VPR for grounded wye circuits with 208Y/120 V, three-phase, four-wire circuits shall be as follows:
- 1. Maximum Continuous Operating Voltage (MCOV):
 - a. Line to Neutral: 180 V.
 - b. Line to Line: 360 V.
 - 2. Peak Voltage Let-Through (Vpk):
 - a. Neutral to Ground: 700 V.
 - b. Line to Ground: 700 V.
 - c. Line to Neutral: 700 V.
 - d. Line to Line: 1200 V.
 - 3. Nominal Current Rating (I-nom): 20 kA
 - 4. Short Circuit Current Rating (SCCR): 100 kA.
- F. Characteristics and protection modes and UL 1449 VPR for 240/120 V, single-phase, three-wire circuits shall be as follows:
- 1. Maximum Continuous Operating Voltage (MCOV):
 - a. Line to Neutral: 150 V.
 - b. Line to Line: 300 V.
 - 2. Peak Voltage Let-Through (Vpk):
 - a. Neutral to Ground: 700 V.
 - b. Line to Ground: 700 V.
 - c. Line to Neutral: 700 V.
 - d. Line to Line: 1200 V.
 - 3. Nominal Current Rating (I-nom): 20 kA
 - 4. Short Circuit Current Rating (SCCR): 25 kA.

2.05 ENCLOSURES

- A. Install integral within switchgear/panelboard.
- B. Indoor Enclosures: NEMA 250, Type 1.
- C. Outdoor Enclosures: NEMA 250, Type 3R.

PART 3 EXECUTION

3.01 INSTALLATION

- A. Comply with NECA 1.
- B. Install an OCPD or disconnect as required to comply with the UL listing of the SPD.
- C. Install SPDs with conductors between suppressor and points of attachment as short and straight as possible, and adjust circuit-breaker positions to achieve shortest and straightest leads. Do not splice and extend SPD leads unless specifically permitted by manufacturer. Do not exceed manufacturer's recommended lead length. Do not bond neutral and ground.
- D. Use crimped connectors and splices only. Wire nuts are unacceptable.
- E. Complete startup checks according to manufacturer's written instructions. Energize SPDs after power system has been energized, stabilized, and tested.

3.02 FIELD QUALITY CONTROL

- A. Perform the following tests and inspections with the assistance of a factory-authorized service representative.
 - 1. Compare equipment nameplate data for compliance with Drawings and Specifications.
 - 2. Inspect anchorage, alignment, grounding, and clearances.
 - 3. Verify that electrical wiring installation complies with manufacturer's written installation requirements.
- B. An SPD will be considered defective if it does not pass tests and inspections.
- C. Prepare test and inspection reports.

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3.03 DEMONSTRATION

- A. Train Owner's maintenance personnel to operate and maintain SPDs.

END OF SECTION 26 43 13

SECTION 26 43 13
SURGE PROTECTION FOR LOW-VOLTAGE
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PART 1 GENERAL**1.01 SUMMARY****A. Section Includes:**

1. Interior and exterior lighting fixtures that are designed for and exclusively use LED lamp technology.
2. Emergency power units.
3. Exit signs.
4. Emergency lighting units.
5. Luminaire supports.

B. Related Sections:

1. Section 26 09 23 "Lighting Control Devices" for automatic control of lighting, including time switches, photoelectric relays, occupancy sensors, and multipole lighting relays and contactors.
2. Section 26 27 26 "Wiring Devices".

1.02 DEFINITIONS

- A. CCT: Correlated color temperature.
- B. CRI: Color Rendering Index.
- C. Fixture: See "Luminaire."
- D. IP: International Protection or Ingress Protection Rating.
- E. LED: Light-emitting diode.
- F. Lumen: Measured output of lamp and luminaire, or both.
- G. Luminaire: Complete lighting unit, including lamp, reflector, and housing.
- H. THD: Total Harmonic Distortion.

1.03 PRIOR APPROVAL

- A. Prior approvals are not required unless otherwise noted on the Luminaire Schedule.

1. All material supplied to the project must meet or exceed the quality, performance, and have similar features to the product originally specified. It is the contractor's responsibility to ensure that substituted equipment matches the exterior dimensions, weight, and configuration of the specified equipment.

1.04 ACTION SUBMITTALS

- A. Product Data: For each type of lighting fixture, arranged in order of fixture designation. Include data on features, accessories, finishes, and the following:
 1. Physical description of lighting fixture including dimensions.
 2. Ballast/Driver, including THD.
 3. Emergency lighting units including battery and charger.
 4. Energy-efficiency data.
 5. Life, output (lumens, CCT, and CRI), and energy-efficiency data.
 6. Fixture UL/ETL rating.
 7. Design Lights Consortium (DLC) certification and/or Energy Star rating.
 8. Photometric data and adjustment factors based on laboratory tests, complying with IESNA Lighting Measurements Testing & Calculation Guides, of each lighting fixture type. The adjustment factors shall be for lamps, ballasts, and accessories identical to those indicated for the lighting fixture as applied in this Project.
 - a. Manufacturer Certified Data: Photometric data shall be certified by a manufacturer's laboratory with a current accreditation under the National Voluntary Laboratory Accreditation Program for Energy Efficient Lighting Products.
 9. Color samples (if color is to be chosen by architect/engineer).
 10. Foot-candle calculations for spot lights and flood lights.
 11. List of all parts necessary for particular installation configuration.
- B. Shop Drawings: For nonstandard or custom luminaires.
 1. Include plans, elevations, sections, and mounting and attachment details.

2. Include details of luminaire assemblies. Indicate dimensions, weights, loads, required clearances, method of field assembly, components, and location and size of each field connection.
3. Include diagrams for power, signal, and control wiring.

1.05 INFORMATIONAL SUBMITTALS

- A. Seismic Qualification Certificates: For luminaires, accessories, and components, from manufacturer.
- B. Sample warranty.

1.06 CLOSEOUT SUBMITTALS

- A. Operation and Maintenance Data.

1.07 MAINTENANCE MATERIAL SUBMITTALS

- A. Furnish extra materials that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.
 1. Plastic Diffusers and Lenses: One for every 100 of each type and rating installed. Furnish at least one of each type.
 2. Fixture-mounted, emergency battery pack: One for every 50 emergency lighting unit.
 3. Ballasts/Drivers: One for every 100 of each type and rating installed. Furnish at least one of each type.
 4. Globes and Guards: One for every 20 of each type and rating installed. Furnish at least one of each type.

1.08 QUALITY ASSURANCE

- A. Luminaire Photometric Data Testing Laboratory Qualifications: Provided by manufacturers' laboratories that are accredited under the National Volunteer Laboratory Accreditation Program for Energy Efficient Lighting Products.
- 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 NFPA 70.

1.09 COORDINATION

- A. Coordinate layout and installation of lighting fixtures and suspension system with other construction that penetrates ceilings or is supported by them, including HVAC equipment, fire-suppression system, and partition assemblies.
- B. Fire rated assemblies: Fixtures installed in fire rated assemblies shall maintain the fire rating of said assembly. Contractor is required to coordinate with Architectural draws to verify assembly ratings.
- C. Insulated ceiling space: Fixtures installed in an insulated ceiling be IC rated or manufacturer recommended clearances between fixture and insulation. Contractor is required to coordinate with Architectural draws to verify insulated areas above ceilings.

1.10 WARRANTY

- A. Warranty: Manufacturer and Installer agree to repair or replace components of luminaires that fail in materials or workmanship within specified warranty period.
- B. Warranty Period: Five years from date of Substantial Completion.
- C. Special Warranty for Emergency Lighting Batteries: Manufacturer's standard form in which manufacturer of battery-powered emergency lighting unit agrees to repair or replace components of rechargeable batteries that fail in materials or workmanship within specified warranty period.

PART 2 PRODUCTS**2.01 PERFORMANCE REQUIREMENTS**

- A. Seismic Performance: Luminaires shall withstand the effects of earthquake motions as noted in 26 05 48.16, "Seismic Controls for Electrical Systems".
- B. Seismic Performance: Luminaires and lamps shall be labeled vibration and shock resistant.
 - 1. The term "withstand" means "the luminaire will remain in place without separation of any parts when subjected to the seismic forces specified and the luminaire will be fully operational during and after the seismic event."
 - 2. Component Importance Factor: 1.5.

2.02 GENERAL LUMINAIRE REQUIREMENTS

- A. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.
- B. Standards - Where noted on plans, comply with the following:
 - 1. ENERGY STAR or Design Lights Consortium (DLC) certified.
 - 2. NRTL Compliance: Luminaires for hazardous locations shall be listed and labeled for indicated class and division of hazard by an NRTL.
 - 3. UL Listing: Listed for damp and/or wet locations as required.
 - 4. Recessed luminaires shall comply with NEMA LE 4.
- C. Indoor fixtures shall have a minimum CRI of 80 UNO and a CCT of 4100 K UNO.
- D. Outdoor fixtures shall have a minimum CRI of 65 UNO and a CCT of 4100 K UNO.
- E. Outdoor fixtures shall have mounting type and distribution as noted on plans.
- F. Minimum rated LED lamp life of 50,000 hours to L70.
- G. Lamps dimmable from 100 percent to 10 percent of maximum light output.
- H. Internal ballast/driver, UNO.
- I. Nominal Operating Voltage: As noted on the plans.
- J. Lens Thickness: At least 0.125 inch minimum UNO.
- K. Reflecting surfaces shall have minimum reflectance as follows unless otherwise indicated:
 - 1. White Surfaces: 85 percent.
 - 2. Specular Surfaces: 83 percent.
 - 3. Diffusing Specular Surfaces: 75 percent.

- L. Lens and Refractor Gaskets for Exterior Luminaires: Use heat- and aging-resistant resilient gaskets to seal and cushion lenses and refractors in luminaire doors.
- M. Source Limitations: For luminaires, obtain each color, grade, finish, type, and variety of luminaire from single source with resources to provide products of consistent quality in appearance and physical properties.
- N. Housings:
 - 1. Rigidly formed, light-tight enclosure that will not warp, sag, or deform in use.
 - 2. Provide weather-tight enclosure with filter/breather for enclosed exterior luminaires.
- O. Metal Parts:
 - 1. Free of burrs and sharp corners and edges.
 - 2. Indoor applications: Sheet metal components shall be steel unless otherwise indicated.
 - 3. Exterior applications: Sheet metal components shall be corrosion-resistant aluminum.
 - 4. Form and support to prevent warping and sagging
- P. Doors, Frames, and Other Internal Access: Smooth operating, free of light leakage under operating conditions, and designed to permit relamping without use of tools. Designed to prevent doors, frames, lenses, diffusers, and other components from falling accidentally during relamping and when secured in operating position. Doors shall be removable for cleaning or replacing lenses.
- Q. Diffusers, and Globes - Tempered glass, acrylic or polycarbonate as noted on plans.
 - 1. Acrylic: One hundred percent virgin acrylic plastic, with high resistance to yellowing and other changes due to aging, exposure to heat, and UV radiation.
 - a. Lens Thickness: At least 0.125 inch (3.175 mm) minimum unless otherwise indicated.
 - b. UV stabilized.
 - 2. Glass: Annealed crystal glass unless otherwise indicated.

2.03 METAL FINISHES

- A. Variations in finishes are unacceptable in the same piece. Variations in finishes of adjoining components are acceptable if they are within the range of approved Samples and if they can be and are assembled or installed to minimize contrast.
- B. Source Limitations: For luminaires, obtain each color, grade, finish, type, and variety of luminaire from single source with resources to provide products of consistent quality in appearance and physical properties.
- C. Factory-Applied, powder-coat finish, UNO, with standard color chosen by Architect or as noted on plans.
 - 1. Factory-Applied Finish for Aluminum Luminaires: Comply with NAAMM's "Metal Finishes Manual for Architectural and Metal Products" for recommendations for applying and designating finishes.
 - a. Finish designations prefixed by AA comply with the system established by the Aluminum Association for designating aluminum finishes.
 - b. Class I, Color-Anodic Finish: AA-M32C22A42/A44 (Mechanical Finish: Medium satin; Chemical Finish: Etched, medium matte; Anodic Coating: Architectural Class I, integrally colored or electrolytically deposited color coating 0.018 mm or thicker), complying with AAMA 611.
 - 2. Factory-Applied Finish for Steel Luminaires: Comply with NAAMM's "Metal Finishes Manual for Architectural and Metal Products" for recommendations for applying and designating finishes.
 - a. Surface Preparation: Clean surfaces to comply with SSPC-SP 1, to remove dirt, oil, grease, and other contaminants that could impair paint bond. Grind welds and polish surfaces to a smooth, even finish. Remove mill scale and rust, if present, from uncoated steel, complying with SSPC-SP 5/NACE No. 1 or SSPC-SP 8.
 - b. Exterior Surfaces: Manufacturer's standard finish consisting of one or more coats of primer and two finish coats of high-gloss, high-build polyurethane enamel.

2.04 LED ASSEMBLIES

- A. Products UL rated for 40 degree C (104 degrees F) ambient environments.
- B. Minimum 4000K color temperature unless noted otherwise in the drawings.

- C. 50,000 hour fixture life including driver, 5 year warranty.
- D. All products compliant with EISNA LM-79 and LM-80 standards.

2.05 EMERGENCY POWER UNIT

- A. Internal Type: Self-contained, modular, battery-inverter unit, factory mounted within lighting fixture body and compatible with ballast. Comply with UL 924.
 - 1. Emergency Connection: Operate all or a portion of LED lamps continuously at an output of 1100 lumens. Connect unswitched circuit to battery-inverter unit and switched circuit to fixture ballast.
 - 2. Operation: Relay automatically turns lamp on when power-supply circuit voltage drops to 80 percent of nominal voltage or below. Lamp automatically disconnects from battery when voltage approaches deep-discharge level. When normal voltage is restored, relay disconnects lamps from battery, and battery is automatically recharged and floated on charger.
 - 3. Environmental Limitations: Rate equipment for continuous operation under the following conditions unless otherwise indicated:
 - a. Ambient Temperature: Less than 0 deg F (minus 18 deg C) or exceeding 104 deg F (40 deg C), with an average value exceeding 95 deg F (35 deg C) over a 24-hour period.
 - b. Ambient Storage Temperature: Not less than minus 4 deg F (minus 20 deg C) and not exceeding 140 deg F (60 deg C).
 - c. Humidity: More than 95 percent (condensing).
 - d. Altitude: Exceeding 3300 feet (1000 m).
 - 4. Test Push Button and Indicator Light: Visible and accessible without opening fixture or entering ceiling space.
 - a. Push Button: Push-to-test type, in unit housing, simulates loss of normal power and demonstrates unit operability.
 - b. Indicator Light: LED indicates normal power on. Normal glow indicates trickle charge; bright glow indicates charging at end of discharge cycle.
 - 5. Battery: Sealed, maintenance-free, nickel-cadmium type.
 - 6. Charger: Fully automatic, solid-state, constant-current type with sealed power transfer relay.

7. Integral Self-Test: Factory-installed electronic device automatically initiates code-required test of unit emergency operation at required intervals. Test failure is annunciated by an integral audible alarm and a flashing red LED.
- B. External Type: Self-contained, modular, battery-inverter unit, suitable for powering LED lamps, remote mounted from lighting fixture. Comply with UL 924.
1. Emergency Connection: Connect unswitched circuit to battery-inverter unit and switched circuit to fixture ballast.
 2. Battery: Sealed, maintenance-free, nickel-cadmium type.
 3. Charger: Fully automatic, solid-state, constant-current type.
 4. Housing: NEMA 250, Type 1 enclosure. Listed for installation remote from luminaire. Remote assembly shall be located no more than half the distance recommended by the emergency power unit manufacturer
 5. Test Push Button: Push-to-test type, in unit housing, simulates loss of normal power and demonstrates unit operability.
 6. LED Indicator Light: Indicates normal power on. Normal glow indicates trickle charge; bright glow indicates charging at end of discharge cycle.
 7. Integral Self-Test: Factory-installed electronic device automatically initiates code-required test of unit emergency operation at required intervals. Test failure is annunciated by an integral audible alarm and a flashing red LED.

2.06 EXIT SIGNS

- A. General Requirements for Exit Signs: Comply with UL 924; for sign colors, visibility, luminance, and lettering size, comply with authorities having jurisdiction.
- B. Internally Lighted Signs:
1. Lamps for AC Operation: LEDs, 50,000 hours minimum rated lamp life.
 2. Self-Powered Exit Signs (Battery Type): Integral automatic charger in a self-contained power pack.
 - a. Battery: Sealed, maintenance-free, nickel-cadmium type.

- b. Charger: Fully automatic, solid-state type with sealed transfer relay.
- c. Operation: Relay automatically energizes lamp from battery when circuit voltage drops to 80 percent of nominal voltage or below. When normal voltage is restored, relay disconnects lamps from battery, and battery is automatically recharged and floated on charger.
- d. Test Push Button: Push-to-test type, in unit housing, simulates loss of normal power and demonstrates unit operability.
- e. LED Indicator Light: Indicates normal power on. Normal glow indicates trickle charge; bright glow indicates charging at end of discharge cycle.
- f. Integral Self-Test: Factory-installed electronic device automatically initiates code-required test of unit emergency operation at required intervals. Test failure is annunciated by an integral audible alarm and a flashing red LED.

2.07 EMERGENCY LIGHTING UNITS

- A. General Requirements for Emergency Lighting Units: Self-contained units complying with UL 924.
 - 1. Battery: Sealed, maintenance-free, lead-acid type.
 - 2. Charger: Fully automatic, solid-state type with sealed transfer relay.
 - 3. Operation: Relay automatically turns lamp on when power-supply circuit voltage drops to 80 percent of nominal voltage or below. Lamp automatically disconnects from battery when voltage approaches deep-discharge level. When normal voltage is restored, relay disconnects lamps from battery, and battery is automatically recharged and floated on charger.
 - 4. Test Push Button: Push-to-test type, in unit housing, simulates loss of normal power and demonstrates unit operability.
 - 5. LED Indicator Light: Indicates normal power on. Normal glow indicates trickle charge; bright glow indicates charging at end of discharge cycle.
 - 6. Integral Self-Test: Factory-installed electronic device automatically initiates code-required test of unit emergency operation at required intervals. Test failure is annunciated by an integral audible alarm and a flashing red LED.

2.08 LUMINAIRE SUPPORTS

- A. Comply with requirements in Section 26 05 29 "Hangers and Supports for Electrical Systems" for channel and angle iron supports and nonmetallic channel and angle supports.
- B. Single-Stem Hangers: 1/2-inch (13-mm) steel tubing with swivel ball fittings and ceiling canopy. Finish same as luminaire.
- C. Twin-Stem Hangers: Two, 1/2-inch (13-mm) steel tubes with single canopy designed to mount a single fixture. Finish same as fixture.
- D. Wires: ASTM A 641/A 641 M, Class 3, soft temper, zinc-coated steel, 12 gauge (2.68 mm).
- E. Rod Hangers: 3/16-inch (5-mm) minimum diameter, cadmium-plated, threaded steel rod.
- F. Hook Hangers: Integrated assembly matched to luminaire, line voltage, and equipment with threaded attachment, cord, and locking-type plug.

2.09 SCREW-IN BASE FIXTURES

- A. Fixture shall be compatible with common type Medium Base E26 bulb.
- B. Fixture shall be dimming compatible and compatible with dimmable LED type bulb.
- C. Lamp shall be compatible with dimmer switch to allow full, flicker-free dimming throughout the lamp's full dimming range.
- D. Comply with UL1598 and comply with minimum performance requirements for retrofit lamps - NEMA SSL 4.
- E. SPARE LAMPS - Spare lamps shall be provided in quantities of 10% of total lamps of each screw-in base type installed. Quantity of spares shall not be less than four (4) spare lamps for any one lamp type.

PART 3 EXECUTION**3.01 GENERAL INSTALLATION**

- A. Comply with NECA 1.
- B. Install luminaires level, plumb, and square with ceilings and walls unless otherwise indicated.

- C. Use fastening methods and materials selected to resist seismic forces defined for the application and approved by manufacturer.
- D. Fasten luminaire to structural support.
- E. Supports:
 - 1. Sized and rated for luminaire weight, and weight of emergency power unit where applicable.
 - 2. Able to maintain luminaire position after cleaning, while relamping and when testing emergency power unit.
 - 3. Provide support for luminaire and emergency power unit without causing deflection of ceiling or wall.
 - 4. Luminaire-mounting devices shall be capable of supporting a horizontal force of 100 percent of luminaire and emergency power unit weight and vertical force of 400 percent of fixture weight.
 - 5. Use fastening methods and materials selected to resist seismic forces defined for the application and approved by manufacturer.
- F. Flush-Mounted Luminaire Support: Secured to outlet box.
- G. Wall-Mounted Luminaire Support:
 - 1. Attached to structural members in walls or to a minimum 20 gauge backing plate attached to wall structural members.
 - 2. Do not attach luminaires directly to gypsum board.
- H. Ceiling-Mounted Luminaire Support:
 - 1. Secure to any required outlet box and attach to structural member in ceiling or to a minimum 20 gauge backing plate attached to ceiling structural members.
 - 2. Do not attach luminaires directly to gypsum board.
 - 3. Provide offset from ceiling as required by luminaire manufacturer.
 - 4. Secure emergency power unit using approved fasteners in a minimum of four locations, spaced near corners of emergency power unit.

- I. Suspended Luminaire Support:
 - 1. Pendants and Rods: Where longer than 48 inches (1200 mm), brace to limit swinging.
 - 2. Stem-Mounted, Single-Unit Luminaires: Suspend with twin-stem hangers. Support with approved outlet box and accessories that hold stem and provide damping of luminaire oscillations. Support outlet box vertically to building structure using approved devices.
 - 3. Continuous Rows of Luminaires: Use tubing or stem for wiring at one point and tubing or rod for suspension for each unit length of luminaire chassis, including one at each end.
 - 4. Do not use ceiling grid as support for pendant luminaires. Connect support wires or rods to building structure.
- J. Lay-in Ceiling Lighting Fixtures Supports: Use grid as a support element.
 - 1. Install ceiling support system rods or wires, independent of the ceiling suspension devices, for each fixture. Locate not more than 6 inches (150 mm) from lighting fixture corners.
 - 2. Support Clips: Fasten to lighting fixtures and to ceiling grid members at or near each fixture corner with clips that are UL listed for the application.
 - 3. Fixtures of Sizes Less Than Ceiling Grid: Install as indicated on reflected ceiling plans or center in acoustical panel, and support fixtures independently with at least two 3/4-inch (20-mm) metal channels spanning and secured to ceiling tees.
 - 4. Install at least two independent support rods or wires from structure to a tab on lighting fixture. Wire or rod shall have breaking strength of the weight of fixture at a safety factor of 3.
- K. Comply with requirements in Section 26 05 19 "Low-Voltage Electrical Power Conductors and Cables" for wiring connections.
- L. Temporary Lighting: If it is necessary, and approved by Architect, to use permanent luminaires for temporary lighting, install and energize the minimum number of luminaires necessary. When construction is sufficiently complete, remove the temporary luminaires, disassemble, clean thoroughly and reinstall.
- M. Remote Mounting of Ballasts/Drivers: Distance between the driver and fixture shall not exceed that recommended by luminaire manufacturer.

3.02 IDENTIFICATION

- A. Install labels with panel and circuit numbers on concealed junction and outlet boxes. Comply with requirements for identification specified in Section 26 05 53 "Identification for Electrical Systems."

3.03 INSULATED CEILING SPACES

- A. Provide IC rated fixture assemblies or manufacturer recommended clearances between fixture and insulation.

3.04 FIRE RATED ASSEMBLIES

- A. Provide fire rated fixture assemblies or a third party fire rated cover.
 - 1. Fire rated covers
 - a. Provide manufacturer recommended clearances for all non IC rated fixtures.

3.05 FIELD QUALITY CONTROL

- A. Perform the following tests and inspections:
 - 1. Operational Test: After installing luminaires, switches, and accessories, and after electrical circuitry has been energized, test units to confirm proper operation.
 - 2. Test for Emergency Lighting: Interrupt power supply to demonstrate proper operation. Verify transfer from normal power to battery power and retransfer to normal.
- B. Luminaire will be considered defective if it does not pass operation tests and inspections.
- C. Prepare test and inspection reports.

END OF SECTION 26 51 00

PART 1 GENERAL**1.01 WORK INCLUDED**

- A. The work of this section consists of the clearing, removal and disposal of vegetation; including trees, stumps and roots; abandoned or to be abandoned structures; fences and debris or other objectionable materials that will interfere with the construction of this project.
- B. This work shall also include the preservation from injury or defacement of all vegetation and existing objects designated to remain or not specifically designated to be removed, as shown or as specified herein.
- C. Review with the Engineer the location, limits, and methods to be used prior to commencing the work under this section.

1.02 GENERAL

- A. See Volume 1 and Division 01 00 00, GENERAL REQUIREMENTS, which contain information and requirements that apply to the work specified herein and are mandatory for this project.

1.03 DISPOSAL REQUIREMENTS

- A. The Contractor shall confirm an acceptable method of disposal with the Owner before proceeding. Also see Volume 1 for environmental control requirements.

PART 2 PRODUCTS**2.01 GENERAL**

- A. Provide all materials, suitable and in adequate quantity, required to accomplish the work as specified herein.

PART 3 EXECUTION**3.01 CLEARING**

- A. Definition: Clearing shall consist of cutting, removing, and disposing of trees, snags, stumps, shrubs, brush, limbs, and other vegetative growth, and shall be performed in such a manner as to remove all evidence of their presence from the surface and shall be inclusive of sticks and branches greater than 2 inches in diameter or thickness. Clearing shall also include the removal and disposal of trash piles, rubbish, miscellaneous concrete, and fencing; and the preservation of trees, shrubs, and vegetative growth which are not designated for removal.

- B. Clearing for the construction of structures, areas of grading, or earthwork shall extend not more than 30 feet beyond the construction limits as shown on the Drawings. Clearing for the construction of pipelines shall not exceed 10 feet on each side of pipe centerline as staked for construction or outside the pipeline easement boundary, whichever is less. Remove trees, brush, and vegetation within the described limits only if needed; and if encountered, remove structures, valve boxes, manholes, walls, slabs, foundations, posts, or debris.
- C. Contractor to remove any consolidated sand that has formed into hardened sandstone from activities related to infiltration of effluent in the area, if it should be encountered in the excavation.

3.02 GRUBBING

- A. Definition: Grubbing shall consist of the removal and disposal of wood or root matter below the ground surface remaining after clearing and shall include structures, stumps, trunks, roots, or root systems greater than 2 inches in diameter or thickness to a depth of 12 inches below the ground surface.
- B. In areas of grading, excavation or embankment, remove topsoil, stumps, roots, structures or foundations a minimum of 12 inches below finish grade. Topsoil in cultivated areas shall be removed to the full depth of the topsoil or to 12 inches, whichever is less, and shall not be mixed with foreign materials. Topsoil shall be stockpiled on-site and protected from erosion. Remove any excess topsoil from the site that is not intended, or needed for, reuse and dispose of it on the Section 10 WRP site in an area designated by the Owner. Backfill all grubbing holes with approved material and compact to approximately the same density as existing surrounding soil.

3.03 SALVAGE AND PROTECTION

- A. Miscellaneous timber, roots, or other debris found at the site shall become the property of the Contractor for his disposal off the project site as specified below.
- B. The Contractor shall protect benchmarks, survey control points, and existing work from damage or displacement.
- C. The Contractor shall maintain a designated site access for vehicle traffic.
- D. The Contractor shall protect existing chain link fences and posts, fence wire, wood posts, metal posts and any other structures not to be removed from the project site.

- E. The Contractor shall protect existing trees, plant growth, and other features not shown to be removed or shown to remain as final landscaping.
- F. Locate, identify, and protect utilities indicated to remain from damage.

3.04 DISPOSAL OF WASTE MATERIAL

- A. Wood and other combustible materials that become the property of the Contractor shall be disposed of or burned by the Contractor at offsite locations, and with means and methods, approved by local regulatory officials. No burning shall be allowed at the project site. Any burning operations off-site shall be subject to all laws governing such operations. The Contractor shall be responsible for any damage to life and/or property caused by fire resulting from any phase of construction. A copy of the Contractor's burning permit shall be sent to the Engineer. Noncombustible material shall become the property of the Contractor and shall be removed from the site of work, unless an approved waste site is authorized by the Owner.
- B. It shall be the Contractor's responsibility to select an acceptable method of disposal off the project site for vegetation, large rocks, or debris not salvageable. The Contractor shall be responsible for obtaining the necessary authorization from the Owner and local agencies for disposal if required; and any accidental loss or damage as a result of the chosen disposal method shall be the Contractor's responsibility and shall in no way involve the Owner or Engineer.
- C. Continuously clean-up and remove waste materials from the site during the work. Do not allow materials to accumulate on site.

END OF SECTION 31 11 00

PART 1 GENERAL**1.01 WORK INCLUDED**

- A. The work of this section covers all excavation, backfill, and embankment associated with the construction of the various structures, building, manholes, and any other structures included in this project.

1.02 GENERAL

- A. See the Volume 1 and Division 01 00 00, GENERAL REQUIREMENTS, which contain information and requirements that apply to the work specified herein and are mandatory for this project.

1.03 CLASSIFICATION OF EXCAVATED MATERIAL

- A. Unclassified Excavation: Materials encountered during the construction of the work regardless of their nature or the manner in which they are removed, will be considered unclassified excavation. Complete all excavation regardless of the type, nature, or condition of the materials encountered. Make own estimate of the kind and extent of the various materials to be excavated in order to accomplish the work.

1.04 DEFINITIONS

- A. Relative Compaction: The ratio, in percent, of the as-compacted field dry density to the laboratory maximum dry density as determined by ASTM D698. Corrections for oversize material may be applied to either the as-compacted field dry density or the maximum dry density, as determined by the Engineer.
- B. Optimum Moisture Content: Determined by the ASTM standard specified to determine the maximum dry density for relative compaction. Field moisture content shall be determined on the basis of the fraction passing the 3/4-inch sieve.
- C. Relative Density: As defined by ASTM D4253 and D4254.
- D. Prepared Ground Surface: The ground surface after clearing, grubbing, stripping, excavation, and scarification and/or compaction.
- E. Completed Course: A course or layer that is ready for the next layer or next phase of the work.
- F. Well-Graded: A mixture of particle sizes that has no specific concentration or lack thereof of one or more sizes. Well-graded does not define any numerical value that must be placed on the coefficient of uniformity, coefficient of curvature, or other specific grain size distribution parameters.

Well-graded is used to define a material type that, when compacted, produces a strong and relatively incompressible soil mass free from detrimental voids.

- G. Influence Area: The area within planes sloped downward and outward at an angle of 45 degrees from the horizontal from (a) 1 foot outside the outermost edge at the base of foundations or slabs; or (b) 1 foot outside the outermost edge at the surface of roadways or shoulder; or (c) 0.5 foot outside the exterior edge at the spring line of pipes and culverts.
- H. Borrow: Material imported from borrow areas off the immediate project site.
- I. Select Backfill Material: Material available onsite that the Engineer determines to be suitable for a specific use.
- J. Imported Material: Material obtained by the Contractor from sources off the immediate project site.
- K. Structural Fill: Fill material as required under and/or adjacent to structures, paving, sidewalks, driveways, curb, etc.
- L. Embankment: The fill material required to raise the existing grade in areas other than under structures.
- M. Unsuitable Materials: Unsuitable materials consist of debris, rubble, trash, organics, and other deleterious materials as determined by the Engineer. Unsuitable materials also include previously placed, non-engineered fills that were not placed in maximum 6-inch to 8-inch thick lifts and/or were not compacted to the densities specified herein.

1.05 SUBMITTALS

- A. Submittals shall be made in accordance with the General Conditions, Section 01 33 00, SUBMITTALS in Division 01 00 00, GENERAL REQUIREMENTS, and the requirements of this section. Certifications that materials conform to the specification requirements along with copies of the test results from a qualified commercial testing laboratory shall be submitted to the Engineer for approval at least 10 days before the material is delivered to the site for use.
- B. The Contractor's dewatering and shoring or excavation sloping systems for the new structures shall be designed by a Professional Engineer with drawings and calculations submitted with the Professional Engineer's State of Arizona stamp and signature. The Contractor shall submit plans, drawings, and calculations for the proposed systems. The submittals shall include information on scheduling and sequencing of construction and protection of new and/or existing structures and utilities. Design

calculations shall address the sequence of excavation and placement of lateral support elements. Drawings shall show the locations of all system elements in plan and section. Design calculations should demonstrate the adequacy of the systems and selected components.

- C. Review by the Engineer of submittals from the Contractor shall not in any way relieve the Contractor from full responsibility for errors therein or from the entire responsibility for complete and adequate design and performance of dewatering and shoring or excavation sloping systems. The Contractor shall be solely responsible for proper design, installation, operation, and maintenance, and any failure of any component of the provided dewatering and shoring or excavation sloping systems.
- D. Submit all materials testing results in accordance with these Specifications and Section 01 40 00, QUALITY CONTROL.

1.06 IMPORTED MATERIAL ACCEPTANCE

- A. All imported materials specified in this section are subject to the following requirements:
 - 1. All tests necessary for the Contractor to locate an acceptable source of imported material shall be made by the Contractor. Certification that the material conforms to the Specification requirements along with copies of the test results from a qualified commercial testing laboratory shall be submitted to the Engineer for approval at least 10 days before the material is delivered to the site for use. All material samples shall be furnished by the Contractor at the Contractor's sole expense. Samples shall be representative and be clearly marked to show the source of the material and the intended use on the project. Sampling of the material source shall be done by the Contractor in accordance with ASTM D75. Notify the Engineer at least 24 hours prior to sampling. The Engineer may, at the Engineer's option, observe the sampling procedures. Tentative acceptance of the material source shall be based on an inspection of the source by the Engineer and/or the certified test results submitted by the Contractor to the Engineer, at the Engineer's discretion. No imported materials shall be delivered to the site until the proposed source and materials tests have been tentatively accepted in writing by the Engineer. Final acceptance will be based on tests made on samples of material taken from the completed and compacted course. All testing for final acceptance shall be performed by the Owner.
 - 2. Gradation tests and standard Proctor tests shall be made by the Contractor on representative samples taken at the place of production prior to shipment to the project site. Representative samples of the finished product for gradation and Proctor testing

shall be taken from each 500 tons of prepared materials or more often as determined by the Engineer, if variation in gradation is occurring, or if the material appears to depart from the Specifications. Test results shall be forwarded to the Engineer within 48 hours after sampling.

3. If tests conducted by the Contractor or the Engineer indicate that the material does not meet Specification requirements, material delivery and placement will be terminated until corrective measures are taken. Material which does not conform to the Specification requirements and is placed in the work shall be removed and replaced at the Contractor's sole expense. Sampling and testing performed by the Contractor shall be done at the Contractor's sole expense.

1.07 SHORING, SHEETING, BRACING, AND SLOPING

- A. Install and maintain shoring, sheeting, bracing, and sloping necessary to support the side of the excavation, to keep and to prevent any movement which may damage adjacent pavements, utilities, or structures, damage or delay the work, or endanger life and health. Install and maintain shoring, sheeting, bracing, and sloping as required by OSHA and other applicable governmental regulations and agencies.

1.08 EXCAVATION SAFETY

- A. The Contractor shall be solely responsible for making all excavations in a safe manner, in accordance with all OSHA and other applicable regulations. Provide appropriate measures to retain excavation side slopes and prevent rock falls to ensure that persons working in or near the excavation are protected. Any necessary trench excavation permits shall be the responsibility of the Contractor.

1.09 CODES, ORDINANCES, AND STATUTES

- A. Contractors shall familiarize themselves with, and comply with, all applicable codes, ordinances statutes, and bear sole responsibility for the penalties imposed for non-compliance.

1.10 TOLERANCES

- A. All material limits shall be constructed within a tolerance of 0.1 foot except where dimensions or grades are shown or specified as minimum. All grading shall be performed to maintain slopes and drainage as shown. No reverse slopes will be permitted.

1.11 QUALITY ASSURANCE

- A. The Contractor shall perform earthwork operations in compliance with these specifications and within the applicable requirements of governing authorities having jurisdiction.
- B. Over-excavation made by the Contractor in earth or rock beyond the specified line and grade shall be corrected, at the expense of the Contractor. In areas not under slabs or footings, this shall be done by filling with structural fill meeting the requirements in this section and compacted to 98 percent of maximum density at optimum moisture as determined by ASTM D698. Over-excavation in areas below slabs or footings shall be corrected as specified in this section under Part 3, EXECUTION. Any other costs incurred by the Owner, or the Engineer as a result of the over-excavation, such as professional engineering or construction inspection services or additional materials, shall be the responsibility of the Contractor. If the over-excavation is directed by the Engineer, the excavation will be paid at a price negotiated with the Contractor through a change order to the lines and grades specified by the Engineer.
- C. Under-compacted soil placed by the Contractor shall, at the expense of the Contractor, be corrected by additional compaction effort or excavation, replacement, and compaction. Any costs incurred by the Owner or the Engineer as a result of the under-compaction, such as additional professional engineering services, materials testing, or construction inspection services, shall be the responsibility of the Contractor.
- D. Materials testing shall be the Contractor's responsibility. Field density testing shall be the responsibility of the Owner's testing representative.
- E. BRACING AND SHORING: Safe temporary cut slopes are the responsibility of the Contractor who shall meet all appropriate OSHA regulations including but not limited to; "Constructions Standards for Excavations" (29 CFR Part 1926.650-.652) Subpart P, effective on the date of the bid opening.

PART 2 PRODUCTS**2.01 EQUIPMENT**

- A. The Contractor may use any type of earthmoving and compacting equipment they may choose; except only walk behind hand compaction equipment will be utilized within 4 feet of structure walls, provided the equipment is in satisfactory condition and of such capacity as to fulfill the requirements of this section.

- B. No embankment or backfill shall be started or continued without adequate compaction equipment on hand. If watering is required, hoses from an adequate source, pumps, or tank wagons or trucks with a distributor capable of adequately spreading the water evenly across the width of the equipment shall be used.

2.02 MATERIAL

- A. Earthfill: Excavated native earth material may be used for backfill if it is placed more than 10 feet from any structure walls and it is free of detrimental quantities of organic material, such as vegetation, roots, or peat. Rocks larger than 3-inches in average dimension and native clay materials shall not be used in backfill. In order to be used as backfill, native earth material shall be well graded from coarse to fine. Moisture conditioning of native materials may be required to achieve specified compaction. Provide imported material of equivalent quality, if required to accomplish the work.
- B. Imported Engineered Gravel Backfill: Where detailed on the Drawings or where specified, imported engineered gravel backfill shall be provided that is reasonably clean (less than 10 percent passing the 200 sieve) naturally occurring or produced aggregate, crushed rock, or gravel graded from 1 ½ -inch maximum with not less than 30 percent and not more than 60 percent passing the No. 4 sieve. Sand fill will not be permitted. Fill shall be free from clay balls and organic material and shall be well graded from coarse to fine, containing sufficient fine material for proper compaction. Where shown on the Drawings, provide ¾-inch minus gravel backfill.
- C. Imported Engineered Structural Fill: Where detailed on the Drawings or where specified, imported engineered structural fill shall be provided that is reasonably clean (less than 20 percent passing a No. 200 sieve) naturally occurring or produced aggregate, crushed rock, or gravel graded from 1 ½ -inch maximum with not less than 25 percent and not more than 65 percent passing the No. 4 sieve. Sand fill will not be permitted. Fill shall be free from clay balls and organic material and shall be well graded from coarse to fine, containing sufficient fine material for proper compaction.
- D. Lean Clay: Lean clay materials may be approved native or imported material. Lean clay must be classified as a low plasticity clay with a plasticity index of not less than 10 and a liquid limit less than 50.
- E. Imported Drain Gravel: Where detailed on the Drawings, imported drain gravel shall be washed river-run gravel or washed crushed rock, hard and durable with a percentage of wear less than 35 percent when tested for resistance to abrasion in conformance with ASTM C535, free of roots and organic material, and conforming to the following gradation requirements:

Sieve or Screen Size	Percent Passing By Dry Weight
2-inch	100
1 ½-inch	95-100
¾-inch	35-70
⅜-inch	10-30
No. 4	0-5
No. 200	0 - 2

- F. Aggregate Base Course and Aggregate Surface Courses: Where detailed on the Drawings or where specified, aggregate base course (ABC) and aggregate surface courses (ASC) shall conform to the following:
1. Crushed Aggregate Base Course (ABC) shall be placed in accordance with Section 310 of the MAG Specifications and shall conform to the requirements of Section 702.2 and the Aggregate Base gradation in Table 702-1 except that the percentage of material passing the No. 200 Sieve shall be 0-10% and shall be non-plastic when tested in accordance with AASHTO T-146, T-89 and T-90.
 2. Crushed Aggregate (gravel) Surface Course (ASC) shall be placed in accordance with Section 310 of the MAG Specifications and shall conform to the requirements of Section 702.2 and the Aggregate Base gradation in Table 702-1 except that the percentage of material passing the No. 200 Sieve shall be 4-15% and the plasticity index shall be 4-12 when tested in accordance with AASHTO T-146, T-89 and T-90.
- G. Controlled Low Strength Material (CLSM): CLSM material used for trench backfill shall be a 1-SACK mix conforming to the requirements of Section 728 of the MAG Specifications and shall be placed in accordance with Section 604 of the MAG Specifications.
- H. Topsoil: Native topsoil, excavated on-site, shall be reused. Native topsoil shall be graded and screened; free of roots, rocks larger than ½-inch, subsoil, debris, large weeds, and other foreign matter. If insufficient native topsoil is available, provide imported borrow topsoil meeting the same requirements.
- I. Geotextile or Filter Fabric: Geotextile (or filter) fabric shall be woven or nonwoven geotextile material as specified in Section 31 34 19, GEOTEXTILES.
- J. Native Gravel Backfill: Excavated sand and gravel free from roots, organic matter, trash, debris and other deleterious material may be used as backfill, as approved by the Engineer. Material shall be well graded from coarse to fine. On-site clay materials may not be used. Maximum size aggregate shall

be 3 inches and not more than 10 percent shall pass the No. 200 sieve. Provide imported gravel material, if required to accomplish the work.

- K. Borrow or Waste Material: The intent of the project for earthwork is to grade the headworks site as shown on the Drawings using native soils. However, imported structural fill is required below all structures and around all structures to within a minimum of 3 feet from the structure wall or footings. This may result in excess material. Excess material may be graded smooth in areas outside the project site, but within the Owner's property as specified.

2.03 WATER FOR COMPACTION

- A. Furnish as required and/or Contractor may coordinate with Owner to utilize on-site treated effluent from the Plant's utility water system. Volume, flow and availability are subject to Owner's operation and so Contractor to coordinate with Owner.

2.04 COMPACTION EQUIPMENT

- A. Compaction equipment shall be of suitable type and adequate to obtain the densities specified and shall provide satisfactory breakdown of materials to form a dense fill.
- B. Compaction equipment shall be operated in strict accordance with the manufacturer's instructions and recommendations. Equipment shall be maintained in such condition that it will deliver the manufacturer's rated compactive effort. If inadequate densities are obtained, larger and/or different types of additional equipment or other methods shall be provided by the Contractor. Hand-operated equipment shall be capable of achieving the specified densities.

2.05 MOISTURE CONTROL EQUIPMENT

- A. Equipment for applying water shall be of a type and quality adequate for the work, shall not leak, and shall be equipped with a distributor bar or other approved device to assure uniform application. Equipment for mixing and drying out material shall consist of blades, discs, or other approved equipment.

PART 3 EXECUTION

3.01 CLEARING AND GRUBBING

- A. Clearing and grubbing shall be done in accordance with Section 31 11 00, CLEARING AND GRUBBING prior to beginning work in this section. Topsoil shall be stripped and stockpiled by this Contractor. This stockpiled

topsoil shall be used on this project as specified in Section 32 40 00, SURFACE RESTORATION.

3.02 EXCAVATION

- A. General: Dewater the ground as hereinafter specified, if necessary, prior to starting excavation. Protect structures, sidewalks and driveways, pavement, fences, benchmarks, survey control points, and other existing features designated to remain and not be disturbed. Excavation is unclassified. Excavation shall be performed to the lines, grades and elevations shown on the Drawings or as required to accomplish the construction. The Engineer reserves the right to make minor adjustments or revisions in lines or grades. Perform all excavation regardless of the type, nature, or condition of the material encountered. The method of excavation used is optional; however, no equipment shall be operated within 5 feet of existing structures or newly completed construction without approval of the Engineer. The Contractor shall protect all existing and newly constructed structures in all cases, and is solely responsible for any damage to those structures during their work. Excavation that cannot be accomplished without endangering present or new structures shall be done with hand tools. The Contractor is responsible for field staking the earthwork. No excavation shall be started until the staking or grade control is complete. Should the Contractor excavate below the designated lines through fault or negligence, the Contractor shall replace such unauthorized over-excavation with approved materials in an approved manner at their own expense.
- B. Classification: All excavation shall be considered unclassified. All material encountered of whatever nature shall be removed and used in embankment or disposed of as specified in this section. The presence of rock or frozen material shall not constitute a claim by the Contractor for extra work.
- C. Limits of Excavation: Excavation shall extend a sufficient distance from walls and footings to allow for placing, removal, and inspection of forms, and to allow for placing of structural fill. Temporary construction excavation side slopes shall be made as steep as safely possible in the upper 15 feet below existing grade. All native sub-grade areas below structures, sidewalks, pavement, or to other similar improvements shall be scarified to a minimum depth of 12 inches, moisture conditioned, and compacted to not less than 98 percent of maximum dry density at 2 percentage points wet of optimum moisture content in accordance with ASTM D698. Undercutting will not be permitted. Where suitable bearing is not encountered at the specified elevation, the Engineer may direct that additional depth be excavated as required. Such over-excavation shall be compensated for on a supplemental agreement or work order basis, if not specifically provided for in the Bid Form. Unauthorized over-excavation by the Contractor shall be corrected by the Contractor using approved materials as specified

hereinbefore at no cost to the Owner. Over-excavation below slabs shall be replaced with select imported engineered structural fill materials, thoroughly compacted to not less than 98 percent of maximum density, (ASTM D 698), to the subgrade elevation. Additional depth of over-excavation below structural concrete footings shall be poured with concrete as a part of the footing, at no additional cost to the Owner.

- D. Protection of Excavation: All necessary bailing, drainage, sheeting, and construction of cribs and cofferdams shall be included as part of the excavation. Excavations over four feet in depth shall be shored, sheeted and braced as may be necessary for the protection of the work and the safety of the personnel, or sloped to the angle of repose of the material when saturated per OSHA standards. When excavation is at the required depth, any water, if present, shall be pumped out for cleaning and foundation bed inspection.
- E. Dewatering of Excavation:
 - 1. Provide and operate equipment adequate to keep all excavations and trenches free of water and meet other specified performance requirements. Remove all water a minimum of 3 feet below the lowest point of excavation during periods when concrete is being deposited, when pipe is being laid, during the placing of backfill, and at such other times as required for efficient and safe execution of the work on a dry and stable subgrade. Avoid settlement or damage to adjacent property. Dispose of water in an approved manner that will not damage adjacent property. When dewatering open excavations, dewater from outside the structural limits and from a point below the bottom of the excavation when possible. Design dewatering system to prevent removal of fines from existing ground.
 - 2. Adjacent areas shall be graded so that surface drainage is away from excavations. Any water accumulating within the excavation shall be promptly removed. Pumping from the interior of any enclosed foundation shall be done so the possibility of any portion of the concrete materials being carried away is eliminated. No pumping will be allowed during the placing of concrete and for 24 hours thereafter, unless it is done from a suitable sump separated from the concrete work by a water tight wall.
 - 3. Positive dewatering systems shall be furnished and installed as necessary to maintain all excavations and trenches free of water at all times until the structure or facility is completely constructed, so that full dead load is applied, and backfill is in place. If necessary, such systems shall remove ground water from outside the limits of the excavation, and shall maintain the water level sufficiently far

below the base of the excavations to prevent buoyancy conditions or softening of the base. The Contractor shall dewater the work area sufficiently to prevent water from seeping through the excavated side slopes. Provisions shall be made for removal of storm runoff and all other water that may enter the excavations. Open-sump pumping from the interior of excavations will be permitted only to dispose of surface runoff, and shall not be used as the primary means of dewatering.

F. Structure Shoring:

1. Where necessary due to site limitations and to maintain steep side slopes, the Contractor shall shore the excavation for various structures. It shall be the Contractor's responsibility to provide and maintain a reasonable and safe excavation for all phases of construction. In no case shall any excavation be made in such a manner so as to endanger or damage adjacent facilities or property adjacent to the site.
2. The Contractor shall design, install, and maintain all shoring. The type of shoring shall be the Contractor's option. The shoring shall be designed and maintained to prevent any movement of soil which may cause damage to the adjacent facilities and property, damage or delay the work, or endanger life and health.
3. Shoring shall be designed and constructed to withstand soil and hydrostatic loadings, and appropriate equipment and surcharge loadings. Tie-backs and bracing shall be installed where required to prevent movement. Design of shoring shall incorporate the Contractor's sequence of excavation and placement of lateral support elements. The Contractor shall repair, at his own expense, all damage resulting from failure to provide adequate support.
4. Shoring shall be removed in a manner which avoids damage to new or existing facilities or adjacent property. All voids left by removal of shoring shall be immediately filled.

G. Approval of Excavation by Engineer: Prior to the placement of concrete for footings, walls, or slabs, the completed excavation shall be inspected and approved by the Engineer or his geotechnical sub-consultant. No footing or slab shall be placed until after the Engineer, Owner or his geotechnical sub-consultant has approved the depth of the excavation and the character of the foundation material. Provide a minimum 12-inch thick (or as otherwise required in Geotechnical Report) layer of imported engineered structural fill below all footings and slabs at bottom of excavations.

H. Blasting: Blasting for excavations will not be permitted.

- I. Overbreak: Overbreak, including slides, is defined as that portion of any material displaced or loosened beyond the finished work as designed by the Engineer. The Contractor shall remove such overbreak and shall replace such overbreak with approved material in an approved manner. The additional work will be accomplished at no additional expense to the Owner.
- J. Stockpiling: If during the excavation it is not possible to place suitable excavated material directly in an embankment, the material may be stockpiled in approved areas for later use.

3.03 BACKFILLING AT STRUCTURES

- A. General: Backfilling shall be performed where indicated or required, to the grades and elevations shown on the Drawings. No backfilling shall be commenced without approval of the Engineer. Do not backfill over porous, wet, frozen, or spongy subgrade surfaces, and do not backfill with frozen materials. Prior to backfilling, all concrete forms shall be removed and the excavation cleaned of all trash and debris. Any paint, insulation, waterproofing or coating which has been applied to below grade surfaces shall be completely dried or cured. Backfill around concrete structures only after the concrete has reached the specified compressive strength indicated in Section 03 30 00, CONCRETE. Backfill water-holding structures only after satisfactory leakage tests have been conducted as specified in Section 03 30 00, CONCRETE. All material used for backfill shall be as specified and of a quality acceptable to the Engineer and shall be free of large and frozen lumps, wood, and other extraneous materials. Do not operate large earth-moving or compaction equipment within 5 feet of concrete structures.
- B. Compaction: Backfill material shall be placed in continuous horizontal layers not to exceed 8 inches in loose lift thickness when heavy, self-propelled compaction equipment is used, and 4 to 6 inches in loose lift thickness if hand-operated equipment (jumping jack, plate compactor) is used. Each layer shall be compacted as specified hereinafter. Compact all materials by mechanical means; flooding or jetting will not be permitted. If compaction tests indicate that compaction or moisture content is not as specified, material placement shall be terminated and correction action(s) shall be taken by the Contractor prior to continued placement. Where backfill is placed on both sides of a wall or column, both sides shall be backfilled in such a manner so that the difference in compacted grade does not exceed 18 inches at any time. Care shall be taken when compacting around structure footings, slabs, and walls to prevent damage to the structure.
- C. Watering: Water may be added only to bring the backfill material to the specified moisture content range (plus or minus 2 percent from optimum)

for compaction. Jetting or ponding of the backfill material will not be permitted.

- D. Imported Engineered Gravel Backfill: Where called for in the Geotechnical Report, imported gravel backfill shall be provided with a minimum depth as shown on the Drawings. Do not exceed loose lifts of 6 inches. Compact each lift to not less than 98 percent of maximum ASTM D698 dry density at optimum moisture content, plus or minus 2 percentage points. Moisten material as required to aid compaction. Place material in horizontal lifts and in a manner which avoids segregation. Gravel fill shall be compacted with compactors, suitable for such material, to the satisfaction of the Engineer. Sand fills will not be permitted.
- E. Imported Engineered Structural Fill Below Structures: Where called in the Geotechnical Report, below all slabs and footings, or as otherwise specified herein or directed by the Engineer, provide hereinbefore specified imported structural fill for foundation preparation at a minimum compacted depth of 8 inches. Place fill material in maximum 6-inch thick loose lifts and compact each lift to not less than 98 percent of maximum ASTM D698 dry density at optimum moisture content, plus or minus 2 percentage points.
- F. Earth Backfill Around Structures: Place hereinbefore specified Earthfill to the specified grade in all areas not designated to be structural fill or gravel fill. Deposit material in horizontal lifts of maximum 8-inch un-compacted loose depth and compact each lift to not less than 95 percent of maximum ASTM D698 dry density. Maintain material at optimum moisture content, plus or minus 2 percentage points. Make allowance for topsoil where required.
- G. Where shown on the Drawings, place hereinbefore specified gravel drain material to the thickness and limits shown on the Drawings. Tamp gravel to a stable condition around sub-drain pipes. Remainder of gravel layer above and below pipes shall be compacted in at least two lifts to achieve a minimum relative density of 70 percent per ASTM 4253-00 and D4254-00.
- H. Any subsequent damage to slabs, piping, concrete structures, facilities, or other structures caused by settlement of fill material shall be corrected and repaired by the Contractor at the Contractor's sole expense.

3.04 MOISTURE CONTROL

- A. During all compacting operations, maintain optimum practicable moisture content for each lift of fill. Maintain moisture content uniform throughout each lift. Insofar as practicable, add water to the material at the site of excavation. Supplement, if required, by sprinkling water and mixing the fill material. At the time of compaction, the water content of the material shall be at optimum moisture content, plus or minus 2 percentage points.

- B. Do not attempt to compact fill material that contains excessive moisture. Aerate material by blading, discing, harrowing, or other methods, to hasten the drying process.

3.05 FIELD DENSITY AND MOISTURE TESTS

- A. The Contractor's testing representative will determine in-place density and moisture content by any one or combination of the following methods: ASTM D2922, D1556, D2216, D3017, or other methods selected by the Engineer. Backfill test areas at Contractor's sole expense.
- B. The frequency and location of testing shall be determined by the Engineer and Owner and as defined in Section 01 40 00, QUALITY CONTROL.
- C. The Engineer may require the Contractor to test any lift of fill at any time, location, or elevation. No areas will be accepted that have compacted densities less than specified hereinbefore.

3.06 WEATHER CONDITIONS

- A. Earthwork operation shall be suspended at any time when satisfactory results cannot be obtained on account of rain, freezing weather, or other unsatisfactory field conditions.

3.07 DRAINAGE

- A. During earthwork operations the grade shall be maintained in such a condition that it will be well drained at all times.
- B. If necessary, temporary drains or diversion ditches shall be installed in order to intercept or divert surface water which could affect the work.

3.08 SITE GRADING

- A. Perform all earthwork to the lines and grades as shown on the Drawings and/or established by the Engineer, with proper allowance for ground or landscaping cover where specified or shown. Shape, trim, and finish slopes of channels to conform with the lines, grades, and cross sections shown. Make slopes free of all exposed roots and stones exceeding 3-inch diameter which are loose and liable to fall. Round tops of banks to circular curves, in general, not less than a 6-foot radius. Rounded surfaces shall be neatly and smoothly trimmed. Neatly blend all new grading into surrounding, existing terrain. Over-excavating and backfilling to the proper grade will not be acceptable. Finished site grading will be reviewed by the Engineer.

3.09 PLACING TOPSOIL

- A. After rough grading is completed and approved by the Engineer, spread topsoil hereinbefore specified over all cuts, slopes, fills, embankments, and all previously vegetated areas damaged by construction in the project site area to a minimum rolled depth of 6 inches to the surface elevations as shown on the Drawings or as established by the Engineer. Loosen the finished surface to a depth of 2 inches and leave in smooth condition, free from depressions or humps.

3.10 CLEANUP

- A. All unsuitable material, waste sheeting or forming, and debris shall be removed from the site and disposed of by the Contractor in approved areas as directed by local regulatory agencies or the Owner. The area shall be graded to required elevations and all rocks and boulders bladed into a furrow and removed for disposal by the Contractor. Remaining topsoil stripped during clearing and stockpiled shall be spread in such a manner as to restore the area surface to its original condition, as approved by the Owner.
- B. All excess native soil materials not required for backfilling around new structures may be disposed of on-site by the Contractor in an area identified by the Owner. Materials shall be clean without any debris or contaminants. Actual area for disposal must be coordinated with the Owner. Disposal area must be shaped and graded as directed by the Owner and Engineer to leave the site with a neat appearance.
- C. Also see Volume 1 and Section 32 40 00, SURFACE RESTORATION for other cleanup requirements.

END OF SECTION 31 23 00

APPENDIX

31 23 00

EARTHWORK FOR STRUCTURES

GEOTECHNICAL INFORMATION



SUNBELT
ENGINEERING & TESTING, LLP

Geotechnical, Environmental,
Materials Testing & Inspection, QA / QC,
Building Condition Survey

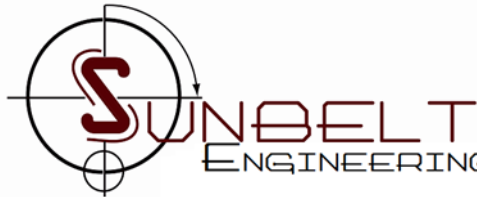
**GEOTECHNICAL ENGINEERING EXPLORATION
FOR PROPOSED NEW CLARIFIER
SECTION 10 WASTEWATER TREATMENT PLANT
LOCATED 901 RICHARDO AVE.
BULLHEAD CITY, ARIZONA**

PREPARED FOR:

BULLHEAD CITY UTILITIES DEPARTMENT
2355 TRANE ROAD
BULLHEAD CITY, AZ 86442

File No. AZ25061
August 13, 2025

4140 S. Lynn Drive, Suite 111 * Fort Mohave, Arizona 86426
Phone (928) 704-7555



Geotechnical, Environmental,
Materials Testing & Inspection, QA / QC,
Building Condition Survey

August 13, 2025
File No. AZ25061

Bullhead City Utilities Department
2355 Trane Road
Bullhead City, AZ 86442

Attn: Ryan Farnell

At your request, we have now completed the geotechnical engineering exploration for the proposed commercial development located at 901 Richardo Ave., Bullhead City, Arizona on approximately ± 0.28 -acre lot.

Transmitted herein are the results of our geotechnical exploration, laboratory testing program and recommendations for use in the design of foundations, concrete slab-on-grade, retaining walls, preliminary asphalt concrete pavement, and information pertaining to grading, excavation difficulties and soil corrosion for the proposed project.

We wish to thank you for the opportunity given to us to conduct this exploration and will be available to discuss any questions you may have in this regard.

Respectfully submitted,
Sunbelt Engineering & Testing, LLP

Reviewed by:

Michael Vela
Project Geologist

James A. Wilson
Director of Operations



EXP. _____

Robert Kalinski, Ph.D., P.E.
Principal Engineer

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1. INTRODUCTION

1.1. GENERAL

This report presents the results of our geotechnical engineering exploration for the proposed new commercial development, located at 901 Richardo Ave., Bullhead City, Arizona, (please see the enclosed location Map, Plate 1, Appendix C). The proposed construction is to consist of a new Clarifier, consisting of concrete slab on grade foundations and wood framed superstructures with associated underground utilities on an approximately ± 0.28 -acre lot (See Plate 2, Appendix C).

1.2 PURPOSE AND SCOPE

The purpose of this geotechnical report is to present the surface and subsurface conditions as related to the engineering properties of the site soils to provide general geotechnical design criteria and construction recommendations for the proposed site development. The scope of this investigation included subsurface exploration, soil sampling, laboratory testing of selected soil samples, engineering analysis, research of pertinent information and preparation of this report. In accordance with this, we have provided information and recommendations concerning:

- General Geology and Seismicity
- Subsurface material & Conditions
- Site Preparation and Earthwork
- Construction Considerations
- Foundation Recommendations
- Suitability of Native Material as Structural Fill
- Engineering properties of the soils, which will influence the design of the future structures, including:
 - Bearing Capacity*
 - Settlement and/or Swelling Potential*
 - Lateral Earth Pressures*
 - Seismic Design Criteria*

We recommend that a pre-construction meeting be held. The owner or the owner's representative, the civil engineer, the geotechnical consultant, the grading and general contractor should attend this meeting to discuss the plans, geotechnical report, and coordination in various construction activities associated with the project.

1.3 PROJECT DESCRIPTION

As mentioned earlier, the proposed project, proposed commercial development, is to consist of new water treatment plant clarifier, with associated underground utilities, roadways and sitework, etc. on approximately ± 0.28 -acre parcel of land. The clarifier structure will consist of prestressed concrete tank. Maximum dead plus long-term live loads for proposed development have been estimated at 15.0 kips per foot for walls and 50 kips for footings.

Grading plans were not available at the time of preparation of this report; however, grading is likely to include cuts and fills of approximately between 1 to 10 feet.

1.4 SITE DESCRIPTION

As mentioned earlier, the site is located within the Section 10 Wastewater Treatment Plant located at 901 Richardo Ave., Bullhead City, Arizona (please refer to Plate 1). The project area consists of the Wastewater Treatment Plant. The topography of the site is generally flat with areas of undulating terrain where not improved, with sparse to thick desert vegetation, sloping gently to the west. As a result, drainage, which occurs primarily in the form of overland sheet flow, is directed towards the west.

1.5 FIELD INVESTIGATION

The subsurface conditions at the site were explored by drilling three (3) borings in August of 2025. Plate 2 presents a site plan showing approximate locations of the borings.

The borings were drilled with a boring diameter of approximately 8 inches using a Dietrich D-50 all-terrain access drill rig utilizing hollow-stem augers to maintain the holes and the boring was advanced to a depth of twenty-six (26') feet below the existing ground surface. Soil samples and penetration blow counts were obtained with a Standard Penetration Test (SPT) sampler. The SPT sampler was driven with a 140-pound hammer and 30-inch fall. The penetration resistance obtained from the soil sampler was used to evaluate consistency and density of the in-situ soil. The soils encountered were classified in the field and through further examination in the laboratory in general accordance with the Unified Soil Classification System for site development.

1.6 LABORATORY TESTING

The laboratory testing program consisted of tests to classify site soils and to determine their engineering properties related to this project. The tests performed are presented below.

<u>Test</u>	<u>Purpose</u>
Atterberg Limits	Classification, foundation design criteria.
Sieve Analysis	Classification, grading and foundation recommendations.
Natural Moisture Content	Moisture determination.
Chemical Solubility	Settlement potential & Cement type in concrete.

Test results are presented in Table 5 and Figures 1 - 25 of Appendix B. Detailed descriptions of the laboratory testing program are presented in Appendix B under the appropriate test headings.

2. DISCUSSION

2.1 GENERAL

As mentioned earlier, the project is located within the Section 10 WWTP at 901 Richardo Ave., Bullhead City, Mohave County, Arizona, in Section 10, Township 19 North, Range 22 West of the Gila and Salt River Meridian, (see enclosed Site Location Map, Plate 1).

2.2 GENERAL GEOLOGY AND SEISMICITY

The site lies on a young eroded basin fill. Sediments deposited in this area are Quaternary in age and generally granular. They are often cemented in varying degrees and depths and may contain soluble chemicals. Generally, the grading of the sediments becomes increasingly finer with distance from the source area and with decreasing elevation. Within the project area, the upper sediments appear to consist primarily of silts, sands, and gravels of alluvial origin. According to the "Geologic Map of Mohave County, Arizona" by Eldred D. Wilson and Richard T. Moore (1959) the project area appears to be underlain by Rhyolite includes tuff and agglomerate (Tr) deposited in the Quaternary and Tertiary respectively. Cemented layers of petrocalcic carbonate (caliche) were not encountered in any of the test pits. However, horizons of "Caliche" could exist within the subsurface of the project area and simply were not detected due to the discontinuous nature of "caliche" and the underlining limited nature of the investigation.

No geomorphic evidence for faulting or fissuring could be established either on the surface or in the subsurface borings. A further review of the available geologic maps and published literature, including the Geologic Map of Mohave County, Arizona by Eldred D. Wilson and Richard T. Moore (1959) and Earthquake Hazards in Arizona by Philip A. Pearthree and Douglas B. Bausch (1999) **did not establish a mapped fault, inferred fault, or mapped fissure zone into or across the property boundaries** or within 2,000' feet of the project area.

Liquefaction potential was qualitatively evaluated for the subject site. For liquefaction to occur, soils must be granular in nature, loosely compacted, and saturated. These conditions are not present within the site soils, as groundwater was encountered in all of the borings at a depth of twenty-six (26') feet, with twenty-six and one-half (26.5') feet, the maximum depth explored. Liquefaction potential at the subject site is considered low.

Using the *National Map Viewer*, provided by the United States Geological Survey (USGS) (<https://viewer.nationalmap.gov/advanced-viewer/>) we have located the center of the site to be at approximately LATITUDE **35.0503782** N LONGITUDE **-114.6015802** W. However, it is the responsibility of structural engineer of record for any future development regarding this geotechnical report to verify the exact coordinates for the purpose of his seismic acceleration calculations.

Using the *Seismic Hazard Curves and Uniform Hazard Response Spectra*, provided by the United States Geological Survey (USGS) (<http://earthquake.usgs.gov/hazards/designmaps/>) we have estimated maximum considered earthquake spectral response accelerations for short (0.2 second) and long (1.0 second) periods for the subject site. Please see **Table 1** below.

Table 1: Seismic Design	0.2 sec	1.0 sec
Mapped Maximum Considered Earthquake Spectral Response Acceleration, S_s and S_1	0.238 g	0.118 g
Site Coefficient, F_a and F_v	1.6	2.364
Maximum Considered Earthquake Spectral Response Acceleration Adjusted for Site Class Effects, S_{MS} and S_{M1}	0.381 g	0.279 g
Design Spectral Response Acceleration, S_{Ds} and S_{D1}	0.254 g	0.186 g

Site Class “D”, (Stiff Soil) as given in **Section 1613, site classification for seismic design of the International Building Code, 2018** is considered to be “appropriate” for this site.

2.3 SUBSURFACE MATERIAL AND CONDITIONS

Exploration as presented on the boring logs indicates that the sub-soils generally consist of one type of material with indistinguishable horizons:

1. **Poorly Graded Sand with varying amounts of silt, loose to dense, slightly moist to wet, brown in color**

The engineering properties of the soils encountered are as follows:

1. **Poorly graded Sand with silt displays no plasticity and is assumed to have low swelling potential. It may be expected to consolidate under light to moderate building loads.**

Chemical analysis of composite soil sample indicates the presence of soluble salts in the native soils (please see Table 5). These soils are considered to be **negligibly** corrosive to metal and concrete.

2.4 GROUNDWATER

During the exploration performed for this project, groundwater was encountered during the borings excavated at the project site. It should be noted that although groundwater levels fluctuate due to seasonal variations, adjacent construction, or development, and other factors, it is unlikely that groundwater will affect the proposed development at this site, as groundwater was encountered in all of the borings at a depth of twenty-six (26') feet, twenty-six and one-half (26.5') feet the maximum depth explored.

3. RECOMMENDATIONS AND CONCLUSIONS

From a geotechnical engineering standpoint, it is our opinion that the subject site is suitable for the proposed development provided that the recommendations contained in this report, and in Appendix A, are incorporated into project design and construction. The following sections present conclusions and recommendations concerning the proposed project.

These recommendations are based on the results of the field and laboratory testing which are presented in this report and on the assumption that an adequate number of tests and inspections will be made during the construction phase of the project to verify compliance with these recommendations. Other recommendations may be possible and will be presented, if necessary, upon your request.

As discussed earlier, we recommend that a pre-construction meeting be held. The owner or the owner's representative, the civil engineer, the geotechnical consultant, the grading and general contractor should attend this meeting to discuss the plans and recommendations given in this geotechnical report, and to provide coordination among the grading and other specialty contractors assigned for the project.

3.1 SITE PREPARATION AND EARTHWORK

- 3.1.1 All earthwork and site preparation should be performed in accordance with the requirements and specifications of the **2018 IBC and the Bullhead City Building Department** and as presented in Appendix A of this report and the "Uniform Standard Specifications for Public Works' Construction, Maricopa Association of Governments," current edition, unless noted otherwise.
- 3.1.2 Based upon the results of our laboratory testing and engineering analyses, it is our professional opinion that the subgrade soils are not suitable for foundation, slab and/or pavement support at their present condition. In order to reduce the risk of future movement and/or cracking of the slab and foundation system it is recommended that, once screened or otherwise separated from the over-excavated surface soils, all the organic material and debris be removed from the soils and that the remaining *clean* fill soils be stockpiled for future use after testing according to Appendix A.
- 3.1.3 All existing surface and subsurface structures, intended to be removed within the area to be developed, should be razed and moved off site. If a septic tank is located within the project site, it is recommended that it be pumped out and removed. Any leach lines, seepage pits or other pipes associated with this structure should also be removed. If a well is encountered, the well casing should be removed to a depth of five (5') feet below existing grade and the

remainder of the well should be filled with lean concrete slurry and backfilled per Appendix A of this report. These recommendations are not meant to supersede any recommendations provided by the Public Health Department or any other government agencies.

- 3.1.4 ***A minimum over-excavation of three (3') feet below foundations or through any man-made fill, whichever is deeper, is required.*** The over-excavation should extend a minimum of five (5') feet beyond the footprint in plan view. The over-excavation may be stopped short if a cemented material such as "caliche" of significant hardness, thickness, and lateral extent is encountered "see item 3.1.7 for more detailed explanation". Upon completion of over-excavation, unless hard caliche is encountered, should be proof rolled and observed by Sunbelt Engineering & Testing, LLP to determine if additional over-excavation will be required due to soft and yielding soils. Once an acceptable bottom is verified, the soils shall be scarified a minimum of twelve (12") inches, moisture-conditioned to $\pm 2\%$ of moisture content and compacted as outlined in 3.1.6.
- 3.1.5 The exposed native subgrade in areas receiving structural fill for foundation support should be scarified to a minimum of twelve (12") inches, moisture-conditioned to $\pm 2\%$ of moisture content, the structural fill material should be placed in thin, loose lifts of eight (8") to twelve (12") inches maximum thickness and compacted to a minimum of ninety-five (95%) of Maximum Dry Density and ninety-eight (98%) percent of maximum dry density as per ASTM D-698 test method in areas where the depth of structural fill is (5') feet or more.
- 3.1.6 The scarification and over-excavation may stop short if hard layers of cemented deposits such as "caliche" of significant vertical and lateral extent and integrity are encountered. Furthermore, the "caliche" must be uniformly established underneath the entire extent of the building foundation. **In no case may the footings be partially supported on cemented material and partially on fill or on non-cemented material.** When this situation arises, the cemented material should be over-excavated to a minimum of twelve (12") inches and replaced by properly compacted structural fill.
- 3.1.7 The native material and man-made uncontrolled fill (if any encountered) at this site may be utilized as structural fill when found competent to meet the swell potential and sulfate content limitations based on laboratory tests and when properly processed and cleared of all organic matters and rocks larger than six (6") inches in diameter. The structural fill should consist of low expansive material containing a swell no greater than 4 percent, and meeting the requirements of Appendix A, section 5.0.

- 3.1.8 To ensure stability of the existing adjacent building foundations and for protection of workers, walls, or other structures likely to be endangered by excavation operations, support systems such as shoring, bracing or underpinning shall be specified by the responsible structural engineer, per **section 1804 of the International Building Code, 2018 Edition**. “No excavation for any purpose shall remove lateral support from any footing or foundation without first underpinning or protecting the footing or foundation against settlement or lateral movement”.
- 3.1.9 Per **Section 1803.5.8 of the 2018 International Building Code**, no rock or similar irreducible material with a maximum dimension greater than 12 inches shall be buried or placed in fills within five feet, measured vertically, from the bottom of the footing or lowest finished floor elevation, whichever is lower, within the building pad. Oversize fill material shall be placed so as to assure the filling of all voids with well-graded soils. Outside of this zone, oversized materials can be placed under the direction of a Sunbelt Engineering representative only on a full-time basis.
- 3.1.10 Please refer to Appendix A for grading operation details.
- 3.1.11 Based on the encountered on-site soils in the borings we recommend that *full-time* verification and inspection of soils should be required during grading operations per **Section 1804 of the International Building Code, 2018 Edition**.

3.2 UNDERGROUND UTILITIES

- 3.2.1 Utility trench backfill material and placement procedures for all on-site improvements should consist of suitable material meeting the specifications outlined in the “Uniform Standard Specifications for Public Works’ Construction, Maricopa Association of Governments,” current edition.
- 3.2.2 Trenches for utilities may stand near vertical at depths of up to two (2) feet. When increased depths are necessary, trenches should be sloped back or shored to provide adequate worker protection and prevent wall collapse. As a minimum all state, federal and local codes, as well as OSHA regulations, should be observed.
- 3.2.3 The utility trenches most likely will not encounter hard “caliche”. However, if encountered, additional effort (use of heavy or special equipment, etc.) may be required for excavation of utility trenches. Grading and general contractors shall make their own interpretation with regard to the hardness of materials and equipment required to excavate utility trenches.

3.3 MOISTURE PROTECTION AND SURFACE DRAINAGE

We recommend that precautions be taken during and after construction to help reduce the potential for saturation of the foundation soils. **Section 1804.4 of the 2018 IBC** states that the ground surface should slope away from the exterior walls and adjacent to foundations of the structures at a slope not less than one unit vertical in 48 units horizontal, (2%) percent, within the first ten (10') feet as measured perpendicular to the face of the wall. If physical obstructions or lot lines prohibit ten (10') feet of horizontal distance, a 5-percent slope shall be provided to an approved alternative method of diverting water away from the foundation. Swales used for this purpose shall be sloped a minimum of 2-percent where located within ten (10') feet of the building foundation. Impervious surfaces shall be sloped a minimum 2-percent away from the building. For paved areas a recommended slope not less than one to two percent (1%-2%) is required. Compaction tests should be performed during construction of utility lines and during backfill of utility trenches to ensure minimum settlement. We recommend that all backfill of utility lines consist of on-site soils compacted to a minimum of ninety-five (95%) percent of Maximum Dry Density (ASTM D-698) to reduce the potential for future subsurface saturation and possible settlement.

A sprinkler system should not be installed next to foundations or slabs. If a sprinkler system is installed, then the sprinkler heads should be placed so that the spray from the heads under full pressure does not fall within three (3') feet of foundations, block walls and concrete slabs. Particular care should be taken during final landscaping of the site so that no plants are adjacent to the structures. Watering of landscaped areas adjacent to any structure should be kept to a minimum.

As an alternative to avoid planting next to foundations and exterior floor slabs, it is advisable to install decorative desert landscaping. If decorative areas are installed, these areas should be underlain with a polyethylene moisture barrier "visqueen". The polyethylene should be glued to the foundation using a mastic compound. Watering of landscaped areas at this site should be kept to a minimum.

3.4 SOIL CORROSION

Based on the results of the laboratory tests (please see table 5 of appendix B), soils on this site should be considered slightly-corrosive to metal and concrete. **The on-site soils exhibit class S0 sulfate exposure, and concrete mix design for concrete in contact with Soils should be designed for S0 sulfate exposure durability per ACI 318, Table 19.3.1.1 and should be used for footings, slab-on-grade, and any other concrete in contact with soil.** As a precaution against the possibility of encountering soils corrosive to metal at greater depths, special protection

such as cathodic protection or use of PVC pipe or protective wrapping of underground metallic utility lines, should be considered for the long-term performance of underground utilities where permitted by local building codes.

3.5 MATERIAL VOLUME CHANGES

There will be a reduction of volume when native soils are compacted. Shrinkage of native soils is estimated to be in the range of 15% to 20% when compacted to ninety-five (95%) percent of the soils Maximum Dry Density as per ASTM D-698 Test Method.

3.6 FILL MATERIAL

3.6.1 Fill soils placed in areas underlying slabs, foundations or other improvements should be compacted to a minimum of ninety-five (95%) percent of the soils' Maximum Dry Density as determined by ASTM D-698 Test Method, or ninety-eight (98%) percent of soils Maximum Dry Density when the depth of fill is five (5') feet or more, unless otherwise noted in this report.

3.6.2 The native material with an expansion potential of less than 4% percent may be utilized as structural fill when properly processed and cleared of all organic matter and rocks larger than six (6") inches in diameter.

3.6.3 Imported materials to be used as structural fill should conform to the requirements set forth in the earthwork specifications in Appendix A, Section 5.1. Samples of all materials proposed for use as structural fill shall be submitted to the soils engineer for testing and approval prior to being transported to the site.

3.7 FOUNDATIONS – CONVENTIONAL (SLAB ON GRADE)

3.7.1 The competent structural fill soils conforming to the grading specifications should be moisture conditioned and compacted to ninety-five (95%) percent of Maximum Dry Density (ASTM D-698). The structure should be founded on conventional spread footings designed for a maximum net allowable bearing capacity of 1,500 pounds per square foot (PSF) based on a minimum twelve (12") inch wide by twelve (12") inch deep footing. The bearing capacity may be increased by 250 psf for each additional six (6") inches of width and embedment and is permitted to be increased 1/3 when considering load combinations, including wind, and earthquake loads. However, the net bearing capacity should in no case exceed 2,250 psf.

MODULUS OF SUBGRADE REACTION For the loose to dense sandy soils encountered, a modulus of subgrade reaction value of 120 pci /in. can be assumed for the design of footing

and/or floor slabs placed directly on native soils or re-worked soil. For floor slabs and/or footings placed on a minimum 8-inch-thick base of compacted aggregate base, a modulus of subgrade reaction value of 150 pci/in. can be assumed.

The expected total settlement is estimated to be one inch, and the differential settlement is estimated to be half of the magnitude of the total settlement or approximately ½ inch.

3.7.2 Minimum footing width and thickness is based on the table given below. In addition, footings should be proportioned as much as practical to minimize differential settlement (Table 2).

Table 2: Minimum Footing Dimensions- Low Expansive

Number of Floors supported by the footing	Width of Footing (inches)	Thickness of Footing (inches)
1	12	15 w/ 2 #4 bars top & bottom minimum
2	15	18 w/ 2 #4 bars top & bottom minimum
3	15	24 w/ 2 #4 bars top & bottom minimum

3.7.3 All exterior footings should be placed a minimum of fifteen (15") inches below the lowest adjacent finished grade below the lowest adjacent finished grade to provide for confinement and to minimize settlement. The estimated friction coefficient is 0.35 for sliding.

3.7.4 The footings should be inspected for moisture content and compaction prior to placement of concrete. Any loose, disturbed soils should be removed before placing footings. Backfill placed around the footing excavation or formed footings should be compacted to be at least ninety (90%) percent of the soil Maximum Dry Density per ASTM D-698.

3.7.5 The extent and conditions of the excavations shall be verified by the soils engineer as outlined in Section 2.2 of Appendix A of this report.

3.8 CONCRETE SLAB-ON-GRADE AND FLATWORK CONSTRUCTION

3.8.1 All conventional concrete slabs on grade shall be at least five (5") inches in thickness. The actual thickness and reinforcement requirements shall be designed by the structural engineer. **Type V Portland Cement is recommended to be used in all slabs, footings, and flatwork construction.**

3.8.2 All reinforced concrete slabs on grade and foundations for columns (if any) and walls shall be supported on a minimum eight (8") inch thick aggregate base course, compacted to

at least 95% of the maximum Dry Density per ASTM D-698. A minimum eight (8") inch base course of aggregate base materials should also be placed below exterior concrete flatwork, which should be properly reinforced.

3.8.3 To facilitate curing of slabs, base materials shall be kept moist prior to the placement of concrete.

3.8.4 Excessive slump (due to a high water-cement ratio) of the concrete and/or improper curing procedures could lead to excessive drying, shrinkage, cracking or curing of slabs and other flatwork. All concrete placements and curing operations shall therefore be performed in accordance with the American Concrete Institute (ACI) Manual of Concrete Practice.

3.8.5 Concrete slabs should be designed to minimize cracking as a result of shrinkage. Saw cut or control joints should be used to control the location of shrinkage cracks in conventional slabs. If used, they should be spaced twelve (12') feet or less apart and in accordance with the American Concrete Institute (ACI) manual of Concrete Practice.

3.8.6 A moisture barrier is recommended beneath the concrete slab and shall consist of a minimum 10-mil thick polyethylene "visqueen" plastic sheet in locations where moisture sensitive flooring, or impervious coverings will be applied or where equipment will be affixed to the slab that is moisture sensitive. When conditions warrant the use of a vapor barrier, the slab designer should refer to ACI 302 and/or ACI 360 for procedures and cautions regarding the use and placement of a vapor retarder. Care should be taken not to puncture the vapor retarder during compaction activity. It is acceptable to "patch" back the visqueen in case of trench excavation by the utility contractor. A twelve (12") inch overlap on each side of the trench should be provided in this case.

3.9 RETAINING WALLS AND BLOCK WALLS

3.9.1 Footings for retaining walls and block walls may be established on compacted structural fill and may be designed for a dead plus long-term live bearing capacity of no more than 1,500 pounds per square foot.

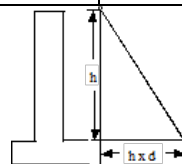
3.9.2 The footings for retaining walls and block walls should be placed a minimum of fifteen (15") inches below the lowest adjacent finished grade to provide for proper confinement and to minimize settlement.

3.9.3 If waterproofing is determined to be necessary, it should be provided per **section 1805.3 of the International Building Code, 2018 Edition**

- 3.9.4 The footings for retaining walls and block walls should be placed neatly against undisturbed soils if possible. If forms are used for the footings, the pockets resulting from removal of forms should be backfilled with non-expansive material meeting the requirements set forth in Appendix A and compacted to a minimum of ninety (95%) percent of the soil Maximum Dry Density as per ASTM D-698.
- 3.9.5 All backfill should be re-compacted to a minimum of ninety-five (95%) percent relative compaction, as per ASTM D-698 test method, using light hand operated equipment. The use of heavy compaction equipment could cause loads exceeding the designed lateral pressures and result in wall failure. Weep holes and a drain system should be provided to minimize the possibility of hydrostatic pressure. Waterproofing will be required for all areas below grade, it should be provided per **section 1805 of the International Building Code, 2018**.
- 3.9.6 Resistance to lateral loads may be calculated using passive lateral support based upon an equivalent fluid weight of 250 pounds per cubic foot and a base coefficient of friction of 0.35.
- 3.9.7 Unrestrained cantilever retaining walls with level backfill to a height of up to 10 feet high may be designed using active pressure based upon an equivalent fluid weight. An equivalent fluid pressure approach may be used to compute the horizontal pressure against the wall. Appropriate fluid unit weights are given on the next page for specific slope gradients of the retained material.

Table 3: Earthquake Induced Forces on Retaining Wall

Surface Slope of Retained Material (H:V)	Equivalent Fluid Weight (pcf)
Level	35
3 to 1	50
2 to 1	65



Lateral Earth Pressure Diagram for Retaining Wall

Where d = equivalent fluid density - **See Table 3 above**

(Example: Total Horizontal force on wall = $dh^2/2 = 35 \times h^2/2$ and will act at $1/3 h$ from bottom of the wall.)

- 3.9.8 In addition to active pressure from the soil, the effects of any structures or roadways should be included in calculating lateral pressures on retaining walls.

3.9.9 The footings should be inspected for moisture content and compaction prior to placement of concrete. Any loose disturbed soils should be removed before placing footings. Backfill placed around the footing excavation or formed footings should be compacted to at least ninety-five (95%) of the soil Maximum Dry Density.

3.9.10 The extent and conditions of the excavations shall be verified by the soils engineer as outlined in Section 2.2 of Appendix A of this report.

3.10 PRELIMINARY ASPHALT CONCRETE PAVEMENT

3.10.1 The asphalt concrete material and placement procedures shall conform to the appropriate section of the "Standard Specifications". This design is based upon an assumed subgrade R-value of 60 for the onsite material; **however, the actual subgrade R-value must be determined by a qualified Sunbelt Engineering & Testing, LLP representative once grading operations have begun.** The following is the minimum asphalt concrete pavement design sections. These sections are designed for an average design period of 20 years.

Table 4: Recommended Onsite Asphalt Pavement Design

	R-VALUE	ASPHALT CONCRETE THICKNESS (Inches)	AGGREGATE BASE THICKNESS (Inches)	Processed Subgrade (Inches)
100' ROW	Minimum 50	5.0 Normal 5.5 Heavy	6.0	12.0
80' ROW	---	4.0 Normal 4.5 Heavy	6.0	12.0
60' ROW	---	3.0 Normal 3.0 Heavy	6.0	12.0
40' ROW Onsite Roadways	---	2.0 Normal 2.0 Heavy	6.0	12.0

3.10.2 The pavement sections provided are based upon the assumption that any existing unsuitable deposits will be removed below the base of the structural section in addition to twelve (12") inches of scarification, moisture-conditioned to $\pm 2\%$ of moisture content and compaction to ninety (95%) percent of Maximum Dry Density as per ASTM D-698.

3.10.3 Base and pavement materials and construction methods are to meet the qualifications set forth in the "Uniform Standard Specifications for Public Works Construction Off-Site Improvements, Maricopa, Arizona" current edition.

3.10.4 The ABC material should be moisture conditioned as noted above and compacted to a minimum of ninety-five (98 %) percent of Proctor Density (ASTM D-698).

3.10.5 Upon completion of grading operation, Sunbelt Engineering & Testing, LLP should be called to perform street pavement designs for both off-site and on-site streets to determine the actual pavement sections if required.

4. LIMITATIONS

The recommendations contained in this report are based on field exploration, laboratory testing, research of pertinent maps and literature and our understanding of the proposed construction. The soils and geologic data used in the preparation of this report were obtained from test holes drilled. It is possible that variations in the soils could exist between the points explored. Therefore, if any soil conditions are encountered on the site, which is different from the ones outlined in this report, Sunbelt Engineering & Testing, LLP should be immediately notified so that we may review the situation that exists and change our recommendations or make supplementary recommendations as needed. In addition, if the scope of the proposed construction, including proposed loading or structural locations, changes from what is described in this report, our firm should be notified.

Site exploration identifies actual subsurface conditions only at those points where samples are taken, when they are taken. Data derived through sampling and subsequent laboratory testing are extrapolated by geotechnical engineers who then render an opinion about the overall subsurface conditions, their likely reaction to the proposed construction and appropriate foundation design. Even under optimal circumstances, actual conditions may differ from those inferred to exist because no geotechnical engineer, no matter how qualified he may be, and no subsurface exploration program, no matter how comprehensive it may be, can reveal what is hidden by earth, rock and time. The actual interface between materials may be far more gradual or abrupt than a report indicates. Actual conditions in areas not sampled may differ from predictions. Nothing can be done to prevent the unanticipated, but steps can be taken to help minimize their impact. For this reason, most experienced owners retain their geotechnical consultants through the construction stage to identify variances, conduct additional tests which may be needed, and to recommend solutions to problems encountered on site.

Subsurface conditions may be modified by constantly changing natural forces. Because a geotechnical engineering report is based on conditions which existed at the time of subsurface exploration, construction decisions should not be based on a geotechnical engineering report whose adequacy may have been affected by time.

As stated earlier, Sunbelt Engineering & Testing, LLP performed the service described in this report to develop engineering information for the purposes defined in Section 1.B of this report, "Purpose and Scope". We did not intend to uncover nor identify any contaminated substances or materials that may be classified as hazardous or flammable substances. Identification of such substances requires specialized exploration techniques and analysis, which were not used in this exploration.

We recommend that a pre-construction meeting be held. The owner or the owner's representative, the civil engineer, the geotechnical consultant, and the contractor should be in attendance to discuss the plans, geotechnical report, and the project plans and specifications.

The recommendations provided in this report assume that Sunbelt Engineering & Testing, LLP will be retained as the geotechnical consultant during the construction phase of the project. It is understood and agreed that if Sunbelt Engineering & Testing, LLP does not provide observation and review of construction phase services, as related to the project's geotechnical aspects, then the OWNER assumes all responsibility for interpretation of the Geotechnical report and for construction observation or review and waives any claims against the Geotechnical Engineer that may be in any way connected with this report's usage. The Geotechnical Engineer shall be responsible for its professional opinions and interpretations provided during construction upon request by OWNER.

Sunbelt Engineering & Testing, LLP should be retained to provide the following:

- Review of site construction plans for conformance with the soil's investigations.
- Observation and testing during site preparation, grading, excavation and placement of fill, footing excavations, base section placement, and concrete placement.
- Consultation as may be required during construction.

APPENDIX A

EARTHWORK SPECIFICATIONS

APPENDIX A

GEOTECHNICAL ENGINEERING EXPLORATION PROPOSED NEW CLARIFIER SECTION 10 WASTE WATER TREATMENT PLANT LOCATED 901 RICHARDO AVE. BULLHEAD CITY, ARIZONA

A1.0 GENERAL

A1.1 Standard Specifications - Where referred to in these specifications, "Standard Specifications" shall mean the "Uniform Standard Specifications for Public Works' Construction, Maricopa Association of Governments" current edition.

A1.2 Scope - The work done under these specifications shall include clearing, stripping, removal of unsuitable materials, excavation, preparation of natural soils, placement and compaction of on-site and imported fill materials.

A1.3 Soils Engineer - The work covered by these specifications shall be inspected by a Soils Engineer. The Soils Engineer will be present during site preparation and grading operations to inspect the work and to perform the tests necessary to evaluate material quality and placement. The Soils Engineer shall submit a report to the Owner, including tabulation of all tests performed.

A1.4 Soils Report - A Geotechnical Engineering Exploration report for a proposed residential development prepared by **SUNBELT ENGINEERING & TESTING, LLP** is available for review and may be used as a reference to the surface and subsurface soil and groundwater conditions on this project. The Contractor shall make his own interpretation with regard to the methods and equipment necessary to perform excavation.

A1.5 Compaction Test Method - Where referred to herein, percent of compaction shall mean the in-place dry density of a soil expressed as a percentage of the Maximum Dry Density of that same soil as determined by the ASTM D-1557 Compaction Test method. Optimum moisture content shall mean the moisture content necessary to obtain the maximum dry density as determined above. Any approved ASTM method determining moisture and compaction may be used. Density tests shall be performed at a minimum of 1 test for each vertical foot of fill and for each approximately 5000 square feet of material placed.

A2.0 SITE PREPARATION

A2.1 Clearing - Areas to be graded shall be cleared of all brush, debris and loose material. These materials shall be removed from the site by the Contractor or stockpiled in a non-structural location designated by the Owner.

A2.2 Over excavation - Uncontrolled fill materials and native soils which are found to be soft, loose, collapsible, highly soluble and/or expansive and which underlie areas on the site where improvements are proposed, shall be over excavated as described in the soils report. After over excavation and before placing fill, the Contractor shall obtain the Soil Engineer's approval of over excavation and site preparation in each area.

A2.3 Dust Control - The contractor shall prevent and maintain control of all dust generated during construction in compliance with all federal, state, county, and city regulations. The project specification should include an indemnification by the contractor to the engineer and owner for all dust generated during the entire construction period.

A3.0 EXCAVATION & CONSTRUCTION CONSIDERATION

A3.1 Extent - Excavation shall be performed to the lines and grades indicated on the plans unless otherwise indicated by the soils report. Shallow excavations into the natural site soils should be possible with conventional excavating equipment but cemented soils (caliche) may require specialized excavation equipment, if encountered. Caving and raveling should be expected in open excavations. Excavations and utility trench excavations should be braced or sloped as required to provide personnel safety and satisfy local, state and Federal safety code regulations. The bracing should be done prior to excavation.

A3.2 Unsuitable Materials - All material not suitable for use in compacted fill, and all oversize rocks and boulders that cannot be incorporated into site grading by being placed in deep fill, embankments or used as rip-rap or for other purposes shall be removed from the site by the Contractor. The Soils Engineer shall determine the suitability of material for use as structural fill.

A4.0 SUBGRADE PREPARATION

A4.1 Ground Surface - The ground surface exposed by stripping and over-excavation shall be scarified to a depth of 12 inches (unless otherwise noted, such as pavement areas) moisture conditioned and compacted as required for engineered fill. Compaction shall be approved by the Soils Engineer prior to placing additional fill.

A5.0 STRUCTURAL FILL

A5.1 Materials - Imported fill materials shall consist of suitable moderately expansive soil. All materials used for structural fill shall be free of deleterious material, have a liquid limit less than 35, a plasticity index of less than 15, contain less than 0.1% soluble sodium sulfate salts, have less than 2% solubility, have no less than 20% passing the #200 sieve, and 100% pass a 3-inch sieve. Material not meeting the above requirements may be suitable for use as structural fill at the discretion of the Soils Engineer. Samples of imported material proposed for use as structural fill shall be submitted to the Soils Engineer for testing and approval before it is imported to the site.

A5.2 Placement - All fill materials shall be placed in layers 6 to 8 inches or less in loose thickness, properly and uniformly moisture conditioned, and compacted to at least 90 percent compaction, 95 percent in areas where the depth of structural fill is 5 feet or more. Fill placed on slopes of 5 horizontal to 1 vertical or steeper shall be keyed into firm, natural soil, rock or caliche by a series of benches. Keying can be performed simultaneously with placement of fill. The method and extent of keying shall be observed and approved by the Soils Engineer.

A5.3 Compaction Equipment - The Contractor shall provide and use equipment of a type and weight suitable for the conditions encountered in the field. The equipment shall be capable of obtaining the required percent of compaction in all areas including those that are inaccessible to ordinary rolling equipment.

A5.4 Reworking - When, in the judgement of the Soils Engineer, sufficient compaction effort has not been used, or where the field density tests indicate that the required compaction or moisture content has not been obtained, or if indications of instability are noted, fill materials shall be reworked and compacted to obtain the required density and moisture content prior to the placement of additional fill materials.

A6.0 UTILITY TRENCH BACKFILL

A6.1 Material - Material for use as bedding shall consist of either sand or aggregate base. Backfill in the remainder of the trench shall consist of material meeting the requirements for structural fill. The native material may be utilized as structural fill between the pipe zone and street section upon approval by the governing agency and compliance with the following recommendations:

1. Backfill should be placed in layers not exceeding 8 inches in thickness, moisture-conditioned and mechanically compacted, as required.
2. No jetting and/or ponding are permitted.
3. Full-time observation and testing will be required.

A6.2 Placement and Compaction - Pipe bedding and all backfill material within six inches of the pipe shall be placed in thin layers not exceeding eight inches in loose thickness and compacted to at least 90%. All other trench backfill shall be placed in layers not exceeding eight inches in loose thickness, moisture conditioned, and compacted as required for adjacent fill, or if this is not specified, to at least 90% compaction under structures, utilities, roadways, parking areas, and concrete flatwork. Backfill shall be placed to 90% compaction in undeveloped areas.

A7.0 SUBGRADE AND AGGREGATE BASE MATERIALS IN ROADWAY

A7.1 Subgrade Preparation - After completion of the utility trench backfill, over-excavation, and prior to the placement of aggregate base components, the upper 6 inches (12 inches when native is used in lieu of Type I aggregate base course) of non-cemented subgrade soil shall be moisture-conditioned and uniformly compacted to at least 90% or as noted in the soils report. This may require scarifying, moisture conditioning, and compaction in both cut and fill areas.

A7.2 Aggregate Base Rock - After the subgrade is properly prepared, aggregate base shall be placed in layers, properly moisture conditioned and compacted to at least 95% maximum dry density. Compacted thickness of aggregate base materials must be approved by the Soils Engineer prior to their incorporation into the pavement structure. In addition, aggregate materials shall meet the requirements of the appropriate section of the "Standard Specifications" for Type II Aggregate Base.

A7.3 Aggregate Sub-Base - Sub-base materials shall consist of materials meeting the requirements of the appropriate section of the "Standard Specifications" or otherwise approved by the soils engineer.

A8.0 ASPHALT CONCRETE PAVEMENT

A8.1 Material and Procedure - The asphalt concrete material and placement procedures shall conform to appropriate sections of the "Standard Specifications". The compacted thickness of the asphalt concrete shall be as shown on the plans. Aggregate materials for asphalt concrete shall conform to the appropriate sections of the "Standard Specifications". The Contractor shall submit a proposed asphalt-concrete mix design to the Soils Engineer for review and approval prior to paving. The mix design shall be based on the Marshall Method.

APPENDIX B

LABORATORY TESTING

LABORATORY TESTING

B.1 Atterberg Limits

Eighteen (18) Atterberg limits were performed in accordance with ASTM D-4318-93. The test is performed by placing a soil pat in a cup and making a standard-sized groove in the pat. The cup is then dropped onto a hard surface from a height of 10 mm. The liquid limit is defined as the water content when the groove closes on 12.7 mm at 25 blows. The lowest water content at which the soil is in a liquid state is called the liquid limit (LL). The lowest water content at which a soil is considered to be in a plastic state is the plastic limit (PL). The plastic limit is determined by rolling a pat of soil into a thread. When the thread begins to crumble at a diameter of 3.18 mm, the water content is the plastic limit. The difference between the liquid limit and the plastic limit is the plastic index (PI) and represents the range of water content over which the soil behaves in a plastic state. The results of these tests are shown in the figures.

B.2 Sieve Analysis

Eighteen (18) sieve analyses were performed in accordance with ASTM D-422-90. The sample was placed on the top of nest sieves (largest openings are on the top sieve with progressively smaller openings on lower sieves), and the nest of sieves was vibrated to allow the individual particles to fall through the sieve openings. The grain-size distribution (particle-size distribution) of the soil was then determined by measuring the dry weight of material retained on each sieve. The results of these tests are shown in the figures.

B.3 Moisture Content

Moisture contents were determined for selected samples. The samples were wet weight and then were oven-dried in accordance with ASTM D-2216-92. After drying, the weight of each sample was measured, and moisture content calculated. Moisture content values are presented in Table 5 below and on the boring logs.

B.4 Chemical Solubility Test Procedure Corrosivity

One (1) chemical solubility test was performed to determine the presence and concentrations of Sodium-Sulfate in soils proposed for engineering fill. Evaluation of such concentrations provides crucial information for determining possible soil corrosiveness to metal and concrete of the 2018 IBC. Veritas Laboratories, using EPA testing method 200.7 and SM 4500 E, performed all chemical solubility testing under contract.

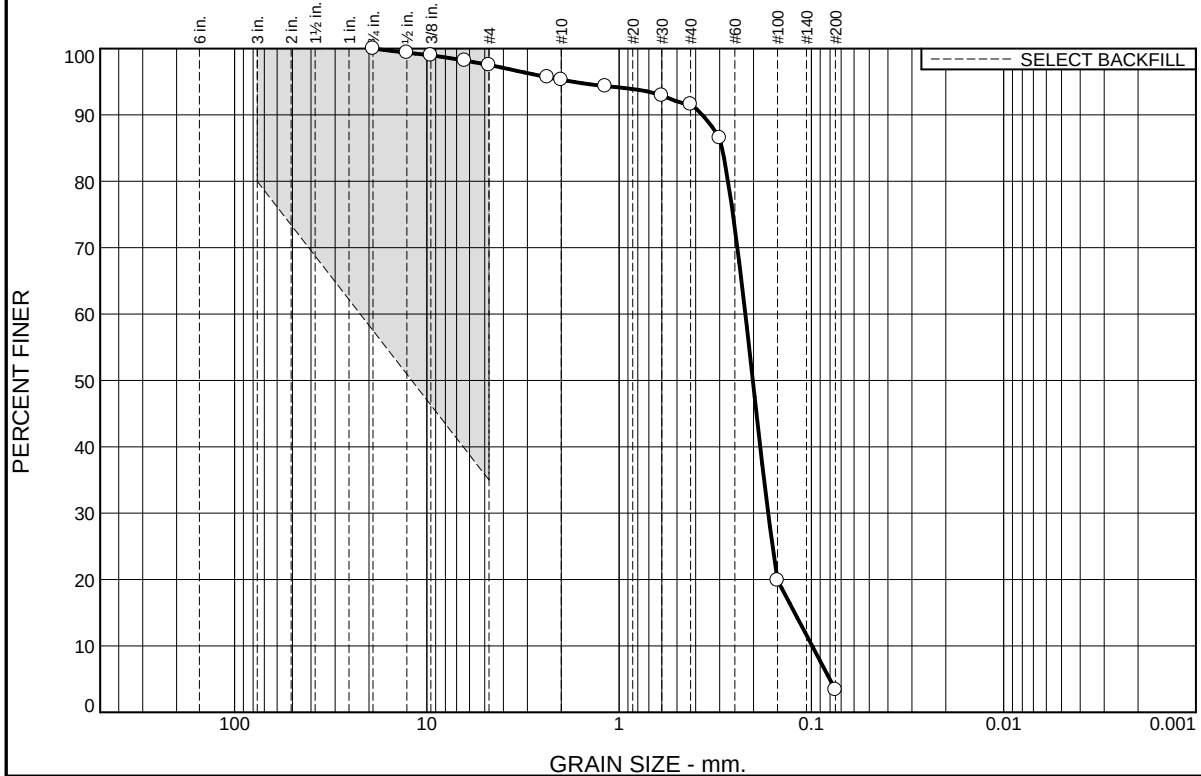
B.5 Laboratory Test Results

TABLE 5: Chemical Analysis

Performed by Veritas Laboratories An approved CCBD agency	SODIUM	SULFATE	SODIUM- SULFATE	SOLUBILITY	MOISTURE CONTENT
B-1 @ 2.5'-3.5'	0.0043	0.0073	0.011	0.024	2.3%

- A. Test Method Used – Sodium analyzed with method ASTM D2791, Sulfate was determined using SM 4500 SO₄ E, Sodium Sulfate was determined by way of calculations.
- B. Sample was obtained per ASTM D1587
- C. Sample location and moisture content – Please see Table 5 above
- D. Sample was obtained by Michael Vela
- E. For results of testing, please see Table 5 above

Particle Size Distribution Report



% +3"	% Gravel		% Sand			% Fines	
	Coarse	Fine	Coarse	Medium	Fine	Silt	Clay
0.0	0.0	2.5	2.2	3.7	88.2	3.4	

SIEVE SIZE	PERCENT FINER	SPEC.* PERCENT	PASS? (X=NO)
0.75	100.0		
0.5	99.4		
0.375	99.0		
0.25	98.2		
#4	97.5	35.0 - 100.0	
#8	95.7		
#10	95.3		
#16	94.3		
#30	92.9		
#40	91.6		
#50	86.5		
#100	19.9		
#200	3.4		

* SELECT BACKFILL

Material Description

Poorly Graded Sand

Atterberg Limits

PL= NP

LL= NV

PI= NP

Coefficients

D₉₀= 0.3687

D₈₅= 0.2916

D₆₀= 0.2205

D₅₀= 0.2017

D₃₀= 0.1678

D₁₅= 0.1222

D₁₀= 0.0990

C_u= 2.23

C_c= 1.29

Classification

USCS= SP

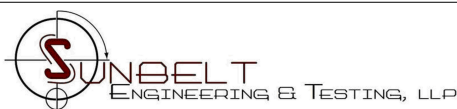
AASHTO= A-3

Remarks

Source of Sample: 1

Depth: 2.5

Date: 08/2025



Client: City of Bullhead
Project: Section 10 WTPP

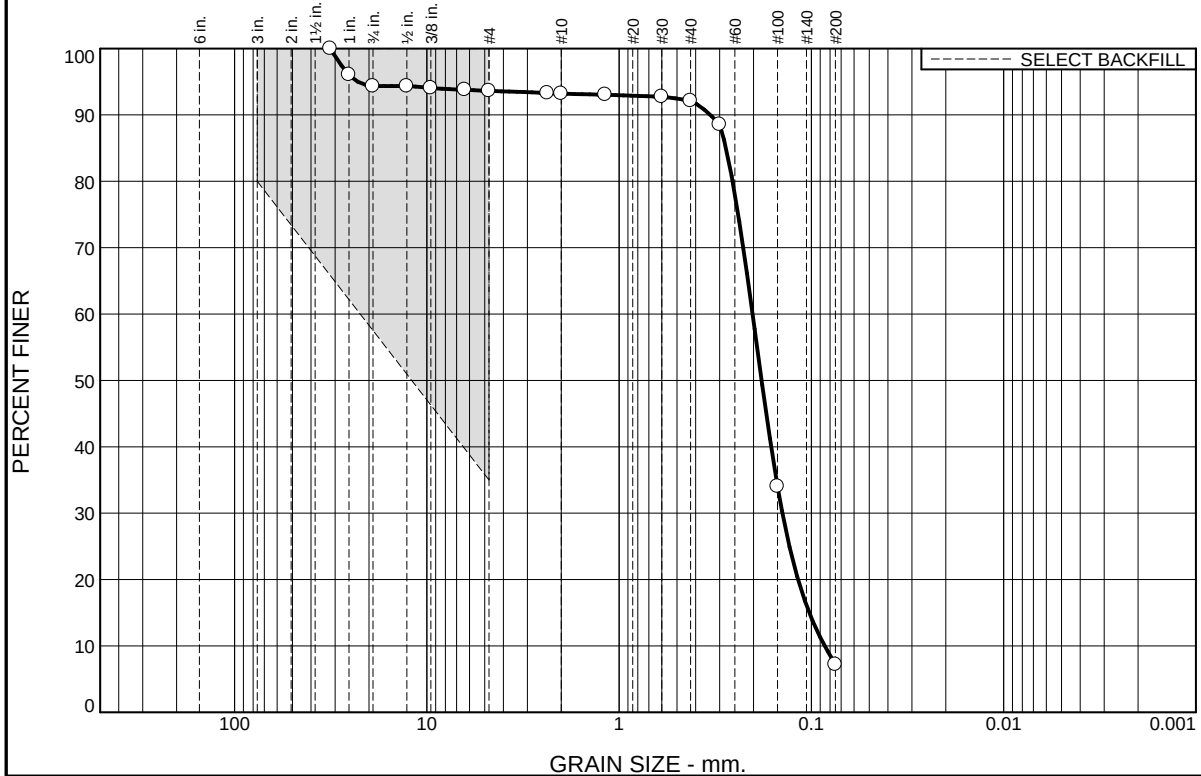
Project No: AZ25061

Figure 1

Tested By: TH

Checked By: JW

Particle Size Distribution Report



% +3"	% Gravel		% Sand			% Fines	
	Coarse	Fine	Coarse	Medium	Fine	Silt	Clay
0.0	5.7	0.7	0.4	1.1	84.9	7.2	

SIEVE SIZE	PERCENT FINER	SPEC.* PERCENT	PASS? (X=NO)
1.25	100.0		
1	96.0		
0.75	94.3		
0.5	94.3		
0.375	94.1		
0.25	93.8		
#4	93.6	35.0 - 100.0	
#8	93.3		
#10	93.2		
#16	93.0		
#30	92.7		
#40	92.1		
#50	88.5		
#100	34.0		
#200	7.2		

* SELECT BACKFILL

Material Description

Poorly Graded Sand with Silt

Atterberg Limits

PL= NP

LL= NV

PI= NP

Coefficients

D₉₀= 0.3349

D₈₅= 0.2781

D₆₀= 0.2023

D₅₀= 0.1815

D₃₀= 0.1415

D₁₅= 0.1025

D₁₀= 0.0852

C_u= 2.37

C_c= 1.16

Classification

USCS= SP-SM

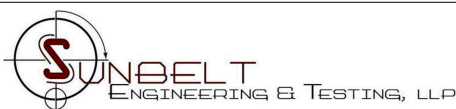
AASHTO= A-3

Remarks

Source of Sample: 1
Sample Number: 2

Depth: 5

Date: 08/2025



Client: City of Bullhead
Project: Section 10 WTPP

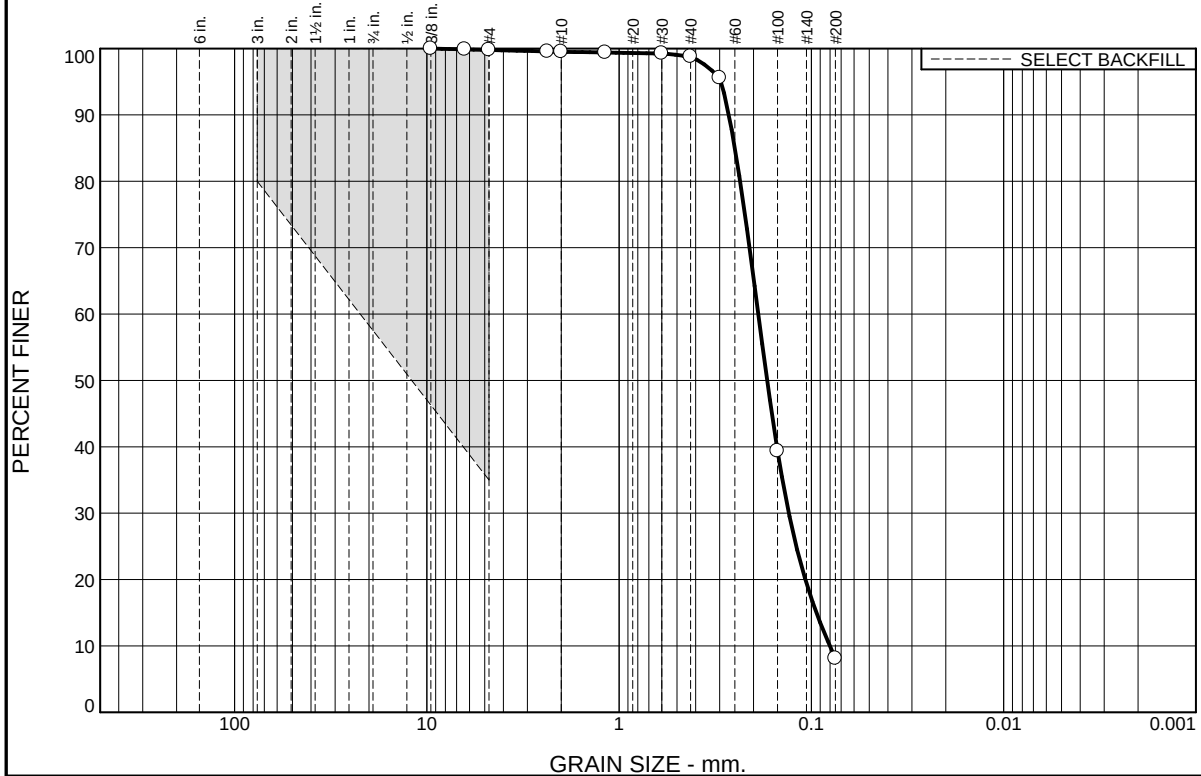
Project No: AZ25061

Figure 2

Tested By: TH

Checked By: JW

Particle Size Distribution Report



% +3"	% Gravel		% Sand			% Fines	
	Coarse	Fine	Coarse	Medium	Fine	Silt	Clay
0.0	0.0	0.2	0.3	0.7	90.7	8.1	

SIEVE SIZE	PERCENT FINER	SPEC.* PERCENT	PASS? (X=NO)
0.375	100.0	35.0 - 100.0	
0.25	99.9		
#4	99.8		
#8	99.6		
#10	99.5		
#16	99.4		
#30	99.3		
#40	98.8		
#50	95.6		
#100	39.4		
#200	8.1		

* SELECT BACKFILL

Material Description

Poorly Graded Sand with Silt

Atterberg Limits

PL= NP

LL= NV

PI= NP

Coefficients

D₉₀= 0.2686

D₈₅= 0.2499

D₆₀= 0.1889

D₅₀= 0.1698

D₃₀= 0.1310

D₁₅= 0.0941

D₁₀= 0.0801

C_u= 2.36

C_c= 1.13

Classification

USCS= SP-SM

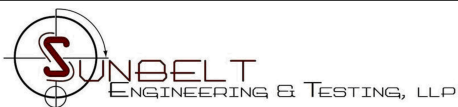
AASHTO= A-3

Remarks

Source of Sample: 1
Sample Number: 3

Depth: 10

Date: 08/2025



Client: City of Bullhead
Project: Section 10 WTPP

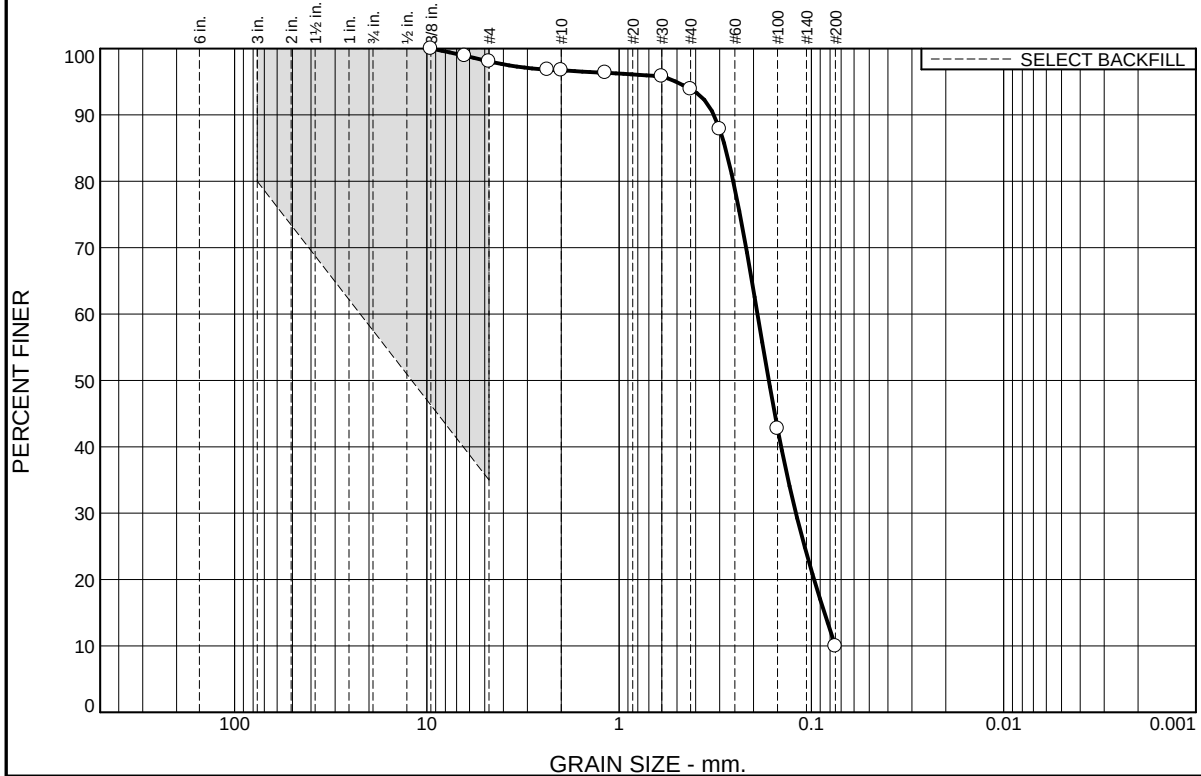
Project No: AZ25061

Figure 3

Tested By: TH

Checked By: JW

Particle Size Distribution Report



% +3"	% Gravel		% Sand			% Fines	
	Coarse	Fine	Coarse	Medium	Fine	Silt	Clay
0.0	0.0	1.9	1.4	2.8	83.9	10.0	

SIEVE SIZE	PERCENT FINER	SPEC.* PERCENT	PASS? (X=NO)
0.375	100.0	35.0 - 100.0	
0.25	98.9		
#4	98.1		
#8	96.8		
#10	96.7		
#16	96.4		
#30	95.8		
#40	93.9		
#50	87.9		
#100	42.8		
#200	10.0		

* SELECT BACKFILL

Material Description

Poorly Graded Sand with Silt

Atterberg Limits

PL= NP

LL= NV

PI= NP

Coefficients

D₉₀= 0.3211

D₈₅= 0.2801

D₆₀= 0.1907

D₅₀= 0.1666

D₃₀= 0.1203

D₁₅= 0.0855

D₁₀= 0.0751

C_u= 2.54

C_c= 1.01

Classification

USCS= SP-SM

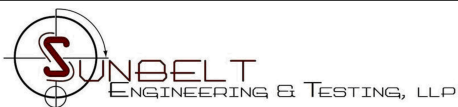
AASHTO= A-3

Remarks

Source of Sample: 1
Sample Number: 4

Depth: 15

Date: 08/2025NV



Client: City of Bullhead
Project: Section 10 WTPP

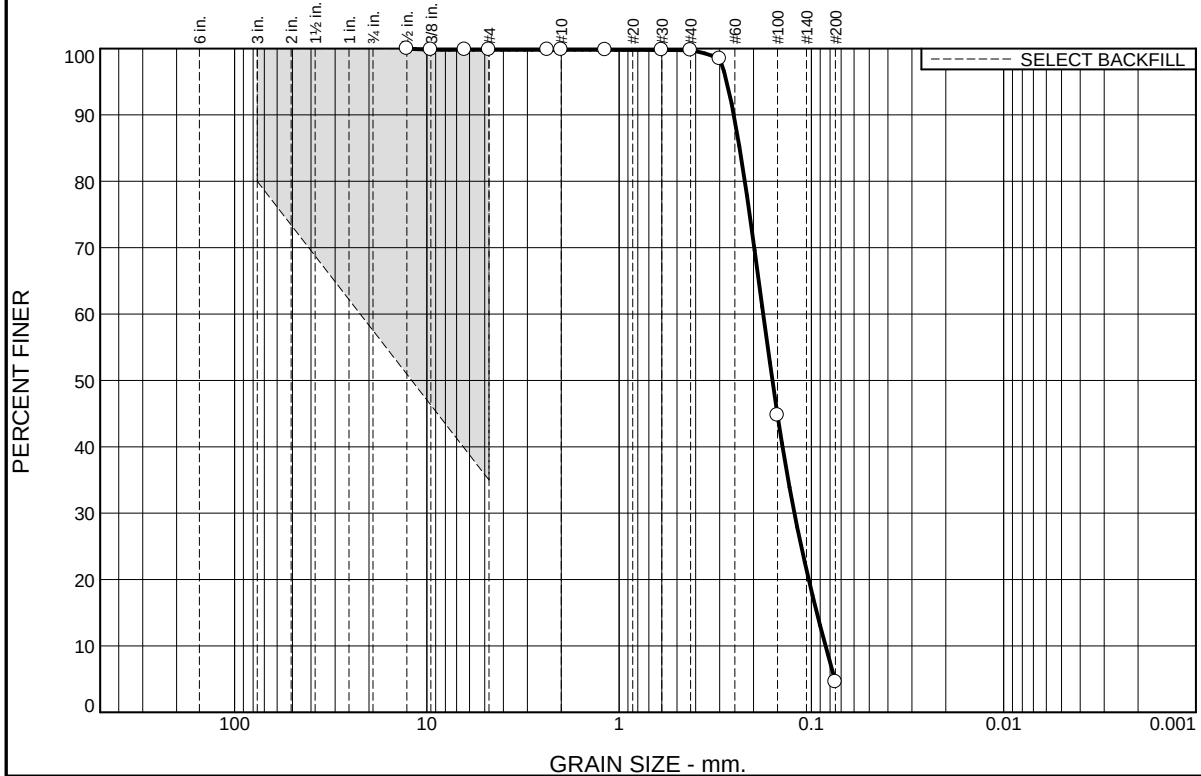
Project No: AZ25061

Figure 4

Tested By: TH

Checked By: JW

Particle Size Distribution Report



% +3"	% Gravel		% Sand			% Fines	
	Coarse	Fine	Coarse	Medium	Fine	Silt	Clay
0.0	0.0	0.2	0.0	0.1	95.1	4.6	

SIEVE SIZE	PERCENT FINER	SPEC.* PERCENT	PASS? (X=NO)
0.5	100.0	35.0 - 100.0	
0.375	99.8		
0.25	99.8		
#4	99.8		
#8	99.8		
#10	99.8		
#16	99.8		
#30	99.8		
#40	99.7		
#50	98.5		
#100	44.7		
#200	4.6		

* SELECT BACKFILL

Material Description

Poorly Graded Sand

PL= NP

Atterberg Limits

LL= NV

PI= NP

Coefficients

D₉₀= 0.2531

D₈₅= 0.2361

D₆₀= 0.1780

D₅₀= 0.1595

D₃₀= 0.1225

D₁₅= 0.0936

D₁₀= 0.0844

C_u= 2.11

C_c= 1.00

Classification

USCS= SP

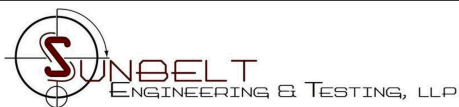
AASHTO= A-3

Remarks

Source of Sample: 1
Sample Number: 5

Depth: 20

Date: 08/2025



Client: City of Bullhead
Project: Section 10 WTPP

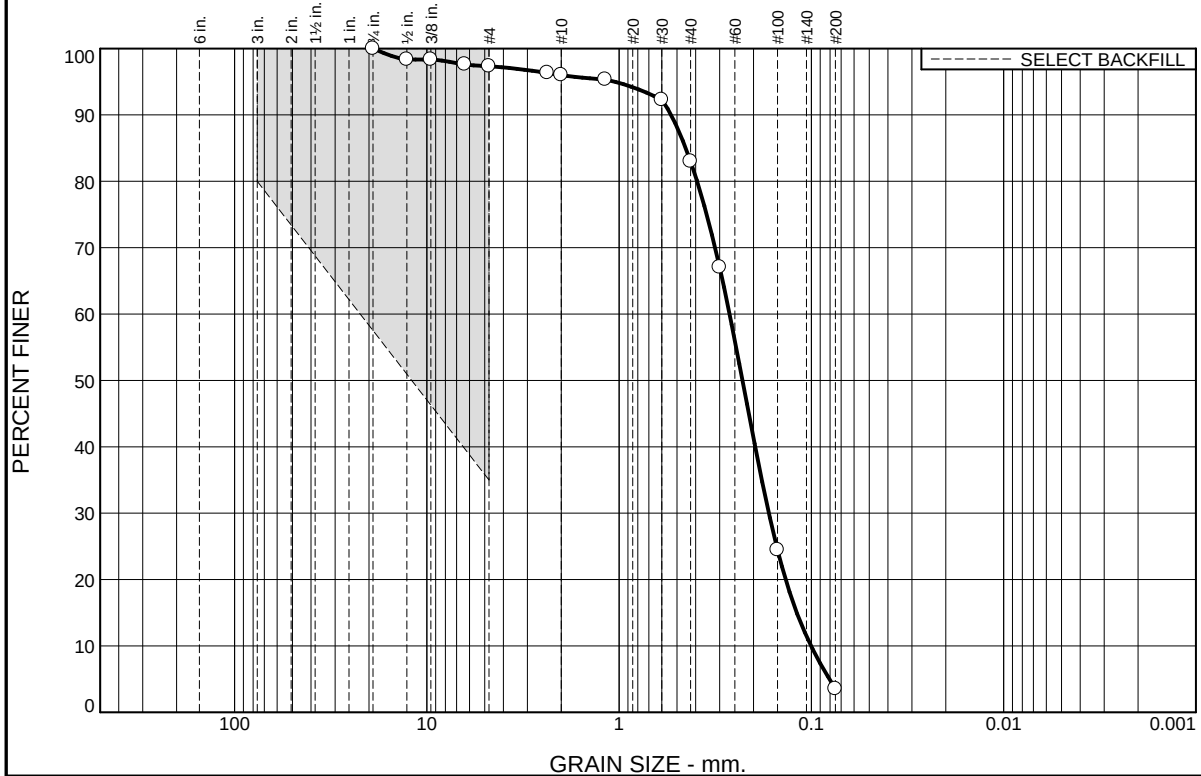
Project No: AZ25061

Figure 5

Tested By: TH

Checked By: JW

Particle Size Distribution Report



% +3"	% Gravel		% Sand			% Fines	
	Coarse	Fine	Coarse	Medium	Fine	Silt	Clay
0.0	0.0	2.7	1.3	13.0	79.5	3.5	

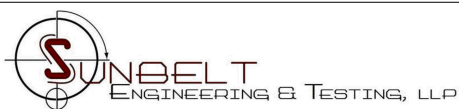
SIEVE SIZE	PERCENT FINER	SPEC.* PERCENT	PASS? (X=NO)
0.75	100.0		
0.5	98.4		
0.375	98.4		
0.25	97.6		
#4	97.3	35.0 - 100.0	
#8	96.3		
#10	96.0		
#16	95.3		
#30	92.3		
#40	83.0		
#50	67.0		
#100	24.5		
#200	3.5		

* SELECT BACKFILL

<u>Material Description</u>		
Poorly Graded Sand		
<u>Atterberg Limits</u>		
PL= NP	LL= NV	PI= NP
<u>Coefficients</u>		
D ₉₀ = 0.5366	D ₈₅ = 0.4504	D ₆₀ = 0.2665
D ₅₀ = 0.2282	D ₃₀ = 0.1664	D ₁₅ = 0.1191
D ₁₀ = 0.1004	C _u = 2.66	C _c = 1.04
<u>Classification</u>		
USCS= SP	AASHTO= A-3	
<u>Remarks</u>		

Source of Sample: 1 Depth: 25
Sample Number: 6

Date: 08/2025



Client: City of Bullhead
Project: Section 10 WTPP

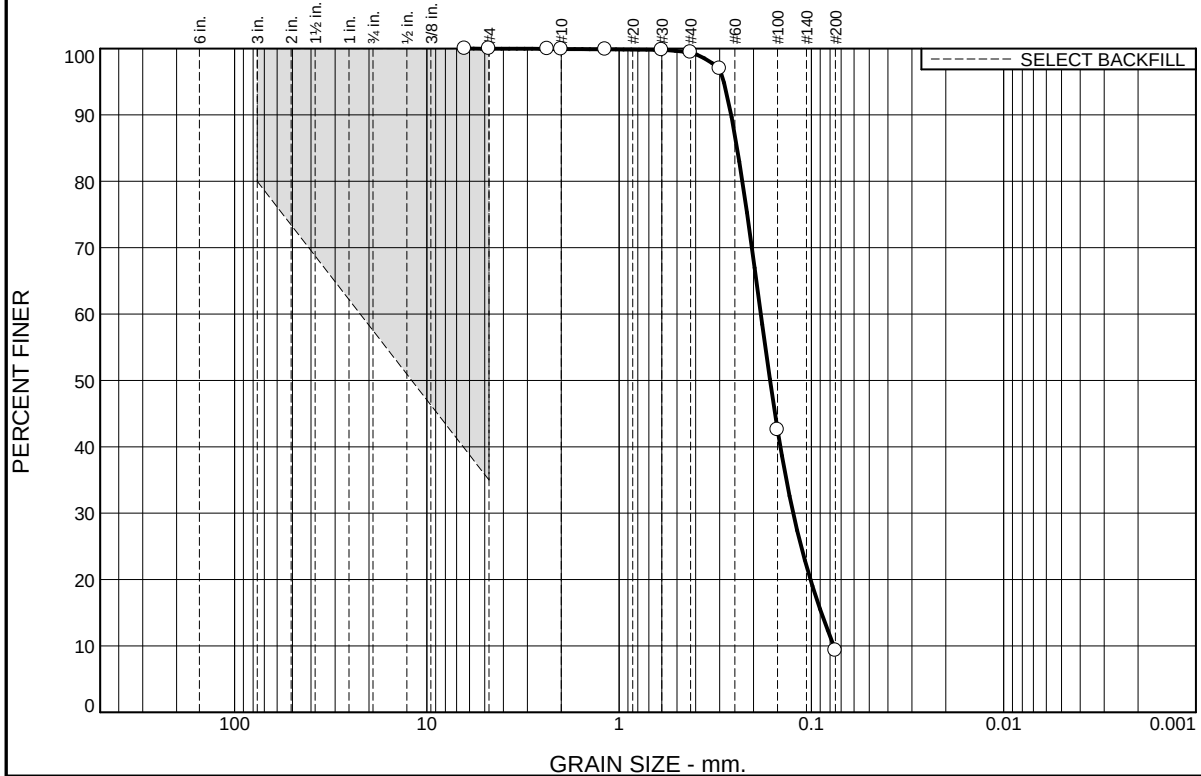
Project No: AZ25061

Figure 6

Tested By: TH

Checked By: JW

Particle Size Distribution Report



% +3"	% Gravel		% Sand			% Fines	
	Coarse	Fine	Coarse	Medium	Fine	Silt	Clay
0.0	0.0	0.0	0.1	0.5	90.1	9.3	

SIEVE SIZE	PERCENT FINER	SPEC.* PERCENT	PASS? (X=NO)
0.25	100.0	35.0 - 100.0	
#4	100.0		
#8	100.0		
#10	99.9		
#16	99.9		
#30	99.8		
#40	99.4		
#50	97.0		
#100	42.6		
#200	9.3		

* SELECT BACKFILL

Material Description

Poorly Graded Sand with Silt

Atterberg Limits

PL= NP

LL= NV

PI= NP

Coefficients

D₉₀= 0.2612

D₈₅= 0.2433

D₆₀= 0.1832

D₅₀= 0.1641

D₃₀= 0.1243

D₁₅= 0.0887

D₁₀= 0.0765

C_u= 2.39

C_c= 1.10

Classification

USCS= SP-SM

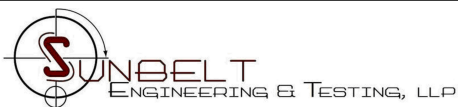
AASHTO= A-3

Remarks

Source of Sample: 2
Sample Number: 1

Depth: 2.5

Date: 08/2025



Client: City of Bullhead
Project: Section 10 WTPP

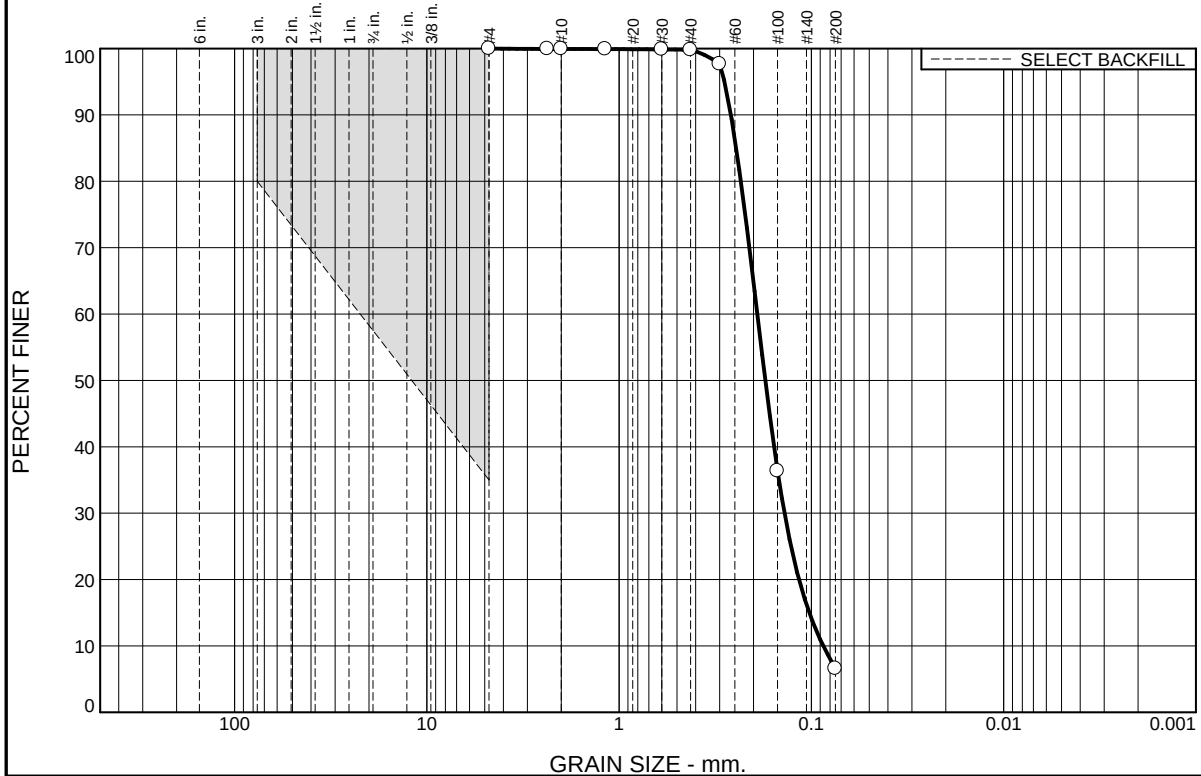
Project No: AZ25061

Figure 7

Tested By: TH

Checked By: JW

Particle Size Distribution Report



% +3"	% Gravel		% Sand			% Fines	
	Coarse	Fine	Coarse	Medium	Fine	Silt	Clay
0.0	0.0	0.0	0.1	0.1	93.2	6.6	

SIEVE SIZE	PERCENT FINER	SPEC.* PERCENT	PASS? (X=NO)
#4	100.0	35.0 - 100.0	
#8	99.9		
#10	99.9		
#16	99.9		
#30	99.9		
#40	99.8		
#50	97.7		
#100	36.4		
#200	6.6		

* SELECT BACKFILL

Material Description

Poorly Graded Sand with Silt

Atterberg Limits

PL= NP

LL= NV

PI= NP

Coefficients

D₉₀= 0.2621

D₈₅= 0.2460

D₆₀= 0.1911

D₅₀= 0.1735

D₃₀= 0.1380

D₁₅= 0.1025

D₁₀= 0.0866

C_u= 2.21

C_c= 1.15

Classification

USCS= SP-SM

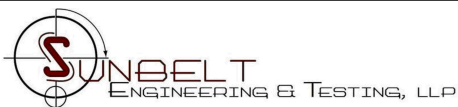
AASHTO= A-3

Remarks

Source of Sample: 2
Sample Number: 2

Depth: 5

Date: 08/2025



Client: City of Bullhead
Project: Section 10 WTPP

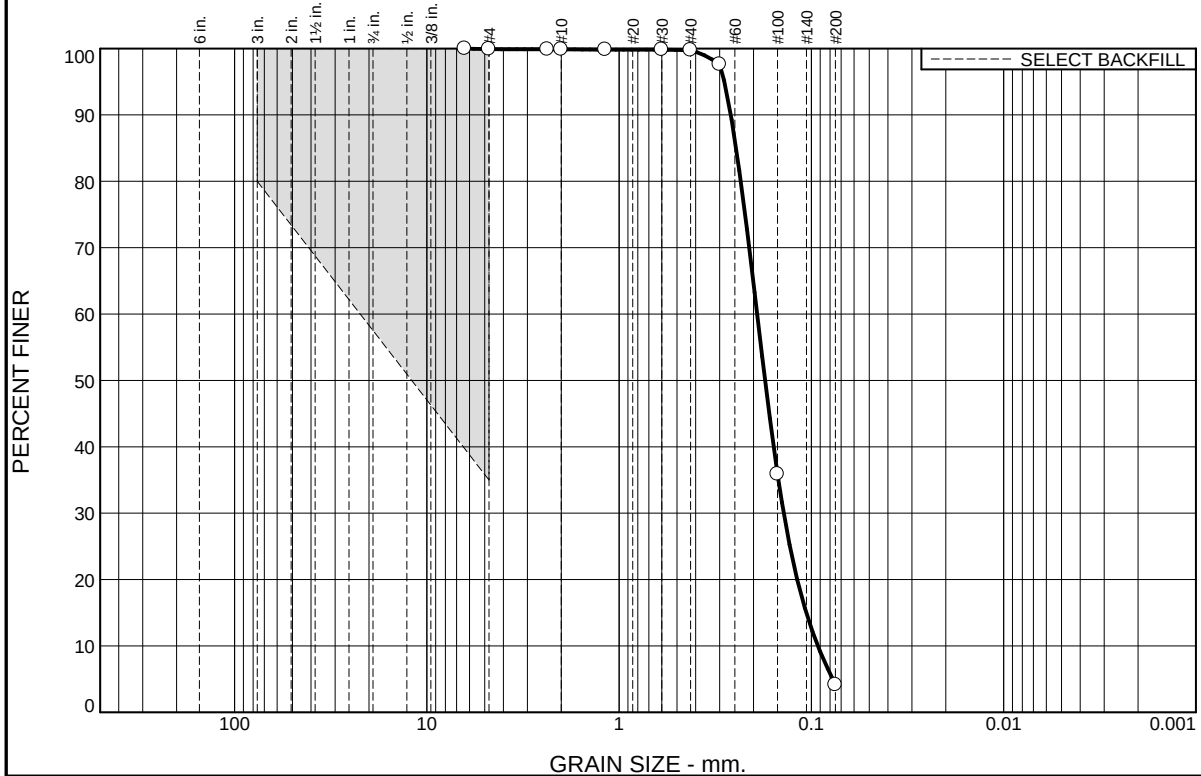
Project No: AZ25061

Figure 8

Tested By: TH

Checked By: JW

Particle Size Distribution Report



% +3"	% Gravel		% Sand			% Fines	
	Coarse	Fine	Coarse	Medium	Fine	Silt	Clay
0.0	0.0	0.1	0.0	0.2	95.5	4.2	

SIEVE SIZE	PERCENT FINER	SPEC.* PERCENT	PASS? (X=NO)
0.25	100.0	35.0 - 100.0	
#4	99.9		
#8	99.9		
#10	99.9		
#16	99.8		
#30	99.8		
#40	99.7		
#50	97.6		
#100	35.9		
#200	4.2		

* SELECT BACKFILL

Material Description

Poorly Graded Sand

Atterberg Limits

PL= NP

LL= NV

PI= NP

Coefficients

D₉₀= 0.2624

D₈₅= 0.2463

D₆₀= 0.1915

D₅₀= 0.1740

D₃₀= 0.1393

D₁₅= 0.1063

D₁₀= 0.0925

C_u= 2.07

C_c= 1.10

Classification

USCS= SP

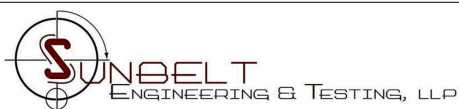
AASHTO= A-3

Remarks

Source of Sample: 2
Sample Number: 3

Depth: 10

Date: 08/2025



Client: City of Bullhead
Project: Section 10 WTPP

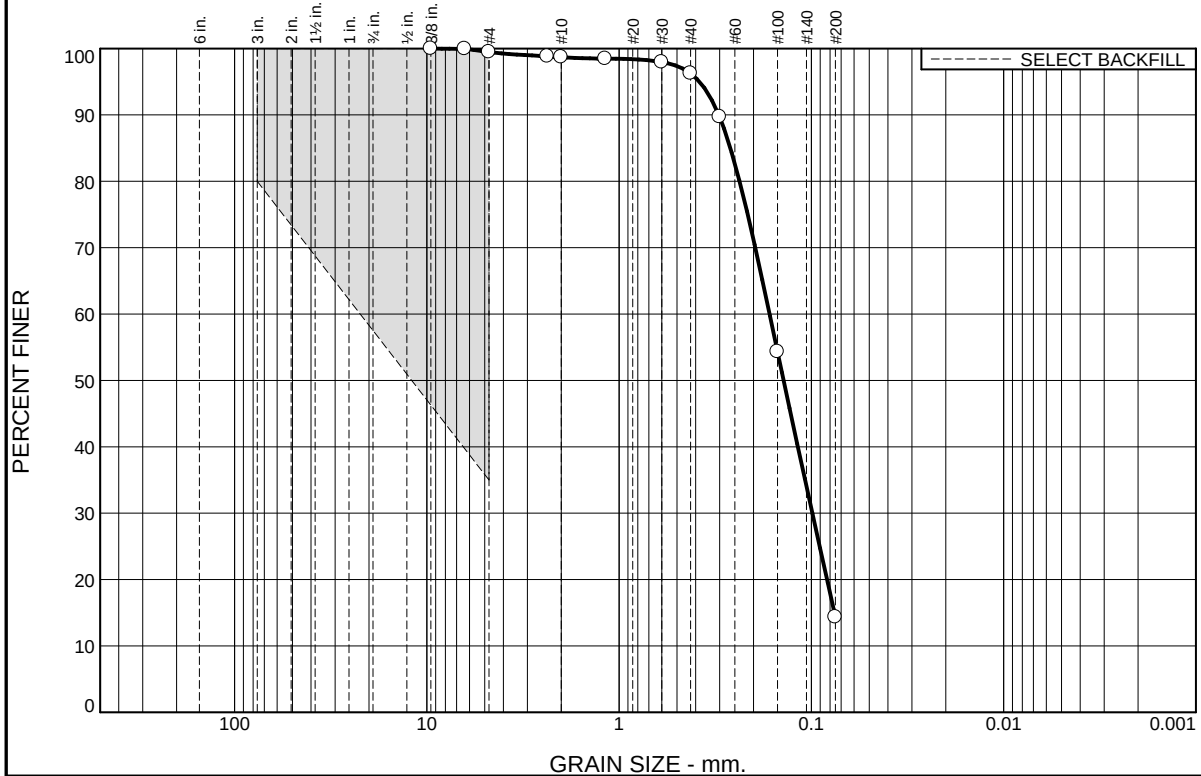
Project No: AZ25061

Figure 9

Tested By: TH

Checked By: JW

Particle Size Distribution Report



% +3"	% Gravel		% Sand			% Fines	
	Coarse	Fine	Coarse	Medium	Fine	Silt	Clay
0.0	0.0	0.5	0.8	2.5	81.9	14.3	

SIEVE SIZE	PERCENT FINER	SPEC.* PERCENT	PASS? (X=NO)
0.375	100.0	35.0 - 100.0	
0.25	99.9		
#4	99.5		
#8	98.8		
#10	98.7		
#16	98.5		
#30	98.0		
#40	96.2		
#50	89.7		
#100	54.3		
#200	14.3		

* SELECT BACKFILL

Material Description

Silty Sand

Atterberg Limits

PL= NP

LL= NV

PI= NP

Coefficients

D₉₀= 0.3030

D₈₅= 0.2639

D₆₀= 0.1650

D₅₀= 0.1395

D₃₀= 0.0988

D₁₅= 0.0759

D₁₀=

C_u=

C_c=

Classification

USCS= SM

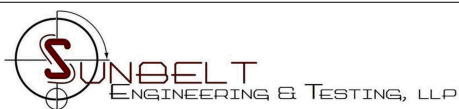
AASHTO= A-2-4(0)

Remarks

Source of Sample: 2
Sample Number: 4

Depth: 15

Date: 08/2025



Client: City of Bullhead
Project: Section 10 WTPP

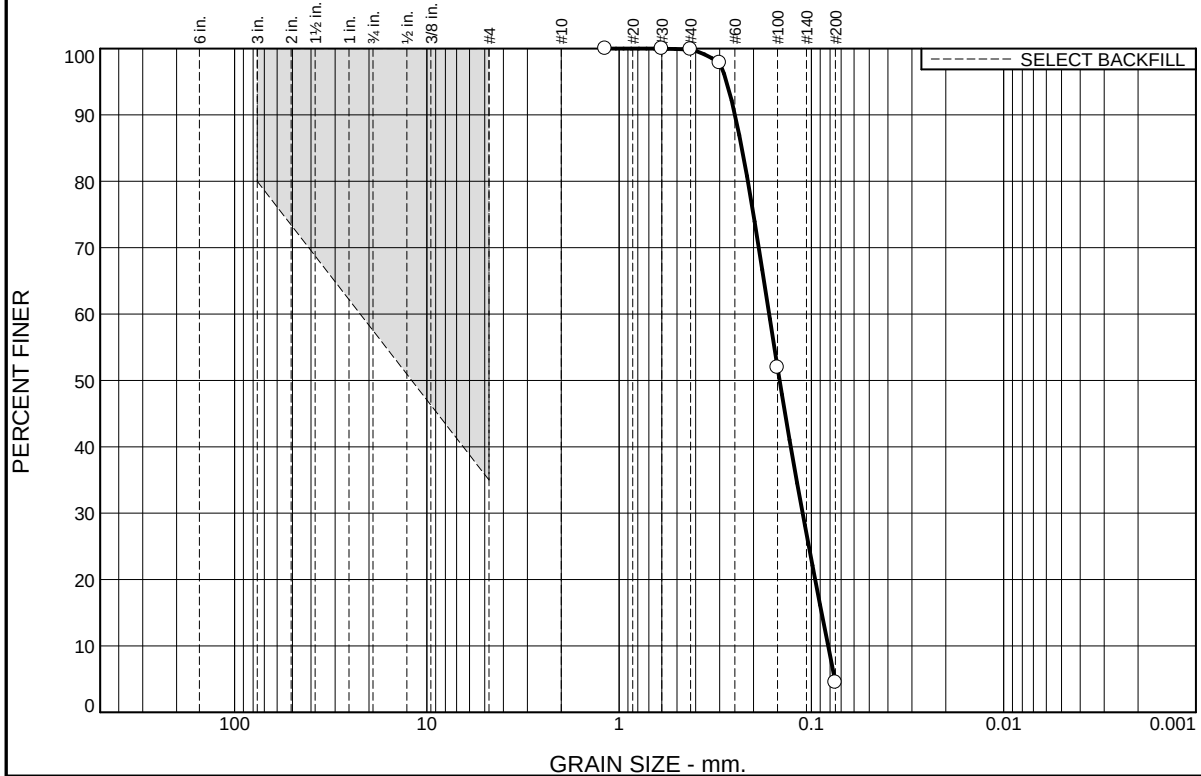
Project No: AZ25061

Figure 10

Tested By: TH

Checked By: JW

Particle Size Distribution Report



% +3"	% Gravel		% Sand			% Fines	
	Coarse	Fine	Coarse	Medium	Fine	Silt	Clay
0.0	0.0	0.0	0.0	0.1	95.4	4.5	

SIEVE SIZE	PERCENT FINER	SPEC.* PERCENT	PASS? (X=NO)
#16	100.0		
#30	100.0		
#40	99.9		
#50	97.8		
#100	51.9		
#200	4.5		

* SELECT BACKFILL

Material Description

Poorly Graded Sand

Atterberg Limits

PL= NP

LL= NV

PI= NP

Coefficients

D₉₀= 0.2495

D₈₅= 0.2300

D₆₀= 0.1659

D₅₀= 0.1463

D₃₀= 0.1110

D₁₅= 0.0884

D₁₀= 0.0818

C_u= 2.03

C_c= 0.91

Classification

USCS= SP

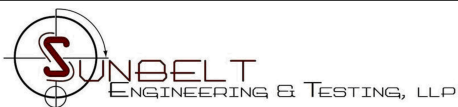
AASHTO= A-3

Remarks

Source of Sample: 2
Sample Number: 5

Depth: 20

Date: 08/2025



Client: City of Bullhead
Project: Section 10 WTPP

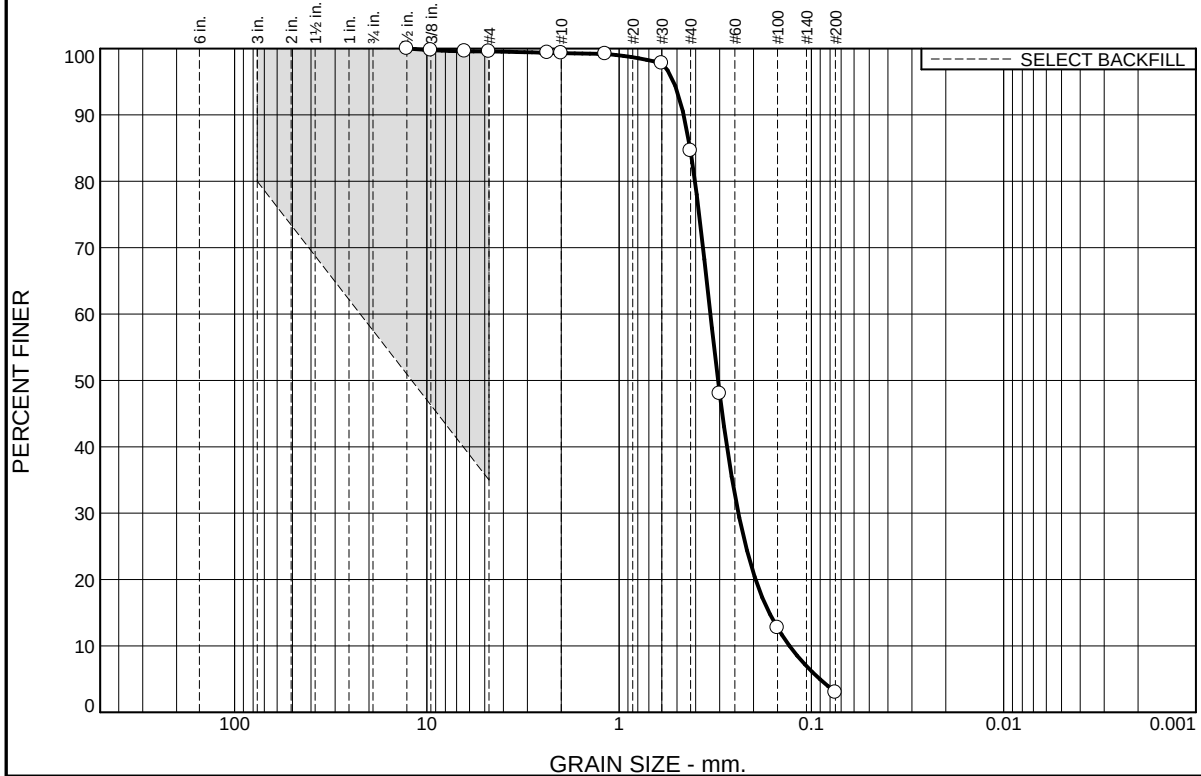
Project No: AZ25061

Figure 11

Tested By: TH

Checked By: JW

Particle Size Distribution Report



% +3"	% Gravel		% Sand			% Fines	
	Coarse	Fine	Coarse	Medium	Fine	Silt	Clay
0.0	0.0	0.4	0.3	14.7	81.6	3.0	

SIEVE SIZE	PERCENT FINER	SPEC.* PERCENT	PASS? (X=NO)
0.5	100.0		
0.375	99.8		
0.25	99.6		
#4	99.6	35.0 - 100.0	
#8	99.4		
#10	99.3		
#16	99.2		
#30	97.8		
#40	84.6		
#50	48.0		
#100	12.7		
#200	3.0		

* SELECT BACKFILL

Material Description

Poorly Graded Sand

Atterberg Limits

PL= NP

LL= NV

PI= NP

Coefficients

D₉₀= 0.4610

D₈₅= 0.4272

D₆₀= 0.3350

D₅₀= 0.3059

D₃₀= 0.2396

D₁₅= 0.1657

D₁₀= 0.1299

C_u= 2.58

C_c= 1.32

Classification

USCS= SP

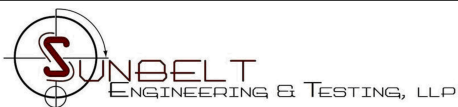
AASHTO= A-3

Remarks

Source of Sample: 2
Sample Number: 6

Depth: 25

Date: 08/2025



Client: City of Bullhead
Project: Section 10 WTPP

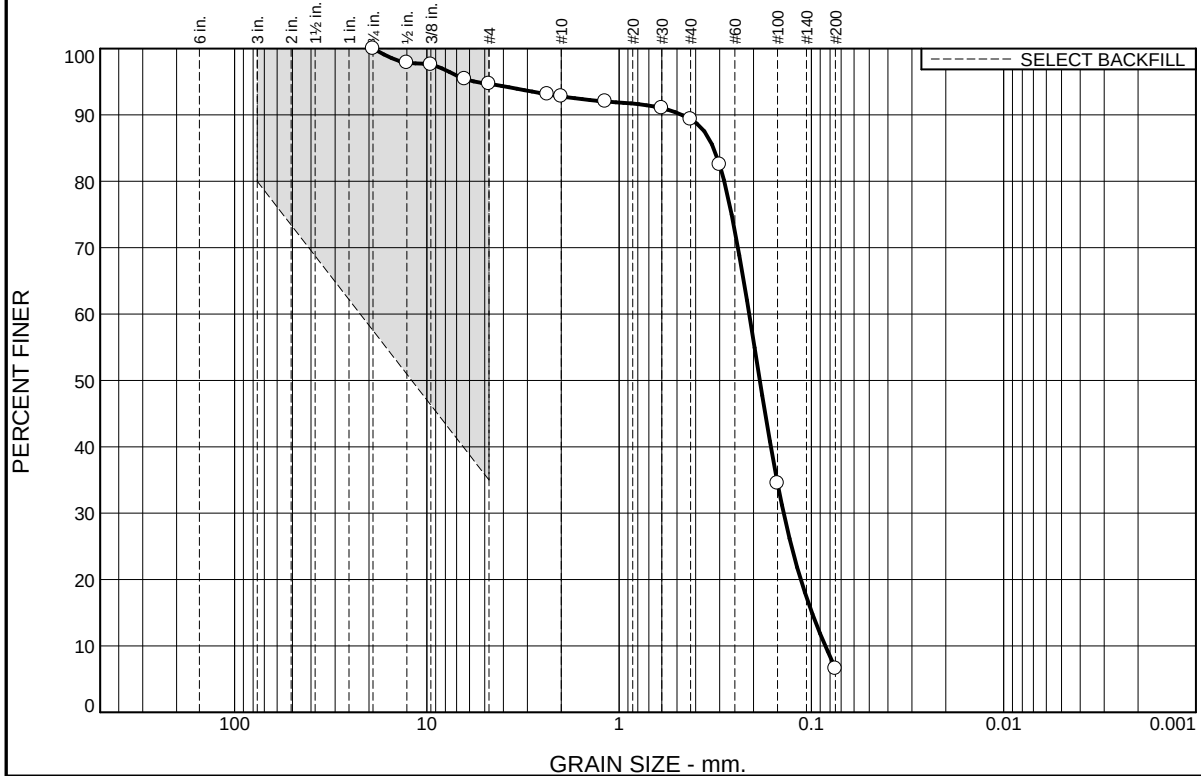
Project No: AZ25061

Figure 12

Tested By: TH

Checked By: JW

Particle Size Distribution Report



% +3"	% Gravel		% Sand			% Fines	
	Coarse	Fine	Coarse	Medium	Fine	Silt	Clay
0.0	0.0	5.3	1.9	3.5	82.7	6.6	

SIEVE SIZE	PERCENT FINER	SPEC.* PERCENT	PASS? (X=NO)
0.75	100.0	35.0 - 100.0	
0.5	97.9		
0.375	97.6		
0.25	95.4		
#4	94.7		
#8	93.1		
#10	92.8		
#16	92.0		
#30	91.0		
#40	89.3		
#50	82.5		
#100	34.5		
#200	6.6		

* SELECT BACKFILL

Material Description

Poorly Graded Sand with Silt

Atterberg Limits

PL= NP

LL= NV

PI= NP

Coefficients

D₉₀= 0.4709

D₈₅= 0.3221

D₆₀= 0.2106

D₅₀= 0.1854

D₃₀= 0.1394

D₁₅= 0.0993

D₁₀= 0.0846

C_u= 2.49

C_c= 1.09

Classification

USCS= SP-SM

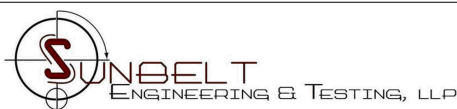
AASHTO= A-3

Remarks

Source of Sample: 3
Sample Number: 1

Depth: 2.5

Date: 08/2025



Client: City of Bullhead
Project: Section 10 WTPP

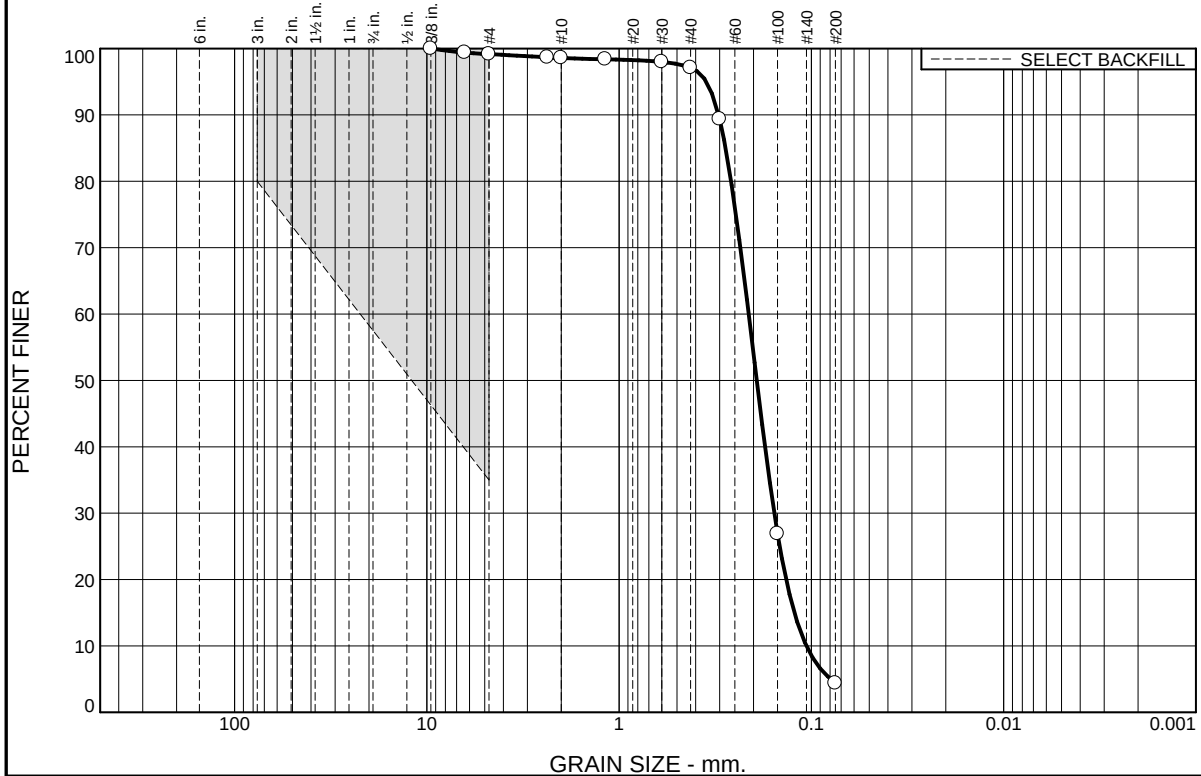
Project No: AZ25061

Figure 13

Tested By: TH

Checked By: JW

Particle Size Distribution Report



% +3"	% Gravel		% Sand			% Fines	
	Coarse	Fine	Coarse	Medium	Fine	Silt	Clay
0.0	0.0	0.8	0.6	1.5	92.7	4.4	

SIEVE SIZE	PERCENT FINER	SPEC.* PERCENT	PASS? (X=NO)
0.375	100.0		
0.25	99.4		
#4	99.2	35.0 - 100.0	
#8	98.7		
#10	98.6		
#16	98.4		
#30	98.0		
#40	97.1		
#50	89.4		
#100	26.9		
#200	4.4		

* SELECT BACKFILL

Material Description

Poorly Graded Sand

Atterberg Limits

PL= NP

LL= NV

PI= NP

Coefficients

D₉₀= 0.3037

D₈₅= 0.2794

D₆₀= 0.2119

D₅₀= 0.1924

D₃₀= 0.1560

D₁₅= 0.1225

D₁₀= 0.1061

C_u= 2.00

C_c= 1.08

Classification

USCS= SP

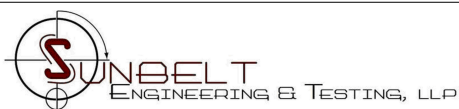
AASHTO= A-3

Remarks

Source of Sample: 3
Sample Number: 2

Depth: 5

Date: 08/2025



Client: City of Bullhead
Project: Section 10 WTPP

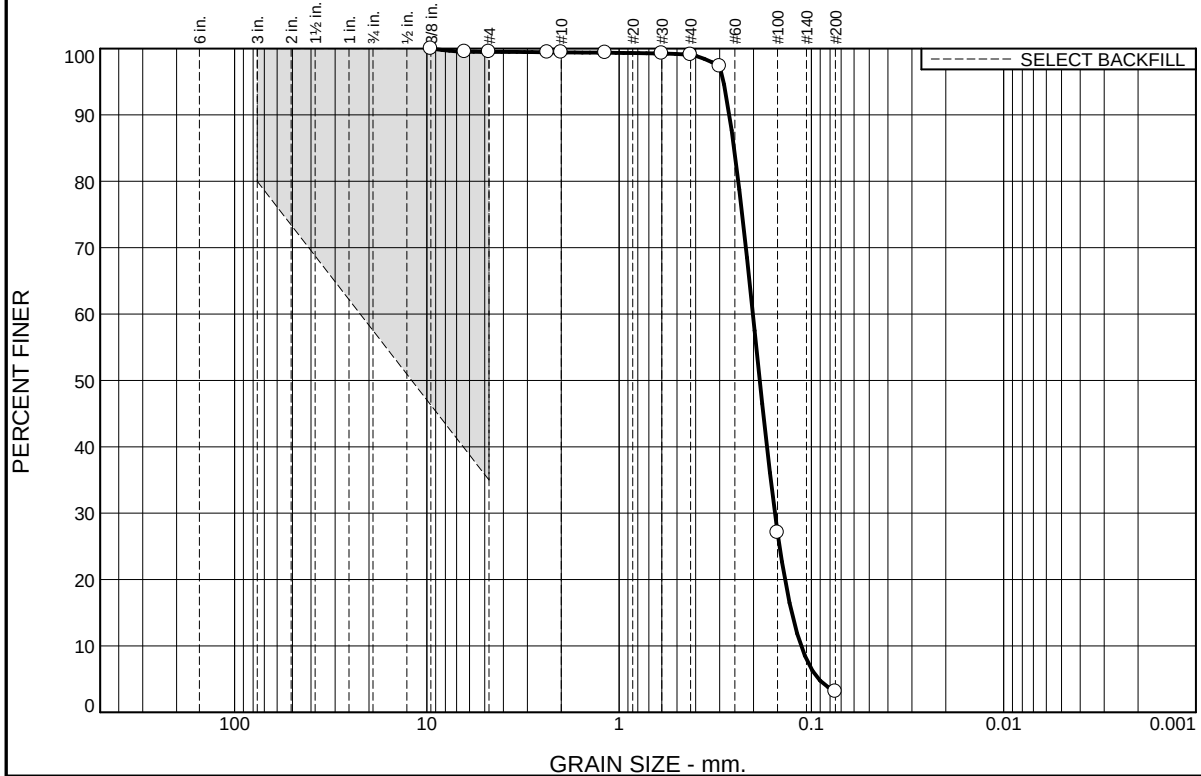
Project No: AZ25061

Figure 14

Tested By: TH

Checked By: JW

Particle Size Distribution Report



% +3"	% Gravel		% Sand			% Fines	
	Coarse	Fine	Coarse	Medium	Fine	Silt	Clay
0.0	0.0	0.5	0.1	0.3	96.0	3.1	

SIEVE SIZE	PERCENT FINER	SPEC.* PERCENT	PASS? (X=NO)
0.375	100.0	35.0 - 100.0	
0.25	99.5		
#4	99.5		
#8	99.4		
#10	99.4		
#16	99.4		
#30	99.3		
#40	99.1		
#50	97.3		
#100	27.1		
#200	3.1		

* SELECT BACKFILL

Material Description

Poorly Graded Sand

Atterberg Limits

PL= NP

LL= NV

PI= NP

Coefficients

D₉₀= 0.2670

D₈₅= 0.2522

D₆₀= 0.2015

D₅₀= 0.1855

D₃₀= 0.1548

D₁₅= 0.1265

D₁₀= 0.1131

C_u= 1.78

C_c= 1.05

Classification

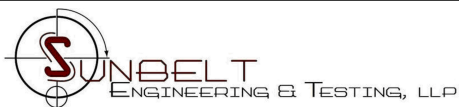
USCS= SP

AASHTO= A-3

Remarks

Source of Sample: 3 Depth: 10
Sample Number: 3

Date: 08/2025



Client: City of Bullhead
Project: Section 10 WTPP

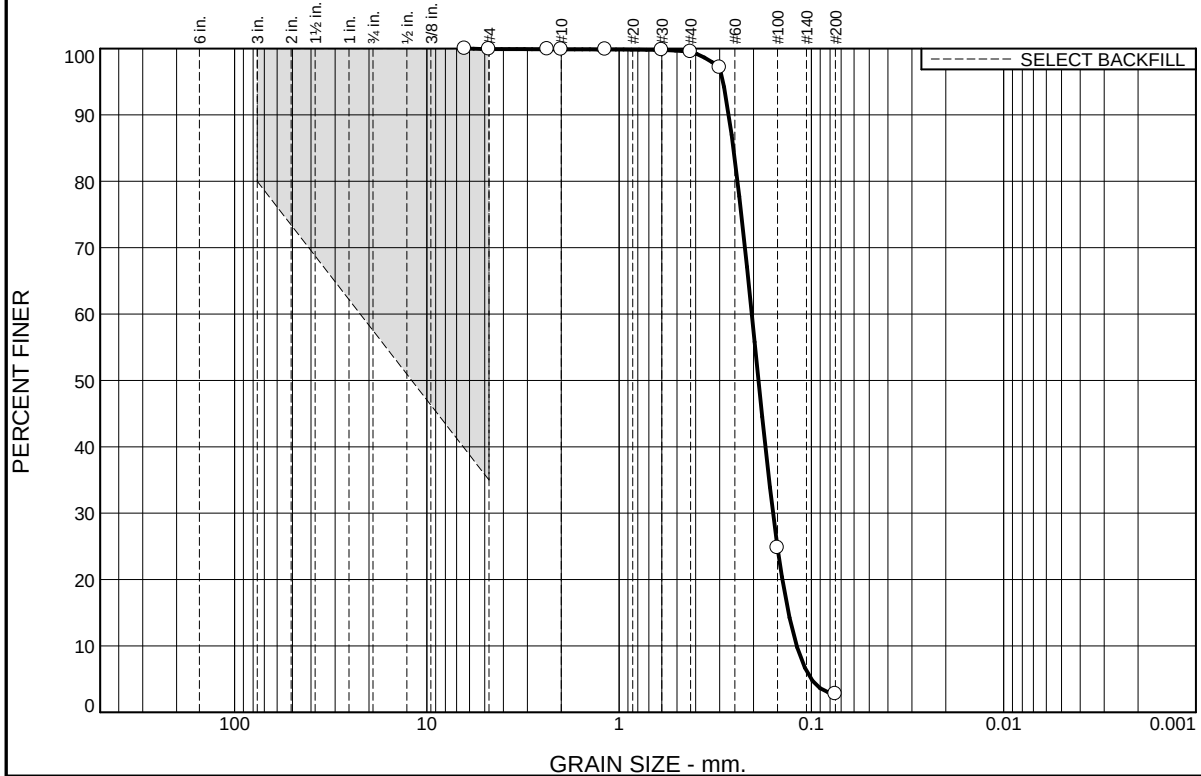
Project No: AZ25061

Figure 15

Tested By: TH

Checked By: JW

Particle Size Distribution Report



% +3"	% Gravel		% Sand			% Fines	
	Coarse	Fine	Coarse	Medium	Fine	Silt	Clay
0.0	0.0	0.1	0.0	0.4	96.7	2.8	

SIEVE SIZE	PERCENT FINER	SPEC.* PERCENT	PASS? (X=NO)
0.25	100.0	35.0 - 100.0	
#4	99.9		
#8	99.9		
#10	99.9		
#16	99.9		
#30	99.8		
#40	99.5		
#50	97.1		
#100	24.8		
#200	2.8		

* SELECT BACKFILL

Material Description

Poorly Graded Sand

Atterberg Limits

PL= NP

LL= NV

PI= NP

Coefficients

D₉₀= 0.2689

D₈₅= 0.2543

D₆₀= 0.2042

D₅₀= 0.1884

D₃₀= 0.1584

D₁₅= 0.1315

D₁₀= 0.1191

C_u= 1.71

C_c= 1.03

Classification

USCS= SP

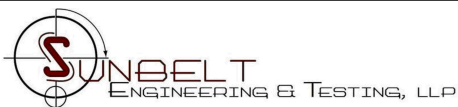
AASHTO= A-3

Remarks

Source of Sample: 3
Sample Number: 4

Depth: 15

Date: 08/2025



Client: City of Bullhead
Project: Section 10 WTPP

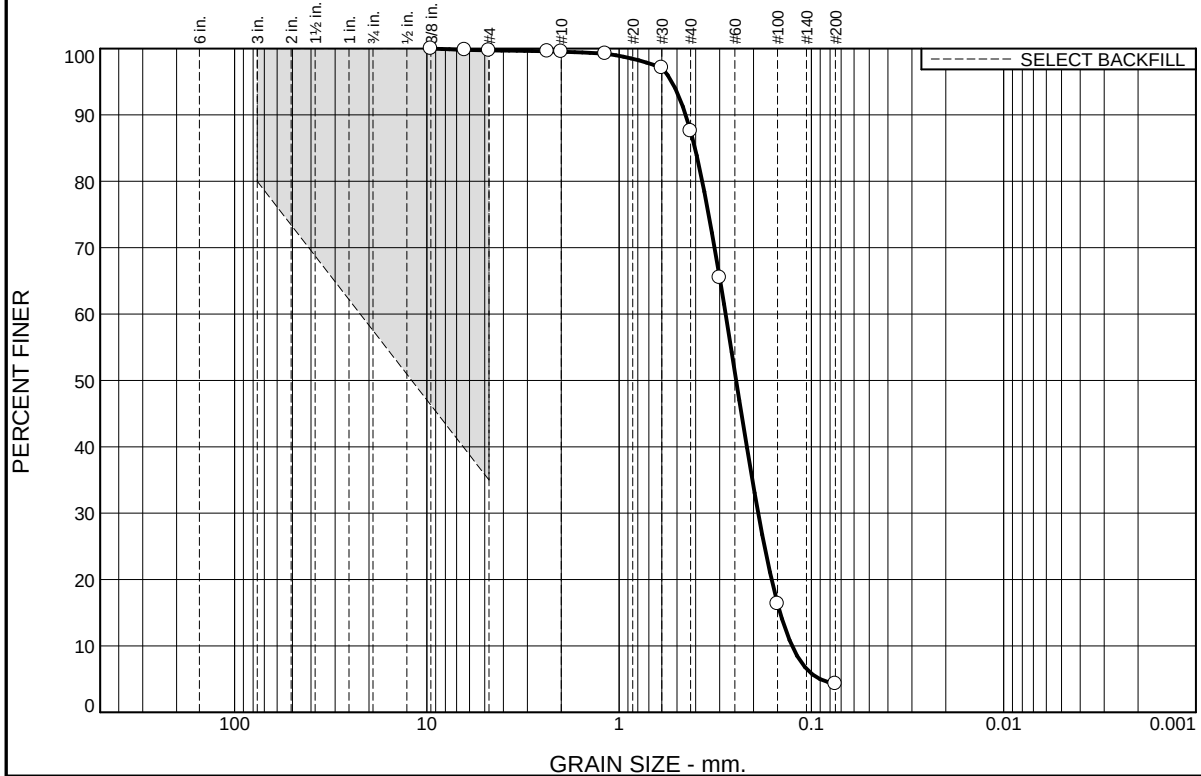
Project No: AZ25061

Figure 16

Tested By: TH

Checked By: JW

Particle Size Distribution Report



% +3"	% Gravel		% Sand			% Fines	
	Coarse	Fine	Coarse	Medium	Fine	Silt	Clay
0.0	0.0	0.3	0.2	11.9	83.3	4.3	

SIEVE SIZE	PERCENT FINER	SPEC.* PERCENT	PASS? (X=NO)
0.375	100.0	35.0 - 100.0	
0.25	99.8		
#4	99.7		
#8	99.6		
#10	99.5		
#16	99.2		
#30	97.1		
#40	87.6		
#50	65.5		
#100	16.4		
#200	4.3		

* SELECT BACKFILL

Material Description

Poorly Graded Sand

Atterberg Limits

PL= NP

LL= NV

PI= NP

Coefficients

D₉₀= 0.4500

D₈₅= 0.4031

D₆₀= 0.2794

D₅₀= 0.2462

D₃₀= 0.1890

D₁₅= 0.1455

D₁₀= 0.1260

C_u= 2.22

C_c= 1.02

Classification

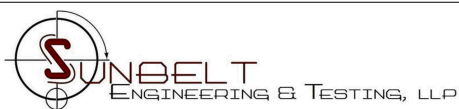
USCS= SP

AASHTO= A-3

Remarks

Source of Sample: 3 Depth: 20
Sample Number: 5

Date: 08/2025



Client: City of Bullhead
Project: Section 10 WTPP

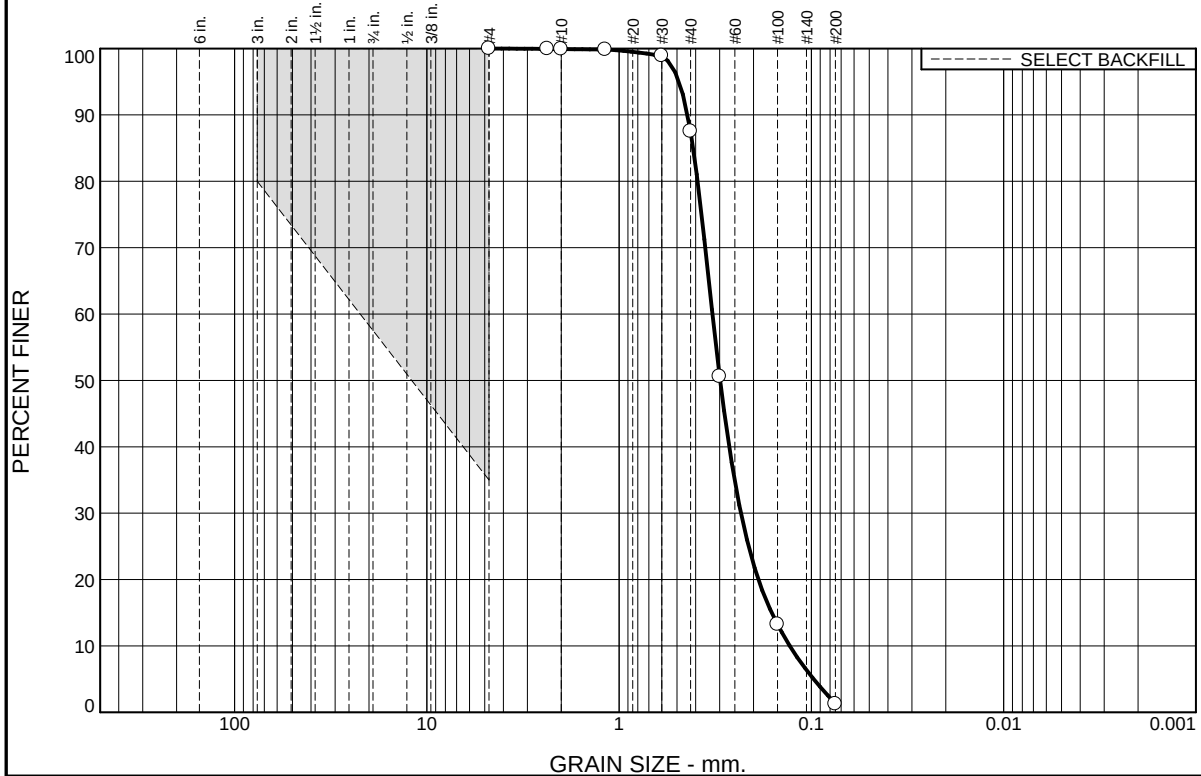
Project No: AZ25061

Figure 17

Tested By: TH

Checked By: JW

Particle Size Distribution Report



% +3"	% Gravel		% Sand			% Fines	
	Coarse	Fine	Coarse	Medium	Fine	Silt	Clay
0.0	0.0	0.0	0.1	12.4	86.2	1.3	

SIEVE SIZE	PERCENT FINER	SPEC.* PERCENT	PASS? (X=NO)
#4	100.0	35.0 - 100.0	
#8	99.9		
#10	99.9		
#16	99.8		
#30	98.9		
#40	87.5		
#50	50.6		
#100	13.2		
#200	1.3		

* SELECT BACKFILL

Material Description

Poorly Graded Sand

Atterberg Limits

PL= NP

LL= NV

PI= NP

Coefficients

D₉₀= 0.4403

D₈₅= 0.4121

D₆₀= 0.3268

D₅₀= 0.2983

D₃₀= 0.2324

D₁₅= 0.1609

D₁₀= 0.1295

C_u= 2.52

C_c= 1.28

Classification

USCS= SP

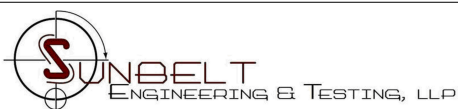
AASHTO= A-3

Remarks

Source of Sample: 3
Sample Number: 6

Depth: 25

Date: 08/2025



Client: City of Bullhead
Project: Section 10 WTPP

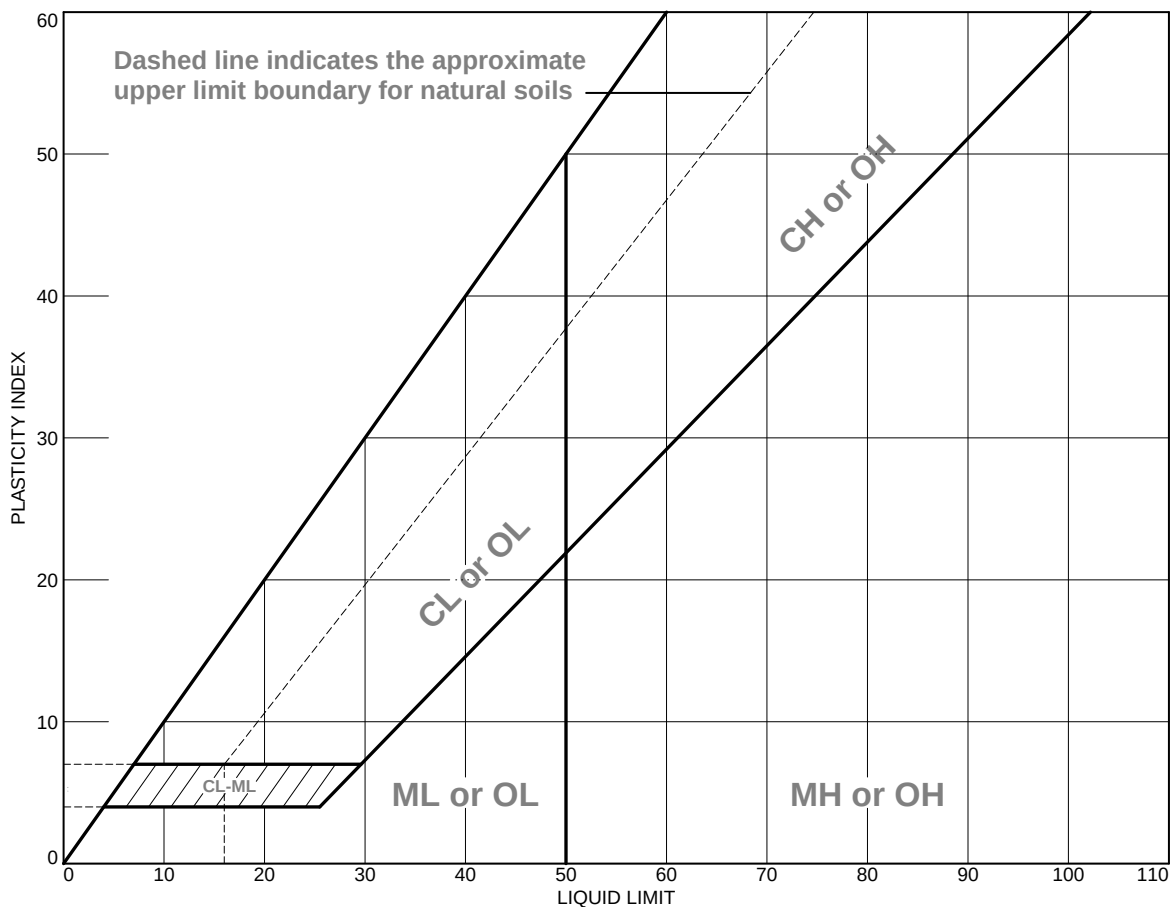
Project No: AZ25061

Figure 18

Tested By: TH

Checked By: JW

LIQUID AND PLASTIC LIMITS TEST REPORT



	Material Description	Sampled	Tested	Technician	LL	PL	PI	%<#40	USCS
●	Poorly Graded Sand	08/2025	08/2025	TH	NV	NP	NP	91.6	SP
■	Poorly Graded Sand with Silt	08/2025	8/2025	TH	NV	NP	NP	92.1	SP-SM
▲	Poorly Graded Sand with Silt	08/2025	08/2025	TH	NV	NP	NP	98.8	SP-SM
◆	Poorly Graded Sand with Silt	08/2025NV	08/2025	TH	NV	NP	NP	93.9	SP-SM
▼	Poorly Graded Sand	08/2025	08/2025	TH	NV	NP	NP	99.7	SP

Project No. AZ25061 **Client:** City of Bullhead

Project: Section 10 WTPP

○ **Source of Sample:** 1 **Depth:** 2.5 **Sample Number:** 1
 □ **Source of Sample:** 1 **Depth:** 5 **Sample Number:** 2
 △ **Source of Sample:** 1 **Depth:** 10 **Sample Number:** 3
 ◇ **Source of Sample:** 1 **Depth:** 15 **Sample Number:** 4
 ▼ **Source of Sample:** 1 **Depth:** 20 **Sample Number:** 5

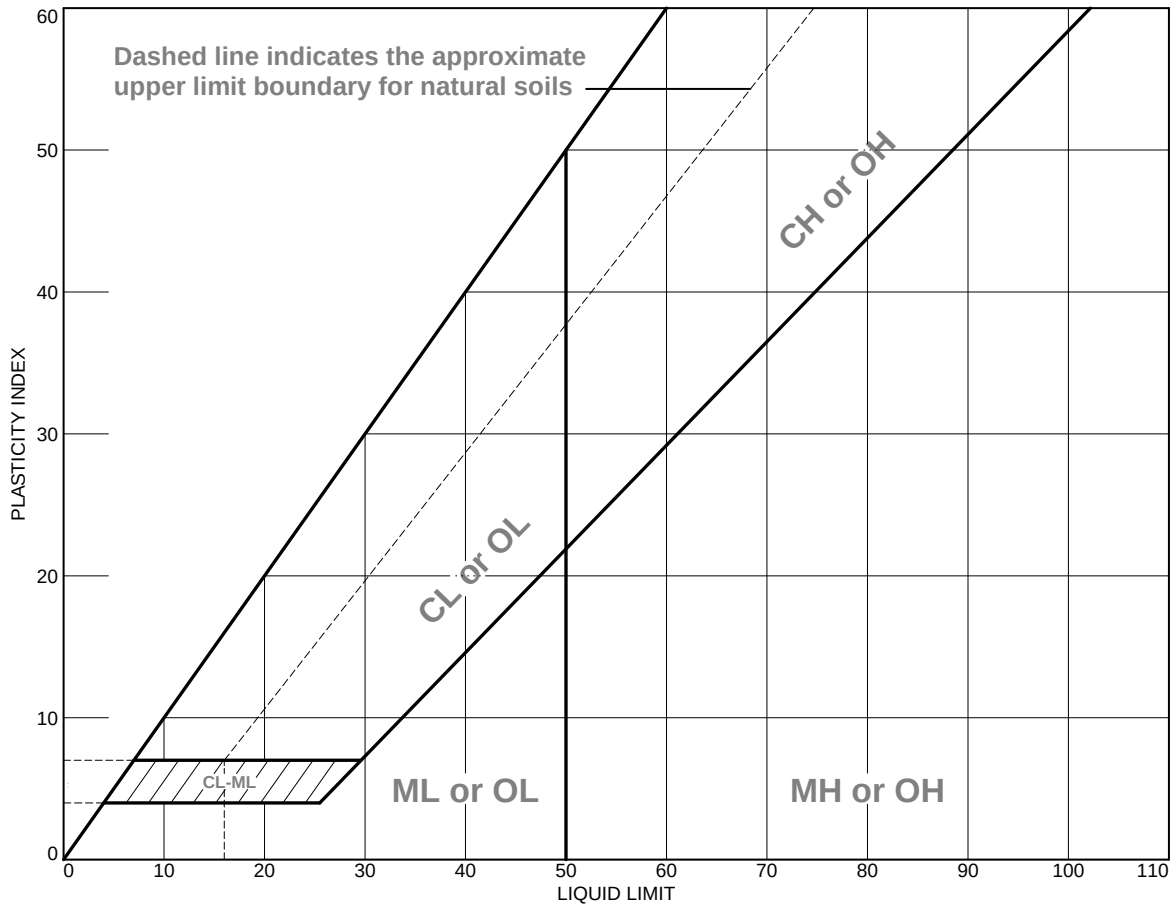


Checked by: JW
Title: Project Manager

Figure 19

Tested By: TH **Checked By:** JW

LIQUID AND PLASTIC LIMITS TEST REPORT

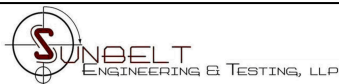


	Material Description	Sampled	Tested	Technician	LL	PL	PI	%<#40	USCS
●	Poorly Graded Sand	08/2025	08/2025	TH	NV	NP	NP	83.0	SP

Project No. AZ25061 **Client:** City of Bullhead

Project: Section 10 WTPP

○ **Source of Sample:** 1 **Depth:** 25 **Sample Number:** 6

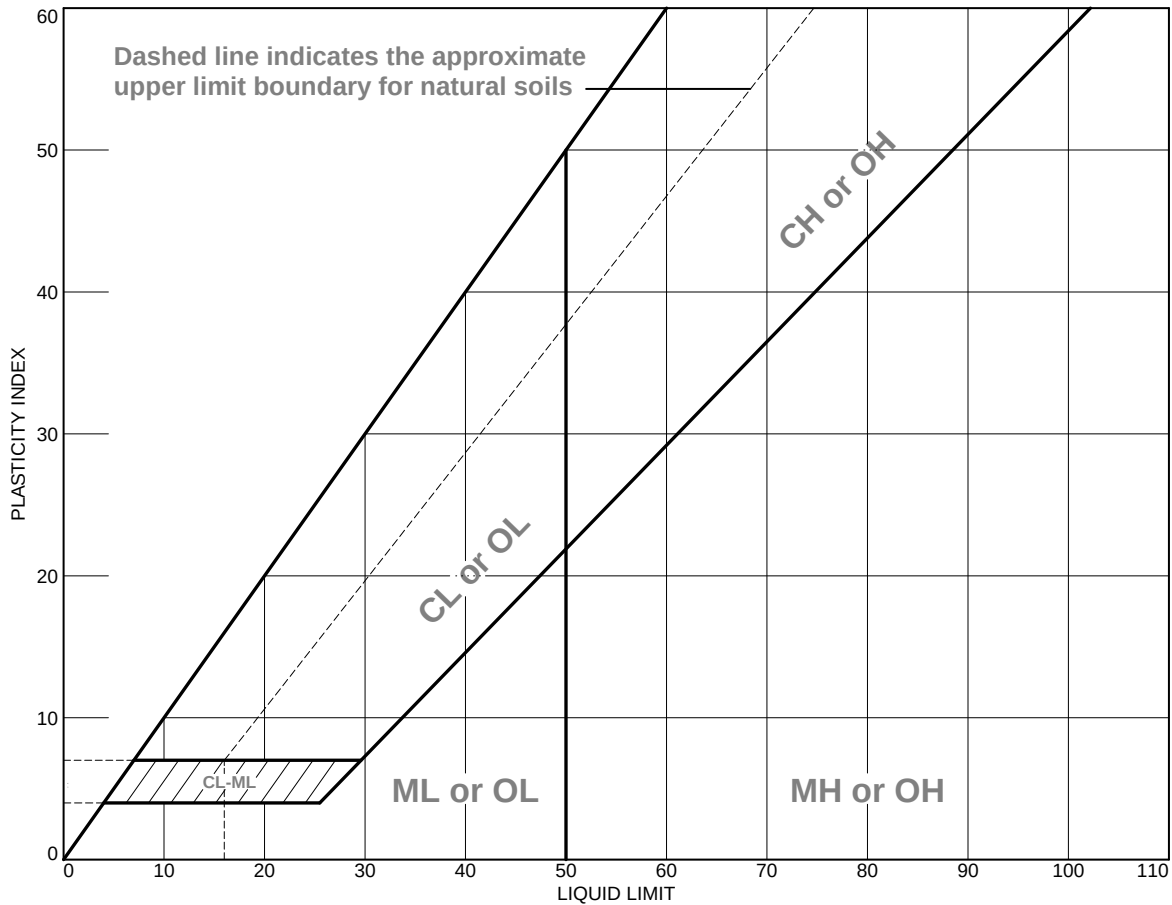


Checked by: JW
Title: Project Manager

Figure 20

Tested By: TH **Checked By:** JW

LIQUID AND PLASTIC LIMITS TEST REPORT

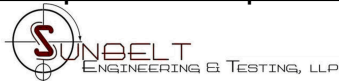


	Material Description	Sampled	Tested	Technician	LL	PL	PI	%<#40	USCS
●	Poorly Graded Sand with Silt	08/2025	08/2025	TH	NV	NP	NP	99.4	SP-SM
■	Poorly Graded Sand with Silt	08/2025	08/2025	TH	NV	NP	NP	99.8	SP-SM
▲	Poorly Graded Sand	08/2025	08/2025	TH	NV	NP	NP	99.7	SP
◆	Silty Sand	08/2025	08/2025	TH	NV	NP	NP	96.2	SM
▼	Poorly Graded Sand	08/2025	08/2025	TH	NV	NP	NP	99.9	SP

Project No. AZ25061 **Client:** City of Bullhead

Project: Section 10 WTPP

○ **Source of Sample:** 2 **Depth:** 2.5 **Sample Number:** 1
 □ **Source of Sample:** 2 **Depth:** 5 **Sample Number:** 2
 △ **Source of Sample:** 2 **Depth:** 10 **Sample Number:** 3
 ◇ **Source of Sample:** 2 **Depth:** 15 **Sample Number:** 4
 ▼ **Source of Sample:** 2 **Depth:** 20 **Sample Number:** 5

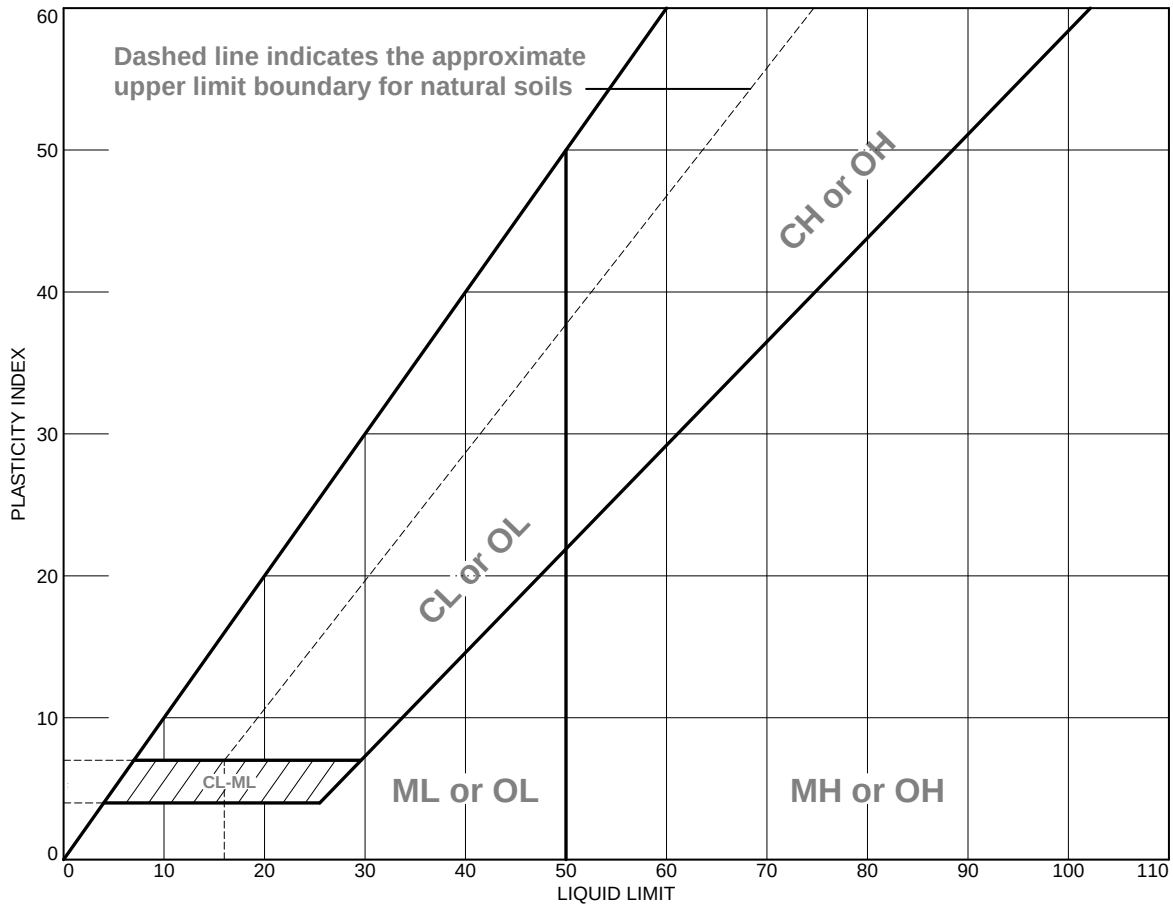


Checked by: JW
Title: Project Manager

Figure 21

Tested By: TH **Checked By:** JW

LIQUID AND PLASTIC LIMITS TEST REPORT

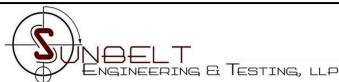


Material Description	Sampled	Tested	Technician	LL	PL	PI	%<#40	USCS
● Poorly Graded Sand	08/2025	08/2025	TH	NV	NP	NP	84.6	SP

Project No. AZ25061 **Client:** City of Bullhead

Project: Section 10 WTPP

○ **Source of Sample:** 2 **Depth:** 25 **Sample Number:** 6

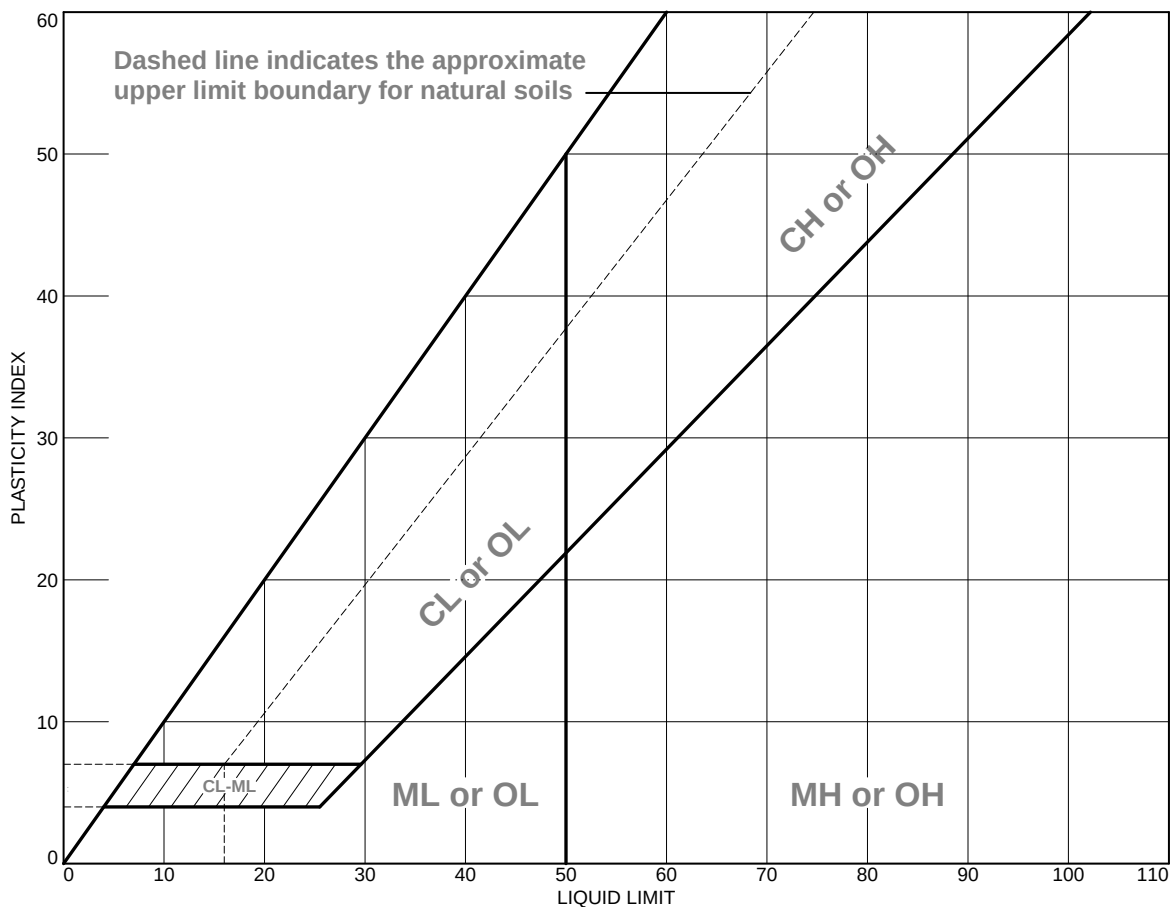


Checked by: JW
Title: Project Manager

Figure 22

Tested By: TH **Checked By:** JW

LIQUID AND PLASTIC LIMITS TEST REPORT

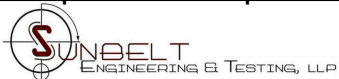


	Material Description	Sampled	Tested	Technician	LL	PL	PI	%<#40	USCS
●	Poorly Graded Sand with Silt	08/2025	08/2025	TH	NV	NP	NP	89.3	SP-SM
■	Poorly Graded Sand	08/2025	08/2025	TH	NV	NP	NP	97.1	SP
▲	Poorly Graded Sand	08/2025	08/2025	TH	NV	NP	NP	99.1	SP
◆	Poorly Graded Sand	08/2025	08/2025	TH	NV	NP	NP	99.5	SP
▼	Poorly Graded Sand	08/2025	08/2025	TH	NV	NP	NP	87.6	SP

Project No. AZ25061 **Client:** City of Bullhead

Project: Section 10 WTPP

○ **Source of Sample:** 3 **Depth:** 2.5 **Sample Number:** 1
 □ **Source of Sample:** 3 **Depth:** 5 **Sample Number:** 2
 △ **Source of Sample:** 3 **Depth:** 10 **Sample Number:** 3
 ◇ **Source of Sample:** 3 **Depth:** 15 **Sample Number:** 4
 ▼ **Source of Sample:** 3 **Depth:** 20 **Sample Number:** 5

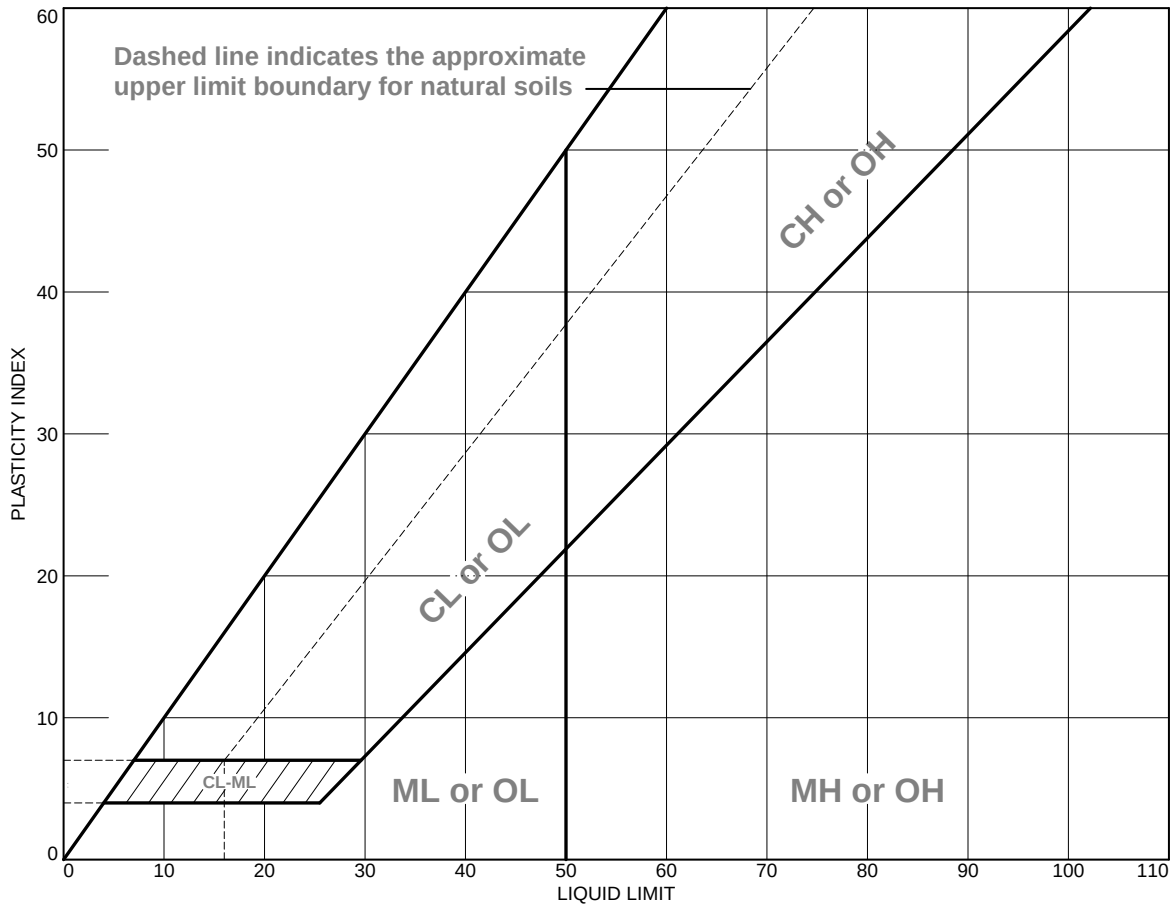


Checked by: JW
Title: Project Manager

Figure 23

Tested By: TH **Checked By:** JW

LIQUID AND PLASTIC LIMITS TEST REPORT

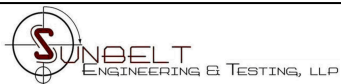


Material Description	Sampled	Tested	Technician	LL	PL	PI	%<#40	USCS
● Poorly Graded Sand	08/2025	08/2025	TH	NV	NP	NP	87.5	SP

Project No. AZ25061 **Client:** City of Bullhead

Project: Section 10 WTPP

○ **Source of Sample:** 3 **Depth:** 25 **Sample Number:** 6



Checked by: JW
Title: Project Manager

Figure 24

Tested By: TH **Checked By:** JW

CLIENT NAME: Sunbelt Engineering & Testing
6330 S. Sandhill Rd, Ste #2
Las Vegas, NV 89120

PROJECT MGR: Tim Harpster

CLIENT PROJECT NAME: **Section 10 WTPP**
CLIENT PROJECT NUMBER: AZ25061
VERITAS LAB ORDER ID: V25H059
DATE RECEIVED AT LAB: Aug-07-2025 09:48

Presented herein are the analytical results for samples received from the above referenced project.

Samples submitted for this project were not sampled by Veritas Laboratories. Unless otherwise noted, samples were received by Veritas Laboratories with proper and complete documentation.

Veritas Laboratories is approved by the Clark County Department of Building as a Quality Assurance Agency (QAA) for inspection and testing services, Category G-CT.

Submitted soil samples for this project were extracted for solubility parameters in a 1:5 (soil to water) ratio and the results corrected for this dilution.

Should you have any questions or comments regarding this report or if we can be of further service to you, please do not hesitate to contact me at (702) 321-8315.

Sincerely,



Bruce G. Cunningham
Laboratory Director
Veritas Laboratories
Nevada Lab Certification ID NV00918

8/7/25

Date

CLIENT COMPANY NAME: Sunbelt Engineering & Testing
 CLIENT PROJECT NAME: **Section 10 WTPP**
 CLIENT PROJECT NUMBER: AZ25061
 VERITAS LAB ORDER ID: V25H059

ANALYTICAL RESULTS

CLIENT SAMPLE ID: **25-1754** DATE/TIME SAMPLED: 8/5/25 0:00
 VERITAS SAMPLE ID: V25H059-01 DATE/TIME RECEIVED: 8/7/25 9:48

Matrix: Soil

Analysis: Soil Solubility/Corrosion Parameters

PARAMETER	RESULT	UNITS	METHOD	DATE ANALYZED
Soluble Sodium	0.0043	%	SM 3500-Na B	8/7/25
Soluble Sulfate	0.0073	%	ASTM D516	8/7/25
Total Soluble Sodium Sulfate	0.011	%	Calculation	8/7/25
Total Soluble Salts (Solubility)	0.024	%	SM 2540C	8/7/25

APPENDIX C

PLATES

CITY OF BULLHEAD
SECTION 10 WTPP
901 RICHARDO AVE.
LOCATED BULLHEAD CITY, ARIZONA



Source:: Google Earth



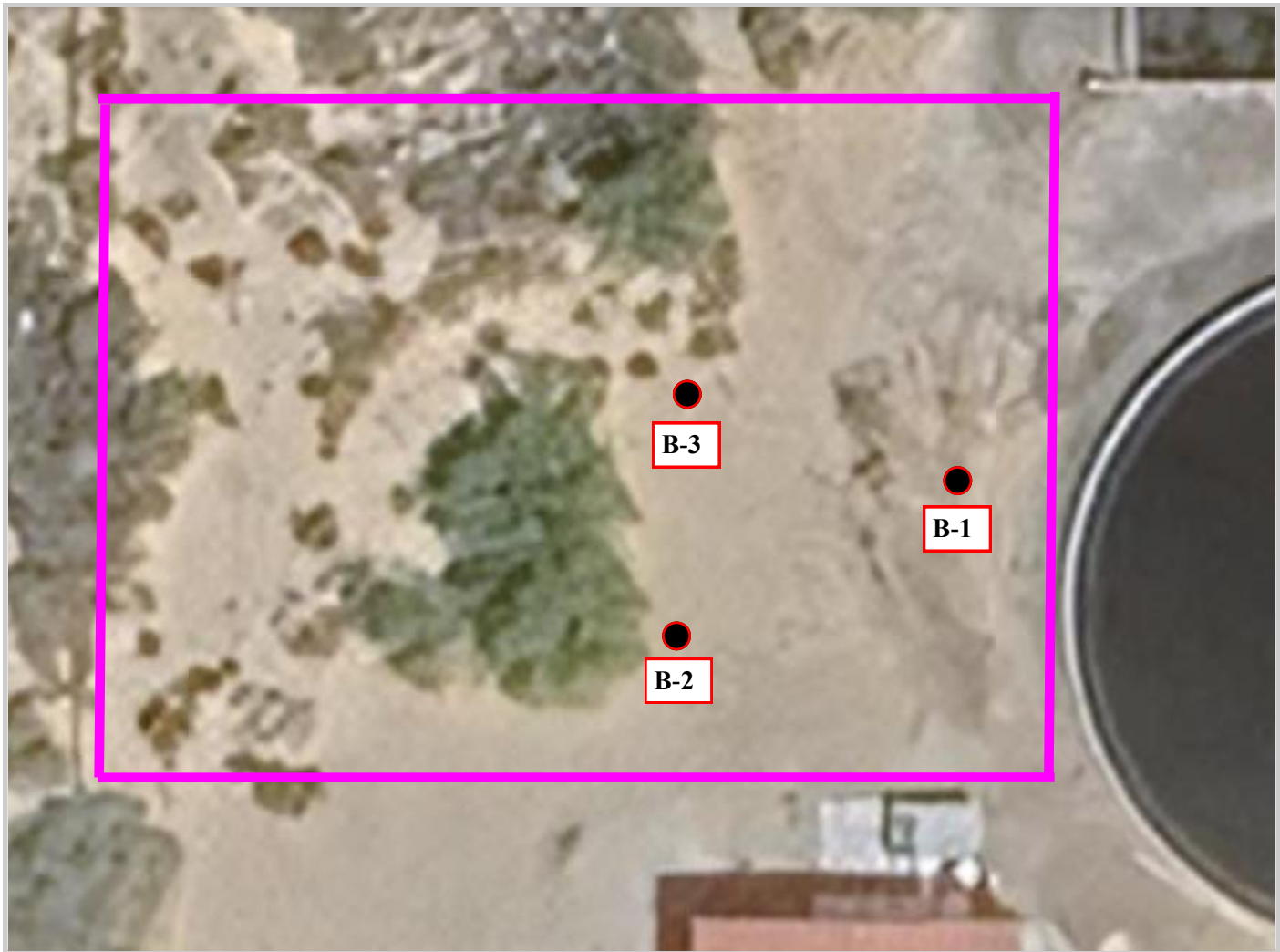
DATE 08/2025

FILE NO. AZ25061

SCALE NOT TO SCALE

PLATE 1
SITE LOCATION MAP

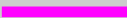
CITY OF BULLHEAD
SECTION 10 WTPP
901 RICHARDO AVE.
LOCATED BULLHEAD CITY, ARIZONA



--App. Boring Locations.....



-- App. Project Boundaries.....



Source: Google Earth

N

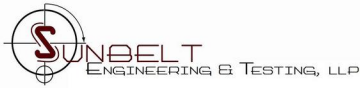


DATE 08/2025

FILE NO. AZ25061

SCALE NOT TO SCALE

PLATE 2
BORINGS
LOCATION MAP



DRILL HOLE LOG

BORING NO.: 1

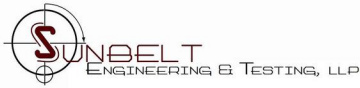
PROJECT: Section 10 WTPP
CLIENT: City of Bullhead
LOCATION: 35.0515, -114.6022
DRILLER: Eagle
DRILL RIG: Dietrich D-50
DEPTH TO WATER > INITIAL ∇ : 26 ft.

PROJECT NO.: AZ25061
DATE: 08/05/25
ELEVATION: 506 ft.
LOGGED BY: MV

AT COMPLETION ∇ : 26 ft.

ELEVATION/ DEPTH	SOIL SYMBOLS, SAMPLERS AND TEST DATA	USCS	Description	NM	DD	STANDARD PENETRATION TEST		
						DEPTH	N	CURVE
								10 30 50
505		SP	Brown Poorly Graded Sand -Slightly Moist -Loose					
	6 12 16	SP	-Med. Dense	2.3		2'-6"-4'	28	
500	11 10 8	SP-SM	Brown Poorly Graded Sand with Silt -Med. Dense	1.5		5'-6'-6"	18	
495	14 20 24	SP-SM	-Dense	2.7		10'-11'-6"	44	
490	5 5 11	SP-SM	-Med. Dense -Trace Clay	2.6		15'-16'-6"	16	
485	9 10 13	SP	Poorly Graded Sand -Med. Dense -Wet	15.8		20'-21'-6"	23	
480	1 6 15	SP	-Med. Dense -Wet	21.1		25'-26'-6"	21	
			26.5' Total Depth Drilled Groundwater encountered at 26'					
475								

This information pertains only to this boring and should not be interpreted as being indicative of the site.



DRILL HOLE LOG

BORING NO.: 2

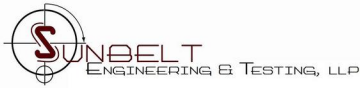
PROJECT: Section 10 WTPP
CLIENT: City of Bullhead
LOCATION: 35.0514 , -114.6023
DRILLER: Eagle
DRILL RIG: Dietrich, D-50
DEPTH TO WATER> INITIAL ▼ : 26 ft.

PROJECT NO.: AZ25061
DATE: 08/05/25
ELEVATION: 505 ft.
LOGGED BY: MV

AT COMPLETION ▼ : 26 ft.

ELEVATION/ DEPTH	SOIL SYMBOLS, SAMPLERS AND TEST DATA	USCS	Description	NM	DD	STANDARD PENETRATION TEST		
						DEPTH	N	CURVE
505 0		SP-SM	Brown Poorly Graded Sand with Silt -Loose					10 30 50
	7 12 18	SP-SM	-Slightly Moist -Med. Dense	3.3		2'-6"-4'	30	
500 5	11 15 18	SP-SM	-Dense	1.9		5'-6'-6"	33	
495 10	8 10 7	SP	-Med. Dense -Slightly Moist	1.4		10'-11'-6"	17	
490 15	5 9 14	SM	Brown Silty Sand	2.2		15'-16'-6"	23	
485 20	8 10 11	SP	Poorly Graded Sand -Med. Dense -Wet	17.6		20'-21'-6"	21	
480 25	4 6 15	SP	-Med. Dense -Wet	20.2		25'-26'-6"	21	
475 30			26.5' Total Depth Drilled Groundwater encountered at 26'					

This information pertains only to this boring and should not be interpreted as being indicative of the site.



DRILL HOLE LOG

BORING NO.: 3

PROJECT: Section 10 WTPP
CLIENT: City of Bullhead
LOCATION: 35.0516 , -114.6022
DRILLER: Eagle
DRILL RIG: Dietrich, D-50
DEPTH TO WATER> INITIAL ∇ : 26 ft.

PROJECT NO.: AZ25061
DATE: 08/05/25
ELEVATION: 505 ft.
LOGGED BY: MV

AT COMPLETION ∇ : 26 ft.

ELEVATION/ DEPTH	SOIL SYMBOLS, SAMPLERS AND TEST DATA	USCS	Description	NM	DD	STANDARD PENETRATION TEST		
						DEPTH	N	CURVE
505 0		SP-SM	Brown Poorly Graded Sand with Silt -Loose					10 30 50
	6 15 11	SP-SM	-Moist -Med. Dense	5.8		2'-6"-4'	26	
500 5	11 18 14	SP	Poorly Graded Sand -Med. Dense	1.3		5'-6'-6"	32	
495 10	6 10 9	SP	-Slightly Moist	0.7		10'-11'-6"	19	
490 15	7 8 8	SP	-Med. Dense	0.8		15'-16'-6"	16	
485 20	6 12 17	SP	-Slightly Moist -Med. Dense	1.6		20'-21'-6"	29	
480 25	4 4 8	SP	-Med. Dense -Wet	20.2		25'-26'-6"	12	
475 30			26.5' Total Depth Drilled Groundwater encountered at 26'					

This information pertains only to this boring and should not be interpreted as being indicative of the site.

KEY TO SYMBOLS

Symbol Description

Strata symbols



Poorly graded sand



Poorly graded sand
with silt



Silty sand

Misc. Symbols



Water table during
drilling



Water table at
boring completion

Soil Samplers



Bulk/Grab sample



Standard penetration test

Notes:

1. Exploratory test boring was drilled 8/2025 using a truck mounted drill rig using HSA to maintain circulation and log the materials and obtain samples.
2. Free water was encountered in one of the borings at a depth of twenty-six (26') feet, with the maximum depth explored of twenty-six and one half(26.5') feet.
3. Boring locations were taped from existing features and elevations extrapolated from the final design schematic plan.
4. These logs are subject to the limitations, conclusions, and recommendations in this report.
5. Results of tests conducted on samples recovered are reported on the logs.

APPENDIX D

LIST OF REFERENCES

LIST OF REFERENCES

1. IBC 2018
2. www.usace.army.mil
3. Foundation Engineering Handbook - Robert Day
4. Foundation Design - Donald Coduto
5. www.seisopt.com
6. Design of Earth retaining structures for dynamic loads - Seed & Whitman
7. ASTM for soils and rock (I)
8. American Concrete Manual of Concrete Practice
9. <http://www.co.mohave.az.us/taxmaps>
10. Geologic Map of Mohave County, Arizona, prepared by the Arizona Bureau of Mines.

PART 1 GENERAL**1.01 WORK INCLUDED**

- A. This section includes furnishing and placing Flowable Fill to the lines and grades shown on the Drawings as backfill in trenches and/or at other locations. Flowable Fill is a self-compacting cementitious material using mineral aggregates (sand and/or gravel), native or processed materials, fly ash/cement, water, air entraining solution and (optionally) other admixtures. Flowable Fill is also known as Controlled Low-Strength Material (CLSM), Controlled Density Fill (CDF), and/or Non-Shrink Backfill.
- B. Flowable Fill is only permitted when specifically called out on the Drawings or elsewhere in these Contract Documents, or when proposed by the Contractor and approved by the Engineer.

1.02 SUBMITTALS

- A. The Contractor shall provide the Engineer with a mix design by either trial batch or field experience methods to verify the required compressive strength of the flowable fill at the 28 day age. Mix design requirements are described in Part 2 PRODUCTS hereinafter. Proportions shall be selected on the basis of unconfined, air cured compressive strength test specimens.

1.03 TESTING

- A. The Owner shall retain an independent testing agency to perform occasional quality assurance tests on the flowable fill consisting of slump, air content measurements, and casting three cylinders for compressive strength tests. The required compressive strength test method and required range are described in Part 2 PRODUCTS hereinafter. Compressive strength tests shall be performed at frequencies of at least one test set per 150 cubic yards and at least one test set per day of placement.

PART 2 PRODUCTS**2.01 MIXTURE OF MATERIALS**

- A. Provide a mixture of the materials described below to produce a self-compacting cementitious material batched on a per cubic yard basis.

2.02 MATERIALS

- A. Portland Cement: Portland cement shall conform to the requirements of ASTM C150, Type II.
- B. Fly Ash: Fly Ash shall conform to ASTM C618, Class C or F.

- C. Coarse Aggregate, Fine Aggregate and Native Materials: Any aggregate gradation which produces performance characteristics of the Flowable Fill specified herein will be accepted, except that the amount of material passing the No. 200 sieve shall not exceed 20 percent. Also, liquid limit and plasticity index shall not exceed 25 and 5, respectively. Aggregates shall conform to ASTM C33.
- D. Water: Water used in mixing shall be clean and free of oil, salt, acid, alkali, sugar, vegetable matter or other substances injurious to the finished product.
- E. Chemical Admixtures: Chemical Admixtures shall conform to the requirements of ASTM C494.
- F. Air Entrainment: Conform to ASTM C260.

2.03 PROPORTIONS

- A. A variety of sand/gravel aggregates, and/or native (or processed) materials meeting the above requirements in conjunction with appropriate amounts of Portland cement and flyash, air entraining solution, and (optionally) other admixtures may be used to produce the required mix properties described herein.
- B. The Contractor shall submit to the Engineer a mix design based upon a trial batch or field experience, including the proportions and sources of all constituent materials, air entraining and (optionally) other admixtures, expressed as cubic yard batch weights. The mix shall contain a minimum of 50 to 75 pounds of cement and up to 250 pounds fly ash per cubic yard, with the remainder of the volumes composed of aggregates, water, and any approved admixtures. Measured compressive strength, air content and yield for the mix design trial batch (or for the field experience based mix design) shall be submitted.

2.04 COMPRESSIVE STRENGTH

- A. Flowable Fill shall be designed to achieve a 28 day compressive strength of 500 psi when tested in accordance with ASTM C39. Test specimens shall be made in accordance with ASTM D4832.

2.05 CONSISTENCY

- A. Consistency of the fresh mixture shall be such that the mixture may be readily placed without segregation. High flowability material generally shall have a slump greater than 8 inches.

- B. As an alternative to slump testing, desired consistency may be approximated by filling an open-ended 3-inch diameter cylinder, 6 inches high, with the mixture and cylinder immediately pulled straight up. The correct consistency of the mixture will produce an approximate 8-inch diameter circular type spread without segregation.
- C. Adjustments of the proportions of constituents may be made to achieve proper solid suspension and optimum flowability. However, strength requirements and proper yield shall be maintained for the actual batch weights.

PART 3 EXECUTION

3.01 CONSTRUCTION

- A. Comply with ACI 304 and ASTM C94 for measuring, mixing, transporting, and placing the Flowable Fill, and as herein specified.

3.02 LIMITATIONS OF PLACEMENT

- A. Mix and place only when the air temperature is at least 35 degrees F and rising. At the time of placement, Flowable Fill shall be at least 40 degrees F. Stop mixing and placement when the air temperature is 40 degrees F and falling.
- B. Flowable Fill shall be placed by methods that preserve the quality of the material in terms of compressive strength, flow, homogeneity, plasticity and workability. The material shall be transported, placed, and/or consolidated so that it flows easily around, adjacent to and under structures. It shall have the flow, consistency, and workability such that the material is self-compacting.
- C. Protect freshly placed Flowable Fill from premature drying, excessive cold and freezing, or hot temperatures. The Flowable Fill surface shall be protected from air temperatures below 40 degrees F to protect against freezing. Begin curing immediately following placement and before the Flowable Fill surface has dried. Continue curing until the Flowable Fill has attained the 28 day strength requirement. This strength shall be determined prior to any load applications or construction activity, unless otherwise directed by an Engineer.

3.03 INSTALLATION AS BACKFILL OR PIPE BEDDING

- A. Support and restrain utilities within the backfill area to prevent movement and flotation during installation of Flowable Fill. Protect structures and utilities from damage caused by hydraulic pressure of Flowable Fill before the Fill hardens. Prevent Flowable Fill from intrusion into utilities.

- B. Place Flowable Fill by chute, pumping, or other approved methods. Place Fill in lifts to prevent lateral pressures from exceeding structural capacity of structures and/or utilities. Place Fill evenly on both sides of utilities to maintain alignment.
- C. Place Flowable Fill to the elevations shown on the Drawings without vibration or other means of compaction.

3.04 INSTALLATION AS FILL FOR ABANDONED UTILITIES OR STRUCTURES

- A. Verify pipes and/or conduits to be abandoned in place are not clogged and are sufficiently empty to permit gravity installation of Flowable Fill for entire length indicated to be filled. Seal lower end of pipes and conduits by a method designed to contain Flowable Fill and to vent trapped air caused by filling operations.
- B. Place Flowable Fill using a method that ensures there are no voids. Fill pipes and conduits from the high end. Fill manholes, tanks, and other structures from grade level access points.
- C. After filling pipes and conduits, seal both ends.

3.05 CLEANING

- A. Remove any spilled and excess Flowable Fill from project site. Restore any facilities or site areas damaged or contaminated by Flowable Fill installation to their existing condition before installation.

END OF SECTION 31 23 23

SECTION 31 23 33

TRENCH EXCAVATION AND BACKFILL FOR PIPELINES

DIVISION 31 00 00 – EARTHWORK **AND APPURTENT STRUCTURES**

PART 1 GENERAL

1.01 STANDARD SPECIFICATION

- A. All applicable portions of this specification section in the Maricopa Association of Governments (MAG) Standard Specifications (Section 601) shall apply with the following additions, deletions, and/or modifications. Modifications are listed below with numbers corresponding to the MAG Standard Specification.

601.1 DESCRIPTION

- A. Include FRP to list of flexible pipes (Add)

6.01.4.6 Compaction Densities (Add)

- 1. Meet the quality control and quality assurance testing requirements in Section 01 40 00, QUALITY CONTROL of this Project Manual.

END OF SECTION 31 23 33

SECTION 32 10 10

STREET EXCAVATION,

DIVISION 32 00 00 – EXTERIOR IMPROVEMENTS BACKFILL, AND COMPACTION

PART 1 GENERAL

1.01 STANDARD SPECIFICATION

- A. All applicable portions of this specification section in the Maricopa Association of Governments (MAG) Standard Specifications (Section 301) shall apply with the following additions, deletions, and/or modifications. Modifications are listed below with numbers corresponding to the MAG Standard Specification.

3.01.3 RELATIVE COMPACTION (ADD THE FOLLOWING)

- A. Field Density Testing
 - 1. Meet the quality control and quality assurance testing requirements in Section 01 40 00, QUALITY CONTROL of this Project Manual.

3.01.7 MEASUREMENT – No Measurement will occur on Project

3.01.8 PAYMENT – Payment will be by lump sum and will be for work complete.

END OF SECTION 32 10 10

PART 1 GENERAL

1.01 DESCRIPTION

- A. Asphalt Concrete Paving

1.02 RELATED SECTIONS

- A. Section 31 23 00 – Earthwork
- B. Section 32 10 10 – Street Excavation, Backfill and Compaction

1.03 REFERENCE SPECIFICATIONS, CODES, AND STANDARDS

- A. Except as otherwise indicated in this Section, the Contractor shall comply with the City of Bullhead's Asphalt and Aggregate Specifications (City Specification) and the latest edition of the Maricopa Association of Governments (MAG) Standard Specifications referenced in the City Specification.

1.04 SUBMITTALS

- A. Per the provisions of Section 01 33 00 Submittals of these specifications, prior to commencement of the work, Contractor shall submit for review the proposed mix design of each class of asphalt concrete and the tack coat material to be used in the work.
- B. Certified Delivery Tickets. Where asphalt concrete is used, the Contractor shall provide certified weighmaster delivery tickets at the time of delivery of each load of asphalt concrete. Each certification shall show the public weighmaster's signature, and the total quantities by weight of all components of the specific design mix. Each certificate shall, in addition, state the mix number, total yield in cubic yards or tons and the time the batch was dispatched, when it left the plant, when it arrived at the job, the time that unloading began, and the time that unloading was finished.

1.05 QUALITY ASSURANCE

- A. The work shall be performed in accordance with the latest edition of the City Specification, MAG Standard Specifications and the contract documents.
- B. Materials incorporated in the work shall be obtained from the same source of supply throughout the life of the project unless the Contractor is otherwise granted written permission by the Engineer.

PART 2 MATERIALS

2.01 ASPHALT CONCRETE

- A. Asphalt concrete as specified in the City Specification shall be as follows:

Pavement Replacement:

Coarse/Fine Aggregate Requirements: Low Traffic.

Marshall Mix Design: 1/2" Mix (3/4" minus).

Use a 75 blow Marshall, PG 70-10 asphalt binder, and hydrated lime as a mineral admixture. Marshall Mix Design Criteria shall conform to Table 11.2-2 in the City Specification.

2.02 TACK COAT

- A. Tack coat shall be an asphalt emulsion of grade SS-1H or CSS-1H in accordance with the City Specification and Section 713 of MAG Specifications.

2.03 AGGREGATE BASE

- A. See Section 31 23 00 Earthwork for Structures.

PART 3 EXECUTION

3.01 EXAMINATION

- A. Contractor shall verify that compacted aggregate base meets density requirements and is dry prior to placement of asphalt concrete.
- B. Contractor shall verify that gradients and elevations of aggregate base are correct prior to placement of asphalt concrete.

3.02 BASE COURSES

- A. See Section 31 23 00 Earthwork for Structures.

3.03 PLACING AND FINISHING

- A. Placing and Finishing shall be in accordance with Section 11.5 of the City Specification.
- B. Temperature limitations in the City Specification apply.
- C. Tack Coat shall be SS-1H or CSS-1H as specified in the City Specification.

The tack coat between layers of new asphalt concrete will not be deleted when the drying bed is paved.

- D. Smoothness shall be in accordance with the City Specification with the exception that in the drying bed the straight edge shall be placed both parallel and perpendicular to the center line of paving lanes. The surface shall vary by no more than three-eighth (3/8) inch for the first lift and one-quarter (1/4) inch for the final lift from the lower edge of the 12-foot straightedge when testing drying bed asphalt concrete for smoothness.

3.04 ACCEPTANCE

- A. Acceptance Testing under Section 11.7 of the City Specification shall be the responsibility of the Contractor's Independent Testing Laboratory.
 - 1. Acceptance testing for trench: Pavement replacement will be two lots unless all pavement replacement is completed in one day.
- B. The allowable deviation and payment reductions specified in Section 11.7.1 of the City Specification are applicable Trench Pavement Replacement.
- C. Pavement thickness provisions of the City Specification Section 11.9 are applicable to this project.
- D. Section 11.10 Density of the City Specification is applicable with air voids in excess of 8% subject to a payment reduction.

END OF SECTION 32 12 16

PART 1 GENERAL**1.01 WORK INCLUDED**

- A. This section covers the work necessary to replace, when directed, all asphalt concrete, gravel surfacing, curbs, sidewalks, drainage facilities, piping, and other features damaged directly or indirectly by the operations incidental to the construction of the project.

PART 2 PRODUCTS**2.01 ASPHALT CONCRETE FOR REPLACEMENT AND/OR REPAIR**

- A. Asphalt concrete mix and tack coat shall be as specified in the Section 32 12 16, ASPHALT CONCRETE PAVEMENT.

2.02 CONCRETE

- A. Concrete for curbs, sidewalks, pavement and miscellaneous construction shall be as specified in Section 03 30 00, CONCRETE.

2.03 PIPE FOR MISCELLANEOUS FACILITIES REPLACEMENT

- A. All pipe which is damaged incidental to the construction shall be replaced with a new length of pipe which is identical to the damaged pipe, or as approved by the Engineer.

PART 3 EXECUTION**3.01 ASPHALT CONCRETE PAVEMENT REPLACEMENT**

- A. Bring the area to a smooth, even grade at the correct distance below the top of the pavement surface so as to provide adequate space for the leveling course and pavement. Trim existing pavement to a straight line to remove any pavement which has been damaged or which is broken and unsound to provide a smooth, sound edge for joining the new pavement.
- B. Compact the subgrade with mechanical vibratory or impact tampers. Determine the amount and method of compaction necessary to prevent subsequent settlement, but as a minimum, 96 percent of its standard proctor maximum dry density. Any subsequent settlement of the finished surfacing during the warranty period shall be promptly repaired by the Contractor at the Contractor's sole cost.
- C. Place sufficient leveling course material to obtain a thickness of at least 10 inches after compaction, and for proper matching with the adjacent existing

pavement. Place the leveling course for the full width of the area where pavement was disturbed, including bituminous surfaced shoulders.

- D. Compact the leveling course with mechanical vibratory or impact tampers. Determine the amount and method of compaction necessary to prevent subsequent settlement. Any subsequent settlement of the finished surfacing during the warranty period shall be promptly repaired at the Contractor's sole cost.
- E. Place the asphalt concrete on the prepared subgrade over the area to a depth of not less than 3 inches or the depth of the adjacent pavement, whichever is greater, but not more than 5 inches. Spread and level the asphalt concrete with hand tools or by use of a mechanical spreader, depending upon the area to be paved. Bring the asphalt concrete to the proper grade and compact by rolling or the use of hand tampers where rolling is impossible or impractical.
- F. A tack coat of emulsified asphalt shall be applied to all match lines when joining new asphalt concrete to old asphalt concrete.
- G. Roll with power rollers capable of providing compression of 200 to 300 pounds per linear inch. Begin the rolling from the outside edge of the replacement progressing toward the existing surfacing, lapping the existing surface at least 1/2 the width of the roller. If existing surfacing bounds both edges of the replacement, begin rolling at the edges of the replacement, lapping the existing surface at least 1/2 the width of the roller, and progress toward the center of the replacement area. Overlap each preceding track by at least 1/2 the width of the roller and make sufficient passes over the entire area to remove all roller marks and to produce the desired result, as determined by the Engineer.
- H. The finished surface of the new compacted paving shall be flush with the existing surface and shall conform to the grade and crown of the adjacent pavement.
- I. Immediately after the new paving is compacted, all joints between new and original asphalt pavement shall be painted with hot asphalt or asphalt emulsion and be covered with dry paving sand before the asphalt solidifies.
- J. The surface smoothness of the replaced pavement shall be such that when a straightedge is laid across the patched area between the edges of the old surfacing and the surface of the new pavement, the new pavement shall not deviate from the straightedge more than 1/4-inch.
- K. Asphalt shall not be applied to wet material. Asphalt shall not be applied during rainfall, sand or dust storms, or any imminent storms that might

adversely affect the construction. The Engineer will determine when surfaces and material are dry enough to proceed with construction. Asphalt concrete shall not be placed (1) when the atmospheric temperature is lower than 40 degrees F, (2) during heavy rainfall, or (3) when the surface upon which it is to be placed is frozen or wet. Exceptions will be permitted only in special cases and only with prior written approval of the Engineer.

3.02 SIDEWALKS AND CURBS AND MISCELLANEOUS CONCRETE CONSTRUCTION

- A. Replace concrete sidewalks and curbs to the same section width, depth, line and grade as that removed or damaged. Cut ends of existing curb to a vertical plane. Prior to replacing the sections, properly backfill and compact the trench to prevent subsequent settlement.
- B. Cut ends of existing curbs to a vertical plane. Construct forms to match existing. Place concrete and finish exposed surfaces similar to adjacent curb.
- C. Replace concrete sidewalks between scored joints and make replacement in a manner that will avoid a patched appearance. Provide a minimum 6-inch thick compacted leveling course of clean 3/4-inch minus crushed rock or gravel of quality hereinbefore specified. Finish concrete surface similar to the adjacent sidewalks. Score joints and finish edges with a steel edging tool.

3.03 STORM SEWERS, WATER MAINS, CULVERTS, AND MISCELLANEOUS PIPING

- A. All storm sewers, water mains, catch basins, piping, or culverts that are removed because of interference with the new construction shall be removed so as to do the least possible damage to the pipe or basin. Pipe damaged by removal shall be replaced with pipe equal to the original at no expense to the Owner.

END OF SECTION 32 40 00

PART 1 GENERAL**1.01 WORK INCLUDED**

- A. This section presents and explains a tabulation of the piping to be used for each of the various piping systems for this project, and as specified in the various detail piping specifications in Division 40 00 00, PROCESS INTERCONNECTIONS.

PART 2 PRODUCTS**2.01 GENERAL**

- A. The piping systems being furnished and installed in this project under Division 40 00 00, PROCESS INTERCONNECTIONS are tabulated in the Piping Schedule included at the end of this section.

2.02 PIPING SCHEDULE

- A. The Piping Schedule lists each service by name and by legend and tabulates the applicable detail piping specification section numbers for each piping material to be used in a given service and location.
- B. The detail piping specification section numbers are referenced also as to nominal pipe size and location, exposed or buried, submerged, concrete encased, etc.
- C. The test pressure for each piping service is listed in the Piping Schedule, as well as whether the test shall be hydrostatic or pneumatic. Text procedures are specified in Section 40 10 05, PIPING - GENERAL.
- D. In locations where the referenced specifications for a service are unacceptable due to unique or localized physical limitations, specifications or acceptable alternative materials are listed in the "Notes/Remarks" column of the Piping Schedule. If not listed, the Contractor shall notify the Engineer for verification of an acceptable alternative.
- E. Where the use of the material listed in the Piping Schedule is not intended but the quantity of the material does not warrant the inclusion of additional materials of construction in the "Notes/Remarks" column, materials of construction will be shown on the Drawings. The material to be used is shown by the standard abbreviation for the material listed herein. In addition, piping not identified by service is identified by material of construction. The appropriate Specification for that material is also listed.

2.03 ABBREVIATIONS

CI - Cast Iron

CISP - Cast Iron Soil Pipe
CLDI - Cement Lined Ductile Iron
CLSTL - Cement lined steel
CONC - Concrete
CPVC - Chlorinated polyvinyl chloride
CU – Copper
DI - Ductile Iron
ELDI - Epoxy - lined ductile iron
ELSTL - Epoxy-Lined Steel
FRP - Fiberglass Reinforced Plastic
GLDI - Glass-Lined Ductile Iron
GS - Galvanized Steel
HDPE - High density polyethylene
MTS - Mill Type Steel
PE - Polyethylene Tubing
PP - Polypropylene
PVC - Polyvinyl Chloride
SST - Stainless Steel
STL – Steel
THPVC – Thickwall PVC (AWWA C900)
WSTL – Welded Steel
< - Less than
≤ - Equal to or less than
> - Greater than
≥ - Equal to or greater than
X=H - Hydrostatic test
X=P - Pneumatic test
NR - Not required

2.04 COLOR CODES AND LABELS

- A. Piping color codes and labels are specified and listed in Section 09 90 00, PAINTING.

2.05 RELATED WORK SPECIFIED AND PERFORMED UNDER OTHER SECTIONS

- A. Other piping and duct on this project may be specified in Division 26 00 00, PLUMBING and Division 23 00 00, HEATING, VENTILATING, AND AIR CONDITIONING (HVAC).

2.06 PIPING SCHEDULE NOTES

- A. Test procedures for pressure pipes are specified in Section 40 05 10, PIPING - GENERAL.
- B. Convert piping materials where shown on Drawings.
- C. Concrete encase piping below building slabs, under structures, and where shown on the Drawings.

- D. PVC or CPVC piping in this service shall be Schedule 80.
- E. Provide protective coating as specified in Section 09 90 00, PAINTING.
- F. Connect to existing piping as shown on the Drawings.

PART 3 EXECUTION

3.01 GENERAL

- A. All piping listed in the Piping Schedule shall be installed in accordance with the referenced detail piping specifications.

END OF SECTION 40 02 05
(See Piping Schedule below)

PIPING SCHEDULE

PIPING SERVICE	LEGEND	PIPE SIZE (inches)	INSTALLATION	SPECIFICATION SECTION ^(a)	TEST PRESSURE AND TYPE (PSIG - X) ^(b)	NOTES/REMARKS ^(c)
Mixed Liquor	ML	ALL	Encased Buried	40 05 10.03 40 05 10.14	15-H	A, B, C, E, F
Drain	DR	ALL	Encased Buried	40 05 10.03 40 05 10.14	5-H	A, B, C, E, F
Scum	SC	ALL	Exposed Buried	40 05 10.03 40 05 10.03	5-H	A, E, F
Secondary Effluent	SE	ALL	Buried	40 05 10.14	15-H	A, F
Activated Sludge	AS	ALL	Exposed Encased Buried	40 05 10.03 40 05 10.03 40 05 10.14	15-H	A, B, C, E, F
Return Activated Sludge	RAS	ALL	Exposed Encased Buried	40 05 10.03 40 05 10.03 40 05 10.14	15-H	A, B, E, F
Utility Water	UW	≤2 ½" ALL	Exposed Buried	40 05 10.09 40 05 10.12 Or 40 05 10.30	125-H	A, B, D, F

- a) 40 05 10.03 – Epoxy Lined Ductile Iron Pipe and Fittings
 40 05 10.04 – Mill Type Steel Pipe and Fittings
 40 05 10.08 – Galvanized Steel Pipe and Malleable Iron Fittings
 40 05 10.09 – Stainless Steel Pipe and Fittings
 40 05 10.12 – Polyvinyl Chloride (PVC) Pipe and Fittings
 40 05 10.14 – Thickwall PVC Pipe (AWWA C900 and AWWA C905)
 40 05 10.30 – High Density Polyethylene (HDPE) Pipe and Fittings
 b) Testing Designation: X = test pressure; H = hydrostatic; P = pneumatic.
 c) See Article 2.06 for applicable notes.

PART 1 GENERAL**1.01 WORK INCLUDED**

- A. The work of this section, and of the Detail Piping Specifications hereinafter, covers the material specification for most pipe, pipe fittings, and pipe accessories to be utilized, including methods of pipe jointing and general installation guidelines.

1.02 GENERAL

- A. Like items of material provided hereunder shall be the end products of one manufacturer. All piping and accessories shall be new products.
- B. See Volume 1, Article 8 GENERAL CONDITIONS and Division 01 00 00, GENERAL REQUIREMENTS, which contain information and requirements that apply to the work specified herein and are mandatory for this project.

1.03 SUBMITTALS

- A. In addition to the requirements of Section 01 33 00, SUBMITTALS in Division 01 00 00, GENERAL REQUIREMENTS, the following information shall be provided:
 - 1. The Contractor shall submit to the Engineer a certification by the manufacturer that all pipe and pipe fittings comply with ANSI, AWWA, ASTM, or other applicable national standards and the applicable portions of this specification.
 - 2. Certified copies of all pipe hydrostatic tests.
 - 3. Metal Framing Support Systems: Detailed installation drawings, catalog information, and complete component specifications.
 - 4. Ductile Iron or Steel Wall Pipes: Manufacturer's data, including thrust collar type and the test report substantiating the pressure rating and safety factor for fabricated thrust collars.
 - 5. Support Systems:
 - a. Drawings of each piping system locating each support, hanger, guide and anchor, including seismic bracing.
 - b. Identify support, hanger, guide, and anchor type by catalog number and shop drawing detail number.
 - 6. Shop Fabricated Piping: Pipe design calculations and detailed shop drawings including:

- a. Detailed pipe sections, special fittings and bends, showing dimensions, coatings and other pertinent information.
 - b. Laying drawing showing location of each pipe section and each special length; number or otherwise designate laying sequence on each piece.
7. Manufacturer catalog data and information for each specified product.
 8. Hydraulic Thrust Restraint: Details including materials, sizes, and assembly ratings, and pipe attachment methods for each pipe material.
 9. Thrust blocks including concrete quantity, area of bearing on pipe, and fitting joint locations.
 10. Joint types, materials, details and drawings for dissimilar buried pipes, restrained joints, couplings, and other similar piping accessories.
 11. Manufacturer's instructions for special procedures and setting dimensions.

1.04 DELIVERY, STORAGE AND HANDLING

A. General:

1. Also see Section 01 66 00, PRODUCT SHIPMENT, HANDLING, STORAGE, AND PROTECTION for other requirements.
2. Accept all piping materials and accessories on site in manufacturer's original packaging and inspect for damage. Handle and store materials according to manufacturer's instructions.

B. Pipe:

1. Protect, support, and handle in a manner to prevent damage to the products, especially linings and coatings.
 - a. When necessary, provide shelter to store pipe and apply water to prevent excessive drying.
 - b. During cold weather, store pipe on supports to prevent damage to coating.
 - c. Do not store pipe on rock or other hard surface.
2. Use implements, tools, facilities, and equipment suitable for proper and safe protection and handling of piping; do not drop or dump pipe into trenches.

- a. Use heavy canvas or nylon slings, not chains or cables, to lift pipe and fittings.
- 3. Cement-Mortar, Glass Lined, Polyethylene Lined, or Ceramic Epoxy Lined Pipe: Tightly close ends with polyethylene plastic wrap to protect lining during shipment; leave plastic wrap on pipe until installation.
- 4. Remove/replace pipe that is damaged beyond repair, in the opinion of the Engineer.
- C. Rubber Gaskets:
 - 1. Store in a cool, well-ventilated area.
 - 2. Do not expose to the direct rays of the sun.
 - 3. Do not allow contact with oils, fuels, or petroleum solvents.

1.05 SEQUENCING AND SCHEDULING

- A. Slab, Floor, Wall, and Roof Penetrations:
 - 1. Order wall pipes and sleeves sufficiently early to ensure they are available for placement in concrete forms.
 - 2. Verify size and location of building and structure penetrations before forming and placing concrete.

1.06 SYSTEM DESIGN REQUIREMENTS AND QUALITY ASSURANCE

- A. General:
 - 1. The Specifications and Drawings are not all inclusive with explicit piping details; provide piping and perform work in accordance with laws and regulations and intended use, including:
 - a. Power Piping: ANSI/ASME B31.1 Code.
 - b. Process Piping: ANSI/ASME B31.3 Code.
 - c. Building Service Piping: ANSI/ASME B31.9 Code.
 - d. Sanitary Building Drainage and Vent Systems: ICBO/IAPMO Uniform Plumbing Code.
 - e. Fuel, Digester Gas, Natural Gas, and Propane Gas Piping: ANSI/ASME B31.2 Code.
 - f. Manufacturers Standardization Society (MSS) Pipe Hanger and Support Standards: MSS SP-58 and MSS SP- 69.

2. Pressure Ratings and Materials Specified: Represent minimum acceptable standards for piping systems.
 3. Piping Systems: Suitable for the services specified and intended.
 4. All pipe and equipment supports and hangers shall be designed to meet the requirements of the State of Arizona for seismic conditions as summarized in the General Structural Notes on the Drawings. Seismic provisions shall also meet the requirements specified in Section 22 05 48, VIBRATION AND SEISMIC CONTROLS FOR PLUMBING AND HVAC PIPING AND EQUIPMENT.
- B. Buried Piping: Provide piping suitable for design conditions as follows:
1. H20-S16 traffic load (AASHTO Standard Specifications for Highway Bridges) with 1.5 impact factor.
 2. Piping both with and without internal pressure.
- C. Piping Materials in Contact with Potable Water: Certified to NSF Standards 61 and 372.

PART 2 PRODUCTS

2.01 GENERAL

- A. The materials to be used for the process piping systems shown on the Drawings are listed by service in Section 40 02 05, PIPING SCHEDULE. Specific material requirements are specified in the Detail Piping Specifications (DPS) hereinafter.

2.02 PIPE JOINTS FOR EXPOSED PIPING

- A. Where specified in the Detail Piping specifications, grooved end pipe joints may be used on exposed steel piping, including locations where flanged joints are shown on the Drawings. All grooved end joints within buildings shall be rigid type. To assure uniformity and compatibility of piping components in grooved end piping systems, fittings and couplings shall be furnished by the same manufacturer.
- B. Flanges shall be used for pipe joints 14-inches and smaller where grooved end joints are not specified or not available, as on certain pipe sizes and fittings.
- C. Restrained flanged coupling adapters, dismantling joints, or unions shall be used where shown on the Drawings, or as necessary to facilitate installation or later access to inline equipment for service or replacement.

2.03 PIPE JOINTS FOR BURIED PIPING

- A. Push-on joint pipe ends shall be used for 4-inch and larger PVC pipe buried below ground surfaces unless shown or detailed otherwise on the Drawings. All fittings shall be push-on joint restrained with concrete thrust blocking, and shall have a minimum pressure rating at least equal to that of the pipe service.
- B. Push-on or mechanical joint pipe ends shall be used for ductile iron pipe buried below ground surfaces unless shown or detailed otherwise on the Drawings. All fittings for standard pressure services (less than 200 psi working pressure) shall be push-on joint restrained with concrete thrust blocking, mechanical joint restrained with concrete thrust blocking, or push-on joint or mechanical joint with alternate mechanical means of thrust restraint as specified hereinafter.
- C. Thrust restraint shall be provided by concrete thrust blocks and/or alternate thrust restraint systems. Thrust blocks and alternate types of thrust restraint are not typically shown on the Drawings, but shall be provided on all buried pressure lines. Allowable soil bearing stress for sizing of concrete thrust blocks shall be 2,000 psf maximum.
- D. Alternate mechanical thrust restraints for ductile iron pipe, with mechanical joints and push-on joints, shall incorporate a ductile iron restraint ring with individually actuated wedges and torque limiting twist-off nuts to ensure proper force on the wedges. Thrust restraints shall be EBAA Iron Sales, Inc. Megalug, or approved equal.
- E. Push-on gasketed joints or flexible couplings shall be used to join buried steel pipe, unless shown otherwise. The flexible couplings shall be provided with thrust ties for all pressurized buried steel pipe. Flexible couplings shall be Dresser, Style 38; Smith-Blair, Style 411; or equal. Thrust ties shall sustain the force developed by 1-1/2 times the operating test pressure specified.
- F. Hex bolts, fasteners, thrust ties, and miscellaneous metals used for buried piping systems shall be series 300 stainless steel.
- G. Within the limitations noted above, all pipe materials and joints do not necessarily have to be the same for all lines in a specific service, except that the materials and joints for any particular building, or between any two buildings, or for any particular buried line, shall be the same. An exception to this is where ends must be changed from push-on to flanged to accommodate valves or fittings.
- H. No change in material or joint selection will be permitted after submittal of shop drawings and their final review by the Engineer.

2.04 JOINTS FOR DISSIMILAR PIPES

- A. Joints between dissimilar buried pipe (steel and ductile iron, PVC and ductile iron, etc.) shall be made with flexible transition couplings as specified hereinafter.
- B. Joints between dissimilar exposed pipe (steel and stainless steel, steel and ductile iron, copper and galvanized steel, etc.) shall be made with an insulated flange or dielectric union as specified hereinafter.

2.05 POLYETHYLENE BAGGING FOR BURIED METAL PIPE

- A. Polyethylene bagging for buried metal piping and fittings shall be 8 mil thick polyethylene consisting of three co-extruded and fused layers of low density polyethylene (LLDPE) infused with a corrosion inhibitor and an anti-microbial additive. Polyethylene bagging shall be V-Bio ® Enhanced Polyethylene Encasement by Ductile iron Pipe Research Association or approved equal.

2.06 PIPE PAINTING AND LABELING

- A. All exposed piping shall be painted for color coding and labeled as specified in Section 09 90 00, PAINTING.

2.07 BUILDING AND EQUIPMENT PIPING EXPANSION PROVISIONS

- A. Pipe anchors shall be placed where required by Code or shown on the Drawings. Flexible couplings or expansion joints shall be provided for piping systems and at connections to equipment where shown. The Contractor may install additional pipe anchors and flexible couplings to facilitate piping installation, provided that he submits complete details describing location, pipe supports, and hydraulic thrust protection. Acceptable types of flexible couplings and expansion joints shall be as specified hereinafter.

2.08 PIPING SUPPORT SYSTEMS

- A. Piping shall be supported, in general, as described hereinafter and as shown by the pipe support details on the Drawings, and in accordance with ASME B31.1 and B31.9, and MSS SP-58 and SP-69. Manufacturers' catalog figure numbers are typical of the types and quality of standard pipe supports and hangars to be employed.
- B. No attempt has been made to show all required pipe supports in all locations, either on the Drawings or in the details. The absence of pipe supports and details on any Drawings shall not relieve the Contractor of the responsibility for providing them throughout.

- C. All submerged piping supports, guides, and fasteners and those installed below channel, basin, and wet well wall tops and cover slabs or other high humidity areas such as in piping galleries shall be Type 316 stainless steel. Concrete anchors and anchor bolts shall be as specified in Section 05 50 00, MISCELLANEOUS METAL ITEMS. All submerged metal piping or piping in high humidity areas shall be electrically isolated from the supports with a wrap of 1/4-inch by 3-inch neoprene rubber between the pipe and oversize clamps.
- D. All support anchoring devices, including anchor bolts, inserts, and other devices used to anchor the support onto a concrete base, roof, wall or structural steel works, shall be of the proper size, strength and spacing to withstand the shear and pullout loads imposed by loading and spacing on each particular support.
- E. Detailed shop drawings of all supports, including support anchoring devices, shall be supplied with the submittals specified hereinbefore.
- F. Where piping connects to equipment it shall be supported by a pipe support and not by the equipment. A pipe support or hanger shall be installed adjacent to each pipe fitting or in-line device such as a valve or meter for all piping larger than 4-inch.
- G. Pipe support system components shall withstand the dead loads imposed by the weight of the pipes filled with water. Commercial pipe supports and hangers shall have a minimum safety factor of 5. In seismic zones, pipe supports shall also comply with all seismic design requirements. See General Structural Notes on the Drawings for seismic loading and design requirements.
- H. All exposed hangers, rods, clamps, protective shields, and metal framing support components and accessories shall be Type 316 stainless steel unless noted otherwise on the Drawings.
- I. Pedestal pipe supports shall be adjustable, with stanchion, saddle, U-bolt, and anchoring flange. Provide neoprene waffle isolation pad under anchoring flanges, adjacent to equipment or where otherwise required to provide vibration isolation.
- J. All piping shall be supported in a manner which will prevent undue strain on any valve, fitting, or piece of equipment. In addition, pipe supports shall be provided at changes in direction or elevation, adjacent to flexible couplings, and where otherwise shown. Pipe supports and hangers shall not be installed in equipment access areas, bridge crane runs, or other similar areas in locations where they will hinder operations and maintenance activities.

- K. Brace all piping 2-½ inches inside diameter and larger for seismic forces in accordance with the General Structural Notes on the Drawings. Seismic provisions shall also meet the requirements specified in Section 22 05 48, VIBRATION AND SEISMIC CONTROLS FOR PLUMBING AND HVAC PIPING AND EQUIPMENT.
- L. Horizontal piping shall be supported with adjustable swivel-ring, split-ring, or Clevis type hangers as shown, Anvil, Figure 104, 108, or 260; Eaton B-Line, Figure B3198H or B3100; or equal. Provide welding insulation saddles for insulated steel piping, Anvil Figure Series 160, Eaton B-Line Figure Series B3160, or equal.
- M. Pipe hangers for copper and plastic piping shall be coated with a plastic or neoprene protective cover. No metal portion of a hanger, support, or brace shall contact pipe directly.
- N. Stacked horizontal runs of small piping along walls shall be supported by a metal framing system as shown, Unistrut, Eaton B-Line Strut, Anvil-Strut, or equal. No pipe shall be supported from the pipe above it.
- O. Horizontal piping hanger support rods shall be supported by attachment to the roof trusses (wood trusses not less than 2 -inches thick) with lag screws and angle clips; by attachment to steel beams with concentric loading I-beam clamps; or by attachment to concrete with inserts, brackets, or flanges fastened with concrete anchors; as required or as shown on the Drawings.
- P. Vertical piping hangers and supports shall be channel and pipe straps manufactured by Unistrut, Eaton B-Line, Anvil, or equal. Piping supports for vertical piping passing through floor sleeves shall be stainless steel steel riser clamps.
- Q. Unless noted otherwise on the Drawings, horizontal pipe support or hanger spacing and hanger rod sizing for steel and ductile iron pipe shall be as follows:

<u>Pipe Size</u>	<u>Maximum Support and Hanger Span</u>	<u>Minimum Rod Size Single Rod Hangers</u>
1-inch and Smaller	6 feet	1/4-inch
1-1/4-inch thru 2-1/2-inch	8 feet	1/4-inch
3-inch and 4-inch	10 feet	3/8-inch
6-inch	12 feet	3/8-inch
8-inch	12 feet	1/2-inch
10-inch and 12-inch	14 feet	5/8-inch
14-inch	16 feet	3/4-inch
16-inch and 18-inch	16 feet	7/8-inch
20-inch	18 feet	1-inch
24-inch	18 feet	1 ¼-inch

30-inch and larger

As shown on the Drawings

- R. The load rating for universal concrete inserts or other attachment devices shall not be less than that of the hanger rods they support.
- S. When supporting cast iron and ductile iron pipe or steel pipe, locate hanger rods near all joints and at each change of direction.
- T. Hanger rod sizing for copper pipe shall be same as for steel pipe. Hanger or support spacing shall be 2 feet less per size than for steel pipe, with 1-inch and smaller supported every 5 feet.
- U. Hanger rod sizing for plastic pipe shall be same as for steel pipe. Spacing of hangers or supports shall be as recommended by the manufacturer for the flow temperature in the pipe.
- V. Vertical sway bracing shall be provided where shown, or on 10-foot maximum centers.
- W. See the Detail Pipe Specifications for stainless steel piping supports and hanger requirements.
- X. U-bolt type supports that tighten directly onto the pipe at the top or bottom points shall not be used for plastic or thin-walled metal (such as copper, stainless steel, etc.) pipe.

2.09 SLAB, FLOOR, WALL, AND ROOF PENETRATIONS AND CLOSURES

- A. All piping penetrations of slabs, floors, walls, and roofs shall be as shown on the Drawings. It shall be the Contractor's responsibility to verify the size and location of all building and structure penetrations prior to pouring concrete.
- B. Ductile Iron Wall Pipes:
 - 1. Provide ductile iron wall pipes where ductile iron piping passes through concrete walls, floors, slabs, and roofs which are to be watertight and where shown on the Drawings. Wall pipe end connections shall be as shown on the Drawings and as specified in the applicable Detail Piping Specification. Wall pipes shall be of a thickness equal to or greater than the remainder of the piping in the line and shall comply with the requirements for fittings in the applicable Detail Piping Specification. Flanges set flush with the face of concrete shall be tapped for stud bolts.
 - 2. All wall pipes shall be provided with standard integrally cast ductile iron seep rings (thrust collars) wherever possible. If standard

castings with integrally cast seep rings are not available to meet special conditions shown on the Drawings, special castings with a steel seep ring shall be made that will provide a watertight installation as shown on the details in the Drawings. Rubber-gasketed compression collars are not acceptable. The welding or brazing of seep rings to ductile iron wall pipes is also not acceptable. The Contractor shall place early orders for wall pipes so they are available in sufficient time for placement in concrete forms.

3. Thrust collars shall be rated for the thrust load developed at 250 psi and shall have a minimum safety factor of 2. Wall pipes shall be as manufactured by American Cast Iron Pipe Company, or equal.
4. Coat wall pipes with System No. 3 as specified in Section 09 90 00, PAINTING. Support wall pipes by formwork to prevent contact with reinforcing steel.

C. Steel and Stainless Steel Wall Pipes:

1. Thickness of steel and stainless steel wall pipes shall match corresponding piping to which attached.
2. Coat wall pipes with System No. 3 as specified in Section 09 90 00, PAINTING. Support wall pipes by formwork to prevent contact with reinforcing steel.

D. Pipe Sleeves:

1. Piping passing through concrete or masonry shall be installed through pipe sleeves where shown on the Drawings. Holes drilled with a suitable rotary drill will be considered in lieu of sleeves in existing walls. Plastic sleeves or stainless steel sleeves shall be used for this project. Plastic sleeves shall be made of HDPE thermoplastic with molded-in waterstop and reinforcing ribs, as manufactured by Link-Seal, Model CS, or equal.
2. All sleeves in exterior buried or water-bearing walls shall have a center flange for water stoppage unless shown otherwise. The annular space between pipes and sleeves shall be watertight. The joint shall be caulked with rubber sealant in areas not needing to be totally leak-proof, or sealed by a modular mechanical unit consisting of interlocking synthetic rubber links shaped to continuously fill the annular space between the pipe and sleeve where a leak-proof installation is needed and where shown on the Drawings. The interconnected rubber links shall be assembled with stainless steel bolts and nuts and stainless steel pressure plates under each bolt head and nut to prevent the nut from turning when the bolt is

tightened. Tightening of the bolts shall cause the rubber sealing links to expand, resulting in a watertight seal between the pipe and wall sleeve opening. The installed closure shall provide electrical isolation of the pipe from the wall sleeve. Closures shall be sized according to manufacturer's instructions for the size of pipes shown on the Drawings, and shall withstand a hydrostatic head of 40 feet of water. Annular mechanical seals shall be Link Seal by GPT/EnPro Industries, Inc; Pipe Seal by Flexicraft Industries: or equal.

3. Wall or floor sleeves shall be coated with the appropriate system for the intended location as specified in Section 09 90 00, PAINTING. When placing sleeves in concrete forms, support them by formwork to prevent contact with the reinforcing steel.

2.10 CORROSION PROTECTION

- A. Corrosion protection shall be provided for all pipe and pipe fittings as specified for specific pipe materials in PART 3 EXECUTION of this section, and in the following related sections:
 1. Section 09 90 00, PAINTING.

2.11 PIPE COUPLINGS AND EXPANSION JOINTS

- A. General: Flexible couplings, flanged coupling adapters, restrained couplings, and transition couplings shall be provided where shown on the Drawings. Size shall be compatible with the outside diameter of pipe(s) on which the coupling is installed. Flexible couplings, transition couplings, and flanged coupling adapters shall be provided with thrust ties where required, including those not shown on the Drawings. Thrust ties shall be attached to steel pipe with fabricated lugs, and to ductile iron pipe with cast-in-place lugs or flange lugs or socket clamps thrust tied across pipe couplings or flanges. Thrust protection shall be adequate to sustain the force developed by the greater of 1.) pipe operating pressure plus transient surge pressure, or 2.) pipe test pressures specified. Buried pipe coupling's coating system shall be fusion bonded epoxy and all bolts and nuts shall be Type 316 stainless steel. Exposed pipe couplings coating system shall match the adjoining pipeline and nuts and bolts shall match the pipeline bolting system specified in the Detailed Pipe specifications.
- B. Flexible Couplings: Flexible couplings for use with exposed PVC pipe shall be Smith-Blair Omni 441, or equal. Minimum working pressure shall be 150 psi. Flexible couplings for steel pipe shall be Dresser Style 38 or Smith-Blair Style 411, or equal. Flexible couplings for use with ductile iron pipe shall be Dresser, Style 38 or 138; Smith-Blair, Style 411 or 441; or equal. Flexible couplings for steel and ductile iron pipe shall be rated for 150 psi minimum working pressure, unless noted otherwise or used for high pressure service.

- C. Buried PVC Flexible Couplings: In buried applications with PVC pipe 12-inches and smaller, PVC flexible couplings shall be used. PVC flexible couplings are not allowable in exposed or concrete encased applications, or for pipes larger than 12 inches. PVC flexible couplings shall be High Deflection type couplings as manufactured by Certainteed, or equal. Couplings shall be rated for 200 psi working pressure and meet the requirements of AWWA C900 for municipal water pipe. Each coupling shall be complete with suitable gaskets to fit each particular application.
- D. Transition Couplings: Transition couplings used to connect pipes with small differences in outside diameter shall be Smith-Blair Omni Style 411 or 441, or Style 413 or 415; PowerSeal Pipeline Products Style 3501; Dresser Style 62 or 162; or equal. Minimum working pressure shall be 150 psi, unless noted otherwise or used for high pressure service.
- E. Flanged Coupling Adapters: Restrained flanged coupling adaptors for ductile iron and steel piping shall be Series 911 as manufactured by Smith-Blair; Series 2100 Megaflange as manufactured by EBAA Iron; Style RFCA as manufactured by Romac Industries; or equal. Restrained flanged coupling adaptors for thickwall PVC piping shall be Series 920 as manufactured by Smith-Blair; Series 2100 Megaflange as manufactured by EBAA Iron; Style RFCA-PVC as manufactured by Romac Industries; or equal. Minimum working pressure shall be 150 psi, unless noted otherwise or used for high pressure service.
- F. Dismantling Joints: Restrained dismantling joints for ductile iron and steel piping shall be Romac Industries Style DJ400; Smith-Blair Style 971; or equal. Minimum working pressure shall be 150 psi, unless noted otherwise.
- G. Expansion Joints and Bellows Type Flexible Couplings: Expansion joints and flexible couplings are not necessarily shown on the Drawings, but these joints and couplings and associated pipe anchors shall be provided by the Contactor, as required to allow for thermal expansion due to differences between installation and operating temperatures. Rigid gallery and trench piping, such as screwed, soldered, grooved end, and socket weld systems, shall provide for pipe expansion by the use of expansion joints, as specified herein:
 - 1. For Screwed, Galvanized, and Black Steel Pipe: Expansion joints for screwed, galvanized, and black steel pipe shall be Flexicraft, Model 2 expansion compensator; Hyspan Model 8503 expansion compensator; or equal. Expansion compensators shall have anti-torque device to protect the bellows. Minimum working pressure shall be 175 psig.
 - 2. For Non-metallic Pipe: Expansion joints for non-metallic pipe such as PVC and CPVC pipe shall be Teflon bellows type having three

convolutions, with ductile iron flanges, drilled 150 pound ANSI standard, and metal reinforcing bands. Expansion joints shall be furnished with limit bolts and elastic stop nuts suitable for the test pressures shown in the Piping Schedule. Expansion joints shall be rated 100 psi at 120 degrees F minimum and shall be Garlock, Style 215; ResistoFlex, R6905; or equal

3. For Flanged Steel Pipe and For Ductile Iron Pipe: Expansion joints shall be elastomer bellows expansion joints and shall be reinforced, molded wide arch type with 125-pound ANSI flanged ends, split galvanized steel flange retaining ring, and control rods to protect the bellows from overextension. The bellows arch shall be non-filled and shall have an inner lining of an elastomeric blend suitable for the design application; for normal water applications, lining shall be Buna-N, nitrile, EPDM, or chlorobutyl. Expansion joints for low pressure air service shall be rated for use at operating temperatures of up to 250 degrees F. Rated torsional rotation shall be minimum 2 degrees for all sizes. Burst pressure shall be four times the working pressure rating. Minimum compression, extension, lateral deflection, and minimum working pressure ratings shall be as follows unless noted otherwise or used for high pressure services.

Size, in	Compression, in	Extension, in	Lateral Deflection, degrees	Working Pressure, psig
2 - 4	1.4	0.7	0.6	200
5 - 10	1.6	0.8	0.7	190
12 - 20	1.6	0.8	0.8	115
24 - 36	2.0	1.0	0.9	90

- H. Concrete Encased Couplings: Couplings encased in concrete shall be sleeve type couplings, Dresser, Smith-Blair, or equal, and not grooved end type couplings.

2.12 SERVICE SADDLES FOR PLASTIC PIPE

- A. Service saddles for ASTM D1785 PVC and CPVC pipe, ASTM D2241 PVC pipe, and AWWA C900 PVC pipe shall have fusion bonded epoxy coated ductile iron bodies with Buna-N or EPDM gasket and stainless steel double straps and bolts. Service saddles shall be capable of withstanding 250 psi internal pressure without leakage or overstressing and the run diameter shall be compatible with the outside diameter of the pipe on which the saddle is installed. Taps shall have iron pipe threads. Saddles shall be Smith-Blair, Style 317; Ford Meter Box, Style FC 102; or equal.

- B. Service saddles for ASTM D2241 PVC pipe and AWWA C900 PVC pipe shall have all stainless steel bodies with Buna-N or EPDM gasket and stainless steel double straps and bolts. Service saddles shall be capable of withstanding 150 psi internal pressure without leakage or overstressing and the run diameter shall be compatible with the outside diameter of the pipe on which the saddle is installed. Taps shall have iron pipe threads. Saddles shall be Smith-Blair, Style 372; Ford Meter Box, Style FS 323; or equal.

2.13 TAPPING SLEEVES

- A. Pipe tapping sleeves for thickwall PVC, ductile iron or steel pipe shall be Smith-Blair Product No. 622, or equal, size as shown on the Drawings. Tapping sleeves shall be able to withstand 175 psig internal pressure without leakage or overstressing. The run diameter shall be compatible with the outside diameter of the pipe on which the tapping sleeve is installed. Taps shall be flanged, AWWA C207 Class D, ANSI 150 pound drilling. Sleeves shall be constructed of carbon steel with a fusion bonded epoxy coating. All bolts and nuts shall be Type 304 stainless steel.

2.14 DETECTABLE PIPE LOCATING TAPE FOR NONMETALLIC PIPE

- A. Material:
 - 1. Solid aluminum foil core encased in a protective high visibility, polypropylene and polyethylene plastic jacket.
 - 2. Special tin or nickel-coated clips to join ends of tape rolls.
- B. Foil: Visible on unprinted side.
- C. Thickness: Minimum 4.0 mils.
- D. Width: 6 inches.
- E. Color: APWA Uniform Color Code for Temporary Marking of Underground Utility Locations.
- F. Identifying Lettering: Minimum 1-inch high, permanent black lettering imprinted continuously over entire length.
- G. Manufacturer and Product:
 - 1. Reef Industries, Terra Sentry Line Detectable.
 - 2. Pro-Line Safety Products, Detectable Marking Tape.
 - 3. Or equal.

2.15 CONCRETE

- A. Thrust Blocks and Encasement: Provide of minimum 4,000 psi at 28 days in accordance with Section 03 30 00, CONCRETE.

2.16 BURIED PIPING ALTERNATE THRUST RESTRAINT SYSTEMS

- A. Alternate thrust restraint systems (instead of concrete thrust blocks) may be used for buried ductile iron and thickwall PVC piping at the Contractor's option for lower pressure (less than 200 psi) services. Alternate systems for lower pressure ductile iron services shall be rated for a minimum pressure of 350 psi for 3-inch to 16-inch piping and 250 psi for piping larger than 16-inch, with a minimum 2:1 safety factor. Alternate systems for lower pressure thickwall PVC services shall be rated to the full pressure rating of the pipe. Alternate systems may be:
 - 1. For ductile iron pipe with mechanical joint fittings, alternate thrust restraint system shall be Series 1100 Megalug as manufactured by EBAA Iron, Inc., or approved equal meeting the requirements of ANSI/AWWA C110/A21.10. Gland body and restraint components shall be made from minimum ASTM A536, 65-45-12 ductile iron and ductile iron wedges shall be heat treated to a range of 370 to 470 BHN.
 - 2. For ductile iron pipe with push-on joints or fittings, alternate thrust restraint system shall be Series 1700 Megalug Harness as manufactured by EBAA Iron, Inc., or approved equal meeting the requirements of ANSI/AWWA C110/A21.10. Restraint ring and wedging components shall be made from minimum ASTM A536, 65-45-12 ductile iron and wedges shall be heat treated to minimum 370 BHN. Connecting tie rods shall be made of low alloy steel conforming to ANSI/AWWA C111/A21.11.
 - 3. For thickwall PVC pipe with mechanical joint fittings, alternate thrust restraint system shall be Series 2000PV Megalug as manufactured by EBAA Iron, Inc., or approved equal meeting the requirements of ANSI/AWWA C110/A21.10. Gland body and restraint wedges shall be made from minimum ASTM A536, 65-45-12 ductile iron.
 - 4. For thickwall PVC pipe with push-on joints, alternate thrust restraint system shall be manufactured of ductile iron conforming to ASTM A536, Series 1900 or Series 2800 Megalug Harness as manufactured by EBAA Iron, Inc., or approved equal.

PART 3 EXECUTION**3.01 GENERAL**

- A. Install all piping, fixtures, equipment, and accessories in strict accordance with the plumbing laws, rules, and regulations of the state or county, and of the City of Bullhead City, whichever represents the higher standard. All work shall be approved by the state, county, and/or the City plumbing inspector. All work shall also be installed according to AWWA C600 and C605.
- B. Drawings do not attempt to show exact details of all piping, and no extra payment will be allowed for obstruction by work of other trades or local obstructions to the work under this Contract which require offsets. Where diagrams have been made to show piping connections, the Contractor is cautioned that these diagrams must not be used for obtaining material quantities. Changes in location of equipment or piping, advisable in the opinion of the Contractor, shall be submitted to the Engineer for approval before proceeding with the work. All measurements and dimensions shall be verified at the site.
- C. In piping that is not flanged, install unions in piping system wherever they will expedite removal of equipment and valves.
- D. All air release valves, water-lubricated bearings, and other appurtenances having water effluent shall be piped to nearest drain with copper tubing pipe, unless otherwise shown on the Drawings.

3.02 DRAIN AND VENT PIPING

- A. Set waste and vent piping occurring above the floor slab true and plumb. Set exposed risers as close to walls as possible. Where vent stacks pass through the roof slab, fit with flashing sleeve to secure the roofing. Flashing and roof connection shall be watertight. Extend vents at least 1 foot above roof. Provide cleanouts where shown and where required by code.

3.03 PIPE PREPARATION AND HANDLING

- A. Each pipe and fitting shall be carefully inspected before the exposed pipe or fitting is installed or the pipe or fitting is lowered into the trench. Interior and exterior protective coatings shall be inspected, and all damaged areas patched in the field with material similar to the original. Plastic pipe shall not have scratches exceeding manufacturer recommended depths. Clean ends of pipe thoroughly. Remove foreign matter and dirt from inside of pipe and keep clean during and after laying.
- B. Use proper implements, tools, and facilities for the safe and proper protection of the pipe. Carefully handle pipe in such a manner as to avoid

any physical damage to the pipe. Do not drop or dump pipe into trenches under any circumstances.

- C. Pipe Cutting: Cutting for closure or other reasons shall be done neatly by methods which will not damage pipe. Plastic pipe shall be cut with fine tooth saw, cutter, or knife designed for use with plastic pipe. Burrs shall be removed by smoothing edges with a knife, file or sandpaper. Spigot end shall be beveled.

3.04 INSTALLATION OF BURIED PIPING

A. General:

1. Buried piping locations are shown on the Drawings. In general, unless specifically shown otherwise in the Drawings, piping elevations and grades are not shown for all buried piping. Where pipe system invert elevations are shown on the Drawings, piping shall be installed in a straight line between adjacent elevations. Where buried pressure piping is shown on the Drawings without elevations and grades, the Contractor shall run buried piping along the lines indicated at the minimum depth of bury specified herein or as required to provide an acceptable installation, in which case the depth of bury shall not be less than that specified. The Contractor shall verify the location of existing piping prior to the submittal of pipe laying and fabrication drawings for review by the Engineer. Where interferences are encountered, the Contractor shall make necessary modifications to the piping indicated in the Drawings. Modifications shall be provided to the Engineer for review as part of the requirements of the piping submittals during construction.
2. Locating Piping Interferences: The Contractor shall perform all necessary work required to determine the location and depth of bury of existing piping where possible interferences with proposed locations of new piping may exist, including "pot-holing" to expose the piping surface. Contractor shall inform the Engineer of his intent to do such work a minimum of 24 hours prior to the commencement of such work.
3. Pipe Cover: Minimum pipe cover shall be 3.0 feet unless otherwise indicated.

- B. Preparation of Trench: Trench Excavation and Backfill and Stabilization shall be in accordance with Section 31 23 33, TRENCH EXCAVATION AND BACKFILL FOR PIPELINES AND APPURTENANT STRUCTURES and as specified below:

1. Provide pipe base material for supporting the pipe for the full width of the trench. Minimum depth of pipe base below the pipe barrel shall be 6 inches. Depth of pipe base under the pipe bell shall not be less than 4 inches.
2. Hand-grade pipe base to proper grade ahead of pipe laying operation. Pipe base shall provide a firm, unyielding support along the entire pipe length.
3. If the trench has been excavated below the required depth for pipe base placement without direction from the Engineer, fill the excess depth, at the Contractor's own expense, with the pipe base specified herein or foundation stabilization material as specified in Section 31 23 33, TRENCH EXCAVATION AND BACKFILL FOR PIPELINES AND APPURTENANT STRUCTURES to the proper subgrade. Place the pipe base or foundation stabilization material for the full width of the trench in layers not exceeding 6 inches deep and compact each layer, until the material does not yield or move, to the grade established for the pipe bedding.

C. Laying Buried Pipe:

1. General:
 - a. All buried pipe shall be prepared as hereinbefore specified and shall be laid on the prepared granular base as specified in Section 31 23 33, TRENCH EXCAVATION AND BACKFILL FOR PIPELINES AND APPURTENANT STRUCTURES and bedded to ensure uniform bearing. No pipe shall be laid in water or when, in the opinion of the Engineer, trench conditions are unsuitable. Joints shall be made as herein specified for the respective types. Take all precautions necessary to prevent uplift and floating of the pipe prior to backfilling.
 - b. Do not deviate more than 1-inch from line or 1/4-inch from grade. Measure for grade at the pipe invert, not at the top of the pipe, because of permissible variation in pipe wall thickness.
 - c. Grade the bottom of the trench by hand to the line and grade to which the pipe is to be laid, with proper allowance for pipe thickness and for pipe base when specified or indicated. Remove hard spots that would prevent a uniform bearing. Before laying each section of the pipe, check the grade with a straightedge and correct any irregularities found. The trench bottom shall form a continuous and uniform bearing and support for the pipe at every point between bell holes, except

- that the grade may be disturbed for the removal of lifting tackle.
- d. At the location of each joint, dig bell (joint) holes of ample dimensions in the bottom of the trench and at the sides where necessary to permit easy visual inspection of the entire joint.
 - e. Provide and maintain ample means and devices at all times to remove and dispose of all water entering the trench during the process of pipe laying. The trench shall be kept dry until the pipe laying and jointing are completed. Removal of water shall be in conformance with specifications in Section 31 23 33, TRENCH EXCAVATION AND BACKFILL FOR PIPELINES AND APPURTENANT STRUCTURES and Section 31 23 00, EARTHWORK FOR STRUCTURES.
 - f. When the pipe laying is not in progress, including the noon hours, the open ends of pipe shall be closed, and no trench water, animals, or foreign material shall be permitted to enter the pipe.
 - g. Where the pipe is connected to concrete structures, the connection shall be made as shown on the Drawings. If the connection is not shown, make connection such that a standard pipe joint is located no more than 24 inches from the structure.
 - h. All buried PVC pipe shall be installed in accordance with the pipe manufacturer's recommendations. Smaller diameter buried plastic pipe with rigid joints shall be laid by snaking the pipe from one side of the trench to the other. Offset shall be as recommended by the manufacturer for the maximum temperature variation between time of solvent welding and during operation.

2. Installation of Concrete Embedded Piping:

- a. Concrete embedded piping shall be installed as shown on the Drawings and as specified in Section 03 30 00, CONCRETE. Maximum allowable distortion for concrete embedded steel pipe is 3 percent of the pipe inside diameter. The Contractor shall perform all necessary work required to insure pipe distortion is minimized including bracing pipe inside diameter, reinforcing pipe circumferentially, increasing pipe wall thickness, and controlling concrete placement where required.
- b. All concrete embedded metallic piping shall be supported as required to prevent contact with reinforcing steel during concrete installation.
- c. Wall Pipes and Pipe Sleeves: Wall pipes and pipe sleeves embedded in concrete walls, floors, and slabs shall be

embedded as specified in Section 03 30 00, CONCRETE and as shown. Support all pipes embedded in concrete walls, floors, and slabs with formwork to prevent contact with the reinforcing steel.

3. Laying Ductile Iron, Polyvinyl Chloride, and FRP (Gravity) Pipe:
 - a. Join ductile iron, polyvinyl chloride, and FRP gravity pipe in strict accordance with the manufacturer's recommendations. Provide all special tools and devices, such as special jacks, chokers, and similar items required for proper installation. Lubricant for the pipe gaskets shall be furnished by the pipe manufacturer, and no substitutions will be permitted under any circumstances.
 - b. Pipe laying shall proceed upgrade with spigot ends pointing in direction of flow. After a section of pipe has been lowered into the prepared trench, clean the end of the pipe to be joined, the inside of the joint, and the rubber ring immediately before joining the pipe. Make assembly of the joint in accordance with the recommendations of the manufacturer of the type of joint used. Provide all special tools and appliances required for the joining assembly.

D. Thrust Blocking and Alternate Thrust Restraint Systems:

1. Provide thrust blocking and/or alternate thrust restraint systems at all buried bends, tees, and other similar locations even though not typically shown on the Drawings. Place thrust block concrete against undisturbed earth. Construct suitable forms to obtain shapes that will provide full bearing surfaces against undisturbed earth, as indicated. Cure thrust blocks before conducting hydrostatic tests. Take care not to over excavate in the areas where thrust blocks are to be placed. The blocking shall be so placed, unless specifically shown otherwise, so that pipe and fitting joints will be accessible for repairs. Thrust blocks shall be sized for hydrostatic test pressure and an allowable soil bearing stress of 2,000 psf maximum.
2. Alternate mechanical thrust restraint system may be used for lower pressure services buried ductile iron piping systems as specified hereinbefore. For high pressure buried ductile iron piping services, provide alternate thrust restraint systems and concrete thrust blocks as specified hereinbefore. Install alternate thrust restraint systems per the manufacturer's installation instructions and AWWA C600.
3. No references to thrust protection details for buried and embedded piping have been shown on the Drawings unless special details are

required. The absence of details on any Drawings shall not relieve the Contractor of the responsibility for providing them throughout.

E. Connecting Dissimilar Pipe Materials:

1. Connect dissimilar pipe materials by means of a flexible coupling specified hereinbefore. Install couplings in strict accordance with the manufacturer's recommendations.

3.05 INSTALLATION OF FLEXIBLE COUPLINGS, FLANGED COUPLING ADAPTERS, TRANSITION COUPLINGS, AND RESTRAINED COUPLINGS

- A. Prior to installation, thoroughly clean oil, and dirt from the pipe to provide a clean seat for the gasket. Care shall be taken that the gaskets are wiped clean before they are installed. Flexible couplings, flanged coupling adapters, and transition coupling gaskets shall be lubricated with manufacturer's standard lubricant before installation on the pipe ends. Install in accordance with the manufacturer's recommendations. Bolts shall be tightened progressively, drawing up bolts on opposite sides until all bolts have a uniform tightness. Workmen tightening bolts shall use torque-limiting wrenches.

3.06 INSTALLATION OF EXPOSED PIPING

- A. All pipe flanges shall be set level, plumb, and aligned. All flanged fittings shall be true and perpendicular to the axis of the pipes. All bolt-holes in flanges shall straddle vertical centerline of pipes.
- B. Piping shall be installed without springing or forcing the pipe in a manner which would set up stresses in the pipe, valves, or connected equipment.
- C. Unless shown otherwise, piping shall be parallel to building lines. Hangers on adjacent piping shall be aligned where possible on common size ranges.
- D. On screwed or welded pipe, unions shall be installed where required for piping or equipment installation, even though they are not shown on the Drawings.
- E. Plastic flanges shall be bolted up using a filler gasket at any joint with a raised face. The filler gasket shall bear the bolt load uniformly and remove the flange moment from that part of the flange protruding beyond the outer edge of the raised face.
- F. Pipe taps to the pipe barrel are unacceptable. Pipe tap connection to ductile iron piping shall only be made at a tapping boss of a fitting, valve body, or equipment casting. Pipe tap connections to steel piping shall be made only with a welded thread-o-let connection.

- G. Required straight runs of piping upstream and downstream of flow measuring devices shall be smooth.
- H. Where valve hand wheels are shown, valve orientation shall be as shown. Where valve hand wheels are not shown, valves shall be oriented to permit easy access to the hand wheels, and to avoid interferences.
- I. Unions, strainers, and all other similar in-line devices shall be installed in piping in a manner which allows adequate clearances for maintenance of the device.

3.07 PIPING CORROSION PROTECTION

A. General:

- 1. All pipe and accessories shall be protected from corrosion and adverse environmental conditions. Protection shall include lining and coatings of pipe, material selection, and/or coatings of supports, tie rods, expansion joints, and all other piping accessories and appurtenances.
- 2. Not all corrosion protection details are included, either on the Drawings or in the Specifications. The absence of specific details on corrosion and environmental protection measures shall not relieve the Contractor of the responsibility of providing them, all as part of the Contract price.
- 3. Also see Section 09 90 00, PAINTING, and the Detail Piping Specifications.

B. Buried Piping Accessories:

- 1. All buried pipe appurtenances made of steel shall have corrosion protection as specified in Section 09 90 00, PAINTING. Flange bolts, nuts, tie rods, and similar items shall be stainless steel or fusion bonded coated. Flexible couplings, grooved couplings, and similar items shall be fusion bonded epoxy coated.

C. Exposed Piping Accessories:

- 1. All exposed surfaces of black and hot-dip galvanized steel, brass, copper and bronze piping components including, but not limited to, pipe supports, expansion joints, pipe guides, flexible couplings, vent and drain valves and fasteners shall be painted in accordance with Section 09 90 00, PAINTING, System No. 5.

2. Pipe support systems shall be painted the same color and paint system as the supported piping. Stainless steel pipe supports shall not be painted unless directed by Engineer.

D. Ductile Iron Pipe:

1. For Exposed Ductile Iron: Exterior protection shall be in accordance with Section 09 90 00, PAINTING, System No. 5. Fittings, bolts, and nuts shall be coated the same as the pipe.
2. Epoxy Linings: All piping that is to be epoxy-lined shall be lined with ceramic epoxy in accordance with Section 40 05 10.03, DPS-Epoxy Lined Ductile Iron Pipe and Fittings. All ductile iron pipe shall be epoxy-lined.
3. Exterior Protection for Buried, Submerged, or Encased Pipe:
 - a. All submerged or concrete encased ductile iron piping shall be coated with epoxy, and coating shall be as specified in Section 09 90 00, PAINTING, System No. 2 (submerged) or System No. 3 (buried and encased). Coating shall be applied by a qualified coating applicator.
 - b. All abraded areas of epoxy coatings on ductile iron or cast iron soil pipe to be submerged or concrete encased shall be cleaned and repaired to provide a protective covering equal to the original and acceptable to the Engineer.
 - c. Exterior Protection for Buried Pipe: Buried ductile iron and cast-iron soil piping shall be wrapped with low density polyethylene tube bagging as specified in paragraph 2.05 above. Backfill material shall be rounded and free of materials that could damage polyethylene encasement. Overlap and secure polyethylene encasement so as to provide a snug fit with minimum space between encasement and pipe. Do not allow foreign materials into space between pipe and encasement. Overlap and secure in place with polyethylene tape. Insect pipe prior to pipe installation and during installation and compaction of backfill. Repair all cuts, tears, holes, punctures or damage with a minimum of three layers of polyethylene adhesive tape.

3.08 PROTECTION FOR NON-METALLIC PIPE

- A. For all non-metallic pipe, duct, and other accessories exposed and outside of buildings, ultraviolet protection and/or color coding shall be provided by coating pipe with System No. 24 as specified in Section 09 90 00, PAINTING.

3.09 PIPE PAINTING AND COLOR CODING

- A. Painting, identification, and color coding of piping systems shall be as specified in Section 09 90 00, PAINTING. Paint systems specified shall be applied to piping prior to insulating. Identification and color coding shall also be applied to the exterior covering of insulated piping.

3.10 EXPANSION PROVISIONS

- A. All piping support systems shall have adequate provisions for accommodating pipe movement due to thermal expansion and/or terminal point movements. Piping expansion provisions shall be provided as specified hereinafter.
- B. Expansion joint details for all piping systems have not been shown unless special details are required. The absence of details on any Drawings shall not relieve the Contactor of the responsibility for providing them throughout the plant. Any modifications to the piping systems which have expansion joint details shown on the Drawings, including the addition of expansion joints where not shown, shall require a review of the piping system indicated. All proposed modifications to the piping systems shown on the Drawings shall be reviewed by the Engineer, prior to construction. The cost of modifying the existing piping system shall be borne by the Contractor.
- C. Expansion Provisions for Grooved End Piping: In those piping systems where the Contractor is given the option of providing either flanged or grooved end joints, expansion provision requirements shall be provided as follows:
 - 1. For piping 3 inches and larger, piping expansion joints indicated on the Drawings may be replaced by an expansion control system incorporating flexible type grooved end joints only where approved by the Engineer.
 - 2. For piping smaller than 3 inches, piping expansion provisions are specified hereinafter. Grooved end piping expansion control systems may be used in lieu of that specified.
- D. Expansion Provisions For Piping Smaller Than 3 Inches:
 - 1. Expansion provisions for steel piping less than 3-inch nominal diameter shall be provided with piping flexibility using expansion bellows type couplings or piping bends. Maximum spacing of couplings or bends shall be as indicated herein under expansion joint spacing. Expansion square-bends shall be used in straight piping runs to provide expansion flexibility. Square-bend dimensions shall be as required by the specific application for an allowable piping

stress of 12,000 psi. Minimum piping temperature for calculations shall be 40 degrees F. Maximum piping temperature shall be 100 degrees F or the maximum operating temperature indicated in Section 40 02 05, PIPING SCHEDULE, whichever is greater. Piping anchors shall be installed at the midpoint between expansion bends, where more than one expansion bend is required in a straight run of piping.

2. Expansion provisions for PVC, CPVC and FRP piping less than 3-inch nominal diameter shall be provided with piping flexibility using expansion type bellows couplings or piping bends. Maximum spacing of couplings or bends shall be as indicated herein under expansion joint spacing. Expansion square-bends shall be used in straight piping runs to provide expansion flexibility. Square-bend dimensions shall be as required by the piping manufacturer for the specific application. Minimum piping temperature for calculations shall be 40 degrees F. Maximum piping temperature shall be 100 degrees F or the maximum operating temperature indicated in Section 40 02 05, PIPING SCHEDULE, whichever is greater. Piping anchors shall be installed at the midpoint between expansion bends, where more than one expansion bend is required in a straight run of piping.
3. Where the application excludes the use of the piping expansion provisions specified, the Contractor shall provide expansion joints designed for the indicated service and application. The Contractor shall provide details of the proposed installation to the Engineer for review as part of the requirements specified herein for Paragraph SUBMITTALS. Installation shall include two pipe alignment guides on each side of the expansion joint spaced at 4 and 14 pipe diameters from the expansion joint. Provide piping anchors at the limits of all straight runs of piping requiring expansion joints. For straight runs of piping requiring more than one expansion joint, piping anchors shall be installed at the midpoint between piping expansion joint locations.

- E. Expansion Joint Spacing (Piping Smaller Than 3 Inches): Unless closer spacing is indicated on the Drawings, the maximum spacing for expansion joints shall be:

Type of Pipe	Max. Run Without Expansion Joint, Loop or Bend (Ft)	Expansion Joint Max. Spacing in Straight Runs Bounded By Expansion Joints (Ft)
Steel (Hot Pipe Service)	30	100

Steel (General Service)	30	100
Copper (Hot Pipe Service)	20	100
Copper (General Service) 1-Inch & Smaller	NR	NR
1 ½-inch thru 2 ½-inch	50	100
PVC, CPVC	20	60
FRP	40	100

3.11 TESTING

- A. General: The Contractor shall conduct pressure and leakage tests concurrently on all newly installed pipelines in accordance with this specification and AWWA C600 and C605. Furnish all necessary equipment and material and make all taps in the pipe, as required. The Engineer will monitor the tests and all testing and results must meet the satisfaction of the Engineer. Test pressures shall be as specified in Section 40 02 05, PIPING SCHEDULE. New pipelines which are to be connected to existing pipelines shall be tested by isolating the new pipe with grooved end pipe caps, spectacle blinds, or blind flanges, plugs or other fittings as appropriate for the pipe type.
- B. Preparation and Execution: Conduct hydrostatic and leakage tests on buried piping after the trench has been adequately backfilled. The Contractor may, if field conditions permit, as determined by the Engineer, partially backfill the trench and leave the joints open for inspection and conduct an initial service leak test. The acceptance test shall not, however, be conducted until all backfilling has been completed. Conduct the tests on exposed piping after the piping has been completely installed, including all supports and anchors. Exposed piping shall have no visible leakage.
- C. Hydrostatic Leak Test:
 1. Water: Water for testing shall be clean and be provided by the Contractor. It shall be the Contractor's responsibility to pipe, valve, pump, and otherwise transport water from the source to the new pipe. Test water shall be clean and shall be of such quality as to minimize corrosion in the piping system.
 2. Procedure: Slowly fill the test section with water to expel air from the pipeline. Temporary vent outlets with valves shall be installed as required for complete venting of the pipeline during filling. Venting during the filling of the system also may be provided by the loosening of flanges having a minimum four bolts or by the use of equipment vents. All parts of the piping system shall be subjected to the test pressure specified in Section 40 02 05, PIPING SCHEDULE, or as specified hereinafter. The hydrostatic test pressure shall be

continuously maintained for a minimum time of 60 minutes and for each additional time as may be necessary to conduct examinations for leakage. Examination for leakage shall be made at all joints and connections. The piping system, exclusive of possible localized instances at pump or valve packing, shall show no visual evidence of weeping or leaking. Any visible leakage shall be corrected at the Contractor's sole expense.

3. **Testing Equipment:** The Contractor shall provide all necessary piping connections together with test pumping equipment, water meters, pressure gauges, hose and suction pipe, and other materials, equipment, facilities, and labor required for the tests. Water meters and pressure gauges shall be accurately calibrated and shall be subject to inspection by the Engineer. Test pressures shall be applied by means of a force of such design and capacity that the required pressure can be applied and maintained without interruption for the duration of each test.
4. Test pressures and limitations shall be as follows if not specifically noted in Section 40 02 05, PIPING SCHEDULE:
 - a. Sections shall be tested at 1.5 times the working pressure at the point of testing.
 - b. Test pressure shall be greater than 1.25 times the normal working pressure at the highest point along the test section.
 - c. Test pressures shall not exceed pipe, fitting, valves, or thrust block design pressures.
 - d. Pressures shall not vary by more than plus or minus 5 psi.
 - e. Minimum test pressure shall be 50 psi.
5. **Buried Pressure Lines:**
 - a. A minimal amount of leakage is permissible from buried pressure lines. Consequently, the hydrostatic testing of these pipelines must be conducted in a different manner, as follows.
 - b. Where any section of pipe is provided with concrete thrust blocking, do not make the pressure test until the concrete has reached at least 75 percent of its design strength and a minimum of at least 6 days have elapsed after the thrust blocking is installed. If high-early cement is used for thrust blocking, the time may be reduced to 3 days. When testing cement mortar lined piping, slowly fill the section of pipe to be tested with water and allow to stand for 24 hours under slight pressure to allow the cement-mortar lining to absorb water.
 - c. Expel all air from the piping system prior to testing and apply and maintain the specified test pressure by means of the

hydraulic force pump. Valve off the piping system when the test pressure is reached and conduct the pressure test for 2 hours, reopening the isolation valve only as necessary to restore the test pressure. The pump suction shall be in a barrel or similar device, or metered so that the amount of water required to maintain the test pressure may be measured accurately. This measurement represents the leakage, which is defined as the quantity of water necessary to maintain the specified test pressure for the duration of the test period. No pipe installation will be accepted if the leakage is greater than the number of gallons per hour as determined by the following formula:

$$L = \frac{SD (P)^{1/2}}{148,000}$$

where L = Allowable leakage in gallons per hour

S = Length of pipe tested in feet

D = Nominal pipe diameter in inches

P = Average test pressure in psi

6. Leakage Repair: The Contractor shall repair any leakage at his own expense and retest the pipeline until allowable leakage is achieved.

D. Pneumatic Leak Tests:

1. Equipment: Contractor shall conduct and furnish the following equipment for the pneumatic tests:

<u>Amount</u>	<u>Description</u>
1	Pneumatic compressor separator-dryer system capable of providing oil-free dry air and equipped with one or more full capacity safety relief valves set at a pressure of not more than 105 percent of the required primary test pressure.
1	Calibrated test gauge.

2. Procedure:

- a. Pneumatic testing shall be performed using accurately calibrated instruments and oil-free, dry air. Test shall be performed only after the piping has been completely installed, including all supports, hangers and anchors, and inspected for proper installation. All parts of the piping system shall be

subjected to test pressure specified in Section 40 02 05, PIPING SCHEDULE. The Contractor shall recognize the hazards associated with air testing and shall take all necessary precautions to protect test personnel and Owner's operating personnel. All piping to be tested shall be secured to prevent damage to adjacent piping and equipment in the event of a joint failure. Any appurtenant instruments or devices that could be damaged by the test shall be removed from the piping or suitably isolated prior to applying the test. Prior to starting the test, the Contractor shall notify the Engineer.

- b. A preliminary pneumatic test not to exceed 25 psig shall be applied to the piping system prior to final leak testing, as a means of locating major leaks. Examination for leakage, detected by soap bubbles, shall be made at all joints and connections. After all visible leaks have been corrected, the pressure in the system shall gradually be increased to not more than $\frac{1}{2}$ of the test pressure, after which the pressure shall be increased in steps of approximately $\frac{1}{10}$ of the test pressure until the required test pressure has been reached. The pneumatic test pressure shall be continuously maintained for a minimum time of 10 minutes and for such additional time as may be necessary to conduct a soap bubble examination for leakage. The piping system, exclusive of possible localized instances at pump or valve packing, shall show no evidence of leakage. Any visible leakage or pressure loss shall be corrected at the Contractor's sole expense.
- c. Following pneumatic testing, lines which are to carry flammable gases shall be thoroughly purged with nitrogen to assure that no explosive mixtures will be present in the system during the filling process.

E. Initial Service Leak Tests:

- 1. **Equipment:** Equipment used for initial service leak testing may be the same as that specified under HYDROSTATIC AND PNEUMATIC LEAK TESTS hereinbefore, or the pump or compressor connected to the piping system.
- 2. **Procedure:** The initial service leak test shall be performed by gradually bringing the piping system up to normal operating pressure and holding it there continuously for a minimum time of 10 minutes. Examination for leakage shall be made at all joints and connections. Soap bubbles shall be used to detect leaks in pneumatically-tested systems. The piping system, exclusive of possible localized instances at pump or valve packing, shall show no visual evidence

of weeping or leaking. Any visible leakage or pressure loss shall be corrected at the Contractor's sole expense.

- F. Test Records: Records shall be made of each piping system installation during the test. These records shall include:
1. Date of test.
 2. Description and identification of piping tested.
 3. Test fluid.
 4. Test pressure.
 5. Remarks, to include such items as:
 - a. Leaks (type, location).
 - b. Repairs made on leaks.
 6. Certification by Contractor and signed acknowledgment by Engineer.

3.12 INTERIM CLEANING

- A. Care shall be exercised during fabrication to prevent the accumulation of weld rod, weld spatter, pipe cuttings and filings, gravel, cleaning rags, etc. within piping sections. All piping shall be examined to assure removal of these and other foreign objects prior to assembly. Shop cleaning may employ any conventional commercial cleaning method if it does not corrode, deform, swell, or otherwise alter the physical properties of the material being cleaned.

3.13 FINAL CLEANING

- A. Following assembly and testing and prior to final acceptance, all pipelines installed under this section, except chemical gas, air lines, fuel lines, and instrument air lines, shall be flushed with water and all accumulated construction debris and other foreign matter removed. Flushing velocities shall be a minimum of 2.5 feet per second. Cone strainers shall be inserted in the connections to attached equipment and left there until cleaning has been accomplished to the satisfaction of the Engineer. Accumulated debris shall be removed through drains 2-inch and larger or by removing spools and valves. Immediately following drainage of flushed lines, the piping shall be air dried with compressed air.
- B. It must be understood that flushing removes only light solids and cannot be relied on to remove heavy materials allowed to get into the pipe during installation. If necessary, the Contractor shall also clean pipelines 2 inches

and larger by pigging with an acceptable flexible pig made specifically for this purpose.

- C. Chemical gas, air, fuel lines, and instrument air piping shall be blown clean of loose debris with compressed air.

3.14 WALL PIPES AND PIPE SLEEVES

- A. Wall pipes and pipe sleeves embedded in concrete walls, floors, and slabs shall be embedded as specified in Section 03 30 00, CONCRETE and as shown. Support all pipes embedded in concrete walls, floors, and slabs with formwork to prevent contact with the reinforcing steel.

3.15 FLEXIBLE JOINTS AT CONCRETE STRUCTURES

- A. A flexible joint shall be provided at the face of all manholes or other structures. The joint may be flush with the face, may be up to one-half pipe diameter away from the face, but shall not be more than 36 inches away from the face, unless specifically shown otherwise on the Drawings.
- B. A second flexible joint may be provided within 24 inches of the first joint.
- C. Flexible joints may be rubber ring joints, mechanical joints, or flexible couplings, unless shown otherwise on the Drawings.

3.16 PERMISSIBLE DEFLECTION AT JOINTS

- A. Wherever it is necessary to deflect pipe from a straight line, either in the vertical or horizontal plane, do not exceed 50 percent of the amount of deflection recommended by the pipe or coupling manufacturer, or as shown on the Drawings.

3.17 FABRICATION OF FLANGED PIPE

- A. Flanged pipe shall be fabricated in the shop, not in the field, and delivered to the jobsite with flanges in place and properly faced. Threaded flanges shall be individually fitted and machine tightened on matching threaded pipe by the manufacturer. Flanges shall be faced after fabrication in accordance with ANSI A21.15/AWWA C115. A sufficient number of selected flange-to-pipe threaded joints shall be hydrostatically shop tested to ensure joint integrity.

3.18 JOINT HARNESSSES FOR STEEL PIPING

- A. Where harnessing across flexible couplings or flanged coupling adaptors is indicated, adequately designed joint harnessing shall be provided. The harnessing assembly shall consist of a combination of adequately designed harness lugs and a suitable number of high strength tie rods. The bearing

plate under the harness rod nut shall be of adequate thickness and beam strength to ensure little or no deflection under thrust loads. Pipe wall where the harness lugs attach shall be reinforced if necessary.

- B. The harnessing design shall be based on maximum thrust induced by an internal pressure as defined in the test pressures in Section 40 02 05, PIPING SCHEDULE, or 100 psig minimum, and shall be submitted with the shop drawings for the pipe and fittings, all of which shall be reviewed by the Engineer before fabrication is started. The harness and accessories shall be furnished with a shop applied primer suitable for finished painting.

3.19 ADDITIONAL INSTALLATION CONSIDERATIONS FOR BURIED DUCTILE IRON OR STEEL PIPE

- A. Transportation, Storage and Handling for Ductile Iron and Steel Pipe: Shop coated materials shall be handled, transported, stored and shipped in a manner that will prevent damage to the coating and lining. Coating or lining damaged in handling or other operations shall be repaired to the approval of and at no additional cost to the Owner. Damage to the coating or lining shall be repaired. Pipe stored along the trench side shall be suitably supported off the ground to avoid damage to the coating. At all times during construction of the pipeline, the Contractor shall use every precaution to prevent damage to protective coating and lining on the pipe. No metal tools or heavy objects shall be permitted to come into contact unnecessarily with the finished coating. Workmen shall not be permitted to walk upon the coating except when absolutely necessary; in such case, they shall wear shoes with rubber or composition soles and heels or other suitable footwear that will not damage the coating. Any damage to the pipe or the protective coating from any cause during the installation of the pipeline and before final acceptance by the Engineer shall be repaired in accordance with these Specifications and at no additional cost to the Owner. Adequate cross bracing shall be installed in the ends of the pipe to maintain the pipe roundness during transportation and handling. The ends of the pipe shall be sealed with clear polyethylene film at the point of manufacture. The seals shall remain until the pipe is being prepared to be installed.
- B. Pipe shall be hoisted from the trench side to the trench by means of wide-belt slings. Metal chains, cables, tongs or other equipment likely to cause damage to the coating shall not be permitted. The Contractor shall allow inspection of the coating on the underside of the pipe while the pipe is suspended from the slings. Coated pipe shall be handled with nylon sling choker belts or equivalent. Caliper clamps shall not be used. Sufficient shoring of dunnage, padding and bonding shall be used when stacking and shipping pipe to adequately protect the pipe and its coating.

- C. Pipe shall not be placed directly on rough ground but should be properly blocked when stored. Rolling pipe on the coated surface shall not be permitted, but if the ends are bare, the pipe may be rolled on sleepers on the bare places. Before placement in the trench, pipe shall be inspected by the Contractor, for damage. In all cases, clean the gasket, the bell interior, the groove area and the spigot area with a rag, brush or paper towel to remove any dirt or foreign material before assembling. Pipe shall be laid up-hill on slopes of 6% or greater. O-ring joints shall be laid by stabbing the spigot into the bell in accordance with pipe manufacturer's instructions. The joint shall be driven home to full engagement, allowable deflection taken by pulling one side, top or bottom as required. Each joint shall be checked with a feeler gauge for the entire circumference to assure that the gasket has not been rolled out during assembly. Pinched or cut gaskets shall be destroyed and a new gasket used. Each pipe length shall be backfilled at least partially before the next length is installed to prevent pull-out or movement of the pipe. The Contractor shall provide a method of detecting movement of the previously placed pipe length, prior to the placement of the next length. Whenever pipe laying is interrupted, the open ends of installed pipe shall be closed with a watertight plug to prevent entrance of trench water, mud or foreign matter.
- D. Cut ends of pipe shall be beveled and filed to prevent gasket damage in joint assembly.
- E. Bolted sleeve-type couplings shall be installed in accordance with AWWA C219. Install joint harnesses in accordance with AWWA M11.

3.20 SAFETY CONSIDERATIONS

- A. No water piping shall be installed immediately over or within a 3-foot plan view clearance of any electrical panel, motor starter, or mechanical mounting panel. Where piping must be located within these zones, install piping inside a PVC conduit or shield the electrical device to prevent direct water access to electrical equipment in the event of a pipe leak, or provide other protection as allowed by the National Electrical Code.

3.21 CONFINED SPACE ENTRY

- A. The Contractor shall satisfy confined space entry requirements for the Engineer and Owner to enter covered structures, large pipes, pipe galleries, and other confined spaces. The requirements shall include furnishing and operating air quality testing equipment, furnishing and operating air movement equipment, and furnishing and operating other equipment and manpower to satisfy confined space entry requirements.

END OF SECTION 40 05 10

DIVISION 40 00 00 – PROCESS INTERCONNECTIONS IRON PIPE AND FITTINGS

PART 1 GENERAL

1.01 WORK INCLUDED

- A. This section covers the work necessary to furnish and install, complete, the cement lined ductile iron pipe and gray cast iron or ductile iron fittings specified herein, and as specified further in Section 40 05 10, PIPING - GENERAL.

1.02 GENERAL

- A. See Section 40 05 10, PIPING - GENERAL, for additional requirements.

1.03 REFERENCE STANDARDS

- A. American Water Works Association:
 - 1. AWWA C105 - Polyethylene Encasement for Ductile-Iron Pipe Systems.
 - 2. AWWA C110 - Ductile-Iron and Gray-Iron Fittings.
 - 3. AWWA C111 - Rubber-Gasket Joints for Ductile-Iron Pressure Pipe and Fittings.
 - 4. AWWA C115 - Flanged Ductile-Iron Pipe with Ductile-Iron or Gray-Iron Threaded Flanges.
 - 5. AWWA C116 - Protective Fusion-Bonded Epoxy Coatings for the Interior and Exterior Surfaces of Ductile-Iron and Gray-Iron Fittings.
 - 6. AWWA C150 - Thickness Design of Ductile-Iron Pipe.
 - 7. AWWA C151 - Ductile-Iron Pipe, Centrifugally Cast.
 - 8. AWWA C153 - Ductile-Iron Compact Fittings.
- B. ASME International:
 - 1. ASME B16.1 - Gray Iron Pipe Flanges and Flanged Fittings: Classes 25, 125, and 250.
 - 2. ASME B31.3 - Process Piping.

SECTION 40 05 10.03
DETAIL PIPING SPECIFICATION:
EPOXY LINED DUCTILE
IRON PIPE AND FITTINGS

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C. ASTM International:

1. ASTM A48/A48M - Standard Specification for Gray Iron Castings.
2. ASTM B-117 - Salt Spray (scribed panel)
3. ASTM G-95 - Cathodic Disbondment
4. ASTM D-714 - Immersion testing
5. ASTM G-22 - Bacterial Resistance

D. EN European Standards:

1. 598: Section 7.8 Abrasion Resistance

PART 2 PRODUCTS

2.01 PIPE

A. Centrifugally cast, Grade 60-42-10 iron, in accordance with AWWA C151/ANSI A21.51, ceramic epoxy-lined in accordance with AWWA C116/ANSI A21.16, 250 psi minimum working pressure, except as follows:

1. Threaded flanged pipe shall be Class 53 minimum for 4-inch through 48-inch.
2. Grooved end pipe shall be Class 53 minimum for 4-inch through 12-inch, Class 54 minimum for 14-inch and larger.
3. Buried pipe shall be thickness Class 51 minimum for 4-inch through 24-inch pipe and Class 53 minimum for 30-inch and greater pipe, unless a thicker class pipe is dictated by ANSI A21.51, Tables 51.2 and 51.3.

2.02 JOINTS

- A. Flanged, grooved end, mechanical joint or push-on as specified herein, with application as specified in Section 40 05 10, PIPING - GENERAL, or as shown on the Drawings.
- B. Flanged joint pipe shall conform to AWWA C115/ANSI A21.15 and shall use ductile iron flanges.

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DETAIL PIPING SPECIFICATION:
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DIVISION 40 00 00 – PROCESS INTERCONNECTIONS IRON PIPE AND FITTINGS

- C. Grooved end joints shall be rigid type, radius cut grooved, conforming to AWWA C606.

2.03 FITTINGS

- A. Gray or ductile iron, 250 psi minimum working pressure, ceramic epoxy-lined and seal-coated. Where taps are shown on fittings, tapping bosses shall be provided. ANSI B16.1 fittings shall be used only for nonstandard fittings not manufactured under AWWA C110/ANSI A21.10 or AWWA C153/ANSI A21.53.
 - 1. Flanged: AWWA C110/ANSI A21.10 or AWWA C153/ANSI A21.53 faced and drilled 125-pound ANSI standard flanges; as manufactured by American Cast Iron Pipe Company, U.S. Pipe, or approved equal.
 - 2. Grooved End: Ductile iron fittings in accordance with AWWA C110/ANSI A21.10 or AWWA C153/ANSI A21.53; rigid radius grooved ends in accordance with AWWA C606 for grooved and shouldered type joints; as manufactured by Victaulic Company, Anvil International, or approved equal.
 - 3. Push-On: AWWA C110/ANSI A21.10 and AWWA C111/ANSI A21.11; Fastite Joint as manufactured by American Cast Iron Pipe Company, Tyton Joint as manufactured by U.S. Pipe, or approved equal.
 - 4. Mechanical Joint: AWWA C110/ANSI A21.10 and AWWA C111/ANSI A21.11; as manufactured by American Cast Iron Pipe Company, U.S. Pipe, or approved equal.

2.04 PIPE AND FITTINGS INTERIOR LININGS AND EXTERIOR COATINGS

- A. All pipe and fittings shall be ceramic epoxy lined and coated on the outside unless otherwise shown.
- B. Interior Ceramic Epoxy Lining:
 - 1. Lining shall be Protecto 401, Ceramapure PL90, or equal ceramic epoxy, in accordance with standards listed above.
- C. Exterior Coating:
 - 1. All buried piping shall be coated on the exterior as specified in Section 09 90 00, PAINTING.

DIVISION 40 00 00 – PROCESS INTERCONNECTIONS IRON PIPE AND FITTINGS

2.05 FLANGES

- A. Ductile iron, AWWA C115/ANSI A21.15, threaded, 250 psi working pressure, ANSI 125-pound drilling.
- B. Grooved end pipe adapter flanges shall be malleable iron, ASTM A47, or ductile iron, ASTM A536, Victaulic Company, Anvil International, or equal.

2.06 GROOVED END COUPLINGS

- A. Grooved end pipe couplings shall be malleable iron, ASTM A47, or ductile iron, ASTM A536, in accordance with AWWA C606; Victaulic Company Style 31, Anvil International, or equal.

2.07 BOLTS

- A. For Class 125 FF Flanges:
 - 1. Exposed Dry Locations: Carbon steel, ASTM A307, Grade A hex head bolts and ASTM A563, Grade A hex head nuts.
 - 2. Submerged and Humid/Corrosive Locations: Type 316L stainless steel, ASTM F594, hex head bolts with minimum yield strength of 75,000 psi and Type 316L stainless steel, ASTM F594 hex head nuts.
- B. For Class 250 RF Flanges:
 - 1. Exposed Dry Locations: Carbon steel, ASTM A 307, Grade B hex head bolts and ASTM A 563, Grade A heavy hex head nuts.
 - 2. Submerged and Humid/Corrosive Locations: Type 316L stainless steel, ASTM F594, hex head bolts with minimum yield strength of 75,000 psi and Type 316L stainless steel, ASTM F594 hex head nuts.
- C. For Grooved End or Mechanical Joint: Manufacturer's standard for exposed dry locations and manufacturer's recommended stainless steel for humid and corrosive applications. Do not use grooved end or mechanical joint flanges in submerged applications.

2.08 GASKETS

- A. Gaskets for push-on and mechanical joints shall be rubber, conforming to AWWA C111/ANSI A21.11.

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DETAIL PIPING SPECIFICATION:
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DIVISION 40 00 00 – PROCESS INTERCONNECTIONS IRON PIPE AND FITTINGS

- B. Gaskets for flanged joints shall be 1/8-inch thick conforming to applicable parts of ANSI B16.21, AWWA C207, and NSF 61. Gasket material shall be free from corrosive alkali or acid ingredients and suitable for use in sewage or potable waterlines. Gaskets shall be full-face type, EPDM elastomer with cloth finish, Garlock Style 98206, or approved equal, for 125-pound FF flanges. Gaskets shall be flat ring type, made of synthetic fibers with a rubber binder or PTFE with glass microspheres, Garlock Style 3760-U or Style 3505, or approved equal, for 250-pound RF flanges.
- C. Gaskets for grooved end joints shall be manufacturer's flush-seal type specifically designed for cast surfaces. Properties shall be as designated in ASTM D2000 for the required service. Dimensions shall conform to AWWA C606.

2.09 LUBRICANT

- A. Lubricant for joints shall be manufacturer's standard.

PART 3 EXECUTION

3.01 HANDLING PIPE

- A. Care shall be taken not to damage the cement lining or exterior coating when handling the pipe.
- B. Thoroughly clean pipe and fittings before installation.

3.02 CUTTING PIPE

- A. As far as is practicable, all epoxy lined ductile iron pipe shall be furnished in the proper lengths and shall not require cutting. If cutting of the epoxy lined pipe is required in the field, it shall be done without damaging the pipe or interior lining, and shall leave a smooth end at right angles to the axis of the pipe.
- B. Cut pipe with milling type cutter, rolling pipe cutter, or abrasive saw cutter. Do not flame cut. The cut end shall be cleaned and coated using epoxy repair material provided by the pipe manufacturer.

3.03 DRESSING CUT ENDS

- A. Dress cut ends of pipe in accordance with the type of joint to be made.
- B. Dress cut ends of buried pipe joints to remove sharp edges or projections which may damage the rubber gasket.

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DETAIL PIPING SPECIFICATION:
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- C. Dress cut ends of push-on joint pipe by beveling, as recommended by the pipe manufacturer.
- D. Dress cut ends of pipe for flexible couplings, flanged coupling adapters, and grooved end pipe couplings as recommended by the coupling or adapter manufacturer.

3.04 FABRICATION OF FLANGED PIPE

- A. Flanged pipe shall be fabricated in the shop, not in the field, and delivered to the jobsite with flanges in place and properly faced. Threaded flanges shall be individually fitted and machine tightened on matching threaded pipe by manufacturer. Flanges shall be faced after fabrication in accordance with AWWA C115/ANSI A21.15. A sufficient number (at least 10 percent) of selected flange-to-pipe threaded joints shall be hydrostatically shop tested to ensure joint integrity.

3.05 JOINING PIPE

- A. Flanged: Prior to connecting flanged pipe, the faces of the flanges shall be thoroughly cleaned of all oil, grease, and foreign material. The rubber gaskets shall be checked for proper fit and thoroughly cleaned. Care shall be taken to assure proper seating of the flange gasket. Bolts shall be tightened so that the pressure on the gasket is uniform. Torque-limiting wrenches shall be used to ensure uniform bearing insofar as possible. If joints leak when the hydrostatic test is applied, the gaskets shall be removed and reset and bolts retightened.
- B. Grooved End: Installation shall be in accordance with the manufacturer's printed instructions.
- C. Push-On and Mechanical Joint: Join pipe with push-on or mechanical type joints in accordance with the manufacturer's recommendations. Provide all special tools and devices, such as special jacks, chokers, and similar items required for proper installation. Lubricant for the pipe gaskets shall be furnished by the pipe manufacturer, and no substitutes shall be permitted under any circumstances.

3.06 TESTING

- A. All pipelines shall be hydrostatically tested at the pressures listed in Section 40 02 05, PIPING SCHEDULE. Test procedures shall be as specified in Section 40 05 10, PIPING - GENERAL. The Contractor shall be responsible

SECTION 40 05 10.03
DETAIL PIPING SPECIFICATION:
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for proper coordination of all pipe, fittings, and other accessories so that all lines are designed to handle the test pressures specified.

3.07 CORROSION PROTECTION

A. As specified in Section 40 05 10, PIPING – GENERAL.

3.08 SUPPORTS AND HANGERS

A. As specified in Section 40 05 10, PIPING - GENERAL.

END OF SECTION 40 05 10.03

DIVISION 40 00 00 – PROCESS INTERCONNECTIONS

PART 1 GENERAL

1.01 SECTION INCLUDES

- A. Work necessary to furnish and install, complete, the stainless steel plant pipe and fittings specified herein and as specified further in Section 40 05 10, PIPING -GENERAL.

1.02 GENERAL

- A. See Section 40 05 10, PIPING - GENERAL for additional requirements.

PART 2 PRODUCTS

2.01 GENERAL SERVICE PIPE AND FITTINGS

- A. Pipe: Stainless steel, pickled and passivated, ASTM A778, Type (TP) 316L or Type (TP) 304L, "as welded" grade, unless otherwise specified hereinafter.
 - 1. 2-1/2-inch and Smaller: ASTM A312, TP316, Schedule 40S, seamless.
 - 2. 3-Inch through 8-Inch: Schedule 10S.
 - 3. 10-Inch and Larger: Schedule 5S.
- B. Joints
 - 1. 2-1/2-Inch and Smaller: Screwed.
 - 2. 3-Inch and Larger: Butt welded or flanged.
- C. Fittings
 - 1. 2-1/2-Inch and Smaller: Screwed, stainless steel, rated 1,000 pound CWP, forgings conforming to ASTM A182, Grade F316 or barstock to ASTM A276, Type 316, dimensions conforming to ANSI B16.3, standard for 150-pound SWP malleable iron screwed fittings.
 - 2. 3-Inch and Larger: Butt welding type, stainless steel, pickled and passivated, schedule to match piping, ASTM A774, Type 316L, conforming to MSS SP-43; "as welded" grade; all ells long radius, unless otherwise designated.
- D. Branch Connections:

SECTION 40 05 10.09
DETAIL PIPING SPECIFICATION:
STAINLESS STEEL
PIPE AND FITTINGS

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1. 2-1/2-Inch and Smaller: Screwed tees as specified under Article FITTINGS, or 3,000-pound WOG forged stainless steel, ASTM A182, Grade 316L commercial welding branch fittings with threaded outlet, as manufactured by Bonney Forge Corporation, Mount Union, PA; Allied Piping Products Pa. Inc., Oaks, PA; or equal.
 2. 3-Inch and Larger: Tees or reducing tees as specified under Article FITTINGS.
- E. Flanges:
1. Submerged Below the Overflow Level of Hydraulic Structures: Forged stainless steel, ASTM A182, Grade F316L, slip-on type, faced and drilled 150-pound, 1/16-inch raised face, ANSI B16.5 standard.
 2. All Other Exposed Applications: Cast steel backing flanges, ASTM A216, Grade WCA, Van Stone type, drilled 125-pound, ANSI B16.1 standard.
- F. Stub Ends: Stainless steel, ASTM A240, Type 316L, as welded grade, conforming to MSS-SP43, or flared nipples, schedule to match pipe.
- G. Bolting:
1. Submerged Below the Overflow Level of Hydraulic Structures: Bolts shall be ASTM F594, Type 316 stainless steel with minimum yield strength of 75,000 psi. Bolts shall have hex heads in accordance with ASME B18.2.1. Nuts shall be ASTM F594, Type 316 stainless steel with hex heads in accordance with ASME B18.2.2.
 2. All Other Exposed Applications: Carbon steel, ASTM A307, Grade A hex head bolts and ASTM A563, Grade A hex head nuts.
 3. When mating flange on valve, equipment, or adjoining pipe is a dissimilar metal, use ASTM A307, Grade B, square head bolts and ASTM A563, Grade A heavy hex head nuts with insulating flange.
- H. Gaskets: Gaskets for flanged joints shall be 1/8-inch thick conforming to applicable parts of ANSI B16.21, AWWA C207, and NSF 61. Gasket material shall be free from corrosive alkali or acid ingredients and suitable for use in sewage or potable waterlines, or for use with hot air up to 250 degrees F. Gaskets shall be full-face type, EPDM elastomer with cloth finish, Garlock Style 98206, or approved equal, for 125-pound FF flanges. Gaskets shall be flat ring type, made of synthetic fibers with a rubber binder

DIVISION 40 00 00 – PROCESS INTERCONNECTIONS

or PTFE with glass microspheres, Garlock Style 3760-U or Style 3505, or approved equal, for 150-pound RF flanges.

- I. Thread Lubricant: Teflon tape.
- J. Covered Welding Electrodes: For Shielded Metal Arc Process Type 316L Pipe, AWS 5.4, E 316L.
- K. Welding Rod and Bare Electrodes: For Gas Tungsten Arc or Gas Metal Arc Processes, Type 316L Pipe, AWS 5.9, ER 316L.

PART 3 EXECUTION

3.01 WELDING

- A. In accordance with latest editions of Section IX, ASME Boiler and Pressure Vessel Code and the American National Standard Code for Pressure Piping, ANSI B31.2 and B31.3, as applicable.

3.02 WELDING PROCEDURE QUALIFICATIONS

- A. Furnish Engineer for prior review, procedure specifications and qualification records of welding procedures for all pipe welding to be performed under this section, in accordance with Section IX, Article II of the ASME Boiler and Pressure Vessel Code.

3.03 WELDING PERFORMANCE QUALIFICATIONS

- A. All welders and welding operators shall be qualified at the Contractor's sole expense by an ASME-approved testing laboratory before performing any welding under this section. Qualification test shall be in accordance with Section IX, Article III of the ASME Boiler and Pressure Vessel Code. Welders and welding operators shall be qualified for making groove welds in Type 316 and 316L stainless steel pipe in position 6g for each welding process to be used.
- B. Prior to the start of the work, Contractor shall submit a list of the welders he proposes using and the type of welding for which each has been qualified.
- C. Qualification test may be waived if evidence of prior qualification is deemed suitable by the Engineer. Contractor shall retest any welders at any time Engineer considers the quality of the welder's work substandard. When Engineer requests the retest of a previously qualified welder, the labor costs for the retest will be at the Owner's expense if the welder successfully

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passes the test. If the welder fails the retest, all cost shall be at the Contractor's expense.

3.04 IDENTIFICATION OF WELDS

- A. Each weld shall be marked with a symbol which identifies the person who made the weld.

3.05 FABRICATION AND INSTALLATION

- A. Wrenches, brushes, slings, and other tools used on stainless steel pipe shall be stainless steel or nonferric materials. Do not use mild steel.
- B. Weld End Preparation: Pipe edges shall be prepared preferably by machine shaping or cutting with an aluminum oxide blade. Oxygen or arc cutting are acceptable only if the cut is reasonably smooth and true and all slag is removed either by chipping or grinding. Beveled ends for butt welding shall conform to ANSI B16.25.
- C. Screwed joints shall be made with fitting threads and pipe threads accurately conforming to the requirements of ANSI B2.1 for standard taper pipe threads. The Contractor shall use clean and sharp dies to provide an accurate thread profile, free of ridges and burrs. Back-welding of joints will not be permitted to remedy joints failing pressure tests. Joints failing the pressure test shall be replaced with a screwed joint which passes the test.
- D. Compression type fittings shall be installed in accordance with manufacturer's instructions.
- E. Cleaning: Surfaces shall be clean and free of paint, oil, rust, scale, slag, or other material detrimental to welding. Prior to welding, wire brush joints to be welded with stainless steel wire brushes or stainless steel wool. Prevent the destruction of the corrosion resistant passive film on stainless steel piping surfaces. Prevent contact of stainless steel piping surfaces with carbon steel and iron filings from such devices as threading machines, grinding wheels, files and any other contamination source.
- F. Alignment and Spacing: Align ends to be joined within existing commercial tolerances on diameters, wall thicknesses, and out-of-roundness. Root opening of the joint shall be as stated in the procedure specification.
- G. Procedure:
 - 1. The direct current, reverse polarity, shielded metal arc or gas metal arc processes or direct current, straight polarity, gas tungsten-arc

SECTION 40 05 10.09
DETAIL PIPING SPECIFICATION:
STAINLESS STEEL
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process shall be used for all field welding. Shop fabrication shall be in accordance with the submitted welding procedure qualifications.

2. No welding shall be performed if there is impingement of any rain, snow, sleet, or high wind on the weld area, or if the ambient temperature is below 32 degrees F. If the ambient is less than 32 degrees F, local preheating to a temperature warm to the hand is required.
 3. Tack welds shall be thoroughly cleaned to avoid porosity or pinholing in the cover pass and shall be small enough to be readily fused into the succeeding bead.
 4. Tack welds, if not made by a qualified welder using the same procedure as for the completed weld, must be completely removed. Tack welds which are removed shall be made with an electrode that is the same as, or equivalent, to, the electrode to be used for the first weld pass. Tack welds which have cracked shall be removed.
 5. Each layer of deposited weld metal shall be thoroughly cleaned prior to the deposition of each additional layer of weld metal, including the final pass, with a power-driven stainless steel wire brush. Surface defects which will affect the soundness of weld shall be chipped out or ground out.
 6. Welds shall be free of cracks, incomplete penetration, weld undercutting, excessive weld reinforcement, porosity, slag inclusions and other defects in excess of the limits prescribed in Chapter V of ANSI B31.2 and B31.3, as applicable.
 7. Branch connections shall be fitted and groove-welded in accordance with the details described and shown in Chapter V of ANSI B31.2 and B31.3 as applicable.
- H. Testing: All lines shall be tested at the pressures listed in Section 40 02 05, PIPING SCHEDULE. Test procedures shall be as specified in Section 40 05 10, PIPING - GENERAL.
- I. Supports and Hangers:
1. All hanger-pipe contact surfaces shall have a dielectric barrier consisting of neoprene rubber wrapping or plastic coated hangers. Hangers shall be as specified in Section 40 05 10, PIPING - GENERAL, except spacing shall be as follows:

SECTION 40 05 10.09
DETAIL PIPING SPECIFICATION:
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Pipe Size	Maximum Support/Hanger Span	Minimum Rod Size Single Rod Hanger
1-inch & Smaller	6 feet	1/4-inch
1-1/2-inch through 4-inch	8 feet	3/8-inch
6-inch	8 feet	1/2-inch
8-inch and 10-inch	10 feet	5/8-inch
12-inch	10 feet	3/4-inch

2. The load rating of universal concrete inserts shall not be less than that of the hanger rods they support.

END OF SECTION 40 05 10.09

SECTION 40 05 10.12
DETAIL PIPING SPECIFICATION:
POLYVINYL CHLORIDE

DIVISION 40 00 00 – PROCESS INTERCONNECTIONS (PVC) PIPE AND FITTINGS

PART 1 GENERAL

1.01 SECTION INCLUDES

- A. Work necessary to furnish and install, complete, the polyvinyl chloride (PVC) pipe and fittings specified herein, and as specified further in Section 40 05 10, PIPING -GENERAL.

1.02 GENERAL

- A. See Section 40 05 10, PIPING - GENERAL, for additional requirements. All PVC piping components shall be the products of one manufacturer.

PART 2 PRODUCTS

2.01 PIPE

- A. PVC, Schedule 80 or Schedule 40, Type I, Grade 1, or Class 12454-B, conforming to ASTM D1784 and ASTM D1785. Provide Schedule 80 pipe where specified in Section 40 02 05, PIPING SCHEDULE and where PVC pipe is threaded.

2.02 NIPPLES

- A. Same as pipe except any threaded nipples shall be Schedule 80.

2.03 JOINTS

- A. Socket-weld, except where connecting to unions, valves, and equipment with threaded connections that may require future disassembly.

2.04 FITTINGS

- A. Schedule 80, as specified under Article PIPE hereinbefore. Fittings shall conform to the requirements of ASTM D2467 for socket type and ASTM D2464 for threaded type.
- B. Where Schedule 40 pipe is allowed, fittings shall be Schedule 40, as specified under Article PIPE hereinbefore. Fittings shall conform to the requirements of ASTM D2466 for socket type and ASTM D2464 for threaded type.

2.05 FLANGES

- A. One piece, molded hub type flat faced flanges, 125-pound standard, as specified under Article FITTINGS hereinbefore.

SECTION 40 05 10.12
DETAIL PIPING SPECIFICATION:
POLYVINYL CHLORIDE

DIVISION 40 00 00 – PROCESS INTERCONNECTIONS (PVC) PIPE AND FITTINGS

2.06 GASKETS

- A. Full-faced, 1/8-inch thick, fabricated from ethylene propylene diene monomer rubber (EPDM) or a blend of fluoroelastomers (FKM) complying with ASME B16.21 and NSF 61.
- B. When mating flange has raised face, use flat ring gasket and provide filler gasket between OD of raised face and flange OD to protect PVC flange from bolting moment.

2.07 EXPANSION JOINTS

- A. See 40 05 10, PIPING – GENERAL.

2.08 BOLTING FOR EXPOSED APPLICATIONS

- A. With Flat Ring Gaskets: Carbon steel, ASTM A307, Grade B square head bolts and ASTM A563, Grade A heavy hex head nuts.
- B. With Full Face Gaskets or in Corrosive Areas: Type 316 stainless steel, ASTM A193, Grade B8M hex head bolts and ASTM A194, Grade 8M hex head nuts.
 - 1. Bolts shall be fabricated in accordance with ANSI B18.2 and provided with washers of the same material as bolts.

2.09 SOLVENT CEMENT

- A. All socket connections shall be joined with an industrial grade CPVC solvent cement conforming to ASTM F493 and NSF/ANSI 61, suitable for water, wastewater and chemical solution applications. Primer shall comply with ASTM F656. Manufacture and viscosity shall be as recommended by the pipe and fitting manufacturer to assure compatibility. Primer shall be Weld-On P-70 and cement shall be Weld-On 724 CPVC, or approved equal.

2.10 THREAD LUBRICANT

- A. Teflon tape.

PART 3 EXECUTION

3.01 GENERAL

- A. All rigid PVC pipe shall be cut, made up, and installed in accordance with the pipe manufacturer's recommendations. Plastic PVC pipe shall be laid by snaking the pipe from one side of the trench to the other for direct bury

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and the offset shall be as recommended by the manufacturer for the maximum temperature variation between time of solvent welding and during operation. PVC pipe shall be properly supported where exposed as shown on the Drawings and as specified in Section 40 05 10, PIPING - GENERAL.

- B. Use Schedule 80 threaded nipple where necessary to connect to threaded valve or fitting. Schedule 40 pipe shall not be threaded.
- C. Only strap wrenches shall be used for tightening threaded plastic joints, and care shall be taken not to overtighten these fittings. Pipe shall not be laid when the temperature is below 40 degrees F, nor above 90 degrees F when exposed to direct sunlight. Ends to be joined shall be shielded from direct sunlight prior to and during the laying operation.
- D. PVC piping shall be installed with unions as necessary for removal of valves and fittings for future maintenance.
- E. Provide adequate ventilation when working with pipe joint solvent cement. Cleaning with primer shall be done in accordance with ASTM F402 and joining with solvent cement shall be done in accordance with ASTM D2855.
- F. Field cuts of PVC pipe shall be done according to the pipe manufacturer's recommendations. Ream cut pipe ends to remove burrs and bevel plain-end pipe. Thoroughly clean pipe and fittings before installation to remove all foreign substances. Installation shall comply with ASME B31.3.
- G. Provide expansion provisions as specified in Section 40 05 10, PIPING – GENERAL to compensate for pipe expansion due to temperature differences.

3.02 TESTING

- A. All lines shall be hydrostatically tested at the pressures listed in Section 40 02 05, PIPING SCHEDULE. Test procedures shall be as specified in Section 40 05 10, PIPING - GENERAL.

3.03 SUPPORTS AND HANGERS

- A. In accordance with the manufacturer's recommendations.

END OF SECTION 40 05 10.12

DIVISION 40 00 00 – PROCESS INTERCONNECTIONS

PART 1 GENERAL

1.01 WORK INCLUDED

- A. This section covers the work necessary for furnishing and installing thickwall PVC pipe (AWWA C900-16) and fittings, complete as specified herein.

1.02 GENERAL

- A. See Section 40 05 10, PIPING - GENERAL for additional requirements.

PART 2 PRODUCTS

2.01 BASIC PIPE MATERIAL

- A. Thickwall PVC pipe shall have a cell classification of 12454A or 12454B as identified by ASTM D 1784, rigid polyvinyl chloride compounds and chlorinated polyvinyl chloride compounds.
- B. PVC pressure pipe shall conform to the requirements of AWWA C900-16 for pipes 4-inches to 54-inches nominal diameter. Pipe outside diameter shall be equivalent to ductile iron or cast iron pipe outside diameters.

2.02 DESIGN REQUIREMENTS

- A. Pressure: The pressure design of each length of pipe shall be based upon the pressure classification as given in Table I and shall meet the test pressures as specified in Section 40 02 05, PIPING SCHEDULE.
- B. Pipe Classification: Pipe shall be supplied in class of pipe shown in Table I and shall meet the standard for strength, flexibility, and durability, and shall be tested in conformance with ASTM D 2241, D 1598, and D 1599.
- C. PVC pipe shall be supplied in nominal size called out on the Drawings and shall meet the standard dimension ratios (DR's) shown in Table I.
- D. DR Values for PVC Pipe: The DR values of the PVC pipe with a cell classification of 12454A or 12454B shall meet the requirements shown in Table I.

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TABLE I PRESSURE CLASSES AND DIMENSION RATIOS (DR's)			
Pipe Size (Inches) and Service	Pipe Pressure Class	AWWA Pipe Standard	DR Values
4-inch to 12-inch (for all services unless noted otherwise)	165	AWWA C900	25
14-inch to 48-inch (for all services)	165	AWWA C900	25

2.03 PIPE AND FITTING MARKING AT THE PLANT

- A. Standard and Random Lengths: Each standard and random length of pipe shall be clearly marked on the outside surface as required by AWWA C900-16, as applicable.
- B. Couplings: All component parts of each coupling shall be clearly marked for use with the pipe which they are intended including relevant AWWA standard requirements. Each coupling shall also be marked with the letter T to indicate that it has been hydrostatically tested.
- C. Preparation at the Plant for Shipment: All pipe and couplings shall, unless otherwise specified, be prepared for standard commercial shipment.
- D. Pipe Lengths:
 - 1. Pipe shall be produced in standard and random lengths. At least 85 percent of the total footage of pipe of any class and size shall be furnished in standard lengths. The remaining 15 percent may be in random lengths.
 - 2. Standard laying lengths shall be 20 feet plus or minus 1-inch for all sizes.
 - 3. Random lengths shall not be less than 10 feet long.
- E. Sockets and Couplings: The integral socket bell of the PVC pipe or the separate coupling for use with the same size and class as that of the pipe shall be furnished with each length of pipe.

2.04 JOINTS

- A. A rubber-ring gasketed push-on style bell and spigot joint providing a positive seal against pressure or vacuum shall be provided. Joint and gasket dimensions shall comply with the manufacturer's production

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standards and those dimensions shall be made available to the Engineer on request. The bell sections shall be designed to be at least as hydrostatically strong as the pipe wall. Joints shall meet the requirements of ASTM D 3139.

- B. Pipe ends shall be square cut and beveled for insertion into a bell. The spigot end shall be marked to show the point of correct insertion. Each length shall be marked as to Class, Type, and Grade.
- C. Rubber ring gaskets shall conform to requirements of the latest edition of ASTM F 477.

2.05 PIPE FITTINGS

- A. Unless otherwise shown or specified, all buried fittings shall be ductile iron mechanical joint fittings, as specified in Section 40 05 10.01, CEMENT LINED DUCTILE IRON PIPE AND FITTINGS.

2.06 LUBRICANT

- A. Lubricant for gasketed push-on or mechanical joints shall be manufacturer's standard.

PART 3 EXECUTION

3.01 MANUFACTURE OF PIPE

- A. Surfaces: The inside and the outside surface of each length of pipe shall be free from nicks, scratches, and other surface defects and blemishes. The pipe shall be homogeneous throughout, free of any bubbles, voids, or inclusions.
- B. Jointing Areas: The jointing areas of the barrel of each length of pipe shall be free from dents and gouges.
- C. Gaskets: The gaskets shall be factory installed.

3.02 PIPE UNLOADING AT THE SITE

- A. Inspect each shipment of pipe and fittings and make provisions for a timely replacement of any damaged material. Unload by hand or use canvas slings to avoid scratching the pipe. Do not slide or drag PVC pipe over an abrasive surface. Pipe with nicks, scratches, and other surface defects shall be replaced with new pipe and removed from the site. Any damaged pipe shall be replaced at the Contractor's expense.

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- B. Stack pipe no higher than 5 feet and provide support for the pipe barrel to prevent bending of the pipe. Pipe stockpiled for more than 30 days shall be covered to protect it from the sun's rays. Provide for air circulation through the stock-pile.
- C. Store rubber rings in a cool, dark place out of the direct rays of the sun.

3.03 DISTRIBUTING PIPE ALONG THE TRENCH

- A. Distribute pipe by hand. Do not drop or drag pipe. Distribute sufficient pipe for 1 day's work, and place with bell end in the direction of pipe laying. Prevent dirt and contaminants from entering the pipe.
- B. Inspect the bell and remove any foreign matter. Clean the spigot end and apply lubricant evenly, covering the beveled nose and sealing surface to the stop mark. Push the pipe straight into the bell with a block and bar until the stop mark on the spigot is even with the end of the bell.
- C. Do not remove the gasket from the pipe.

3.04 PREPARATION OF TRENCH

- A. The trench bottom shall be smooth and free from stones larger than 1/2-inch, large dirt clods, and frozen material.
- B. Pipe Base: Pipe base material shall be placed and graded by hand to provide uniform support to the entire length of the pipe. Stabilize the pipe base material with not less than one pass with an adequate vibratory compactor. Compact pipe base material to at least the compaction as defined in Section 31 23 33, TRENCH EXCAVATION AND BACKFILL FOR PIPELINES AND APPURTENANT STRUCTURES. Re-grade and re-compact as necessary to provide full-length bearing for the pipe.

3.05 MAKING SPECIAL JOINTS

- A. Follow manufacturer's recommended procedure, and use only the recommended tools for cutting and beveling.

3.06 TESTING

- A. All lines shall be hydrostatically tested at the pressures listed in Section 40 02 05, PIPING SCHEDULE. Test procedures shall be as specified in Section 40 05 10, PIPING - GENERAL. The Contractor shall be responsible for proper coordination of all pipe, fittings, and other accessories so that all lines are designed to handle the test pressures specified.

END OF SECTION 40 05 10.14

SECTION 40 05 10.30
DETAIL PIPING SPECIFICATION:
HIGH DENSITY POLYETHYLENE (HDPE)
PIPE AND FITTINGS

DIVISION 40 00 00 – PROCESS INTERCONNECTIONS

PART 1 GENERAL

1.01 WORK INCLUDED

- A. This section covers the work necessary to furnish and install, complete, the high density polyethylene (HDPE) pipe and fittings specified herein, and as specified further in Section 40 05 10, PIPING-GENERAL.

1.02 GENERAL

- A. See Section 40 05 10, PIPING-GENERAL for additional requirements. All piping system components shall be the products of one manufacturer.

1.03 SUBMITTALS DURING CONSTRUCTION

- A. Submittals during construction shall be made in accordance with Section 01 33 00, SUBMITTALS in Division 01 00 00, GENERAL REQUIREMENTS. In addition, the following specific information shall be provided:
 - 1. A statement, in writing, from the pipe manufacturer that it is listed with the Plastic Pipe Institute as a qualified extruder for the polyethylene resin being used to manufacture the pipe for this project.
 - 2. Catalog information confirming that the pipe and fittings conform to the requirements of PART 2 PRODUCTS of this Specification.

1.04 DEFINITIONS

- A. Dimension Ratio (DR): The ratio of the pipe outside diameter to its specified minimum wall thickness.
- B. Hydrostatic Design Basis (HDB): The categorized long-term strength in the circumferential or hoop direction as determined by PPI TR-3 and ASTM 2837.
- C. Hydrostatic Design Stress (HDS): The maximum allowable working hoop stress in the pipe wall when the pipe is subjected to sustained long-term hydrostatic pressure. HDS is equal to HDB x 0.5, for water applications.
- D. Standard Dimension Ratio (SDR): A dimension ratio that corresponds to a number in a standard series of preferred dimension ratios established by ASTM F412.

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PART 2 PRODUCTS

2.01 REFERENCES

- A. The following documents are a part of this section. Where this Specification section differs from these documents, the requirements of this section shall apply.
1. ASTM D 3350: Standard Specification for Polyethylene Plastics Pipe and Fittings Materials.
 2. ASTM D 2239: Standard Specification for Polyethylene (PE) Plastic Pipe (SDR-PR) Based On Controlled Outside Diameter.
 3. ASTM D 3035: Polyethylene (PE) Plastic Pipe (SDR-PR) Based On Controlled Outside Diameter (IPS pipe sizes less than 4 inches).
 4. ASTM F 714: Polyethylene (PE) Plastic Pipe (SDR-PR) Based On Outside Diameter (IPS pipe sizes 4 inches and larger).
 5. ASTM D2837: Standard Test Method for Obtaining Hydrostatic Design Basis for Thermoplastic Pipe Materials or Pressure Design Basis for Thermoplastic Pipe Products
 6. AWWA C901: Polyethylene (PE) Pressure Pipe and Fittings, ½ inch Through 3 inch, for Water Distribution.
 7. AWWA C906: Polyethylene (PE) Pressure Pipe and Fittings, 4 inch Through 63 inch, for Water Distribution.

2.02 PIPE

- A. The pipe shall be extruded from an extra high molecular weight, high density polyethylene compound and shall conform to the following requirements:
1. The polyethylene resin shall meet or exceed the requirements of ASTM D 3350 for PE 4710 resin materials with a cell classification of 445574C/E, or better.
 2. For exposed applications, the polyethylene compound shall be suitably protected against degradation by ultraviolet light by means of carbon black, well dispersed by pre-compounding in a concentration of not less than 2 percent (cell classification letter C).

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3. The minimum Hydrostatic Design Basis (HDB) of the pipe product shall be 1600 psi at 73 degrees F, as determined in accordance with ASTM D 2837.
 4. The polyethylene pipe manufacturer shall provide certification that stress regression testing has been performed on the specific product. The certification shall include a stress life curve per ASTM D 2837. The stress regression testing shall have been done in accordance with ASTM D 2837.
 5. Materials shall be listed with the name of the pipe and fitting manufacturer in the latest edition of Plastic Pipe Institute (PPI) TR-4, PPI Listing of Ratings for Thermoplastic Piping Materials or Pipe. The material shall also be approved for potable water in accordance with NSF/ANSI 61.
 6. Manufacturer's certification shall state that the pipe was manufactured from one specific resin in compliance with these specifications. The certificate shall state the specific resin used, its sources, and list its compliance to these specifications.
 7. The pipe shall contain no recycled compound except that generated in the manufacturer's own plant from resin of the same specification and from the same raw material supplier.
 8. The pipe shall be extruded using a melt homogenizing / plasticating extruder and "appropriate" die. The extruder screw design should be customized for the HDPE being processed. The extruded tubular melt shall be vacuum or pressure sized in downstream cooling tanks to form round pipe to specification diameter and wall thickness per AWWA C901 and C906.
 9. Pipe shall be produced from materials in compliance with the Safe Drinking Water Act.
- B. Small diameter pipe and tubing (1/2-inch to 3-inch) shall be manufactured in accordance with AWWA C901 and ASTM D 3035, with Iron Pipe Size (IPS) outside diameters. Unless noted otherwise on the Drawings or in Section 40 02 05, PIPING SCHEDULE, smaller diameter pipe shall have a minimum design working pressure of 200 psi and a maximum DR of 11.0.
- C. Large diameter pipe (4-inch to 12-inch) shall be manufactured in accordance with AWWA C906, with Ductile Iron Pipe Size (DIPS) outside diameters. Unless noted otherwise on the Drawings or in Section 40 02 05,

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PIPING SCHEDULE, larger diameter pipe shall have a minimum design working pressure of 160 psi and a maximum DR of 13.5.

- D. Pipe shall be marked in accordance with ASTM F 714 and/or AWWA C906, as appropriate for pipe size and IPS or DIPS designation. Marking shall indicate the pipe's pressure rating or pressure class and the DR, at a minimum.
- E. HDPE pipe shall be as manufactured by Performance Pipe, a Division of Chevron Phillips Chemical Company; JM Eagle; Asahi-America; or equal.

2.03 FITTINGS

- A. Polyethylene fittings shall be molded or fabricated by an approved manufacturer. All polyethylene fittings shall have the same or higher pressure rating as the adjoining pipe when installed. All fittings shall be manufactured from the same approved resin type, grade, and cell classification as the pipe itself. Comply with pipe or tubing manufacturer's recommendations for compatible fittings.
- B. Molded fittings shall be manufactured and tested in accordance with ASTM D 3261 and shall be so marked. Molded fittings shall also be tested in accordance with AWWA C906 for larger fittings.
- C. Fabricated fittings shall be made by heat fusion joining specially machined shapes cut from pipe, polyethylene sheet stock, or molded fittings. Fabricated fittings shall be tested in accordance with AWWA C906.

2.04 JOINTS

- A. Sections of HDPE pipe shall be joined into continuous lengths on the job site above ground. The joining method shall be the thermal butt fusion method as outlined in ASTM D 2657. Butt fusion joining of pipe and fittings shall be performed in accordance with the manufacturer requirements and recommendations.
- B. Pipe manufacturer shall provide a trained technician to the Contractor and certify that Contractor's personnel have received the proper training in the manufacturer's recommended procedures. The heat fusion equipment used in the joining procedures should be capable of meeting all conditions recommended by the pipe manufacturer, including, but not limited to, temperature requirements, alignment, and interfacial fusion pressure.
- C. Heat fusion joining shall be 100 percent efficient, offering a joint weld strength equal to or greater than the tensile strength of the pipe. Socket

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fusion shall not be used. Extrusion welding or hot gas welding of HDPE shall not be used. Flanges (flange adapters and back-up rings), unions, grooved-couplers, transition fittings, and some mechanical couplers may be used to mechanically connect HDPE pipe without butt fusion. Refer to the manufacturer's recommendations.

- D. Where noted on the Drawings, or needed for pipe repairs or joining to an existing pipe, electrofusion couplings may be used. Electrofusion couplings shall be manufactured from a PE 4710 resin similar to the HDPE pipe specifications hereinbefore and shall be in compliance with ASTM D2513, ASTM F1055, ASTM F2897, and AWWA C906 standards. Provide manufacturer recommended electrofusion machine for joining pipe. Couplings shall be as manufactured by Performance Pipe, a Division of Chevron Phillips Chemical Company, or approved equal.

2.05 FLANGES

- A. ASTM A 240, Type 316 stainless steel backing flanges with 150-pound, ANSI B16.1 Standard drilling. Flanges shall be complete with one-piece, molded polyethylene stub ends. Flanged connections shall have the same pressure rating as the pipe or greater.

2.06 GASKETS

- A. Flat ring, 1/8-inch thick EPDM elastomer with cloth finish, full face type, conforming to AWWA C207 and applicable parts of ANSI B16.21 and NSF 61, suitable for sewage and potable water use.

2.07 BOLTING

- A. Type 316 stainless steel, ASTM A193, Grade B8 hex head bolts; and ASTM A 194, Grade 8 hex head nuts. Bolts shall be fabricated in accordance with ANSI B18.2 and provided with washers of the same material as the bolts.

PART 3 EXECUTION

3.01 GENERAL

- A. All polyethylene pipe shall be cut, fabricated, and installed in strict conformance with pipe manufacturer's recommendations. Joining, laying, and pulling of polyethylene pipe shall be accomplished by personnel experienced in working with polyethylene pipe. The pipe manufacturer shall certify, in writing, that the Contractor is qualified to join, lay, and pull the pipe or a representative of the pipe manufacturer shall be onsite to oversee the

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pipe joining. Expenses for the representative shall be paid for by the Contractor.

3.02 TRANSPORTATION

- A. Care shall be taken during transportation of the pipe that it is not cut, kinked, or otherwise damaged.

3.03 STORAGE

- A. Pipes shall be stored on level ground, preferably turf or sand, free of sharp objects which could damage the pipe. Stacking of the polyethylene pipe shall be limited to a height that will not cause excessive deformation of the bottom layers of pipes under anticipated temperature conditions. Where necessary due to ground conditions, the pipe shall be stored on wooden sleepers, spaced suitably and of such widths as not to allow deformation of the pipe at the point of contact with the sleeper or between supports.

3.04 HANDLING PIPE

- A. The handling of the joined pipeline shall be in such a manner that the pipe is not damaged by dragging it over sharp and cutting objects. Ropes, fabric, or rubber-protected slings and straps shall be used when handling pipes. Chains, cables, or hooks inserted into the pipe ends shall not be used. Two slings spread apart shall be used for lifting each length of pipe. Pipe or fittings shall not be dropped onto rocky or unprepared ground. Slings for handling the pipeline shall not be positioned at butt-fused joints. Sections of the pipes with cuts and gouges exceeding 10 percent of the pipe wall thickness or kinked sections shall be removed and the ends of the pipeline rejoined.

3.05 JOINING PIPE SECTIONS

- A. Pipes shall be joined to one another, to the polyethylene fittings, and to the flange connections by means of thermal butt-fusion. Polyethylene pipe lengths, fittings, and flanged connections to be joined by thermal butt-fusion shall be of the same type, grade, and class of polyethylene compound and supplied from the same raw material supplier.
- B. Mechanical connections of the polyethylene pipe to auxiliary equipment such as valves, screens, and other piping systems shall be through flange connections which shall consist of the following:
 - 1. A polyethylene “stub end” shall be thermally butt-fused to the ends of the pipe.

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2. Provide Type 316 stainless steel backing flange, as specified hereinbefore. Insulating flanges shall be used where shown.
 3. Bolts and nuts of sufficient length to show a minimum of three complete threads when the joint is made and tightened to the manufacturer's standard. Re-torque the nuts after 4 hours.
 4. Gaskets as specified.
- C. Butt-Fusion or Socket Fusion Joining: Butt-fusion and/or socket fusion of pipes and fittings shall be performed in accordance with the pipe manufacturer's recommendations as to equipment and technique.
- D. Special Precautions at Flanges: Polyethylene pipe connected to heavy fittings, manholes, and rigid structures shall be supported in such a manner that no subsequent relative movement between the polyethylene pipe at the flanged joint and the rigid structures is possible.
- E. Special Precautions for Temperature Effects: Long runs of polyethylene pipe shall be connected at the time of day and temperature as recommended by the pipe manufacturer to address expansion and contraction.

3.06 TESTING

- A. All lines shall be tested at the pressures specified in Section 40 02 05, PIPING SCHEDULE and as indicated in Section 40 05 10, PIPING-GENERAL. The Contractor shall be responsible for proper coordination of all pipe, fittings, and other accessories so that all lines are designed to handle the test pressures specified.

END OF SECTION 40 05 10.30

PART 1 GENERAL**1.01 WORK INCLUDED**

- A. This section covers the work necessary for furnishing and installing the various manual gate valves, ball valves, globe valves, plug valves, check valves, butterfly valves, and other special valves, complete.

1.02 GENERAL

- A. Like items of equipment specified herein shall be the end products of one manufacturer in order to achieve standardization for operation, maintenance, spare parts, and manufacturer's service.
- B. See the GENERAL CONDITIONS and Division 01 00 00, GENERAL REQUIREMENTS, which contain information and requirements that apply to the work specified herein and are mandatory for this project.

1.03 SUBMITTALS DURING CONSTRUCTION

- A. Submittals during construction shall be made as required in Section 01 33 00, SUBMITTALS in Division 01 00 00, GENERAL REQUIREMENTS. In addition, the following specific information shall be provided:
 - 1. Valve Type Number.
 - 2. Specific details regarding valve construction, valve operators, valve boxes, extension stems, floor-stems, chain wheels, etc., as applicable for each valve type.
 - 3. Submit each valve type as a complete package.
 - 4. If requested by the Engineer, the valve manufacturer shall furnish an affidavit stating the materials options furnished have complied with these and other referenced specifications.

1.04 MANUFACTURERS' SERVICES

- A. Manufacturer's services shall be provided in accordance with Section 01 66 40, MANUFACTURERS' SERVICES.

PART 2 PRODUCTS**2.01 GENERAL**

- A. All valves shall be complete with all necessary operating handwheels, chain wheels, chains, extension stems, floor stands, valve boxes, worm and gear operators, operating nuts, lever operators, wrenches, and other accessories

or appurtenances which are required for the proper completion of the work included under this section. Operators and other accessories shall be sized and furnished by the valve supplier and factory mounted.

- B. Valves and operators shall be suitable for the exposure they are subject to: buried, submerged, interior, exterior, as applicable. They shall have all safety features required by OSHA. Unless otherwise shown, valves shall be the same size as the adjoining pipe. Renewable parts including discs, packing, and seats shall be of types recommended by valve manufacturer for intended service, but not of a lower quality than specified herein.
- C. All units shall have the name of the manufacturer and the size of the valve cast on the body or bonnet or shown on a permanently attached plate in raised letters.
- D. For the purpose of designating the type and grade of valve desired, manufacturers' name is given in the following specifications. Valves of equal quality by other manufacturers will be considered in accordance with the General Conditions.
- E. The structure and appurtenant facilities have been designed around the first named manufacturer's equipment. Equipment furnished by all qualified interested manufacturers will be considered, provided that necessary structural and mechanical changes required are submitted in conformance with the requirements of the GENERAL CONDITIONS and Division 1, GENERAL REQUIREMENTS. The Contractor shall bear all costs for necessary changes for a complete and satisfactory installation.

2.02 VALVE TYPES

- A. Valve types are specified by number in this Specification. The valves are indicated on the Drawings by valve equipment number call-out and size.
- B. Not all valves specified herein may be used on this project. The Contractor shall coordinate all valve types with the Drawings and other specifications in these Contract Documents.

2.03 DESIGN FEATURES

- A. Brass and bronze components of valves and appurtenances which have surfaces in contact with the water shall be alloys containing less than 16 percent zinc and 2 percent aluminum.
- B. Approved alloys are of the following ASTM designations:

1. A126, Class B, B 61, B 62, B 98 (Alloy UNS No. C65100, C65500, or C66100), B 139 (Alloy UNS No. C51000), B 584 (Alloy UNS No. C90300 or C94700), B 164, B 194, and B 127.
 2. Stainless steel Type 316 may be substituted for bronze at the option of the manufacturer and with the approval of the Engineer.
- C. All gland bolts and nuts shall be Type 316 stainless steel.
- D. Valve ends shall be as specified or as shown on the Drawings, and to suit the adjacent piping.

2.04 VALVE OPERATORS

- A. General: All valves shall be equipped with operators. The valve operator types, as specified herein, describe only the general characteristics of the operator. The operator shall be compatible with the valve with which it will be used and shall be of the same manufacturer, or a product that is recommended by the valve manufacturer. The operator shall be sized to operate the valve for the full range of pressures and velocities imposed by the service. All valve operators shall open by turning counterclockwise.
- B. Manual Operators:
1. General:
 - a. Manual handwheel operators shall be provided unless otherwise shown or specified. Ferrous handwheels shall be epoxy-coated or galvanized steel and then field painted the same color as the valve and associated pipeline. Lever operators may be supplied on quarter-turn type valves 6 inches and smaller, if recommended by the manufacturer; however, operator force shall not exceed 80 pounds under any operating condition, including initial breakaway.
 - b. When the maximum force required to operate a valve under full operating head exceeds 80 pounds, gear reduction operators shall be provided. Gear operators shall be totally enclosed and lubricated.
 - c. On quarter-turn valves, the valve operators shall be of the self-locking type to prevent the disc or plug from creeping and shall be provided with position indicators to show the position of the valve disc or plug. Operators of the worm and gear type shall have self-locking worm gears, one-piece design, of cast or ductile iron gear material, accurately machine cut. The worm shall be hardened alloy steel, with thread ground and polished.

- d. Operators of the geared traveling nut type shall have threaded steel reach rods with an internally threaded bronze or ductile iron nut.
 2. Exposed Operators:
 - a. Exposed operators shall be furnished with chain wheel operators (CWO), geared operators (GO), extension stems, floor stands, and other elements as shown on the Drawings or as required to permit operation from the normal operating level.
 - b. Lever type operators shall have some means of being fixed in any given position to prevent accidental movement; shall be of rugged, noncorrosive construction; and shall be fully compatible with the valve.
 3. Buried Operators:
 - a. Buried service operators on valves larger than 2-1/2 inches shall have a 2-inch AWWA operating nut. Buried operators on valves 2 inches and smaller shall have cross handle for operation by forked key. All moving parts of the valve and operators shall be enclosed in a housing to prevent contact with the soil.
 - b. Buried service operators for plug valves shall be standard gear operators. Buried services operators for AWWA butterfly valves shall be traveling nut operators designed to withstand 300 foot-pounds of input torque at the fully open or fully closed positions without damage to the valve or operator and shall be grease packed and gasketed to withstand a submersion in water to 10 psi. Under certain circumstances where the valve is a large diameter or a high pressure service, the engineer may require that the operator be designed to withstand a 450 foot-pound input torque.
 - c. Valves shall be installed with extension stems, as required, and valve boxes.
 4. Unless specified otherwise hereinafter or shown otherwise on the Drawings, exposed operators shall be of the type listed below:

<u>Type of Valve</u>	<u>Size</u>	<u>Operator</u>
Gate	All Sizes	Handwheel
Butterfly	6" and Smaller	Locking lever with 10-position plate

	8" and Larger	Geared handwheel
Plug	5" and Smaller	Wrench lever
	6" and Larger	Geared handwheel except as noted hereinafter
Globe and Angle	All Sizes	Handwheel, unless otherwise noted
Ball	All Sizes	Lever

5. Where valve centerline is more than 6 feet 9 inches above floor elevation, chain and wheel guide assemblies, or chain lever assemblies, shall be provided.

2.05 ACCESSORIES

- A. Tagging: Each valve operator shall be provided with a 1-1/2-inch minimum diameter heavy brass or stainless steel tag. Each tag shall bear the valve number shown on the Drawings. The tags shall be attached to the operator with key rings so that ring and tag cannot be removed. The numbers and letters shall be of block type, with 1/4-inch high numbers and letters stamped thereon.

2.06 APPURTENANCES

- A. Valve Boxes for Buried Valves: Valve boxes shall be Buffalo two-piece sliding (slip) type, cast iron, with 5-1/4-inch minimum inside diameter shaft of appropriate length for the installation. The word SEWER or WATER (as appropriate) shall be cast into the top of the lid. Extension pieces, if required, shall be the manufacturer's standard type. Units shall be Tyler Union No. 29U, Bingham and Taylor Figure No. 4908, Proselect Series PSB461A, or equal. All units shall be complete with all necessary bases and accessories.
- B. T-Handled Operating Wrenches for Buried Valves: Provide two galvanized or painted steel operating wrenches, 4.0 to 4.5 feet total length, Penn-Troy Manufacturing T-Wrench, Raptor Waterworks No. 410 Series, or equal.
- C. Extension Stems for Valve Operators: Where the depth of the valve is such that its centerline is more than 3 feet below grade, operating extension stems shall be provided to bring the operating nut to a point 6 inches below the surface of the ground and/or box cover. Extension stems shall be constructed of galvanized steel, or stainless steel if submerged, and shall be complete with 2-inch square operating nut as manufactured by Clow Valve Company, Troy Valve Company, or equal.

2.07 GATE VALVES

- A. V121: Gate valves 3 inches and larger for water service shall be ductile iron body, bronze-mounted valves with ANSI 125-pound flanged ends, resilient wedge gate, and non-rising bronze stem conforming to AWWA C509/515. Valves shall be rated Class 150-pound CWP, 250 psi working pressure minimum, and shall be Clow Valve Company F-6102; Mueller Company 2361 Series; or equal.
- B. V150: Knife gate valves 24-inch and smaller shall be bonnetless wafer body type with outside stem and yoke, rated for 150 psi CWP, with handwheel or floor stand operators as shown on the Drawings. Valves shall be self-cleaning, non-clogging, with round port, raised face, and resilient neoprene seats. Valves shall provide drip-tight shutoff under the intended operating conditions. Valves shall have all wetted metal parts and stem of Type 316 stainless steel, yoke sleeve of acid resisting bronze, and gate finish ground both sides with a sharp knife edge. Packing system shall be multiple layers of neoprene, flax, or combinations thereof, to provide a leak-tight seal around the gate. Valve superstructure and yoke shall be designed to provide full and complete peripheral access to gland bolts when valves are equipped with manual or power actuators. Valves shall be BT Series 22 knife gate valve manufactured by Orbinox; Model VL as manufactured by Wey Valve Manufacturing; or equal.

2.08 BALL VALVES

- A. V307: Ball valves 3 inches and smaller shall have Type 316 stainless steel bodies with Type 316 stainless steel balls. Valves shall be 2-piece, full port type with threaded ends, rated 300-pound WOG minimum. Seat, body seal, and stem packing shall be reinforced PTFE. Valves shall have lever operators. Valves shall be Watts Series S-FBV-1, KF Contromatics Series 8200, Bray Flow-Tek Model S80, or equal

2.09 PLUG VALVES

- A. V405: Eccentric plug valves 4 inches through 20 inches shall be of the non-lubricated type. Valves shall be rated 175 psi minimum for valves 12 inches and smaller and 150 psi minimum for valves 14 inches and larger. Bodies shall be of the rectangular ported design and shall have an ASTM A126-Grade B cast iron body with 125-pound ANSI Standard flanged ends, or as shown on the Drawings. Valves shall have a Type 316 stainless steel or ductile iron plug, a Buna-N or other resilient plug facing suitable for the application, Acrylonitrile Butadiene (NBR) packing, and stainless steel bearings. Shaft seals shall be of multiple V-ring or U-cup type and shall be externally adjustable and repackable without removing the actuator or bonnet from the valve under pressure. Seats shall be raised and shall have a 1/8-inch welded overlay of 95 percent minimum pure nickel completely

covering the raised surface to insure that the plug contacts only nickel. Eccentric valves and actuators shall be as manufactured by DeZurik Series PEC; Homestead Series 120; Crispin Valve Series K-Flo 700 or 800; Henry Pratt Ballcentric; or equal.

2.10 CHECK AND FLAP VALVES

- A. V603: Check valves 2 inches through 12 inches shall be full body ANSI B16.1 Class 125 flanged end, ASTM A536 Grade 65-45-12 ductile iron body, Buna-N rubber flapper swing type, with stainless steel external fasteners. Valve body shall have a flow area equal to the nominal pipe diameter at all points throughout the valve. Valve seat shall be on a 45-degree angle. The access cover shall be large enough to permit disc replacement without removing the valve from the line. The interior shall be fully coated with a liquid thermosetting epoxy. Valves shall be rated for 175 psi working pressure minimum, and shall be VAG GA Industries Model 200-D, Cla-Val Model 584 Series, or equal.

2.11 BOLTS, GASKETS, GLANDS, NUTS, AND SOLVENT CEMENTS

- A. Bolts, gaskets, glands, nuts, and miscellaneous accessories required to install all manual valves are to be furnished as specified in Section 40 05 10, PIPING - GENERAL.
- B. Bolts and nuts for flanged connections in buried or submerged services shall be Type 316 stainless steel, with American Standard regular hexagonal dimensions. Bolts for flanged connections in exposed services shall be galvanized steel with American Standard regular unfinished square or hex heads. Nuts in exposed applications shall be galvanized steel with American Standard regular hexagonal dimensions.
- C. Gaskets for connections in chemical services shall be compatible with the chemicals as recommended by the manufacturer and as approved by the Engineer. Gaskets for flanged connections in all other services shall be 1/8-inch thick cloth inserted rubber suitable for sewage or potable water services. Gaskets shall extend from the inside diameter of the flange to at least the inside edge of the bolt holes (ring gaskets) for raised face flanges, or they shall extend beyond the bolt circle to the outside edge of the flange (full face gaskets for 125 pound flat face flanges). Bolt holes shall be factory punched through full face gaskets. Use of split or segmented gaskets is not acceptable.
- D. Solvent cement and primers for solvent weld connections in chemical services shall be compatible with the chemicals as recommended by the manufacturer and as approved by the Engineer.

PART 3 EXECUTION

3.01 GENERAL

- A. Before installation, carefully clean valves of all foreign material, adjust stuffing boxes, and inspect valves in open and closed positions. Install valves in accordance with the applicable portions of these Specifications. Some valves require special orientation, see the Drawings. Unless otherwise indicated, install valves with the stem vertical. Mount horizontal valves in such a manner that adequate clearance is provided for operation. Installation practices shall conform to manufacturer's recommendations.
- B. Valves shall be tested at the same time that the adjacent pipeline is tested. Joints shall be watertight at test pressures before acceptance. The Contractor will be held liable for any damage caused by the testing.
- C. Thoroughly clean threads of screwed joints by wire brushing, swabbing, or other approved methods. Apply joint compound or Teflon tape to threads prior to making joints. Joints shall be watertight at test pressures before acceptance.
- D. Bolt holes of flanged valves shall straddle the vertical centerline of the pipe run. Prior to installing flanged valves, the flange faces shall be thoroughly cleaned. After cleaning, insert gasket and bolts, and tighten the nuts progressively and uniformly. If flanges leak under pressure, loosen or remove the nuts and bolts, reseal or replace the gasket, retighten and/or reinstall the nuts and bolts, and retest the joints. Joints shall be watertight at test pressures before acceptance.

3.01 BURIED VALVES

- A. Buried valves shall be set with the operating nut vertical. An 8 by 16 by 2-inch concrete block shall be placed under the valve for support. The valve shall be protected from corrosion as specified herein and in Section 40 05 10, PIPING - GENERAL. Valve boxes shall be centered and plumb over the operating nut and shall be set so that no shock or stress will be transmitted to the valve.
- B. Buried valves shall have manufacturer's standard interior and exterior coating of powder epoxy (fusion bonded epoxy). Bolts, nuts, and washers (including in bonnet and stuffing box) shall be Series 300 stainless steel as specified hereinbefore.

3.02 EXPOSED VALVES

- A. Generally, unless otherwise indicated on the Drawings, all valves installed in horizontal runs of pipe having centerline elevations 4 feet 6 inches or less above the finish floor shall be installed with their operating stems vertical. Valves installed in horizontal runs of pipe having centerline elevations

between 4 feet 6 inches and 6 feet 9 inches above the finish floor shall be installed with their operating stems horizontal. If adjacent piping prohibits this, the stems and operating handwheel shall be installed above the valve horizontal centerline as close to horizontal as possible. Valves installed in vertical runs of pipe shall have their operating stems orientated to facilitate the most practicable operation.

- B. Where manually operated valves are over 6 feet 9 inches above the floor line, chain wheel and guide assemblies or chain lever assemblies shall be furnished and installed for operation of the valves, unless otherwise directed by the Engineer.
- C. Teflon tape or joint compound shall be applied to the male end of threaded joints. Tape or compound shall be used only on metal pipe or fittings. Valves shall be installed with the stem plumb and vertical.

3.03 ISOLATION VALVES

- A. A line size ball valve and union shall be installed upstream of each solenoid valve, in-line flow switch, or other in-line electrical device, excluding magnetic flowmeters, for isolation during maintenance.

3.04 ACCESS DOORS

- A. Location of valves shall be as required to provide accessibility for control and maintenance. Furnish access doors in finished walls and plaster ceilings where necessary for valve access.

3.05 ANCHOR BOLTS

- A. Anchor bolts for floor stands, stem guides, etc. shall be in accordance with this specification and Section 05 50 00, MISCELLANEOUS METAL ITEMS.

3.06 CERTIFICATION

- A. If requested by the Engineer, the valve manufacturer shall furnish an affidavit stating the materials options furnished has complied with these and other referenced specifications.

END OF SECTION 40 05 53

PART 1 GENERAL

1.01 WORK INCLUDED

- A. This section covers the work necessary to furnish and install the various self-contained automatic process valves, complete.

1.02 GENERAL

- A. Like items of equipment specified herein shall be the end products of one manufacturer in order to achieve standardization for operation, maintenance, spare parts, and manufacturer's service.
- B. See Volume 1, Article 8, CONDITIONS OF THE CONTRACT and Division 01 00 00, GENERAL REQUIREMENTS, which contain information and requirements that apply to the work specified herein and are mandatory for this project.

1.03 SUBMITTALS DURING CONSTRUCTION

- A. Submittals during construction shall be made as required in Section 01 33 00, SUBMITTALS in Division 01 00 00, GENERAL REQUIREMENTS.

PART 2 PRODUCTS

2.01 GENERAL

- A. All valves shall be complete, with all necessary operating appurtenances included in the work under this section.
- B. All units shall have name of their manufacturer and the size of the valve cast on the body or bonnet or shown on a permanently attached plate in raised letters.
- C. For the purpose of designating the type and grade of valve desired, manufacturers' name is given in the following specifications. Valves of equal quality by other manufacturers will be considered in accordance with the General Conditions.
- D. The structure and appurtenant facilities have been designed around the first named manufacturer's equipment. Equipment furnished by all qualified interested manufacturers will be considered, provided that necessary structural and mechanical changes required are submitted in conformance with the requirements of CONDITIONS OF THE CONTRACT and Division 01 00 00, GENERAL REQUIREMENTS. The Contractor shall bear all costs for necessary changes for a complete and satisfactory installation.

2.02 VALVE TYPES

- A. Valve types are specified by number. The type of valve to be used for each service and application is indicated on the Drawings by valve number call-out and corresponds to the valve type through various schedules in this section.

2.03 AIR RELEASE AND AIR AND VACUUM VALVES

- A. Unless noted otherwise below, all air release and air and vacuum valves shall have cast iron or ductile iron body and cover, and stainless steel float. Float guides, bushing, and lever pin shall be stainless steel or bronze. Unless noted otherwise below, the orifice shall have the manufacturer's largest standard diameter (size) for the design pressure. All valves shall comply with AWWA C512 and all potable water service valves shall be NSF 61 certified. An isolation valve, as specified hereinafter, shall be provided for each air release type valve. Valves shall be as specified below and as shown in Table 1.
 - 1. Type 39: Sewage combination air release valves 1-inch through 4-inch size shall allow large volumes of air to escape out of the large orifice when filling a pipeline and close when liquid enters the valve. When the valve is closed and pressurized, the small air release orifice shall open to allow small pockets of air to escape automatically and independently of the large orifice. Sewage combination air release valves shall be rated for 150 psi working pressure and designed to minimize clogging. All valves shall be constructed of cast iron, ductile iron, or semi-steel body and cover with stainless steel float and trim built to manufacturer's standards suitable for sewage service. Valves shall have NPT inlet and outlet connections. Sewage combination air release valves shall be fitted with blow-off valves, quick disconnect couplings, and a minimum of 6-feet of hose to permit back-flushing after installation without dismantling valve. Valves shall be Dezurik/APCO Model 443 through 449; Val-Matic Valve and Manufacturing Corporation Model 801A through 804; or equal. An isolation valve shall be installed with all Type 39 valves. Isolation valves shall be V400 for sizes 3-inch and smaller, and V405 for 4-inch size, as specified in Section 40 05 53, MANUAL VALVES.

TABLE 1				
Valve No.	Type No.	Inlet and Outlet Size (inches)	Design Pressure (psig)	Service
ARV	39	2"	10	RAS

2.04 ACCESSORIES

- A. Tagging: Each valve operator shall be provided with a 1-1/2-inch minimum diameter heavy brass or stainless steel tag. Each tag shall bear the valve number shown on the Drawings. The tags shall be attached to the operator with key rings so that ring and tag cannot be removed. The numbers and letter shall be of block type, with 1/4-inch high numbers and letters stamped thereon.

PART 3 EXECUTION

3.01 GENERAL

- A. Before installation carefully clean valves of all foreign material, and inspect valves in open and closed positions. Install valves in accordance with the applicable portions of these Specifications. Installation practices shall conform to manufacturers' recommendations.
- B. Prior to installing flanged valves, the flanged faces shall be thoroughly cleaned. After cleaning, insert the gasket and tighten the nuts progressively and uniformly. If flanges leak under pressure, loosen the nuts, reseal or replace the gasket, retighten the nuts, and retest the joints. Joints must be watertight or airtight at test pressures before acceptance.
- C. Thoroughly clean threads of screwed joints by wire brushing, swabbing, or other approved methods. Apply approved joint compound to threads prior to making joint. Joints shall be watertight or airtight at test pressures before acceptance.

3.02 TESTING

- A. Valves shall be tested at the same time that the adjacent pipeline is tested. Joints shall show no visible leakage under test. Repair joints that show signs of leakage prior to final acceptance. If there are any special parts of control systems or operators that might be damaged by the pipeline test, they shall be properly protected. The Contractor will be held responsible for any damage caused by the testing.

3.03 PAINTING

- A. All exterior ferrous metal surfaces shall be shop painted with manufacturer's standard paint and shall be compatible with the adjacent piping paint system as specified in Section 09 90 00, PAINTING. Valves shall be field painted the same as the adjacent pipe.

END OF SECTION 40 05 55

PART 1 GENERAL**1.01 WORK INCLUDED**

- A. This section covers the work necessary for furnishing and installing hand-pull stop gates, complete.

1.02 GENERAL

- A. See the GENERAL CONDITIONS and Division 01 00 00, GENERAL REQUIREMENTS, which contain information and requirements that apply to the work specified herein and are mandatory for this project.

1.03 SUBMITTALS DURING CONSTRUCTION

- A. Submittals during construction shall be made as required in Section 01 33 00, SUBMITTALS in Division 01 00 00, GENERAL REQUIREMENTS. In addition, the following specific information shall be provided:
1. Detailed custom drawings of the gate assembly with dimensional and mounting information and a listing of the materials of construction. General arrangement drawings and cut sheets are not considered acceptable drawings.

1.04 QUALITY ASSURANCE

- A. All gates shall be shop inspected for proper operation prior to shipment.
- B. Welds shall be performed by welders with ASME Section IX or AWS D1.2 certification.
- C. Manufacturer shall be ISO 9001:2015 certified.

PART 2 PRODUCTS**2.01 GENERAL**

- A. Gates shall be fabricated to match the dimensions specified in the following schedule:

Gate Type	Gate Width	Gate Height	Gate Invert Elevation	Top of Structure Elevation	Max. Water Level
Wall Mounted	4'-6"	4'-6"	0'	19'-6"	18'-0"

- B. Gates shall provide a substantially leak-free seal.

2.02 MANUFACTURERS:

- A. Stop gates and accessories shall be as manufactured by the following:
 - 1. RW Gate Company
 - 2. Whipps, Inc.
 - 3. Or approved equal.

2.03 MATERIALS OF CONSTRUCTION

- A. Contractor's option to supply aluminum or stainless-steel gates. All stainless steel shall be Type 304 or 316 unless otherwise indicated herein. Aluminum shall be Type 6061-T6, unless otherwise shown on Drawings or indicated herein.
- B. Guides, rests, and fasteners shall be Type 316 stainless steel unless otherwise shown.

2.04 SLIDE

- A. The slide shall consist of an aluminum or Type 304 stainless steel plate that is reinforced with stiffeners to withstand the specified head conditions. The slide shall engage the frame a minimum of 1-inch on each side.
 - 1. The slide plate and stiffeners shall have a minimum material thickness of 1/4-inch.
 - 2. The slide shall be reinforced with plates or channel shaped members to restrict deflection to 1/16-inch or less at the design head.
 - 3. The stiffeners shall be welded to the slide.
 - 4. Dual lifting handles shall be provided on slides with opening widths in excess of 24 inches.
 - a. Lifting handles shall be lifting slots in the top of the stop plate.

2.05 FRAME AND GATE GUIDES

- A. The frame shall be constructed of extruded aluminum or stainless steel and shall be reinforced to withstand the specified operating conditions.
 - 1. Frames shall have a minimum material thickness of 3/8-inch.
 - 2. Frames shall have a minimum weight of 4 lbs/ft.

- B. Frames shall be completely clear of the wall opening in the fully open position and shall cause no obstruction to flow.
- C. The gate guides shall be of a one-piece design with gussets that extend along the outside and top to accommodate unseating head. The members shall incorporate a tubular cross section along the guides for rigidity.
- D. Wall mounted frames shall be of the flanged frame type. Slat frames shall only be provided on gates with frames that will be embedded in the concrete wall or mounted inside existing channels.

2.06 SEALS

- A. The seal system shall consist of UHMWPE side seals and an EPDM invert seal.
 - 1. The UHMWPE seals shall be arranged to ensure that there is no metal-to-metal contact between the slide and frame.
 - 2. Rubber side seals such as J-bulb seals, P-seals and D-seals are not acceptable in lieu of UHMWPE seals.
 - 3. The invert seal shall use a compressible EPDM seal located on the bottom of the slide or in the invert of the frame.
 - a. The invert seal shall be of a flush bottom arrangement.
 - b. The invert seal shall be mechanically fastened with stainless steel bolts.
 - c. Invert seals attached solely by the use of adhesives are not acceptable.
 - 4. All seals shall be secured with assembly bolts. All seals shall be field removable and field replaceable without the need to remove the gate frame from the wall.

2.07 ANCHORAGE

- A. Anchor bolts shall be 316 stainless steel, fully threaded and shall have a minimum diameter of 1/2-inch.
 - 1. Anchor bolts shall be of the epoxy type.

2.08 STOP GATE STORAGE RACK

- A. Fabricate of aluminum rod, Type 6061-T6 or Type 304 stainless steel, as shown on the Drawings. Coat as specified herein for embedment into concrete

2.09 FINISH

- A. The frame shall be Type 304 stainless steel or aluminum. All aluminum shall be mill finish. Metal in contact with concrete shall be field coated per Section 09 90 00, System No. 3.
- B. For stainless steel installations, all heat tint and slag from the welding process shall be passivated in accordance with ASTM380. If bead blasting is used, the entire slide and entire frame shall be bead blasted.

PART 3 EXECUTION**3.01 INSTALLATION**

- A. Installation shall be performed in accordance with the Manufacturer's installation instructions and the approved installation drawings.
- B. Installation instructions and installation drawings shall be provided in the Manufacturer's O&M manual.
- C. Non-shrink grout shall be applied by the Contractor, between the gate frame and the wall to ensure that there is no leakage around the gate.

END OF SECTION 40 05 59

DIVISION 40 00 00 – PROCESS INTERCONNECTIONS

PART 1 GENERAL

1.01 WORK INCLUDED

- A. This section covers the work necessary to furnish and install the fabricated slide and sluice gates and appurtenances, complete. Slide and sluice gates will be provided by the precast polymer concrete channel manufacturer as part of a complete headworks channel package.

1.02 GENERAL

- A. Like items of equipment specified herein shall be the end products of one manufacturer.
- B. See Volume 1, Article 8, GENERAL CONDITIONS and Division 01 00 00, GENERAL REQUIREMENTS, which contain information and requirements that apply to the work specified herein and are mandatory for this project.

1.03 MANUFACTURERS' SERVICES

- A. A manufacturer's representative for the equipment specified herein shall be present at the polymer concrete manufacturer's site for a minimum of 2 person-days, travel time excluded, for installation inspection and certification of the dry installation. The representative shall be present at the Bullhead City Section 10 WWTP project site for a minimum of 2 person days for functional and leakage testing and operator training.
- B. See Section 01 66 40, MANUFACTURERS' SERVICES of Division 01 00 00, GENERAL REQUIREMENTS.

1.04 SUBMITTALS

- A. Submittals shall be made in accordance with Section 01 33 00, SUBMITTALS in Division 01 00 00, GENERAL REQUIREMENTS applicable to this project.
- B. Submittals shall include, at a minimum, detailed custom drawings of the gate assembly with dimensional and mounting information and a listing of the materials of construction. General arrangement drawings and cut sheets are not considered acceptable drawings.
- C. Calculations using the design seating and unseating heads provided in the Gate Schedule shall be provided to confirm compliance with the safety factors listed in AWWA C561 for all parts of the frame, anchorage and slide including the portion of the slide that engage the frame.

DIVISION 40 00 00 – PROCESS INTERCONNECTIONS

1.05 QUALITY ASSURANCE

- A. The gate manufacturer shall have been regularly engaged in the manufacture of slide gates and sluice gates for at least ten years and shall have at least 50 gate installations of similar size that are at least 5 years old.
- B. All gates shall be shop inspected for proper operation prior to shipment. Sluice gates, gates with seals on all four sides, shall be factory leakage tested in the unseating head direction with clean water at the design head. Certified test data shall be included in the O&M.
- C. Welds shall be performed by welders with ASME Section IX or AWS D1.6 certification.

PART 2 PRODUCTS

2.01 GENERAL

- A. The use of a manufacturer's name and model or catalog number is for the purpose of establishing the standard of quality and general configuration desired only. Products of other manufacturers will be considered in accordance with the General Conditions.
- B. Equipment furnished by all qualified interested manufacturers will be considered, provided that necessary structural, electrical, and mechanical changes required are submitted in conformance with the General Conditions and Division 01 00 00, GENERAL REQUIREMENTS.
- C. Wherever the term "stainless steel" is used in this Specification, Type 316 stainless steel is to be used, unless specifically indicated otherwise.
- D. Specific information relative to the various slide gates including identification numbers, design head conditions, gate sizes, mounting requirements, methods of operation, and other information is tabulated within the Slide Gate Schedule at the end of this section.
- E. All slide gates shall be complete including all gates, guides, frames, bench stands, floor stands, baseplates, brackets, anchor bolts, stems, and stem guides; manual operators; and all other necessary appurtenances.
- F. Materials shall be manufacturer's standard except as hereinafter modified or required.

SECTION 40 05 59.23
STAINLESS STEEL SLIDE
AND SLUICE GATES

DIVISION 40 00 00 – PROCESS INTERCONNECTIONS

2.02 MANUFACTURERS:

- A. Slide gates and accessories shall be as manufactured by the following:
 - 1. Whipps, Inc.

2.03 TAGGING REQUIREMENTS

- A. Each gate operator shall be provided with a 1-1/2-inch minimum diameter heavy stainless steel tag. Each tag shall bear the gate tag number shown in the Slide Gate Schedule, and on the Drawings.
- B. The tags shall be attached to the operator by soldered split key rings so that ring and tag cannot be removed. The numbers and letters shall be of block type, with 1/4-inch high numbers and letters stamped thereon and filled with black enamel.

2.04 MATERIALS OF CONSTRUCTION

- A. All stainless steel referenced in this specification shall be Type 316 unless otherwise indicated herein.
 - 1. All welded stainless steel components shall be constructed of Type 316L stainless steel.
 - 2. All structural stainless steel used in the construction of slides and frames shall have a minimum material thickness of 1/4-inch.
 - 3. All non-welded stainless steel components, excluding anchor bolts and assembly bolts, shall be Type 316 or Type 316L stainless steel.
 - 4. Anchor bolts and assembly bolts shall be Type 316 stainless steel.
 - 5. Invert seals and compression load pad/cord shall be neoprene, nitrile, silicone, or EPDM, ASTM D2000.
 - 6. Side seal shall be ultra-high molecular weight polymer (UHMWPE), ASTM D4020.
 - 7. Stem Guides and Bushings: Stainless Steel, Silicon Bronze, ASTM B584, Alloy 873 or UHMWPE, ASTM D4020.

2.05 SLIDE GATES

- A. All slide gates shall be of the stainless steel, rising stem, and self-contained type, unless noted otherwise in the Slide Gate Schedule. All slide gates,

SECTION 40 05 59.23
STAINLESS STEEL SLIDE
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DIVISION 40 00 00 – PROCESS INTERCONNECTIONS

unless otherwise specified, shall conform to AWWA C561. Gate assembly styles are designated as follows:

1. Style A: Gate assembly shall be upward acting/opening type for channel mounting (embedded or surface) or wall mounting on concrete structures with Type 316 stainless steel anchor bolts, as specified. Wall-mounted sluice gates may use a wall thimble.
2. Style B and Style C: Gate assemblies shall be of the downward acting/opening weir gate type with invert seal for wall surface mounting on concrete structures with Type 316 stainless steel anchor bolts, as specified.

B. Guide Frames:

1. Guide frames shall be of stainless steel, minimum thickness of ¼-inch, of the general shapes indicated on the Drawings and Slide Gate Schedule. The vertical guides shall be designed for maximum rigidity and shall extend in one continuous piece from the gate invert to form posts for support of the operator support yoke when required for gate operators. When guides extend above the operating floor, they shall be sufficiently strong so that no further reinforcements are required.
2. Guide frames to be formed and welded to create a one-piece design capable of hosting wrap around gussets to support the exterior leg of the guide frame receiving forces from unseating heads. Gussets required when the width of the opening x the head form the invert exceeds 36 sq.ft. Frames bolted together are not acceptable.
3. The frame invert shall be stainless steel, minimum thickness of ¼-inch. When “flush bottom” is indicated on the Slide Gate Schedule, provide an EPDM or neoprene insert which shall function as a seating surface for the gate disc.
4. Vertical guide frames and invert extrusions shall be joined with factory welded corners.
5. Guide slots shall be sized to provide a minimum disc engagement of 1 inch on each side.
6. On self-contained gates, the side frame shall extend above the operating floor and the operating mechanism shall be mounted to the yoke. When shown, the frame may extend to or below the operating floor and a floorstand may be mounted on the yoke.
7. Lifting lugs shall be provided on all frame styles.

DIVISION 40 00 00 – PROCESS INTERCONNECTIONS

- C. Seals: The seal system shall consist of self-adjusting, UV stabilized UHMWPE seals with a nitrile, silicone, or EPDM compression cord for all sealing edges of the gate. Gates using a non-self-adjusting wedge design may also be considered.
1. The UHMWPE seals shall be arranged to ensure that there is no metal-to-metal contact between the slide and frame.
 2. The compression cord/wedge shall be contained by the UHMWPE seal so that it shall not be in contact with the slide.
 3. Seal system shall be self-adjusting for the life of the gate.
 4. On upward-opening gates, J-bulb seals or similar rubber seals are not acceptable for top seals in lieu of UHMWPE seals.
 5. The invert seal shall be of a flush bottom arrangement. The invert seal on upward opening gates shall use a compressible neoprene or EPDM seal located in the invert of the frame. Downward opening weir gates shall have this seal across the top of the opening.
 6. All seats and seals shall be secured with stainless steel assembly bolts. All seals shall be field removable and field replaceable without the need to remove the gate frame from the wall. Gates that require disassembly of any portion of the frame, to replace seals, are unacceptable.
 7. Anchor bolts shall not penetrate the seats or seals and anchor bolts shall not prevent the removal or replacement of seats or seals.
 8. For sluice gates that will experience unseating head, the seal system shall have been shop tested with a minimum 30,000 cycle operating test in an abrasive environment to confirm the ability of the seals to withstand the abrasive condition with negligible deterioration and to confirm that the leakage restriction requirement is still possible.
 - a. The shop test shall have been performed on a stainless steel sluice gate and the test results shall have been certified by the manufacturer in writing.
 - b. A copy of the test shall be provided to the Engineer.
- D. Slide: The slide shall consist of a stainless steel plate that is reinforced with stiffeners to withstand the specified head conditions. The slide shall engage the frame a minimum of 1-inch on each side.

DIVISION 40 00 00 – PROCESS INTERCONNECTIONS

1. The slide shall be reinforced with plates or channel shaped members to restrict deflection to 1/16-inch or less at the design head.
2. The stiffeners shall be welded to the slide plate in the horizontal and vertical positions.
3. On rising stem gates, a stem connector shall be welded to the slide as a means of connecting the operating stem. The bottom portion of the stem shall be affixed to the stem connector with a minimum of two attachment bolts.
4. On non-rising stem gates, the slide shall be arranged to allow travel of the stem along the length of the slide.

E. Stems:

1. Lifting stems shall be one-piece Type 316 stainless steel, with a minimum diameter of 1-1/2-inch, and of ample cross-section to prevent distortion. Threaded portion of stem at operator end shall extend 2 inches above the operator when gate is in full OPEN or CLOSED position (as applicable). Stem threads shall be machine rolled, full-depth or double-lead rolled ACME threads, and shall have minimum RMS surface roughness of 32 micro-inches.
2. Stems shall be sized by the gate manufacturer so that the ratio of the unsupported stem length to the radius of gyration (L/r), both in inches, shall not exceed 200. Submit gate stem sizes for approval before manufacturing.
3. Stems shall be designed to withstand in compression, without damage, the thrust equal to at least 2 times the rated output of the hoisting mechanism, with a 40-pound effort applied to the crank.
4. Stems having electric motor-driven floor stands shall be designed to withstand at least 1.25 times the output thrust of the motor in the stalled condition.
5. Stem guides shall be adjustable in two directions and shall be spaced so that the L/r ratio does not exceed 200. All stems shall be furnished with adjustable stop collar for the CLOSED position. Stop collar shall be bronze and shall be internally threaded and provided with a stainless steel set screw.
6. Slide gates having a width greater than 48 inches and having twice the height shall have dual stems. For downward opening weir type gates, stems shall be located near outside edges of gate.

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2.06 STEM COVERS

- A. Each gate shall be provided with a transparent fracture resistant plastic polycarbonate or butyrate, vented pipe stem cover and cap. Provide stem covers with OPEN/CLOSED designators with 1-inch graduations on clear mylar pressure sensitive, adhesive tape, suitable for outdoor application.

2.07 GATE OPERATORS

- A. All slide gates with single stems shall be provided with a frame-mounted gear box with nut compatible with the use of a drill as indicated on the Slide Gate Schedule.
- B. Geared Operators:
 - 1. Geared operators shall be drill-operated and shall have weatherproof housings with solid bronze lift nut and shall be mounted on high-strength cast iron or stainless steel pedestal or base or on the frame of self-contained gates. Maximum manual turning or crank effort required to operate gate shall not exceed 40 pounds.
 - 2. The lift nut shall be internally threaded with Acme threads. Ball-thrust or tapered roller bearings shall be provided above and below a flange on the operating nut to support both opening and closing thrusts. Grease lubrication fittings shall be provided for all bearings. Mechanical seals shall be provided at all housing penetrations. Input pinions shall be provided with needle or ball bearings.
 - 3. All geared bench or floor operators shall be provided with a 2" nut suitable for portable electric drill operation after removal of handwheel. Provide one adapting chuck to fit all slide gate operators and to fit electric drill operator specified hereinafter.
 - 4. Cordless Electric Drill Gate Operator: Provide one heavy-duty cordless drill, complete with overload release clutch set to 50 foot-pounds of torque, charging kit, battery, and adapting chuck suitable for operating all gates furnished under this section. The drill shall be furnished by the gate manufacturer. The drill shall be capable of delivering a minimum of 50 foot-pounds of torque and shall maintain a minimum speed of 60 rpm under full load conditions. Motor shall be suitable for 15-minute operation under full load when rested for the same period of time between operations. The cordless drill shall be Milwaukee, DeWalt, or equal.

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2.08 ANCHOR BOLTS AND HARDWARE

- A. All necessary attaching bolts, anchor bolts, mounting and assembly hardware shall be of Type 316 stainless steel and shall be furnished by the slide gate manufacturer. Anchor bolts shall have a minimum diameter of ½-inch.

2.09 SPARE PARTS AND SPECIAL TOOLS

- A. The following spare parts and special tools shall be furnished. All parts and tools shall be suitably marked and packed in a single, hinged-cover, heavy gauge metal box.

ITEM	QUANTITY
Stop collars for all diameter stems, closing and opening positions	1 of each different size
Bronze lift nuts for stem sizes and types of operators	1 of each different size
Special tools	1 set
Spare drill battery to match specified drill	1

PART 3 EXECUTION

3.01 INSTALLATION

- A. All metal surfaces, except stainless steel, in contact with concrete shall be field coated by the Contractor with un-thinned bitumastic paint, per System No. 27 of Section 09 90 00, PAINTING, or be insulated with suitable protective neoprene gasket materials.
- B. Insofar as practical, the slide gate assemblies shall be completely factory assembled, shipped as a unit, disassembled onsite and installed in strict conformance with the manufacturer's recommendations. Operators shall be field mounted after installation of the appropriate gate assemblies. The parts and assemblies that are, of necessity, shipped unassembled shall be packaged and tagged in a manner that will protect the equipment from damage and facilitate the final identification and assembly in the field.
- C. All anchor bolts and necessary bolt setting plates shall be provided by the manufacturer. Anchor bolts for guide frames and all other bolts shall be Type 316 stainless steel. Two nuts shall be provided for each anchor bolt, and anchor bolts shall be cast-in-place during concrete placement, unless otherwise shown. Threads shall be protected and shall be cleaned before the nuts are attached and tightened. Isolate all anchor bolts from reinforcing steel.

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- D. All stainless steel bolts shall be coated with an anti-galling compound before the nuts are attached and tightened.
- E. All gates shall be thoroughly cleaned and shall operate without vibration or binding.

3.02 TESTING AND ADJUSTMENT

- A. All slide gates installed under this section shall be substantially watertight when closed, under the conditions indicated in the Slide Gate Schedule. Leakage shall not exceed 0.1 gallons per minute per foot of wetted seal periphery at all design conditions listed in the Gate Schedule.
- B. Gates shall be tested over their full range of travel to verify proper operation and compliance with the functional requirements specified herein.

3.03 MANUFACTURER'S SERVICES AND CERTIFICATE(S)

- A. After installation, all slide gates shall be field tested in the presence of the Engineer and a representative from the gate manufacturer to ensure that all equipment is in full compliance with the section. Each gate shall be cycled to confirm operation without binding, scraping, vibrating, or distorting. The effort to open and close manual operators shall be measured and may not exceed the maximum operating effort specified hereinbefore. At the Engineer's discretion, where feasible, the Contractor shall water test any gate to ensure that leakage does not exceed the specified allowable leakage.
- B. Provide manufacturer's certificate(s) in accordance with Section 01 66 40, MANUFACTURERS' SERVICES of Division 01 00 00, GENERAL REQUIREMENTS.

3.04 CLEANING

- A. Where concrete or grout work was performed in the vicinity of installed gates, Contractor shall thoroughly clean the exposed portions of the gate frames and slides to remove all concrete or grout from uncoated aluminum surfaces.

3.05 SLIDE GATE SCHEDULE

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STAINLESS STEEL SLIDE
AND SLUICE GATES

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SLIDE GATE NUMBER	LOCATION	TYPE OF GATE ¹	FRAME MOUNTING TYPE	OPENING TYPE	OPENING WIDTH, IN	GATE CLOSED ELEVATION, IN	FLOOR ELEVATION ²	TOP OF WALL ELEVATION	INVERT ELEVATION OF OPENING ³	SEATING HEAD ⁴ , ft	UNSEATING HEAD ⁴ , ft	TYPE OF OPERATOR
WG-xx-1	Clarifier Splitter Box	B	Wall-mount	Wall opening	48	511.54	497.93	512.04	509.29	1.5 ft	N/A	Hand wheel
WG-xx-2	Clarifier Splitter Box	B	Wall-mount	Wall opening	48	511.54	497.93	512.04	509.29	1.5 ft	N/A	Hand wheel
WG-xx-3	Clarifier Splitter Box	B	Wall-mount	Wall opening	48	511.54	497.93	512.04	509.29	1.5 ft	N/A	Hand wheel
WG-xx-4	Clarifier Splitter Box	B	Wall-mount	Wall opening	48	511.54	497.93	512.04	509.29	1.5 ft	N/A	Hand wheel

NOTES:

1. Gate styles shall be as follows:
 Style A: upward opening for channel or wall surface mounting.
 Style B: Downward opening weir gates with invert seal for wall surface mounting.
2. Floor elevation is the concrete floor beneath the gate structure.
3. All gates and gate frames shall be completely clear of the wall opening in the fully open position and shall cause no obstruction to flow.
4. Seating/un-seating head is calculated as the maximum difference between the upstream and downstream water surfaces.

END OF SECTION 40 05 59.23

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PART 1 GENERAL

1.01 DESCRIPTION OF WORK

- A. This section covers instrumentation and associated electrical equipment, and appurtenances.
- B. Project description:
 - 1. The controls specified herein and on the project Drawings shall provide monitoring and communication for the RAS/WAS room in the Solids Handling Building and the new clarifier.
 - a. Clarifier controls will be provided by Westech.
 - b. RAS pumps will be controlled by the plant SCADA system.
 - c. Instrumentation and control components marked with a diamond on the drawings are in the PICS contractor's scope.
 - 2. The System shall include the following:
 - a. Components specified in Section 40 60 10.03
 - b. Wiring from new components to locations shown on the Drawings.

1.02 RELATED SECTIONS

- A. The work of the following sections is related to the work of this section. Other sections, not referenced below, may also be related to the proper performance of this work. It is the Contractor's responsibility to perform and coordinate all the work required by the Contract Documents.
 - 1. Section 01 33 00 – SUBMITTALS
 - 2. Section 01 66 00 – PRODUCT SHIPMENT, HANDLING, STORAGE, AND PROTECTION
 - 3. Section 01 66 40 – MANUFACTURER'S SERVICES
 - 4. Section 01 77 00 – CONTRACT CLOSEOUT
 - 5. Division 26 00 00 – ELECTRICAL
 - 6. Section 46 05 50, INSTALLATION OF OWNER FURNISHED SCREENING SYSTEM
 - 7. P&ID Drawings

1.03 COORDINATION

- A. Division 26 Specifications outline the installation requirements for 120 and/or 480 VAC power to those items identified on the Drawings. Division 40 Specifications outline provisions and installation of all signal and control wiring. Arrangements shall be made by PICS Contractor with Electrical

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Contractor to install any required 120-volt signal and control wiring and conduits within the scope of the work described herein.

- B. Contractor and PICS Subcontractor shall coordinate with the Owner's SCADA Systems Administrator on all programming, quality assurance, integration of existing PLC/HMI to new equipment, loop checks, scaling of field devices, and start up and training.
- C. Work under this section shall be coordinated with the process, mechanical, and electrical work to ensure that:
 - 1. All instruments, wiring, and other components to be provided under this section are properly installed and interfaced with other system components.
 - 2. The proper type, size, and number of control wires with conduits are provided and installed.
 - 3. Proper electric power circuits are provided for all components and systems.

1.04 SUBMITTALS

- A. Component Parts List: The Component Parts List shall be a complete parts list for the entire instrumentation and control system, and shall have the following features:
 - 1. All components shall be grouped by facility and then by component type, with the component types identified in a similar manner to the component identification code used in these Specifications.
 - 2. All components shall be listed with their exact and complete manufacturer's part number, including all options or accessories.
 - 3. All components shall be identified with their complete tag number as shown in these Specifications, or as modified or assigned by the PICS Subcontractor and approved by the Engineer.
 - 4. All components without tag numbers shall be grouped within component types by manufacturer's part number. Exact quantities shall be listed for each part number.
- B. Submit catalog information, descriptive literature, wiring diagrams, and shop drawings on all panels, controllers, recorders, indicators, transmitters, primary elements, flow measuring equipment and appurtenances, pressure regulating valves, gauges, and all other components of the system as follows:
 - 1. Individual data or specification sheets shall be provided for all components provided under this section citing all specific features for each specific component (e.g.: part number, scale range, materials

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of construction, special options included, etc.). Each component data sheet shall bear the component name and instrument tag number designation shown in the Drawings and Specifications.

2. Catalog information on electrical devices furnished under this section.
3. Shop drawings and catalog material for all new control panels and enclosures.
4. Panel elementary diagrams of pre-wired panels. Diagrams shall be similar to those diagrams shown on the Drawings, but with the addition of all switched analog signals and all auxiliary devices such as relays, alarms, fuses, lights, fans, heaters, etc.
5. Interconnecting point-to-point wiring diagrams, showing all component and panel terminal board identification numbers and external wire numbers. This diagram shall include all intermediate terminations between field elements and panels (e.g., terminal junction boxes, motor control centers, etc.), and 120 VAC power supply circuits.
6. Input/output instrumentation loop diagrams, which shall consist of wiring diagrams for each discrete and analog loop, showing all terminal numbers, the location of the DC power supply, the location of any booster or logic transfer relays or common dropping resistors, etc. The diagrams shall be divided into three areas for identification of element locations: I/O panel terminals, control panel, and field, respectively. I/O panel and control panel window areas shall show the transmitters, digital panel meter, power supplies, and all other components required to operate a single field instrument's loop(s). Field window areas shall depict the field sensor, a diagrammatic representation of where the sensor is located in relation to other equipment, and the wiring connections to the sensor. It shall be the Contractor's responsibility to ensure that the loop diagrams and actual equipment being furnished, and associated wiring, agree with the wiring and schematic diagrams.
7. Power requirement summary for all control panels. Power requirements shall state required voltages, currents, and phases(s).

C. Spares and Expendables:

1. Provide recommended spares and expendable items in sufficient quantities to support the PICS for a period of 3 years after the date of Substantial Completion.

1.05 MANUFACTURERS' SERVICES

- A. Manufacturer's services shall be provided in accordance with Section 01 66 40, MANUFACTURERS' SERVICES.

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1.06 OPERATION AND MAINTENANCE MANUALS

- A. Operation and Maintenance Manuals and Maintenance Summary Sheets for the equipment specified herein shall be furnished as specified in Section 01 77 00, CONTRACT CLOSEOUT in Division 01 00 00, GENERAL REQUIREMENTS.

1.07 WARRANTY

- A. Materials, equipment, and workmanship shall be guaranteed for one year from the date of Substantial Completion in accordance with provisions of these Contract Documents.

1.08 ENVIRONMENTAL REQUIREMENTS

- A. Standard Environmental Requirements: Unless otherwise noted, design equipment for continuous operation in these environments:

- 1. Freestanding Panel:

- a. Inside: NEMA 12.

- B. Environmental Design Requirements: Following defines the types of environments referred to in the above.

- 1. Inside, Air Conditioned:

- a. Temperature:

- 1) Normal: 60 to 90 degrees F.
 - 2) With Up to 4-Hour HVAC System Interruptions: 40 to 120 degrees F.

- b. Relative Humidity:

- 1) Normal: 10 percent (winter) to 70 percent (summer).
 - 2) With Up to 4-Hour HVAC System Interruption: 10 to 100 percent.

- c. NEC Classification: Nonhazardous.

- 2. Inside, Non-Conditioned:

- a. Temperature: 45 to 120 degrees F.
 - b. Relative Humidity: 10 to 95 percent noncondensing.
 - c. NEC Classification: Nonhazardous.

3. Outside:
 - a. Temperature: 32 to 125 degrees F.
 - b. Relative Humidity: 10 to 100 percent, sun, rain, snow, freezing rain.
 - c. NEC Classification: Nonhazardous.

PART 2 PRODUCTS

2.01 GENERAL

- A. For equipment listed under COMPONENT SPECIFICATIONS, the design is based on the first named manufacturer. Listed manufacturers and/or model numbers shall be deemed to be used for the purpose of establishing a standard of quality and facilitating the description of the material or process desired. This procedure is not to be construed as eliminating from competition other products of equal or better quality by other manufacturers where fully suitable in design and shall be deemed to be followed by the words "or equal". The decision relative to equality shall be solely by the Engineer.
- B. Should the Contractor select other equipment that requires different installation requirements, wiring and conduit, enclosures, intrinsically safe barriers, accessories, etc., the Contractor shall obtain approval from the Engineer for such changes to the design and shall make all approved changes at no additional cost to the Owner or Engineer.
- C. Field Installed Equipment: Equipment not installed in control panels, such as primary elements and transmitters shall be provided as specified herein.

2.02 SIGNAL CHARACTERISTICS

- A. Analog Signals, Current Type:
 1. 4 to 20mA dc signals conforming to ISA S50.1.
 2. Unless otherwise indicated for specific PICS Subsystem components, use the following ISA 50.1 options:
 - a. Transmitter Type: Number 2, two-wire.
 - b. Transmitter Load Resistance Capacity: Class L.
 - c. Fully isolated transmitters and receivers.
 3. Analog Signals, Voltage Type: 1 to 5 volts dc within panels where a common high precision dropping resistor is used.
 4. Analog Input (AI) signals shall be field powered and not require power from the PLC.

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5. Furnish signal isolation for analog signals that are sent from one enclosure to another. Do not wire in series instruments on different panels, cabinets, or enclosures.
- B. Discrete signals are two-state logic signals of two types. Discrete Input (DI) signals to the PLC must be dry contact relays capable of accepting 120VAC, 0.25A. The relay coil is to be energized from field power, the PLC will provide power for the Common/N.O./N.C. contacts, indicating input status. Discrete Output (DO) signals from the PLC will be dry contact relays capable of accepting 120VAC, 0.25A. The relay coil is to be energized from the PLC power. The field source will provide power for the Common/N.O./N.C. contacts, starting the field device. Any alarm signals external to control panel shall be normally open, close to alarm. Provide isolated contacts rated for 5 amperes at 120 VAC and 2 amperes at 30 VDC as a minimum contact rating.
- C. Pulse Frequency Signals:
 1. Direct current pulses whose repetition rate is linearly proportional to process variable.
 2. Pulses generated by contact closures or solid-state switches as indicated.
 3. Power source less than 30V dc.
- D. Special Signals: Other types of signals used to transmit analog and digital information between field elements, transmitters, receivers, controllers, and digital devices.

2.03 ELECTRIC POWER AND SIGNAL WIRING

- A. Provide electric power and signal wiring as shown on the Drawings.
- B. Control and signal wiring external to the control panels and all power wiring shall conform to Division 16, ELECTRICAL.
- C. Control and signal wiring in control panels shall be restrained by plastic ties or ducts. Hinge wiring shall be secured at each end so that any bending or twisting will be around the longitudinal axis of the wire and the bend area shall be protected with a sleeve.
- D. Arrange wiring neatly, cut to proper length, and remove surplus wire. Provide abrasion protection for any wire bundles which pass through holes or across edges of sheet metal.
- E. Use Manufacturer's recommended tool with the proper sized anvil, for all crimp terminations. No more than two wires may be terminated in a single

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crimp lug and no more than two lugs may be installed on a single screw terminal.

- F. An insulating barrier shall be constructed between 480, 240 or 120VAC power wiring and other voltages within a panel. Terminations of the power wiring shall be protected to prevent incidental contact by an operator.
- G. Wires within Enclosures:
 - 1. AC Circuits:
 - a. Type: 300-volt, Type MTW stranded copper, unless equipment manufacturer requires higher voltage rating.
 - b. Size: For current to be carried, but not less than No. 18 AWG.
 - 2. Analog Signal Circuits:
 - a. Type: 300-volt stranded copper, twisted shielded pairs, rated for instrumentation signal usage, unless equipment manufacturer requires higher voltage rating.
 - b. Size: No. 18 AWG, minimum.
 - 3. Other DC Circuits.
 - a. Type: 300-volt, Type MTW stranded copper, unless equipment manufacturer requires higher voltage rating.
 - b. Size: For current carried, but not less than No. 18 AWG.
 - 4. Special Signal Circuits: Use manufacturer's standard cables.
 - 5. Wire Identification: Numbered and tagged at each termination.
 - a. Wire Tags: Slip on, heat shrink wire labels with machine printed markings and numbers. Adhesive, snap on, or taped-on tags are not acceptable.
 - b. Manufacturers: Brady Perma-Sleeve, or equal.
- H. Wires entering or leaving enclosures, terminate and identify as follows:
 - 1. Analog and discrete signal, terminate at numbered terminal blocks.
 - 2. Twisted shielded pair conductors must have shield floating on the field end and terminated to ground in the Control Panel.
 - 3. Special signals; terminated using manufacturer's standard connectors.
- I. Wire shall be enclosed in either a sheet metal raceway, or plastic wiring duct. Wiring for signal circuits shall be separated at least 8 inches from any power wiring.

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- J. All interconnecting wires between panel mounted equipment and external equipment shall be terminated at numbered terminal blocks. All wires shall be identified per the requirements of Section 16120, LOW VOLTAGE ELECTRICAL POWER CONDUCTORS AND CABLES.

2.04 TERMINAL BLOCKS

A. Terminal Blocks for Enclosures:

1. Quantity:

- a. Accommodate present and spare indicated needs.
- b. Wire spare I/O points to FLEX I/O terminal blocks.
- c. One wire per terminal for field wires entering enclosures.
- d. Maximum of 2 wires per terminal for 18 AWG wire for internal enclosure wiring.
- e. Spare Terminals: 25 percent of all connected terminals, but not less than 10 per terminal block.

2. General:

- a. Connection Type: Screw compression clamp.
- b. Compression Clamp:
 - 1) Complies with DIN-VDE 0611.
 - 2) Hardened steel clamp with transversal grooves that penetrate wire strands providing a vibration-proof connection.
 - 3) Guides strands of wire into terminal.
- c. Screws: Hardened steel, captive and self-locking.
- d. Current Bar: Copper or treated brass.
- e. Insulation:
 - 1) Thermoplastic rated for 32 to plus 200 degree F.
 - 2) Two funneled shaped inputs to facilitate wire entry.
- f. Mounting:
 - 1) Standard DIN rail.
 - 2) Terminal block can be extracted from an assembly without displacing adjacent blocks.
 - 3) End Stops: Minimum of one at each end of rail.
- g. Wire preparation: Stripping only permitted.
- h. Jumpers: Allow jumper installation without loss of space on terminal or rail.

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- i. Marking System:
 - 1) Terminal number shown on both sides of terminal block.
 - 2) Allow use of preprinted and field marked tags.
 - 3) Terminal strip numbers shown on end stops.
 - 4) Mark terminal block and terminal strip numbers as shown on Panel Control Diagrams and Loop Diagrams.
 - 5) Fuse Marking for Fused Terminal Blocks: Fuse voltage and amperage rating shown on top of terminal block.
- j. Test Plugs: Soldered connections for No. 18 AWG wire.
 - 1) Pin Diameter: 0.079 inch.
 - 2) Manufacturer and Product: Allen Bradley; 1492-J4 series terminal blocks.
- 3. Terminal Block, General-Purpose:
 - a. Rated Voltage: 600 VAC.
 - b. Rated Current: 30 amp.
 - c. Wire Size: No. 22 to 10 AWG.
 - d. Rated Wire Size: No. 10 AWG.
 - e. Color: Grey body.
 - f. Spacing: 0.25 inch, maximum.
 - g. Test Sockets: One screw test socket 0.079-inch diameter.
 - h. Manufacturer and Product: Allen Bradley; 1492-J4 series terminal blocks.
- 4. Terminal Block, Ground:
 - a. Wire Size: No. 22 to 12 AWG.
 - b. Rated Wire Size: No. 12 AWG.
 - c. Color: Green and yellow body.
 - d. Spacing: 0.25 inch, maximum.
 - e. Grounding: Ground terminal blocks electrically grounded to the mounting rail.
 - f. Manufacturer and Product: Allen Bradley; 1492-JG6 series terminal blocks.
- 5. Terminal Block, Blade Disconnect Switch:
 - a. Rated Voltage: 600 VAC.
 - b. Rated Current: 10-amp.
 - c. Wire Size: No. 22 to 12 AWG.

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- d. Rated Wire Size: No. 12 AWG.
 - e. Color: Grey body, orange switch.
 - f. Spacing: 0.25 inch, maximum.
 - g. Manufacturer and Product: Allen Bradley; 1492-JKD4 series terminal blocks.
6. Terminal Block, Fused, 24 VDC:
- a. Rated Voltage: 600 VDC.
 - b. Rated Current: 16-amp.
 - c. Wire Size: No. 22 to 10 AWG.
 - d. Rated Wire Size: No. 10 AWG.
 - e. Color: Grey body.
 - f. Fuse: 0.25 inch by 1.25 inch.
 - g. Indication: LED diode 24 VDC.
 - h. Spacing: 0.512 inch, maximum.
 - i. Manufacturer and Product: Allen Bradley; 1492-H5 series terminal blocks.
7. Terminal Block, Fused, 120 VAC:
- a. Rated Voltage: 600 VAC.
 - b. Rated Current: 16-amp.
 - c. Wire Size: No. 22 to 10 AWG.
 - d. Rated Wire Size: No. 10 AWG.
 - e. Color: Grey body.
 - f. Fuse: 0.25 inch by 1.25 inch.
 - g. Indication: Neon Lamp 110 VAC.
 - h. Leakage Current: 1.8 mA, maximum.
 - i. Spacing: 0.512 inch, maximum
 - j. Manufacturer and Product: Allen Bradley; 1492-H5 series terminal blocks.
8. Terminal Block, Fused, 120 VAC, High Current:
- a. Rated Voltage: 600 VAC.
 - b. Rated Current: 35 amps.
 - c. Wire Size: No. 18 to 8 AWG.
 - d. Rated Wire Size: No. 8 AWG.
 - e. Color: Grey.
 - f. Fuse: 13/32 inch by 1.5 inch.
 - g. Spacing: 0.95 inch, maximum.
 - h. Manufacturer and Product: Allen Bradley; 1492-H5 series terminal blocks.

2.05 RELAYS

- A. Control circuit switching, not accomplished by the Flex I/O shall be accomplished with relays.
- B. Relays for interfacing and control applications shall be the compact, general purpose plug-in type. Contact arrangements shall be as noted or shown and shall be rated for not less than 10 amperes at 120 VAC or 28 VDC. Coil voltage shall be as noted or shown.
- C. Relays shall have plain plastic dust covers and mounting sockets with screw terminals and hold-down springs. Relays shall be UL recognized.
- D. Relays shall be Potter and Brumfield KUP or KUL series; IDEC RH Series; or equal.
- E. All relays shall have a screw terminal interface with the wiring. Terminals shall have a permanent, legible identification. Relays shall be mounted such that the terminal identifications are clearly visible and the terminals are readily accessible.
- F. Time delay relays shall be multi-timing function type, using digital electronic circuitry and shall provide a wide range of adjustable time delays. As much as possible, all time delay relays used on this project shall be the same brand and serial number. Relays shall be UL listed. Contacts shall be DPDT, rated for 120 VAC, 7 amps, minimum.
- G. Time delay relays shall be ATC Series 328, IDEC Series RTE; or equal.

2.06 POWER SUPPLIES

- A. Provide DC power supplies as required to power instruments requiring external DC power. Redundant DC power supplies shall be installed in each Remote I/O enclosure.
- B. Power supplies shall convert 120 VAC, 60 Hz power to 24 volt DC power or other DC voltages required.
- C. Requirements
 - 1. Safety: UL 508 listed.
 - 2. MTBF: Greater than 500,000 hours in accordance with IEC 61709.
 - 3. Mounting: 35mm DIN-rail conforming to DIN EN 50022.
 - 4. Operating Temperature: -25°C to +70°C.
 - 5. Minimum Efficiency: 88% at full load.
 - 6. Voltage Adjustments: By means on front of unit.
 - 7. Finger Safe: In accordance with IEC 529.

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- 8. Short Circuit Current: Automatically limited with automatic reset when fault is corrected.
- 9. Failure Indication: Contact for remote indication of failure if input supply power is lost.
- D. Provide NEMA enclosure for all power supplies outside the control panel.
- E. Power supplies shall be mounted so that dissipated heat does not adversely affect other components.
- F. Manufacturer: Allen-Bradley, P/N 1606XL120DR.

2.07 CORROSION PROTECTION

- A. Provide a Corrosion-Inhibiting Vapor Capsule in each Control Panel. Corrosion-Inhibiting Vapor Capsule Manufacturers:
 - 1. Northern Instruments; Model Zerust VC.
 - 2. Hoffmann Engineering Co; Model A-HCI.

2.08 NAMEPLATES, NAME TAGS, AND SERVICE LEGENDS

- A. All components provided under this section, both field and panel mounted, shall be provided with permanently mounted name tags bearing the entire instrument tag number of the component. Panel mounted tags shall be plastic; field mounted tags shall be stamped stainless steel.
- B. Service legends and nameplates shall be engraved, rigid, laminated plastic type with adhesive back. Unless otherwise noted, color shall be black with white letters, and letter height shall be 3/16 inch. Service legends shall also, where possible, be engraved on illuminated lenses.

2.09 COMPONENT SPECIFICATIONS

A. GENERAL

- 1. The following are detailed but generalized component/assembly specifications. Where components are proposed that are other than those specified, the Engineer reserves the right to decide on their equality.
- 2. A component calibration table is provided at the end of this Section.

B. ELECTROMAGNETIC FLOW METER:

- 1. Tags: FE/FIT- RAS1, RAS2, RAS3
- 2. Flow Element

- a. NEMA Rating: 4X
- b. Nominal Diameter as per Drawings
- c. Lining: to be compatible with process fluid (raw sewage)
- d. Accuracy: 0.25%
- e. Electrodes: Stainless Steel
- f. Electrode grounding: Integral grounding electrode(s)
- g. Manufacturer's original power and signal cables supplied with flow element. Length as shown on Drawings.
- h. Grounding rings, flanges and lugs as required
- i. Operating pressure: 150 psi

3. Flow Transmitter

- a. Power Supply: 120VAC
- b. Analog Output: 4-20mA DC
- c. Range: 0 – 100,000 gal/day
- d. Totalizer Digital Output (Pulsed, Rate programmable)
- e. Bi-directional flow metering capability
- f. NEMA Rating: NEMA 4X
- g. Field mount enclosure (see Drawings). For remote mount transmitter, verify distance from element to transmitter and supply cables.
- h. Two-line digital display (display in gpd)

- 4. Manufacturer: Badger Meter, Siemens, Endress & Hauser, or approved equal.

C. PRESSURE GAUGE

- 1. Tags: P01, 02
- 2. The pressure gauge shall have the following characteristics:
 - a. Type: Bourdon tube, liquid filled
 - b. Case: Black aluminum
 - c. Dial: 2 ½" with white face and black letters, glass lens
 - d. Connection size: ¼"
 - e. Wetted parts: Type 316 SST
 - f. Accuracy: 1% full scale
 - g. Working pressure: Maximum 75% of full scale

PART 3 EXECUTION

3.01 GENERAL

- A. Install materials and equipment in a workmanlike manner utilizing persons skilled in the trade. Provide work which has a neat and finished appearance.

3.02 DELIVERY, STORAGE, AND HANDLING

- A. Provide site and warehouse storage facilities for instrumentation.
- B. Prior to shipment, include corrosive-inhibitive vapor capsules in shipping containers, and related equipment as recommended by the capsule manufacturer.
- C. Prior to installation, store items in dry indoor locations. Provide heating in storage areas for items subject to corrosion under damp conditions.
- D. Cover panels and other elements that are exposed to dusty construction environments.

3.03 PROTECTION DURING CONSTRUCTION

- A. Throughout this Contract, the Contractor shall provide protection for materials and equipment against loss or damage and the effects of weather. Prior to installation, store items in indoor, dry locations. Provide heating in storage areas for items subject to corrosion under damp conditions. Specific storage requirements shall be in accordance with the manufacturer's recommendations.

3.04 CORROSION PROTECTION

- A. All control panels, enclosures, and other equipment containing electrical or instrumentation and control devices, including spare parts, shall be protected from corrosion through the use of corrosion inhibiting vapor capsules. Prior to shipment, the capsules shall be provided within the shipping containers and equipment as recommended by the capsule manufacturer.
- B. Corrosion-Inhibiting Vapor Capsule Manufacturers:
 - 1. Northern Instruments; Model Zerust VC.
 - 2. Hoffmann Engineering Co; Model A HCl.

3.05 EQUIPMENT FINISH

- A. Provide materials and equipment with manufacturer's standard finish. Provide manufacturer's standard finish color, except where specific color is indicated. If manufacturer has no standard color, finish equipment with light gray color.

3.06 CLEANING AND TOUCHUP PAINTING

- A. Keep the premises free from accumulation of waste material or rubbish. Upon completion of work, remove materials, scraps, and debris from premises and from interior and exterior of all devices and equipment. Touchup scratches, scrapes, or chips in interior and exterior surfaces of devices and equipment with finishes matching as nearly as possible the type, color, consistency, and type of surface of the original finish.

3.07 MATERIAL AND EQUIPMENT INSTALLATION

- A. Follow manufacturers' installation instructions explicitly, unless otherwise indicated. Wherever any conflict arises between manufacturers' instructions, and these Contract Documents, follow Engineer's decision, at no additional cost to Owner. Keep copy of manufacturers' installation instructions on the jobsite available for review at all times.

3.08 GENERAL INSTALLATION

- A. Panels and panel mounted equipment shall be assembled as far as possible at the factory. No work other than correction of minor defects or minor transit damage shall be done on the panels at the jobsite. Upon completion of work, remove materials, scraps, and debris from premises and from interior and exterior of all devices and equipment. Touchup scratches, scrapes, or chips in interior and exterior surface finishes with material matching original color and finish.
- B. Wiring shall not be spliced or tapped except at device or terminal blocks. No more than two wires may be terminated in a single crimp lug, and no more than two lugs may be installed on a single screw terminal.
- C. General Contractor shall coordinate with instrument suppliers, the electrical contractor, and other project contractors to ensure that:
 - 1. All components provided under this section are properly installed.
 - 2. The proper type, size, and number of control wires and conduits are provided and installed.
 - 3. The proper type, size, and number of pneumatic tubes and conduits are provided and installed.
 - 4. Proper electric power circuits are provided to supply all components and systems.

SECTION 40 60 10.03

PROCESS INSTRUMENTATION AND CONTROL SYSTEM (PICS):

DIVISION 40 00 00 – PROCESS INTERCONNECTIONS **EQUIPMENT**

3.09 FUNCTIONAL TESTING

- A. Instruments associated with equipment systems shall be functionally tested along with the equipment system they are integrated into. Startup procedures shall include simulation of all alarm settings to trigger alarms.
- B. Contractor shall certify instrumentation along with equipment systems for proper installation and operation.

3.10 COMPONENT CALIBRATION TABLE

COMPONENT CALIBRATION TABLE		
TAG NUMBER	FUNCTION	OPTIONS, CALIBRATION INFO, SCALE RANGE, SET POINTS
LE/FIT-RAS1, RAS2, RAS3	Electromagnetic flow meter	Flow Range: 0 – 1,200 gpm
PI-01	Pressure Gauge (RAS System Pressure)	0-30 psi

END OF SECTION 40 60 10.03

PART 1 GENERAL

1.01 WORK INCLUDED

- A. This section covers the work necessary to furnish and install, complete the submersible non-clog centrifugal wastewater type pumps with accessories as specified herein.
- B. Equipment numbers are as follows:

Equipment #	Description
P-RW-1	RAS Pump 1
P-RW-2	RAS Pump 2
P-RW-3	RAS Pump 3

1.02 GENERAL REQUIREMENTS

- A. Like items of equipment provided hereunder, although for different services, shall be the end products of one manufacturer.
- B. See the GENERAL CONDITIONS and Division 01 00 00, GENERAL REQUIREMENTS, which contain information and requirements that apply to the work specified herein and are mandatory for this project.

1.03 DEFINITIONS

- A. Total Dynamic Head (TDH): Total dynamic head in feet of liquid pumped shall be the discharge head minus the suction head (or plus the suction lift), both measured at the pump flanges and corrected to pump centerline, plus the difference in velocity heads at the same points.
- B. Overall Efficiency: Overall efficiency shall include motor and hydraulic efficiencies, taking into account pump friction and pump discharge pipe elbow losses.

1.04 SUBMITTALS DURING CONSTRUCTION

- A. Submittals shall be made as required in Section 01 33 00, SUBMITTALS in Division 01 00 00, GENERAL REQUIREMENTS. In addition, the following specific information shall be provided:
 - 1. Detail drawings, and descriptions of all items of equipment, showing all dimensions, parts, construction details, and materials of construction.
 - 2. Performance data curves including a family of curves for variable speed pumps showing head, capacity, horsepower demand, and

pump efficiency over the entire operating range of the pump, from shutoff to maximum capacity. The equipment Manufacturer shall indicate separately the head, capacity, horsepower demand, overall efficiency, and minimum submergence required at the guarantee point. Performance requirements shall be as defined in the Hydraulic Institute Standards.

3. Proposed factory and field test descriptions in sufficient detail to fully describe the specific tests to be conducted and quantities to be measured to demonstrate full conformance with these Specifications.
4. Submit written certification of actual power consumption for each pump model provided.
5. Complete information regarding the painting systems proposed for use and to substantiate suitability for domestic wastewater contact/service.
6. Complete motor rating and list of special motor features being provided.
7. Certified copy of test report for identical motor tested in accordance with NEMA MG 1-12.53a and IEEE Standard 112, Test Method B, showing full-load efficiency not less than specified value. Motors not as specified will be rejected.

1.05 MANUFACTURERS' SERVICES

- A. Manufacturer's services shall be provided in accordance with Section 01 66 40, MANUFACTURER'S SERVICES and the following:
 1. A Manufacturer's representative of the equipment specified shall be present at the jobsite for installation assistance, inspection and certification of the installation, equipment testing, startup assistance, and training of Owner's personnel for the minimum person-days listed for the services hereunder, travel time excluded:
 - a. 1½ person-days for installation assistance, functional and performance testing, and certification of the installation.
 - b. ½ person-day for pre-startup classroom or jobsite training.

1.06 OPERATION AND MAINTENANCE MANUALS

- A. Operation and Maintenance Manuals and Maintenance Summary Sheets for the equipment specified herein shall be furnished as specified in

Section 01 77 00, CONTRACT CLOSEOUT in Division 01 00 00, GENERAL REQUIREMENTS.

- B. The O&M manuals shall contain at a minimum full descriptions of the pumps, performance curves, spare parts lists, and detailed instructions for all operation and maintenance tasks to be performed by the operator.

1.07 WARRANTY

- A. The Manufacturer shall warrant that its equipment shall be free from defects in material and workmanship; and that it will replace or repair, any part or parts for which examination shall show to have failed under normal use and service by the Owner within five (5) years following the date of Substantial Completion.
 - 1. The Manufacturer shall be responsible for freight associated with shipping defective equipment to the factory or service location.

PART 2 PRODUCTS

2.01 GENERAL

- A. The use of a manufacturer's name and model or catalog number is for the purpose of establishing the quality and configuration desired only.
- B. The structure and appurtenant facilities have been designed around the first named manufacturer's equipment. Equipment furnished by all qualified interested manufacturers will be considered, provided the necessary structural, electrical, and mechanical changes required are submitted in conformance with the requirements of the GENERAL CONDITIONS and Division 1, GENERAL REQUIREMENTS. The Contractor shall bear all costs for necessary changes for a complete and satisfactory installation.

2.02 MANUFACTURER AND MODEL:

- A. Barnes, Model 8XESCDU with E28 frame.

2.03 SERVICE CONDITIONS

- A. Provide four (4) pumps, three (3) duty and one (1) shelf spare.
- B. The pumps shall be dry-run submersible end suction centrifugal chopper type, installed in a dry pit installation, with permanently connected inlet and outlet pipe. The pumps shall be capable of operating in a continuous, non-submerged condition in a horizontal position.

- C. Fluid Pumped: Pumps shall handle Return Activated Sludge with potential for rags and re woven stringy material with maximum sphere of 3 inches.
- D. Pumping Temperature (PT): 50°F to 85°F.
- E. Minimum NPSH Available: flooded suction
- F. Site Elevation: 495 feet.
- G. The pumps shall be designed for continuous duty.

2.04 PERFORMANCE REQUIREMENTS

- A. Pump Design Points:
 - 1. Design Point (100% speed): 1,100 gpm at 14 feet total head, minimum efficiency = 58.5%.
 - 2. Shutoff Head minimum shall be 36 feet.
 - 3. Configuration Requirements:
 - a. Pump configuration: non-submersible
 - b. Maximum pump speed: 1,750rpm
 - c. Maximum rated horsepower: 7.5 hp
 - d. Driver type: variable speed
 - e. Drive configuration: non-submersible
 - f. Discharge: 8-inch
 - g. Power: 3 phase, 480 volts, 60 hertz

2.05 PUMP CONSTRUCTION

- A. Materials of Construction:

Volute	ASTM A48 Class 30 Cast Iron
Impeller	Standard: ASTM A536, 65-45-12 Ductile Iron Optional: ASTM A532 Class III Type A White Iron
Slicing Blade	ASTM A276 440C Stainless Steel, Heat Treated to 53-60 HRC
Striker Plate	ASTM A276 440C Stainless Steel, Heat Treated to 53-60 HRC
Motor Housing	ASTM A48 Class 35B Cast Iron
Wear Ring	ASTM B505 C95400 Lead Free Bronze
External Hardware	304 Stainless Steel
Lifting Bail	304 Stainless Steel
Shaft	416 Stainless Steel
Cooling Jacket	304 Stainless Steel (E21, E28 and E32 Frame)

	ASTM A48 Class 35B Cast Iron (E36 Frame)
Seals	Standard: Carbon/Silicon Carbide/Buna Upper, Silicon Carbide/Silicon Carbide/Buna Lower Optional: Silicon Carbide/Silicon Carbide/Buna Upper Seal, Tungsten Carbide/Tungsten Carbide/Buna for both Upper and Lower Seals
Coating	Liquid End: Two coats of Axalta Corlar® amidoamine epoxy, 10 mil minimum thickness, in the manufacturer's standard color Motor Cap: Resicoat® R4 Powder Coat Epoxy, in the manufacturer's standard color
Gaskets	Buna-N
O-Rings	Buna-N
Motor Rotor Bars	Die Cast Aluminum
Motor Cooling Liquid	Monopropylene Glycol and Distilled or Deionized Water
Elastomeric plug holding plate	304 Stainless Steel (E21 and E28) ASTM A48 Class 30 Cast Iron (E32 and E36)
Cable Entry Housing	ASTM A48 Class 30 Cast Iron
Nameplate	304 Stainless Steel

- B. The pump end components will be ASTM A48 Class 30 Cast Iron, aside from the impeller. The volute shall be a single piece non-concentric design, with smooth passages of sufficient size to pass solids that may enter through the impeller. The volute shall include a drain port connection. The volute discharge connection shall be a standard 125 lb. flange, slotted to accommodate ANSI or MM ISO Flanges used in sewage applications, and shall be a centerline connection. The suction connection shall be a standard ANSI 125 lb. flange. The volute shall be designed to withstand 1.5x the maximum shutoff head.
- C. The slicing blade-impeller assembly will be dynamically balanced to ISO G6.3 specifications, and will be capable of handling solids, fibrous materials, and other matter typically found in raw wastewater. The impeller shall be keyed to the shaft and shall have a taper lock connection. The impeller will be a:
1. Dual-vane design with pump out vanes on both sides. The matching volute will include a replaceable volute wear ring at the
- D. The open center chopping mechanism shall consist of a stationary striker plate and a rotating slicing blade. Both blades shall be constructed of high quality, ASTM A276 440C stainless steel, heat treated to 53-60 HRC. The slicing blade shall be press fitted on to the impeller suction, and secured with four stainless steel pins. The striker plate shall be fixed to the volute

suction, and shall be an ANSI flange design. The clearance between the striker plate and slicing blade shall be adjustable, in order to maintain a clearance of 0.003" to 0.010". The striker plate shall be sealed internally against the volute with an O-ring. This design shall allow for a solids handling pump to be easily upgraded to a chopper pump. Designs that utilize a chopping nut, impeller without a separate slicing mechanism, upper cutters, or that cannot easily upgrade a solids handling pump to a chopper will not be accepted.

- E. The pump and motor shaft will be a solid, continuous piece of 416 stainless steel, keyed and tapered for the matching impeller fit to reduce rotor imbalance and minimize stress risers associated with stepped shafts. Shafts utilizing a coupling or other attachment method will not be acceptable. The shaft will have a maximum allowable deflection of 0.002 inches at the lower mechanical seal during operation.
- F. The mechanical seals will be a tandem system, consisting of two totally independent mechanical seals, each with its own single spring system acting in a common direction. The upper seal will have a carbon rotating face and a silicon carbide stationary face and will be located between the coolant chamber and the motor housing. The lower seal will have a silicon carbide rotating face and a silicon carbide stationary face and will be located between the pump and the coolant chamber. Both seals will have 300 series stainless steel hardware and Buna-N elastomers.
 - 1. Alternate seal materials include a silicon carbide/silicon carbide upper seal, tungsten carbide/tungsten carbide upper seal, and tungsten carbide/tungsten carbide lower seal. Combination of these seal configurations will be acceptable. Seal faces with materials other than those specified above will not be acceptable.
- G. Both seals shall be pinned in place to prevent rotation of the stationary seat and shall seal to the pump housing and must operate in a coolant chamber which shall provide superior heat transfer & seal cooling. The coolant must be environmentally safe non-toxic material. The seals must not require routine maintenance or adjustment but should be easily replaced. The seal shall be commercially available and not a pump manufacturer's proprietary design. Double mechanical seals with a single or double spring and/or cartridge seals will not be accepted.
- H. The common pump and motor shaft shall rotate on two bearings. These bearings shall be high quality and commercially available. The bearings will be sealed, permanently grease lubricated for superior lubrication, cooling, and life. The lower bearing shall be of the double row ball type, locked in position to accept radial and axial thrust loads and the upper bearing shall be of the pre-loaded single ball type for radial loads as needed to provide a nominal L10 life of 100,000 hours.

- I. Gaskets except for seal gland and bearing retainer shall be of the angular gland compression O-ring type eliminating critical slip fits and the possibility of damage during service associated with sliding O-ring sealing arrangements. Mating surfaces where watertight sealing is required shall be machined and fitted with O-rings.
- J. The exterior of the pump liquid end will be coated per Manufacturer's standard coating system.
- K. Cable Entry Seal:
 - 1. The cable entry seal design shall preclude specific torque requirements to insure a water tight and submersible seal. The cable entry shall consist of a single cylindrical elastomer grommet, flanked by washers, all having a close tolerance fit against the cable outside diameter and the entry inside diameter and compressed by the body containing a strain relief function, separate from the function of sealing the cable.
 - 2. The assembly shall provide ease of changing the cable when necessary using the same entry seal.
 - 3. The cable entry junction chamber and motor shall be sealed from each other, which shall isolate the stator housing from foreign material gaining access through the pump top.
- L. Each pump shall be provided with cables adequate length to reach the junction box without the need for splices. Cables shall be of multi-conductor type motor cable with stainless steel braided shielding, a Chloroprene outer jacket and tinned copper conductors insulated with ethylene-propylene rubber suitable for submersible pump applications. The conductors shall be arranged in twisted pairs. Cable sizing shall conform to NEC and IEEE Specifications for pump motors. The cable shall contain all power and control conductors required for the pump system to meet these specifications.

2.06 DRIVE MOTORS

- A. Each pump shall be equipped with a submersible electric motor connected for operation on a 460 volt, three phase, 60 hertz service. The pump motors shall be a premium efficiency, squirrel-cage, induction, shell type design, housed in an air filled, watertight chamber, NEMA Type B design.
- B. The major driver components will be ASTM A48 Class 35B Cast Iron.
- C. The stator shall be press fit into the motor housing, for mechanical stability and optimal heat transfer.

- D. The motor shall be inverter duty rated, in accordance with NEMA MG-1, Part 31, and shall have a minimum 1.15 service factor. The motor shall be designed for use in submersible or dry applications, where the motor shall operate fully submerged, partially submerged, or completely unsubmerged. The motor shall continue to operate satisfactorily should the dry pit flood. The motor horsepower shall be non-overloading throughout the entire pump performance curve.
- E. The rotor bars shall be die cast aluminum with integral cooling fins.
- F. The motor will be capable of operating at a maximum submergence depth of 66 ft (20m), and shall be IP68 protection rated.
- G. The motor will be IE3 rated in accordance with IEC 60034-30 at nominal voltage and frequency, with testing per CSA C390/IEEE114. The motor will be capable of 30 evenly spaced starts per hour without overheating.
- H. The motor shall include a factory installed closed loop cooling system. The cooling system shall be completely self-contained. The cooling liquid shall be a mixture of 30% monopropylene glycol and 70% distilled or deionized water, and shall be circulated between a jacket and the cast iron motor housing by a secondary, independent impeller. This secondary impeller shall be mounted directly to the motor shaft between the mechanical seals. The bearing bracket shall act as a heat exchanger to move the heat from the motor to the coolant liquid. The seal plate shall be finned and act as a heat exchanger to move the heat from the coolant to the pumped media. The system shall have at minimum one fill port and one drain port. An external coolant source, a cooling system circulating the pumped media or a design without a cooling system will not be acceptable. The cooling jacket shall be 304 Stainless Steel.

2.07 MOTOR PROTECTION

- A. All stators shall incorporate three thermal switches (dry contact), rated for 120VAC, NC connected in series. If motor thermal protection is implemented using the thermistors, the equipment supplier shall provide thermistor protection relays which shall be installed and wired in the associated MCC VFD sections. The switches shall be installed in the stator windings to provide over-temperature protection of each phase winding. In the event of high temperature, the thermal switches shall open, stop the motor and activate an alarm. These thermal switches shall be used in conjunction with and supplemental to external motor overload protection and shall be connected to the associated VFD MCC section. The motor and pump shall be designed and assembled by the same manufacturer.

- B. Provide a seal leak sensor for each pump with required control modules to provide a dry 120VAC rated contact for each seal alarm sensor. The modules shall have 120VAC power supply and shall be wired to the seal leak sensors located between the seal and stator housing. When moisture is detected, the sensors will stop the motor and activate an alarm. The pump supplier shall provide a seal leak detector for each seal leak sensor. The seal leak detectors shall be installed, wired, setup and commissioned by the Contractor. They shall be installed and wired in the associated MCC VFD sections.
- C. External Sensors to Pump:
 - 1. Pump Manufacturer shall supply one current transformer which shall be affixed inside the control panel (by others) and capable of measuring up to 200 amperes AC in conjunction with an external protection relay.
- D. External Protection Relay:
 - 1. Pump Manufacturer shall supply an External Protection Relay that shall be capable of monitoring the sensors internal to the pump. The relay shall also be capable of measuring actual pump current and voltage using the external CT and direct voltage inputs respectively. The relay shall allow acceptable limits to be set for all sensor inputs for "Warning" and "Alarm" states. These states shall cause internal "Warning" and "Alarm" relays to activate in order to be used by user's control scheme. The relay shall also facilitate the connection to control schemes that use RS485 MODBUS.
- E. Provide a motor shaft grounding bushing on the motor shaft. Connect grounding bushing to the motor housing and to the equipment grounding conductor.

2.08 PUMP ACCESSORIES

- A. Pump Identification Plate: The following data shall be included on the nameplate:
 - 1. Manufacturer's Name
 - 2. Pump Part Number, Model Number and Serial Number
 - 3. Motor Horsepower Rating
 - 4. Voltage, Phase and Frequency
 - 5. Motor Speed
 - 6. Motor Service Factor
 - 7. Motor Full Load Amps
 - 8. Ambient Temperature Rating
 - 9. Code Letter

10. Pump Weight
 11. Impeller Diameter
 12. Motor Insulation Class
- B. Horizontal Cart System: The pump shall be supplied with a horizontal mounting accessory, consisting of a sliding cart, which will allow the driver to be maintained without disturbing the suction and discharge piping. The cart shall include a 1" vertical allowance, for ease of installation. The cart must be mounted on a concrete pad, which must be provided by others. Designs that require removal of existing piping shall not be accepted.
- C. Anchor Bolts: Provide Type 316 stainless steel anchor bolts, 3/4-inch diameter minimum, for mounting pump discharge connection elbow. Length shall be adequate for conditions shown on the Drawings, through the grout fill and for at least 6-inches embedment into the concrete floor slab.

2.09 SPARE PARTS

- A. The following spare parts shall be provided for each pump:
1. One spare full diameter impeller-slicing blade assembly for each pump model
 2. one spare set of mechanical seals,
 3. all gaskets,
 4. all O-Rings.
 5. Spare wear rings for each pump model

PART 3 EXECUTION

3.01 FACTORY TESTS

- A. Pumps: A factory test certified by the pump Manufacturer shall be performed on the pumps actually furnished, and written notice of the same shall be furnished to the Engineer. Information required to be furnished at the time of test is necessary to show conformance to specified performance. Certified testing in accordance with Hydraulic Institute Standards 11.6 and 14.6. shall be provided.
- B. The pump manufacturer shall perform a pump performance test to verify hydraulic performance as standard.
- C. A hydrostatic test shall be performed on dry pit pumps to verify casting integrity.
- D. Each motor shall be dielectric tested to verify the motor insulation integrity.

3.02 PREPARATION FOR SHIPMENT, STORAGE, AND PROTECTION

- A. Equipment and materials shall be prepared and protected for shipment and shipped in accordance with the requirements of Division 1, GENERAL REQUIREMENTS.
- B. The contractor shall be responsible for receiving the equipment, unloading it from the common carrier, and storing it safely until it is ready to be installed.

3.03 PUMP AND MOTOR INSTALLATION

- A. Install pumps in accordance with the Manufacturer's recommendations. Mount pump bases as shown on the Drawings and recommended by the Manufacturer. The size of the concrete bases shall be determined by the dimensions of the pump and base and shall be as shown in the Manufacturer's literature. Anchor bolts shall be sized and provided by the Contractor and material shall be as specified herein. Bolts shall be accurately placed with templates.
- B. Handle carefully and protect the pumps and appurtenances to avoid damaging the equipment. Install the pump base so that connection may be made to the discharge headers without any springing or otherwise forcing either the pump or the header. Adjust pump assemblies such that the units are properly aligned, plumb, and level. Carefully fit and coat all bolt threads with lubricant to facilitate future removal.

3.04 PAINTING

- A. The equipment shall be shop coated with Manufacturer's standard coating system.
- B. Manufacturer shall ship touch-up paint for field repairs.

3.05 FIELD TESTS

- A. Prior to Functional Testing, the CONTRACTOR shall have the Manufacturer's representative perform the following:
 - 1. Megger test the stator and power cables.
 - 2. Check proper rotation.
 - 3. Check power supply voltage.
 - 4. Measure motor operating load and no-load current.
 - 5. Check level control operation and sequence.

6. Functional Test: After installation, the pumping system shall be field tested using potable water for a minimum of 30 minutes and check for correct direction of rotation in the presence of the Manufacturer's representative and the Owner's representative. The CONTRACTOR shall be responsible for providing water and for conveying the water to the site and providing required meter and back-flow prevention check valve assembly. Each pump shall be operated at normal conditions through its range of capacities with fault conditions simulated as practical. Once each pump has been tested separately, the pumps will be operated in parallel. A test log shall be presented to the Engineer upon the completion of each test that records the following:
 - a. Flow, as measured by plant instrumentation.
 - b. Pump horsepower and total head as measured by Contractor provided instruments.
 - c. Driving motor voltage and amperage measured for each phase.
 - d. Motor manufacturer's guaranteed power factor and efficiency at 1/4, 2, 3/4, and full load.
- B. Each pump shall operate over its intended operating range without undue noise, vibration, or cavitation. The CONTRACTOR shall monitor and record vibration at three symmetrically located points on each pump at maximum and minimum speed and supply data to the OWNER.
- C. Test Failure:
 1. Units failing to meet the Specifications to the satisfaction of the Engineer must be more accurately tested in accordance with Hydraulic Institute Standards. If the pump fails the second test, the unit will be rejected, and the Contractor shall furnish a unit that will perform as specified. In addition, if the specified pump fails the second test, all identical pumps to the pump under test shall be tested under the same provisions, whether specified or not, at the Contractor's sole expense.

3.06 MANUFACTURER'S CERTIFICATE(S)

- A. In accordance with Section 01 66 40, MANUFACTURER'S SERVICES of Division 1, GENERAL REQUIREMENTS, upon completion of the installation and on-site testing, and before acceptance by the OWNER, the Pump Manufacturer or the authorized Pump Manufacturer's Representative shall submit a written statement that the pump installation has been inspected and is completed in accordance with the Manufacturer's recommendations.

1. Certificate submittal shall also include all results and testing data recorded during field testing.

END OF SECTION 43 10 30

PART 1 GENERAL

1.01 WORK INCLUDED

- A. This section specifies the requirements for the construction of a clarifier tank with an AWWA D110 Type III wire or strand wound, prestressed, concrete circular core wall; including all design, site work, excavation, reinforcing, concrete work, appurtenances, leakage testing, and backfill directly related to the tank unless otherwise specified.

- 1. Clarifier equipment is by WesTech and furnished by the Owner.

1.02 RELATED WORK SPECIFIED IN OTHER SECTIONS

- A. Submittals: Section 01 33 00.
- B. Coordination and Site Conditions: Section 01 14 16.
- C. Quality Control: Section 01 40 00.
- D. Construction Facilities and Temporary Controls: Section 01 50 00
- E. Painting: Section 09 90 00
- F. Earthwork for Structures: Section 31 23 00
- G. Installation of Owner Furnished Clarifier Equipment: Section 46 05 50

1.03 GENERAL REQUIREMENTS

- A. The tank shall consist of a cast-in-place reinforced concrete floor, a wire or strand wound precast prestressed concrete wall, launder, pipe penetrations, and facilitate mounting and connection of all portions of the clarifier mechanism, piping, and effluent weir. The installation of the concrete clarifier tank shall be completed in accordance with the Drawings and these specifications as well as any applicable Manufacturer's instructions. The Prestressed Concrete Tank Manufacturer shall furnish all labor, materials, tools, and equipment necessary to construct and test the wire or strand wound, prestressed concrete clarifier tank and appurtenances as indicated on the Drawings, and as specified.
- B. See CONDITIONS OF THE CONTRACT and Division 01 00 00, GENERAL REQUIREMENTS, which contain information and requirements that apply to the work specified herein and are mandatory for this project.

- C. The Drawings indicate general and typical details of construction. Where conditions are not specifically indicated but are of similar character to the details shown, similar details of construction shall be used, subject to the review and approval of the Engineer.

1.04 QUALITY ASSURANCE

- A. Singular Responsibility: It is the intent of this specification to require single party responsibility for the design and the construction of the clarifier tank. The clarifier tank design and construction shall be performed by an established Prestressed Concrete Tank Manufacturer of recognized ability, having at least ten years of experience in the design and construction of clarifier tanks with an AWWA D110 Type III wire or strand wound prestressed concrete core wall as specified herein. The design and construction of all aspects of the foundation, floor slab, wall, launder, pipe penetrations, prestressing, and shotcrete of the wire or strand wound circular prestressed clarifier tank shall be performed by the Prestressed Concrete Tank Manufacturer. The Prestressed Concrete Tank Manufacturer may subcontract labor for reinforcing steel installation and for concrete slab placement under the Prestressed Concrete Tank Manufacturer's direct supervision.
- B. All tank work shall be performed by a company that specializes in the design and construction of wire or strand wound prestressed concrete clarifier tanks using the method of circumferential prestress reinforcing and with proven capability of meeting all the requirements of these specifications. No company is considered qualified unless it has designed and built in its own name or under one of its divisions at least twenty AWWA D110 prestressed concrete tanks with a Type III core wall in the last ten years. The company shall have in its own name or under one of its divisions, at least five clarifier tanks with an AWWA D110 Type III core wall that are located within seismic zone B or greater per AWWA D110-13, Appendix A, and have been in successful service for at least five years. Experience in the design and construction of tanks with a Type I, II or IV core wall does not count toward the ten years of experience.
- C. The Prestressed Concrete Tank Manufacturer shall have in its employ a design professional engineer with a minimum of ten years of experience, registered in the State of Arizona. The design engineer shall have been the engineer of record for a minimum of ten tanks with an AWWA D110 Type III core wall. The design engineer shall have designed a minimum of five clarifier tanks with an AWWA D110 Type III core wall in seismic zone B or greater per AWWA D110-13, Appendix A, in the past five years.
- D. The Prestressed Concrete Tank Manufacturer shall have in its employ for this project a team consisting of a clarifier tank superintendent, project

manager, certified shotcrete foreman, prestressing foreman, and precast erection foreman, each of whom shall have constructed a minimum of three tanks with an AWWA D110 Type III core wall and a capacity of at least 700,000 gallons or larger.

- E. Experience in the design and construction of tanks with an AWWA D110 Type I, Type II or Type IV core wall, tanks having a fixed wall base, mild-steel reinforced tank core wall or tank core wall incorporating internal stressing systems does not count toward the experience requirements outlined above.

1.05 SUBMITTALS

- A. Submittals during construction shall be made as required in Section 01 33 00, SUBMITTALS in Division 01 00 00, GENERAL REQUIREMENTS.
- B. The Prestressed Concrete Tank Manufacturer shall submit drawings, specifications, design calculations, and data including: dimensions, size, and shape of clarifier tank and launder; appurtenances including, pipe penetrations, and mounting locations for clarifier equipment, piping, and weir; structural calculations for the tank structure. These submittals shall be stamped and signed by a State of Arizona Registered Professional Engineer employed by the Prestressed Concrete Tank Manufacturer. The tank's warranty shall be included with the submittals.
- C. Review by the Engineer of the drawings and calculations submitted by the Prestressed Concrete Tank Manufacturer will not in any way relieve the Prestressed Concrete Tank Manufacturer of full responsibility for the accuracy and completeness of the drawings and calculations.
- D. Quality Control Submittals:
 - 1. Prestressed Concrete Tank Installer: Certified by Prestressed Concrete Tank Manufacturer that installer is qualified to do the Work.
 - 2. Prestressed Concrete Tank Manufacturer's Site Representative: Certified by Prestressed Concrete Tank Manufacturer that the representative is qualified and experienced in type of Work to be performed.
 - 3. Prestressed Concrete Tank Manufacturer's installation instructions.
 - 4. Reinforcing steel shop drawings showing fabrication and placement.
 - 5. Catalog cuts or shop drawings of all appurtenances (i.e. pipe penetrations, water stops, etc.)

6. Statements of Qualification: The Prestressed Concrete Tank Manufacturer shall submit evidence of previous experience meeting the requirements outlined in Section 1.04 Quality Assurance. Include project references of previous projects that meet these requirements.
7. Concrete Mixtures: Design proportions for all concrete and shotcrete. Concrete strengths of trial mixes. Admixtures to be used in the concrete or shotcrete and their purpose.
8. Prestressed Concrete Tank Manufacturer's hydrostatic leak testing plan.
9. Prestressed Concrete Tank Manufacturer's Certificate of Compliance and Proper Installation stating that the tank has been designed, fabricated, erected, inspected, and tested in accordance with AWWA D110.

1.06 MANUFACTURER'S SERVICES

- A. If not erected by the Prestressed Concrete Tank Manufacturer or manufacturer's authorized dealer, a manufacturer's representative of the tank specified and provided shall be present at the jobsite for installation assistance, inspection and certification of the installation, and leakage testing for the minimum person-days listed for the services hereinunder, travel time excluded:
 1. Three person-days for installation assistance, inspection, and certification of the installation.
 2. Three person days for leakage testing.
 3. Additional field trips may be required to resolve field installation problems. If needed, these additional trips shall be at no additional cost to the Owner.

1.07 DESIGN STANDARDS AND REFERENCES

- A. American Water Works Association (AWWA):
 1. The prestressed concrete tank materials, design, fabrication, and erection shall meet all applicable requirements of ANSI/AWWA Standard D110, Wire and Strand-wound, Circular, Prestressed Concrete Water Tanks, latest version.
- B. American Concrete Institute (ACI):
 1. ACI 301 Specifications for Structural Concrete

2. ACI 305 Hot Weather Concreting
 3. ACI 306 Cold Weather Concreting
 4. ACI 309R Guide for Consolidation of Concrete
 5. ACI 318 Building Code Requirements for Reinforced Concrete and Commentary
 6. ACI 347R Guide to Formwork for Concrete
 7. ACI 350 Code Requirements for Environmental Engineering Concrete Structures and Commentary
 8. ACI 350.3 Seismic Design of Liquid Containing Concrete Structures and Commentary
 9. ACI 372R Design and Construction of Circular Wire- and Strand Wrapped Prestressed Concrete Structures
 10. ACI 506R Guide to Shotcrete
- C. American Society for Testing and Materials (ASTM):
1. ASTM A123/A123M Standard Specification for Zinc (Hot-Dip Galvanized) Coatings on Iron and Steel Products
 2. ASTM A185 Standard Specification for Steel Welded Wire Reinforcement, Plain, for Concrete
 3. ASTM A416 Standard Specification for Steel Strand, Uncoated Seven-Wire for Prestressed Concrete
 4. ASTM A421/A421M Standard Specification for Uncoated Stress-Relieved Steel Wire for Prestressed Concrete
 5. ASTM A475 Standard Specification for Zinc-Coated Steel Wire Strand
 6. ASTM A615/A615M Standard Specification for Deformed and Plain Carbon-Steel Bars for Concrete Reinforcement
 7. ASTM A653/A653M Standard Specification for Steel Sheet, Zinc-Coated (Galvanized) or Zinc-Iron Alloy-Coated (Galvannealed) by the Hot-Dip Process

8. ASTM A706/A706M Standard Specification for Low-Alloy Steel Deformed and Plain Bars for Concrete Reinforcement
9. ASTM A821 Standard Specification for Steel Wire, Hard Drawn for Prestressing Concrete Tanks
10. ASTM A1008/A1008M Standard Specification for Steel, Sheet, Cold-Rolled, Carbon, Structural, High-Strength Low-Alloy, High-Strength Low-Alloy with Improved Formability, Solution Hardened, and Bake Hardenable
11. ASTM C31 Standard Practice for Making and Curing Concrete Test Specimens in the Field
12. ASTM C33 Standard Specification for Concrete Aggregates
13. ASTM C39 Standard Test Method for Compressive Strength of Cylindrical Concrete Specimens
14. ASTM C231 Test Method for Air Content of Freshly Mixed Concrete by the Pressure Method
15. ASTM C618, Type F Standard Specification for Coal Fly Ash and Raw or Calcined Natural Pozzolan for Use in Concrete
16. ASTM D698 Standard Test Methods for Laboratory Compaction Characteristics of Soil Using Standard Effort (12,400 Ft. – lbf/ft³) 600 KN-M/M³)
17. ASTM C920 Specification for Elastomeric Joint Sealants
18. ASTM D1056 Standard Specification for Flexible Cellular Materials – Sponge or Expanded Rubber
19. ASTM C1116/C1116M Standard Specification for Fiber-Reinforced Concrete and Shotcrete
20. ASTM D1556 Standard Test Method for Density and Unit Weight of Soil in Place by the Sand-Cone Method
21. ASTM D1557 Standard Test Methods for Laboratory Compaction Characteristics of Soil Using Modified Effort (56,000 Ft. – lbf/ft³) 2700 KN-M/M³)
22. ASTM D2000 Classification System for Rubber Products in Automotive Applications

- D. American Society of Civil Engineers (ASCE):
 - 1. ASCE Standard 7 Minimum Design Loads for Buildings and Other Structures
- E. US Army Corps of Engineers
 - 1. Specification CRD-C-572, Specification for PVC Waterstop
- F. U.S. Nuclear Regulatory Commission:
 - 1. TID-7024, Dynamic Pressure on Fluid Containers of Nuclear Reactors and Earthquakes

1.08 DESIGN CRITERIA

- A. The prestressed concrete tank shall be designed and constructed in accordance with the provisions of AWWA D110 Standard for Wire or Strand Wound Circular Prestressed-Concrete Water Tanks, Type III core wall, ACI 350, ACI 350.3, ASCE 7 and IBC.
- B. Horizontal prestressing shall be continuous. Discontinuous prestressing tendons or strands will not be allowed.
- C. The Prestressed Concrete Tank Manufacturer shall use the following loadings and requirements in the design calculation:
 - 1. Capacity: 715,000 gallons.
 - 2. Dimensions: Per Drawings.
 - 3. Dead Load: Shall be the estimated weight of all permanent imposed loads. Unit weight of concrete 150 pounds per cubic foot; steel 490 pounds per cubic foot.
 - 4. Liquid Load: Shall be the weight of all the liquid when the clarifier is filled. Unit weight of liquid 65 pounds per cubic foot.
 - 5. Wind Load: Shall be as required by ASCE 7.
 - 6. Seismic Criteria:
 - a. Seismic design shall be based on the applicable sections of AWWA D110, ASCE 7, TID 7024, and the local jurisdictional building code. Impulsive and convective forces, as well as fluid spectral velocity shall be calculated utilizing each code and the maximum value of each component shall be utilized.

- b. Risk Category: III
- 7. Backfill Height: Per drawings
- 8. Backfill Pressure: Earth loads shall be determined by rational methods of soil mechanics. Backfill pressure shall not be used to reduce the amount of required prestressing.
- 9. Foundation Loads: The tank foundation shall be proportioned so that soil pressure shall be less than the soil bearing capacity. The allowable gross soil bearing capacity specified in the Geotechnical Report.
- 10. ASCE 7/AWWA D110-13 Design Criteria:
 - a. A constant freeboard of two feet will be maintained. Sloshing is not expected.
 - b. Dynamic Effects of Backfill: Seismic design shall consider the additive effects of the dynamic backfill loading.
 - c. Base Restraint Cable Design:
 - 1) When allowable shear resistance of the bearing pad is less than the total base shear obtained from the maximum values of impulsive and convective components and the dynamic effects of backfill, base restraint cables shall be utilized. The allowable cable stress is 0.75 fpu.
 - 2) For the total base shear obtained from the loading conditions of ASCE 7 that incorporate an over strength factor (Omega Factor), the allowable bearing pad shear or seismic cable stress (if required by design) shall be increased by 20-percent. The Omega factor shall be incorporated in accordance with ASCE 7 for all loading cases.
- D. The Prestressed Concrete Tank Manufacturer shall design the composite concrete wall with steel diaphragm and closure steel slot plate in combination with vertical mild steel reinforcement based on the following design criteria and requirements:
 - 1. The prestressed tank wall shall be considered as a cylindrical shell with partial edge restraint.

2. The prestressed tank wall shall be reinforced vertically by deformed steel reinforcing bars. The steel diaphragm can be taken as effective vertical reinforcing.
3. The prestressed tank wall shall be of precast construction. The minimum core wall thickness shall be a minimum of 6 inches. The core wall is that area of the wall interior to all circumferential prestressing. Shotcrete or cast-in-place concrete core walls are not permitted.
4. For wire wound tanks, a stress plate shall be required at all above grade locations where prestress wires are displaced 24 inches or greater. The stress plate shall be designed to transfer stress across the opening.
5. No reduction in ring compression or tension in the wall will be taken due to restraint at the bottom.
6. The long-term prestressing losses caused by shrinkage, creep, and relaxation in the prestressed reinforcement of the tank walls shall not be assumed less than 25,000 psi.
7. Lateral soil pressures shall not be considered in resisting seismically generated shear forces between the wall footing and the wall.

E. Floor Slab

1. The floor slab shall be designed as per the recommendations by the geotechnical report and per the Prestressed Concrete Tank Manufacturer following the AWWA D-110 standard. Construction joints will only be allowed as shown on the shop drawings and as approved by the Engineer. Construction joints shall incorporate a horizontal 6-inch PVC waterstop.
2. Wall footings may be constructed above or below floor grade. If required, the floor shall have thickened regions to facilitate transitions from under slab concrete pipe encasements into the floor, appurtenance loadings and temporary bracing requirements.
3. Minimum cross-sectional area ratio of floor reinforcement to concrete shall be 0.5-percent.
4. Polypropylene or cellulose fibers may be used at the Prestressed Concrete Tank Manufacturer's discretion.

- F. Extended footings shall be provided to prevent sliding of the clarifier tank due to differential backfill surrounding the tank. Design of the extended footing shall be stamped and signed by an Arizona Registered Professional Engineer employed by the Prestressed Concrete Tank Manufacturer.

1.09 WARRANTY

- A. See Part 3 EXECUTION for various Contractor and Prestressed Concrete Tank Manufacturer warranty requirements.

PART 2 PRODUCTS

2.01 GENERAL

- A. The prestressed concrete tank and tank foundation shall be designed by the Prestressed Concrete Tank Manufacturer in accordance with the design criteria, design standards, and specifications herein. The tank shall be erected by the Prestressed Concrete Tank Manufacturer in accordance with the design standards and specifications herein.
- B. The use of a manufacturer's name and model or catalog number is for the purpose of establishing the standard of quality and general configuration desired only. Products of other manufacturers will be considered in accordance with the GENERAL CONDITIONS.

2.02 CONCRETE

- A. Concrete shall conform to ACI 301.
- B. Cement shall be Portland cement Type I, Type II, Type III, or Type IV.
- C. Admixtures, other than air-entraining, superplasticizers, shrinkage reducing and water reducing admixtures will not be permitted unless approved by the Engineer.
- D. If air entrainment is utilized, the total volumetric air content of the concrete or shotcrete before placement shall not exceed 8% ($\pm 1.5\%$) as determined by ASTM C173 or ASTM C231.
- E. Concrete for tank wall and launder construction shall have a minimum compressive strength of 4,500 psi at twenty-eight days and a maximum water to cementitious ratio of 0.42.
- F. Concrete for the tank floor, footings, pipe encasement, and all other work shall have a minimum compressive strength of 4,500 psi at twenty-eight days, shall not be air-entrained, unless exposed to freeze thaw conditions,

and have a maximum water to cementitious ratio of 0.42. The coarse and fine aggregate shall meet the requirements of ASTM C33. Coarse aggregate shall be No. 467 with 100-percent passing the 1½ inch sieve. Superplasticizers, water-reducing, and shrinkage reducing (if applicable) admixtures shall be incorporated into the floor concrete. If fibers are used, they shall be virgin polypropylene or cellulose fibers, Microfiber by Grace, Fibermesh 150 by Propex, UltraFiber 500 by Buckeye, or Engineer approved equal. Fiber lengths shall be a maximum of ¾ inches. The amount of fibers added to the concrete mix shall conform to the Manufacturer's recommendations.

- G. Proportioning for concrete shall be in accordance with ACI 301.
- H. All concrete shall have a maximum water-soluble chloride ion concentration of 0.06-percent by weight of cementitious material.

2.03 SHOTCRETE

- A. Shotcrete shall conform to ACI Standard 506, except as modified herein.
- B. The wet mix process shall be employed for shotcreting.
- C. Shotcrete used for covering prestressed wire or strand shall consist of not more than three parts sand to one-part Portland cement by weight. Additional coats of shotcrete shall consist of not more than four parts sand to one-part Portland cement by weight. Polypropylene fibers shall be included in the shotcrete used for the finish cover coat. Fibers shall be Fibercast 500 by Propex, Fibermesh or Engineer approved equal. Fibers shall be virgin polypropylene and comply with ASTM C-1116 performance level I. Fiber length shall be ¼ inch. The amount of the fibers added to the shotcrete used for the finish cover coat shall conform to the Manufacturer's recommendations. Fly ash may be incorporated into the finish cover coat. Fly ash shall conform to ASTM C618, Type F. Shotcrete shall have a minimum strength of 4,500 psi at twenty-eight days and have a maximum water to cementitious ratio of 0.42.
- D. Rebound material shall not be reused in any form for shotcrete.
- E. If used by the Prestressed Concrete Tank Manufacturer, the total volumetric air content of the shotcrete before placement shall not exceed 7-percent (±1-percent) as determined by ASTM C-173 or ASTM C-231.
- F. Fine Aggregates:
 - 1. The fineness modulus shall be between 2.7 and 3.4. A well-graded coarse sand shall be used for all shotcrete applications.

2. The gradation for the fine aggregates shall adhere to the "Grading No. 1" requirements listed in "Table 1.1 – Grading Limits for Combined Aggregates" of ACI 506.
- G. All shotcrete shall have a maximum water-soluble chloride ion concentration of 0.06-percent by weight of cementitious material.

2.04 REINFORCING STEEL

- A. Reinforcing steel shall be new billet steel Grade 60, as shown on the Drawings, meeting the requirements of ASTM A615. Welded wire fabric and weldable reinforcing steel shall conform to ASTM A185 and ASTM A706, respectively.
- B. Reinforcing steel shall be accurately fabricated and shall be free from loose rust, scale, and contaminants, which reduce bond.
- C. Reinforcing steel shall be accurately positioned on supports, spacers, hangers, or other reinforcements and shall be secured in place with wire ties or suitable clips. Rebar chair supports may be either steel with plastic tips, turned up legs or plastic.
- D. Continuous reinforcing is required through floor and cast in place dome construction joints, where applicable.

2.05 BASE RESTRAINT CABLES

- A. Where required by design, the tank designer shall use base restraint cables to resist earthquake and/or wind loads. Base restraint cables shall be hot-dipped galvanized seven-wire strand and shall be manufactured in accordance with ASTM A416 prior to galvanizing, and ASTM A475 after galvanizing. Only seven-wire strand will be allowed.
- B. Hot-dipped galvanized seven-wire strand shall have a nominal strand diameter of 0.375 in, 0.50 in or 0.60 in. 0.375-inch diameter strand shall have a MUS after galvanization of 21.36 kips and a min. yield at 1-percent extension of 15.60 ksi. 0.50-inch diameter strand shall have a MUS after galvanization of 38.25 kips and a min. yield at 1-percent extension of 28.00 ksi. 0.60-inch diameter strand shall have a MUS after galvanization of 54.20 kips and a min. yield at 1-percent extension of 40.70 ksi. All strands shall have a minimum of weight of Zinc Coating of 0.85 oz/sq.-ft.
- C. Neoprene sleeves for base restraint cables shall be closed-cell conforming to ASTM D1056, Type 2, Class A, and Grade 3. The sleeves shall have a compression deflection limited to 25-percent at 9 to 13 psi, hardness of 60

to 80 durometer, a minimum tensile strength of 175 psi, a minimum elongation of 180-percent, and a maximum compressive set of 35-percent

2.06 STEEL DIAPHRAGM

- A. The steel diaphragm shall conform to ASTM A1008 and shall be a minimum thickness of 0.017 inches. It shall be vertically ribbed with reentrant angles. The back of the channels shall be wider than the front, providing a mechanical keyway anchorage with the concrete and shotcrete encasement.
- B. The steel diaphragm shall extend to within 1 inch of the full height of the wall panel with no horizontal joints. Vertical joints within a wall panel shall be roll seamed or otherwise fastened in a fashion that results in a firm mechanical lock. Joints between wall panels that are not roll seamed shall be edge sealed with polysulfide or polyurethane sealant.
- C. No punctures will be permitted in the diaphragm except those required for pipe sleeves, temporary construction openings, or special appurtenances. The Engineer shall approve details of the openings. All openings shall be completely edge-sealed with polysulfide or polyurethane sealant.
- D. Diaphragm steel may be considered as contributing to the vertical reinforcement of the wall.
- E. Steel closure plates shall be used at wall slots between precast wall panels on the exterior face to create a continuous steel diaphragm.

2.07 CIRCUMFERENTIAL PRESTRESSING STEEL

- A. Steel for prestressing shall either be cold drawn, high carbon wire or galvanized seven wire strand.
- B. The wire shall meet the requirements of ASTM A821 and have a minimum ultimate tensile strength of 210,000 psi.
- C. Galvanized strand shall meet the requirements of ASTM A416 prior to galvanizing with zinc coating for galvanizing meeting the requirements of ASTM A641/641M or ASTM A475. Each wire shall be individually hot-dipped galvanized before being stranded. The minimum weight of zinc coating per unit area of uncoated wire surface area shall be no less than 0.85 ounces per square foot.
- D. Splices for horizontal prestressed reinforcement shall be ferrous material compatible with the reinforcement and shall develop the full strength of the

wire or strand. Wire or strand splice and anchorage accessories shall not nick or otherwise damage the prestressing.

2.08 ELASTOMERIC MATERIALS

- A. A 9-inch minimum waterstop with centerbulb shall be polyvinyl chloride meeting the requirements of the Corps of Engineers Specification CRD-C 572. Splices shall be made in accordance with the Manufacturer's recommendations subject to the approval of the Engineer. Waterstop shall be manufactured by Greenstreak Plastic Products Company, Inc., or Engineer approved equal.
- B. Bearing pads shall be natural rubber or neoprene.
 - 1. Natural rubber bearing pads shall contain only virgin natural polyisoprene as the raw polymer and the physical properties shall comply with ASTM D2000 Line Call-Out M 4 AA 414 A1 3.
 - 2. Neoprene bearing pads shall have a hardness of 40 to 50 durometer, a minimum tensile strength of 1,500 psi, a minimum elongation of 500-percent, and a maximum compressive set of 50-percent. Pads shall meet the requirements of ASTM D2000 Line Call-Out M 2 BC 410 A1 4 B14 or M 2 BC 414 A14 C12 F17 for 40 durometer material.
- C. Sponge filler shall be closed-cell neoprene or rubber conforming to ASTM D1056, Type 2, Class A, and Grade 1 or 3. Compression deflection limited to 25-percent at 2 to 5 psi.
- D. Polysulfide or polyurethane sealant will be a two or three component elastomeric compound meeting the requirements of ASTM C920. Sealants shall have permanent characteristics of bond to metal surfaces, flexibility, and resistance to extrusion due to hydrostatic pressure. Air cured sealants shall not be used.
- E. Hydrophilic Waterstop: Provide waterstop where hydrophilic water stop is shown on the Drawings, or where otherwise approved by the Engineer. Hydrophilic waterstop shall be Adeka Ultraseal P-201, or equal.

Accessories shall be provided as follows:

- 1. Provide manufacturer's recommended primer adhesive to secure waterstop to concrete, or other specific surfaces as required.
- 2. Provide concrete nails as required to secure waterstop in vertical applications to concrete surfaces.

2.09 APPURTENANCES

- A. The Prestressed Concrete Tank Manufacturer shall provide and install all appurtenances as shown on the drawings. Appurtenances shall include the following:
 - 1. Pipe Penetrations: As much as possible, factory locate all openings in the tank wall and slab for pipe penetrations and provide complete with appurtenances as shown or as needed. Provide flanges, waterstops, and other items for a watertight installation and reinforce panes as needed to comply with AWWA D110.
 - 2. Concrete launder shall be constructed as shown on the Drawings and coordinated with WesTech.
- B. The Contractor shall coordinate and provide the following:
 - 1. General Contractor shall install under-slab concrete encased piping shall as shown on the Drawings.
 - 2. General Contractor shall install the central pedestal that supports the clarifier mechanism center column.
 - 3. Grout for floor and launder shall be placed by General Contractor.
 - 4. Concrete coating system shall be applied by General Contractor per Section 09 90 00 and as shown on the Drawings.
 - 5. General Contractor shall install owner furnished WesTech clarifier equipment as specified in Section 46 05 50 and as shown on the Drawings.
 - 6. Stairs shall be installed by the Contractor as shown on the Drawings. Stairs shall be free-standing and no attachments to the clarifier wall shall be allowed.

PART 3 EXECUTION

3.01 GENERAL

- A. The Contractor and Prestressed Concrete Tank Manufacturer shall provide all tools, equipment, labor, and materials to construct the foundation and tank. The tank shall be designed and constructed by the Contractor and Prestressed Concrete Tank Manufacturer to safely sustain the structure and its live and dead loads and to fully comply with AWWA D110.

- B. Verify layout and orientation of tank accessories, utilities, and piping connections.

3.02 SAFETY

- A. Every precaution shall be taken to keep personnel and visitors outside the prestressing area.
- B. At no time shall anyone stand in the line of stressed wire or strand.
- C. No personnel are allowed outside of the tank, other than the prestressing crew, within 100 feet from the wrapping operation. Additional precautions shall be taken by Contractor and Prestressed Concrete Tank Manufacturer should specified clearance not be available.
- D. Where access to the site by unauthorized persons is outside the Contractor's control, while prestressing work is in progress, Contractor shall erect protective fencing.
- E. Contractor and Prestressed Concrete Tank Manufacturer to conform and enforce all Local and Federal OSHA safety rules and regulations.

3.03 CLEARING, GRUBBING, AND STRIPPING

- A. See SECTION 31 11 00 CLEARING AND GRUBBING.

3.04 EXCAVATION AND BACKFILL

- A. The Contractor shall excavate to such depths and widths to provide adequate room for tank construction. A minimum working area of 15 feet beyond the circumference of the tank foundation at an elevation 12 inches below the top of the tank foundation shall be provided. Excavated material may be used as suitable backfill material.
- B. The excavation shall be dewatered as required during construction. The dewatering method used shall prevent disturbance of the clarifier tank foundation soils.
- C. The Contractor shall excavate rock, if encountered, to the lines and grades indicated on the drawings, or as directed by the Engineer. Refer to the Earthwork for Structures specification Section 31 23 00 for further detail.
- D. In the event the subgrade material is disturbed or over-excavated by the Contractor during excavation, it shall be removed and replaced with compacted select fill, at the Contractor's expense.

- E. After excavation is complete, the bottom of the excavation shall be proof rolled and leveled as directed by the geotechnical engineer before the compacted select fill is placed. The geotechnical engineer shall observe the subgrade for conformance with the original geotechnical report and its suitability for the tank foundation. Before any select fill is to be placed against rock surfaces, the rock shall be relatively free of all vegetation, dirt, clay, boulders, scale, excessively cracked rock, loose fragments, ice, snow, and other objectionable substances. All free water left on the surface of the rock shall be removed.
- F. A leveling base material consisting of a minimum 6-inch thick layer or as recommended by the geotechnical report of compacted select fill shall be placed beneath the entire tank foundation. Select fill shall consist of a clean, well graded, angular or sub-angular, $\frac{3}{4}$ " (maximum) base material. The base material shall permit free drainage without the loss of fines or intermixing with subgrade material by limiting the amount of material that passes the No. 200 sieve to a maximum 8 percent by weight of the total base material. Select fill shall be placed in layers not exceeding 6 inches and compacted to a minimum density equal to 98-percent of the maximum laboratory density in accordance with ASTM D1557. Field testing for density achieved shall be in accordance with ASTM D1556 or D2922. A 30-mil polyethylene liner shall be placed between the subgrade and leveling base material as shown on the drawings. Joints in the polyethylene shall be overlapped a minimum of 6 inches.
- G. The surface elevation of the leveling base shall be fine graded to a tolerance of plus zero inches to minus $\frac{1}{2}$ inch over the entire foundation areas. Fine grading tolerances for floor pipe encasements shall be plus zero inches to minus 6 inches.
- H. The tank shall be backfilled and rough graded to the contours shown on the drawings. Unless other material is specified by the Engineer, materials used for backfilling shall be suitable on-site material.
- I. Frozen material shall not be used for backfill nor shall fill material be placed on snow, ice, or frozen material. Rock or concrete spoils (greater than 6 inches) shall not be used in backfill within 2 feet of the tank wall.

3.05 FLOOR

- A. The floor and wall footings shall be constructed to the dimensions shown on the Approved Shop Drawings.
- B. Prior to placement of the floor concrete, all piping that penetrates the floor shall be set and encased in concrete.

- C. The vertical waterstop shall be placed and supported so that the bottom of the center bulb is at the elevation of the top of the footing. The waterstop shall be supported without puncturing any portion of the waterstop other than pre-manufactured holes, grommets or hog rings for tying at 12 inches o.c. The waterstop shall be spliced using a thermostatically controlled sealing iron in accordance with the manufacturer's recommendations and each splice shall be successfully spark tested prior to encasement in concrete.
- D. The floor shall be cured by applying one coat of curing compound, curing blankets and/or flooding with water, and shall remain saturated for a minimum of seven days.

3.06 PRECAST WALL PANEL CONSTRUCTION AND ERECTION

- A. The precast wall panel shall be constructed with a continuous waterproof steel diaphragm embedded in the exterior of the precast panel. Horizontal joints in the diaphragm will not be allowed.
- B. No holes for form ties, nails, or other punctures will be permitted in the wall.
- C. Temporary wall openings may be provided for access and removal of construction materials from the tank interior subject to the approval of the Engineer.
- D. Wall beds shall be constructed to provide finished panels with the proper curvature of the tank.
- E. Polyethylene sheeting shall be placed between successive pours to provide a high moisture environment and a long slow cure for the concrete.
- F. The erecting crane and lifting equipment shall be capable of lifting and placing the precast panels to their proper location without causing damage to the panel.
- G. The precast panels shall be erected to the correct vertical and circumferential alignment. The edges of adjoining panels shall not vary inwardly or outwardly by more than 3/8 inch and shall be placed to the tank radius within $\pm 3/8$ inch.
- H. Joints between precast wall panels shall be bridged with a 10-gauge steel plate edge sealed with polysulfide or polyurethane and filled with mortar as shown on the drawings. No through-wall ties will be permitted.

- I. The steel diaphragm shall extend to within 1 inch of the full height of the wall panel with no horizontal joints. Vertical joints within a wall panel shall be roll seamed or otherwise fastened in a fashion that results in a firm mechanical lock.

3.07 CONCRETE

- A. All concrete shall be conveyed, placed, finished, and cured as required by pertinent ACI standards.
- B. Reinforcing steel shall be accurately positioned on supports, spacers, hangers, or other reinforcements and shall be secured in place with wire ties or suitable clips.
- C. Weather Limitations
 1. Unless specifically authorized in writing by the Engineer, concrete shall not be placed without special protection during cold weather when the ambient temperature is below 35 degrees Fahrenheit and when the concrete is likely to be subjected to freezing temperatures before initial set has occurred and the concrete strength has reached 500 psi. Concrete shall be protected in accordance with ACI 306. The temperature of the concrete shall be maintained in accordance with the requirements of ACI 301 and ACI 306. All methods and equipment for heating and for protecting concrete in place shall be subject to the approval of the Engineer.
 2. During hot weather, concreting shall be in accordance with the requirements of ACI 305.
 3. Placement of concrete during periods of low humidity (below 50-percent) shall be avoided when feasible and economically possible, particularly when large surface areas are to be finished. In any event, surfaces exposed to drying wind shall be covered with polyethylene sheets immediately after finishing, or flooded with water, or shall be water cured continuously from the time the concrete has taken initial set. Curing compounds may be used in conjunction with water curing, provided they are compatible with coatings that may later be applied, or they are degradable.
- D. Finishes: The tank shall be given the following finishes:
 1. The floor slab shall receive a rough broom finish to accept grout topping. The top of the wall footing, exterior to the waterstop, shall receive a trowel finish.

2. The interior of the precast wall panels shall receive a horizontal light broom finish.
3. Exterior shotcrete shall receive a natural gun / nozzle finish.
4. Concrete launder interior base shall receive a rough broom finish to accept grout topping. Remainder of launder surfaces shall be a form finish.
5. For all formed concrete surfaces, all irregularities that project greater than 1/4" from the surface shall be ground off. All holes greater than 3/4" wide or 1/2" deep should be patched.

E. Curing

1. Concrete shall be cured using water methods, sealing materials, or curing compounds. Curing compounds shall not be used on surfaces to which decorative coatings, mortar, or shotcrete is to be applied.

F. Testing

1. For concrete placed in precast panels or wall slots, a set of four cylinders shall be made for each truck load of concrete placed. One cylinder shall be tested at seven days, two at twenty-eight days, and one held as a spare. For concrete placed in the floor or foundation, two sets of five cylinders for the first 50 cubic yards, and one set of five cylinders for every 100 cubic yards thereafter placed in the same day. Two cylinders shall be tested at seven days, two at twenty-eight days, and one held as a spare.
2. Slump, air content and temperature testing shall be performed on each truck where cylinders are taken.
3. All concrete testing shall be in accordance with ASTM C31 and C39, at the expense of the Prestressed Concrete Tank Manufacturer, and shall be conducted by an independent testing agency approved by the Engineer.

3.08 SHOTCRETING

A. Weather Limitations

1. Shotcrete shall not be placed in freezing weather without provisions for protection against freezing. Shotcrete placement can start without special protection when the temperature is 35 degrees Fahrenheit and rising and shall be suspended when the temperature is 40 degrees Fahrenheit and falling. The surface to which the shotcrete is

applied shall be free from frost. Cold weather shotcreting shall be in accordance with ACI 506, ACI 301 and ACI 306.

2. Hot weather shotcreting shall be in accordance with the requirements of ACI 506, ACI 301 and ACI 305.

B. Coating of Steel Diaphragm

1. The steel diaphragm shall be covered with a layer of shotcrete at least ½ inch thick prior to prestressing.
2. Total minimum coating over the steel diaphragm shall be 1½ inches including diaphragm cover, wire or strand cover, and finish cover coat.

C. Coating Over Prestressing Wire or Strand

1. Each prestress wire or strand shall be individually encased in shotcrete. Shotcrete thickness shall be sufficient to provide a clear cover over the wire and strand of at least ¼ inch and 3/8 inch, respectively.
2. Finish cover coat shotcrete shall be applied as soon as practical after the last application of wire or strand coat.
3. The minimum final shotcrete cover over the outermost prestressing wire or strand layer shall be 1 inch.

D. Placement of Shotcrete

1. Shotcrete shall be applied by an ACI 506 certified nozzleman.
2. Manually applied shotcrete shall be applied with the nozzle held at a small upward angle not exceeding five degrees and constantly moving during application in a smooth motion with the nozzle pointing in a radial direction toward the center of the tank. The nozzle distance from the prestressing shall be such that shotcrete does not build up or cover the front face of the wire or strand until the spaces behind and between the prestressing elements are filled.
3. Unless applied by an automated shotcrete process, total cover coat thickness shall be controlled by shooting guide wires. Vertical wires shall be installed under tension and spaced no more than two feet apart to establish uniform and correct coating thickness. Monofilament line (100 lb. test) or 18 or 20-gauge high tensile strength steel wire shall be used. Guide wires shall be removed after placement of the cover coat.

4. Shotcrete applied by an automated shotcrete process shall be applied using the wet mix only. Nozzles shall be kept mounted on power driven machinery enabling the nozzle to travel parallel to the surface to be sprayed at a uniform linear or bi-directional speed. The nozzle shall be kept at a uniform constant distance from the surface, always ensuring a right-angle spray of the material to the surface. The high velocity impact shall be developed pneumatically by injecting compressed air at the nozzle.

E. Curing

1. Shotcrete shall be cured using water curing methods, sealing materials or curing compounds at the option of the Prestressed Concrete Tank Manufacturer. Curing compounds shall not be used on surfaces to which decorative coatings, mortar or shotcrete is to be applied. Curing compounds used within the tank wall shall be suitable for use with potable water. Intermediate layers of shotcrete shall be kept damp by water curing or other means no sooner than twelve hours after the shotcrete has been applied.
2. Water curing is not required should additional shotcrete be applied on the entire wall surface within the following twelve hours.
3. Indiscriminate use of continuous water cure for intermediate layers shall be avoided.
4. Complete shotcrete surfaces, which do not receive any additional coatings, may be water cured for a period of at least seven days by encapsulating the shotcrete inside of plastic sheeting.

F. Testing

1. Testing of shotcrete shall be in accordance with ACI 506, except as specified herein. One test panel shall be made for each of the following operations: core wall, wire or strand cover, and cover coat. Test panels shall be made from the shotcrete as it is being placed, and shall, as nearly as possible, represent the material being applied. The method of making a test sample shall be as follows: A frame of wire fabric (1-foot square, 3 inches in depth) shall be secured to a plywood panel and hung or placed in the location where shotcrete is being placed. This form shall be filled in layers simultaneously with the nearby application. After twenty-four hours, the fabric and plywood backup shall be removed, and the sample slab placed in a safe location at the site.

2. The sample slab shall be moist cured in a manner identical with the regular surface application. The sample slab shall be sent to the testing laboratory. Nine 3-inch cubes shall be cut from the sample slab and subjected to compression tests in accordance with current ASTM Standards. Three cubes shall be tested at the age of seven days, three shall be tested at the age of twenty-eight days, and three shall be retained as spares. Testing shall be by an independent testing laboratory, approved by the Engineer and at the Prestressed Concrete Tank Manufacturer's expense.

3.09 CIRCUMFERENTIAL PRESTRESSING

- A. Prestressing shall be performed utilizing continuous wire or strand. Prestressing wire/strand will be placed on the wall with a machine capable of consistently producing a stress in the wire/strand within a range of minus 7-percent to plus 7-percent of the stress required by the design. No circumferential movement of the prestressing along the tank wall will be permitted during or after stressing. Stressing may be accomplished by drawing the wire through a die or by another process that results in uninterrupted elongation, thus assuring uniform stress throughout its length and over the periphery of the tank.
- B. Each coil of prestressing shall be temporarily anchored at sufficient intervals to minimize the loss of prestress in case a wire/strand breaks during wrapping.
- C. Minimum clear space between prestressing wires is 5/16 inch or 1.5 wire diameters, whichever is greater. Minimum clear distance between prestressing strands is 3/8 inch or 1.5 strand diameters, whichever is greater. Any wires or strands not meeting the spacing requirements shall be respaced. Prestressing shall be placed no closer than 2 inches from the top of the wall, edges of openings, or inserts, nor closer than 3 inches from the base of walls or floors where radial movement may occur.
- D. The band of prestressing normally required over the height of an opening shall be displaced into circumferential bands immediately above and below the opening to maintain the required prestressing force. Bundling of the prestressing steel shall be prohibited.
- E. For wire wound tanks, a stress plate shall be used at all permanent wall penetrations above grade that results in displacement of wire/strand equal to or greater than 24 inches in height. The stress plate shall accommodate a portion of the prestressing normally required for the height of the opening. The remaining prestressing normally required shall be displaced into circumferential bands immediately above and below the penetration.

The effect of banded prestressing shall be taken into account in the design.

- F. Ends of individual coils shall be joined by suitable steel splicing devices capable of developing the full strength of the prestressing wire/strand.
- G. The Prestressed Concrete Tank Manufacturer shall furnish a calibrated stress recording device, which can be recalibrated, to be used in determining wire/strand stress levels on the wall during and after the prestressing process. At least one stress reading per vertical foot or one stress reading for every roll of prestressing, whichever is greater, shall be taken immediately after the wire or strand has been applied on the wall. Readings shall be recorded and shall refer to the applicable height and layer of the prestressing for which the stress is being taken. The Prestressed Concrete Tank Manufacturer shall keep a written record of stress readings. All stress readings shall be made on straight lengths of wire/strand. If applied stresses fall below the design stress in the steel, additional wire or strand will be provided to bring the force on the core wall up to the required design force. If the stress in the steel is more than 7-percent over the required design stress, the wrapping operation should be discontinued, and satisfactory adjustment made to the stressing equipment before proceeding.
- H. When a mechanical stressing system is utilized a continuous electronically (or substantial equivalent) monitored permanent recording of the applied force shall be made during the entire circumferential prestressing application. All such recordings shall be based on a continuous sensing of the applied force on the wire/strand between the tensioning system and the wall when, and as, the strand is being wrapped and laid on the wall.

3.10 TESTING

- A. The Contractor shall, at the completion of clarifier tank construction, thoroughly clean the interior of the tank.
- B. Contractor and Prestressed Concrete Tank Manufacturer shall coordinate leak testing of the clarifier tank by measurement and observation.
 - 1. Leak testing shall be performed prior to backfilling of the tank. All exterior wall surfaces must be visible.
 - 2. Water will be provided by the Owner. It shall be the Contactor's responsibility to pipe, haul, or otherwise transport water from the Owner's sources to the tank. The Contractor shall also provide all equipment, materials, and labor necessary to conduct the leakage testing.

3. The tank shall be filled to the normal operating level and allowed to sit for at least 24 hours before start of the leak test.
 4. During the leak test, the Contractor and Prestressed Concrete Tank Manufacturer shall measure the drop in liquid level over the next 72 hours to determine the liquid volume loss for comparison with the allowable leakage. Evaporative losses shall be measured or calculated and deducted from the measured loss to determine the net liquid loss (leakage). The net liquid loss for a period of 24 hours shall not exceed 0.05 percent of the tank capacity ($0.0005 \times 713,000$ gallons = 357 gallons).
 5. If the leakage exceeds the maximum allowable, the leakage test shall be extended to a total of five days. If at the end of five days the average 24-hour leakage does not exceed the maximum allowable, the test shall be considered satisfactory. If the net liquid loss exceeds the maximum allowable, leakage shall be considered excessive and the tank shall be repaired. No visible leaks or seepage or damp spots will be allowed in order to pass the leakage test. Repair all leaks in accordance with the Prestressed Concrete Tank Manufacturer's written instructions and hydrostatically retest tank. Water for subsequent tests, if required, shall be paid for by the Prestressed Concrete Tank Manufacturer.
- C. Damp spots will not be permitted at any location on the tank wall. Damp spots are defined as spots where moisture can be picked up on a dry hand.

3.11 WARRANTY

- A. If within one year from the date of substantial completion, the tank or any part thereof shall prove to be defective in material or workmanship, the Prestressed Concrete Tank Manufacturer shall provide and install an identical or similar replacement or at the Owner's option, repair, or provide a monetary refund for the defective part. The one-year Contractor warranty shall be through the Contractor's bonding company. In addition to the Contractor's one-year warranty, a three-year Prestressed Concrete Tank Manufacturer's warranty shall be provided.

3.12 ONE-YEAR INSPECTION AND REPAIRS

- A. Within 1-month prior to the one-year anniversary date of initial tank use, the Contractor and the Prestressed Concrete Tank Manufacturer's authorized representative shall make a visual inspection of the tank interior and appurtenances; tank exterior and appurtenances; and the immediate area

surrounding the tank. A written summary of this inspection shall be filed with the Owner, Engineer, and the Prestressed Concrete Tank Manufacturer.

- B. A warranty inspection of the tank by the Owner and/or the Engineer shall also be made within the warranty period. A list of any defects and failures identified during the inspection will be prepared and transmitted to the Contractor. The list will serve as notice of repairs required under warranty at no additional cost to the Owner.
- C. Repairs:
 - 1. The Prestressed Concrete Tank Manufacturer shall repair any defects in the tank system discovered at this time in a timely manner in accordance with the written Prestressed Concrete Tank Manufacturer's instructions as reviewed and approved by the Engineer. All tank repair or any damage to other work caused by such defect or repairing of the defects including any additional design services by the Engineer, full-time inspection during repairs, and re-warranty inspections shall be at sole cost to the Prestressed Concrete Tank Manufacturer.
 - 2. For all repairs, the Prestressed Concrete Tank Manufacturer shall provide an extended warranty (equal to the original warranty period length) or longer if required by the General Conditions commencing on the date of final acceptance of the repair work.
 - 3. Prestressed Concrete Tank Manufacturer shall complete all tank repairs within 60 calendar days of receiving the warranty inspection summary list.

3.13 CLEAN-UP

The premises shall be kept clean and orderly at all times during the work. Upon completion of construction, the Contractor shall remove or otherwise dispose of all rubbish and other materials caused by the construction operation. The Contractor shall leave the premises in as good a condition as it was found.

END OF SECTION 43 41 65

SECTION 43 05 50

INSTALLATION OF OWNER FURNISHED CLARIFIER EQUIPMENT

DIVISION 46 00 00 – WATER AND WASTEWATER EQUIPMENT

PART 1 GENERAL

1.01 WORK INCLUDED

- A. This section includes information useful to the Contractor for the installation, testing, and startup of Owner furnished clarifier equipment for one new and two existing clarifier tanks.
 - 1. Clarifier equipment is provided by Westech who is also referred to as “Manufacturer” in this section.
- B. This section includes work performed by the Contractor in support of the prestressed concrete tank installation for Clarifier 3.
- C. All work under this section shall be carefully coordinated with Section 43 41 65, TYPE III CONCRETE CLARIFIER, and the prestressed concrete tank supplier.

1.02 GENERAL

- A. See GENERAL CONDITIONS and Division 01, GENERAL REQUIREMENTS, which contain information and requirements that apply to the work specified herein and are mandatory for this project.

1.03 RELATED SECTIONS

- A. Section 03 30 00, CONCRETE
- B. Section 09 90 00, PAINTING
- C. Section 43 41 65, TYPE III CONCRETE CLARIFIER

PART 2 PRODUCTS

2.01 EQUIPMENT INFORMATION

- A. Preliminary submittal information for the Owner furnished equipment is attached to this specification. Additional information will be made available to the Contractor upon award of the project.
- B. Items included in submittal “to be installed by others” or “provided by others” shall be the responsibility of the Contractor to procure and install.

SECTION 43 05 50

INSTALLATION OF OWNER FURNISHED CLARIFIER EQUIPMENT

DIVISION 46 00 00 – WATER AND WASTEWATER EQUIPMENT

PART 3 EXECUTION

3.01 PREPARATION FOR STORAGE AND PROTECTION

- A. Equipment shall be stored and protected in accordance with the requirements of Section 01 66 00, PRODUCT HANDLING, STORAGE, AND PROTECTION of Division 01, GENERAL REQUIREMENTS. In addition, the following shall be done:
 - 1. Care during storage and procedures for installation, lubrication and startup of the motors shall be in strict conformance with Westech's instructions.

3.02 SITE PREP AND CONTRACTOR'S SCOPE FOR CLARIFIER 3

- A. The Contractor is responsible for the following:
 - 1. Excavation
 - 2. Installation of under-slab piping as shown on the Drawings
 - 3. Installation of the center concrete foundation as shown on the Drawings
 - 4. Launder grouting
 - 5. Concrete coating
 - 6. Connection piping outside of the clarifier tank
 - 7. Stairs to walkway
 - 8. Exterior and site work

3.03 EQUIPMENT INSTALLATION

- A. Westech will be onsite and will perform the installation of the mechanisms according to the scope provided in the attached proposals. Contractor shall support Westech's work with the following:
 - 1. Cleaning of the existing clarifier tanks.
 - 2. Concrete repairs as identified during cleaning. The extent and cost of repairs will be determined during construction following review by the engineer and Owner. A change order will be executed for the concrete repair work and a portion of funds from the Owner Contingency (Bid Item No. 20) will be used for payment. Concrete repairs should not be included in the contractor's cost at time of bid.
 - 3. Concrete coating.
 - 4. All items identified above for Clarifier 3.

SECTION 43 05 50

INSTALLATION OF OWNER FURNISHED CLARIFIER EQUIPMENT

DIVISION 46 00 00 – WATER AND WASTEWATER EQUIPMENT

- B. Install the equipment in accordance with the Manufacturer's directions and these Specifications. Where Manufacturer's instructions conflict with this specification, Manufacturer's instructions shall govern.
- C. Installation shall utilize standard torque values and be installed secure in position and neat in appearance. Installation shall include any site preparation tasks, pre-installation tasks as determined by the Manufacturer; such as local assembly, touch-up painting, etc. and any other installation tasks and materials such as wiring, conduit, controls stands, as specified by the Manufacturer.
 - 1. A representative of the Manufacturer will be present to certify installation of the equipment, attend during testing and startup, and train the Owner's staff. Contractor shall coordinate times for the presence of the Manufacturer's representative with Manufacturer, Owner, and Engineer.
- D. Handle carefully and protect the equipment and appurtenances to avoid damaging the equipment.

3.04 FIELD ACCEPTANCE TESTS

- A. Pre-operational checkout: Contractor shall assist Manufacturer's representative during the following for each clarifier mechanism:
 - 1. Verification of equipment alignment
 - 2. Pre-operation lubrication
 - 3. Manufacturer's recommendations for pre-start preparation and pre-operational checkout procedures.
- B. Functional and Performance Test:
 - 1. The Contractor, with the assistance of the Manufacturer's representative if applicable, shall perform functional and performance tests on the clarifier equipment to demonstrate its operation to the satisfaction of the Owner and Engineer.
 - 2. Testing shall be performed in accordance with the Manufacturer's instructions.
 - 3. A test log shall be presented to the Engineer upon the completion of each test that records the following:
 - a. Motor full load amperage for all motors.
 - b. Any notes of irregularities noted during testing and how they were remedied.

SECTION 43 05 50

INSTALLATION OF OWNER FURNISHED CLARIFIER EQUIPMENT

DIVISION 46 00 00 – WATER AND WASTEWATER EQUIPMENT

3.05 LAUNDER GROUT

- A. Contractor shall place grout in the launder of Clarifier 3 in accordance with the Drawings and Section 03 30 00.

3.06 CONCRETE COATING

- A. Contractor shall apply concrete coating to the top of the new and two existing clarifier tanks and launders as shown on the Drawings and specified in Section 09 90 00, PAINTING, System No. 12.
 - 1. Coating shall be applied after launder grout has cured and moisture is in acceptable range for coating application.

END OF SECTION 43 05 50

Proposal for Clarifier No. 1

Proposal

Bullhead City WWTP

Bullhead City, Arizona

Representative

Dan Bertschman
Goble Sampson
Mesa, AZ
dbertschman@goblesampson.com
(480) 969-3667

Owner

Bullhead City

Contact

Justin Saltzgeber
jsaltzgeber@westechwater.com
(801) 631-0962

Jeff Flitton
jflitton@westechwater.com
(801) 290-1208

Proposal: 2493366 F_Rev2 Tuesday, April 8, 2025

WESTECH[®]





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Technical Proposal



Item A – One (1) Mechanism Replacement for WesTech COP Clarifier 90' Dia. Model COPC1A

Item B – Install One (1) COP Clarifier Mechanism



Commercial Proposal



Bidder's Contact Information

Pricing

Payment Terms

Schedule

Freight



Warranty



Terms and Conditions





Technical Proposal

Item A – One (1) Mechanism Replacement for WesTech COP Clarifier 90' Dia. Model COPC1A

WesTech shall supply One (1) replacement mechanism on a WesTech 90' COP Clarifier Model COPC1D, Serial No. 5114B, at Bullhead City WWTP in Bullhead City, Arizona. This proposal includes a design change going from a Ducking Skimmer to a Baffle Skimmer which changes the Model number to COPC1A. This proposal also includes replacement of Weirs and Baffles, Density Current Baffle, and Control Panel

Summary	
Item	Unit
Number of Mechanisms	1
Tank Diameter	90 ft

Detailed Scope of Supply				
Item	Unit	Qty	Size/Description	Material
Drive Unit	each	1	C31 with Torque Control Device	Steel
Center Influent Column	each	1	With Influent ports	Steel
Feed Well with Supports	set	1	With baffled scum ports and skimmer blade	Steel
Energy Dissipating Inlet Well	set	1	With multiple inlet gates and supports	Steel
Drive Cage	each	1	Square	Steel
Rake Arms	each	2	With spiral blades, sludge scraper blades, and squeegees	Steel
Sludge Withdrawal Ring	each	1	With sludge ports and discharge	Steel
Skimmer Blades	set	2	With skimmer arms and supports	Steel
Hinged Scum Skimmer Assembly	each	2	With 4' blades, wipers, and hinged skimmer arms	304
Scum Box Assembly	each	1	With 4' wide beach, drop box, and supports	Steel
Scum Flushing Valve Assembly	each	2	With activation arm	UHMW/SS
Anti-rotation Baffle	each	1	Frame support and baffles	Steel/Neoprene
Weirs and Baffles	lot	1	V-notch 9" weirs, 12" Baffles, with supports and hardware	FRP
Density Current Baffles	lot	1	With supports and hardware	FRP
Fasteners	lot	1	As required	Steel/304 SS
Control Panel Assembly	each	1	NEMA 4X	304SS



Technical Proposal

Drive Unit Details

Description	Proposed Unit
Drive Type	C31 Cage Drive
Housing Material	Steel
Continuous Rated Torque (ft·lbs)	19,000
Rake Speed (RPM)	0.05
Motor Size (HP)	1½
Motor Speed/VAC/Hz/Phase	1800 RPM/230/460V/60Hz/3 Ph
Torque Control Settings (ft·lbs)	Alarm: 19,000 (100%) Motor Cutout: 22,800 (120%)
Main Gear and Pinion Lubrication	Grease
Main Bearing Lubrication	Grease
Attachment Points to Column & Cage	Same as Existing Drive

Electrical and Controls Equipment – Clarifier Control Panel

Parameter	Value
Quantity	1
Enclosure	NEMA 4X, 304 stainless steel wall-mount
Required Power Supply	480 VAC, 3 phase, 60 Hertz
Motor Starter	Included
Components	Door mounted off/on switch Run light and motor cutout light Thermal overloads Control relays Timer Terminal blocks Fuses
Alarms	Top mounted, amber strobing alarm light and horn to indicate high torque condition Alarm silence and reset pushbuttons
Level of Assembly	Wiring for field connections brought to terminal strip All interconnecting wiring is to be by others

Items NOT Included in WesTech's Base Scope of Supply:

- Piping, Valves, or Fittings
- Wiring



Technical Proposal

- Lubricants
- Unloading or storage
- Erection or assembly – unless purchased as part of this proposal
- Concrete work
- Any field paint, touch-up, and repair to shop painted surfaces

Additional Information

- A submittal will be sent for customer review. The submittal will consist of general arrangement drawings.
- One (1) electronic PDF copy of the Operation & Maintenance Manual is included.

Item B – Install One (1) COP Clarifier Mechanism

WesTech shall provide the manpower, supervision, and tools to remove the existing mechanism and install the new WesTech equipment on a 90- foot diameter WesTech COP Clarifier Model COPC1A at Bullhead City WWTP in Bullhead City, Arizona.

Installation of Equipment

On-Site Removal & Erection

Details	Description
Site Location	Bullhead City WWTP
Equipment Location	Tank Open with Close Crane Access to the Tank
Labor Type	Non-union – The foreman will be the crew lead for quality and safety
Work Schedule	50 hours/week, 5 days/week, day shift – site access 24/7
Scope of Items Erected	QTY (1) Clarifier Mechanism– Remove existing & install new

Item	Task	Owner	WesTech
1.00	Project Services		
1.20	GA Drawings		✓
1.30	Project Management		✓
1.35	Civil work – Pipe / underground protection	✓	
1.37	Site Training – ½ day allowed	✓	
1.40	Mobilization / Demobilization		✓
1.60	Supervision & Quality control		✓
1.70	Safety and Coordination – any dedicated safety personnel	✓	
1.71	Operation & Maintenance Manuals		✓



Technical Proposal

1.73	Equipment Check-out and Calibration (if power is connected)	✓
1.78	Storing / Receiving / Transporting to work area	✓
2.00	Site Work	
2.10	Permits – any necessary	✓
2.11	Gaskets & bolts for interconnecting piping to WesTech nozzles	✓
2.12	Grouting of floor (if required)	✓
2.13	Electrical power 440V at 120A or 110V at 240A + 110V at 60A	✓
2.14	Provide safe working environment	✓
2.15	Power line spotter if necessary	✓
2.16	Roll-off dumpsters and disposal of demolished materials	✓
2.17	Lift plans	✓
2.18	Removal of existing unit	✓
2.19	Installation of new unit	✓
2.20	Hydro test water, connections & disposal	✓
2.21	Tenting, heating – cold weather items	✓
2.3	Security and/or fencing for job site, including lay down area	✓
11.00	Equipment	
11.3.1	Engineering & Design	✓
11.60	Cranes, forklifts for remove /installation	✓
16.00	Electrical	
16.1.0	Electrical Equipment	✓
16.1.6	System control panel	✓
16.1.7	Disconnect / Hook-ups / Electrical Wiring, Conduit	✓

Clarifications/Comments

- WesTech considers the construction area around the tanks to be used for access to the tank and construction site.
- Any damage to roadways will be considered normal wear and tear and will be repaired by others.
- Assumed total access to the tank prior to arriving, including, if applicable, the ability to get a crane in a safe position for removal and installation of equipment.



Clarifications and Exceptions

General Clarifications

Terms & Conditions: This proposal, including all terms and conditions contained herein, shall become part of any resulting contract or purchase order. Changes to any terms and conditions, including but not limited to submittal and shipment days, payment terms, and escalation clause shall be negotiated at order placement, otherwise the proposal terms and conditions contained herein shall apply.

Escalation: If between the proposal date and actual procurement and through no fault of the Seller, the relevant cost of labor, material, freight, tariffs, and other Seller costs combined relating to the contract, increase by greater than 2.5% of the overall contract price, then the contract price shall be subject to escalation and increased. Such increase shall be verified by documentation and the amount of contract price escalation shall be calculated as either the actual increased cost to the Seller or, if agreed by the Parties, the equivalent increase of a relevant industry recognized third-party index, and in both cases without any additional profit or margin being added.

Build America, Buy America Act (BABAA) and Other Domestic Content Requirements: WesTech is U.S. based and proudly manufactures many products available to meet various domestic procurement requirements. Due to variability in legislation, products, and project-based specifications, WesTech is unable to guarantee compliance with domestic content requirements unless stated otherwise in our official project proposal. For products where domestic sourcing is not currently available, WesTech can provide documentation to support application for relevant waivers (Non-Availability, De Minimis, or others).

USA Tariffs and Current Trade Laws: All prices are based on current USA and North America tariffs and trade laws/agreements at time of bid. Any changes in costs due to USA Tariffs and trade laws/agreements will be passed through to the purchaser at cost.

Exceptions

Not applicable



Commercial Proposal

Proposal Name: Bullhead City WWTP

Proposal Number: 2493366 F Rev 2

Tuesday, April 08, 2025

1. Bidder's Contact Information

Company Name	WesTech Engineering, LLC
Primary Contact Name	Justin Saltzgiver
Phone	(801) 631-0962
Email	jsaltzgiver@westechwater.com
Address: Number/Street	3665 S West Temple
Address: City, State, Zip	Salt Lake City, UT 84115

2. Firm Pricing

Currency: USD

Scope of Supply

A	One (1) Mechanism Replacement for WesTech COP Clarifier 90' Dia. Model COPC1A	\$529,582
B	Install One (1) COP Clarifier Mechanism	\$217,452
	Taxes (sales, use, VAT, IVA, IGV, duties, import fees, etc.)	Not Included

Prices are valid for a period not to exceed 30 days from date of proposal.

Additional Field Service

Daily Rate (Applicable Only to Field Service Not Included in Scope)	\$1,350

Pricing does not include field service unless noted in scope of supply but is available at the daily rate plus expenses. The greater of a two week notice or visa procurement time is required prior to departure date. Our field service policy is subject to change and can be provided upon request.

3. Payment Terms

Submittal Approval	25%
(Invoicing for the submittal approval will not be posted until after 6/15/2025)	
Release to Fabrication	25%
Notification of Ready to Ship	50%
Completion of Install Service	100%

All payments are net 30 days. Partial shipments are allowed. An approved Letter of Credit is required if Incoterms CIF, CFR, DAP, CIP, or CPT are applicable. Payment is required in full for all other Incoterms prior to international shipment. Other terms per WesTech proforma invoice. Please note that the advising bank must be named as: Wells Fargo Bank, International Department, 9000 Flair Drive, 3rd Floor, El Monte, California 91731, USA.

4. Schedule

Submittal following Purchase Order Acceptance/Contract Execution	8 weeks
Ready to Ship, after Receipt of Submittal Approval	28 weeks
Estimated Weeks to Ready to Ship	36 weeks*

Due to supply chain disruptions and volatility, delivery schedule is a best estimate only and may be improved or hampered based on date of contract execution, scope selection, and materials availability. *Customer submittal approval is typically required to proceed with equipment fabrication and is not accounted for in the schedule above. Project schedule will be extended to account for time associated with receipt of customer submittal approval.

5. Freight

Domestic	FOB Shipping Point - Prepaid and Added (FSP-PPA)	
From	Final Destination	Number of Trucks
WesTech Shops	Bullhead City, AZ.	3



One-Year Warranty

Equipment manufactured or sold by WesTech Engineering, LLC, once paid for in full, is backed by the following warranty:

Subject to the terms below, WesTech warrants all new equipment manufactured or sold by WesTech Engineering, LLC to be unencumbered and free from defects in material and workmanship, and WesTech will replace or repair, F.O.B. its factories or other location it chooses, any part or parts returned to WesTech which WesTech's examination and analysis determine have failed within the warranty period because of defects in material and workmanship. The warranty period is either, one calendar year immediately following start-up, or eighteen (18) months from when WesTech sent its ready-to-ship notification to the purchaser, whichever expires sooner. All repair or replacement parts qualifying under this warranty shall be free of charge. Purchaser will provide timely written notice to WesTech of any defects it believes should be repaired or replaced under this warranty. WesTech will reject as untimely any warranty defect claim that purchaser submits more than thirty (30) days after the possible warranty defect first occurred. Unless specifically stated otherwise, this warranty does not cover normal wear, consumables, or coatings. Purchasers are invited to inspect the equipment in the shop for proper surface preparation and coating application prior to shipment. This warranty is not transferable.

This warranty shall be void and shall not apply where the equipment or any part thereof

- has been dismantled, modified, repaired, or connected to other equipment, outside of a WesTech factory, or without WesTech's written approval, or
- has not been installed in complete adherence to all WesTech's or parts manufacturer's requirements, recommendations, and procedures, or
- has been subject to misuse, abuse, neglect, or accident, or has not at all times been operated and maintained in strict compliance with all of WesTech's requirements and recommendations therefor, including, but not limited to, the relevant WesTech Operations & Maintenance Manual and any other of WesTech's specified guidelines & procedures, or
- has been subject to force majeure events; use of chemicals not approved in writing by WesTech; electrical surges; overloading; significant power, water or feed supply fluctuations; or non-compliance with agreed feedwater or chemical volumes, specifications or procedures.

In any case where a part or component of equipment under this warranty is or may be faulty and the component or part is also covered under the warranty of a third party then the purchaser shall provide reasonable assistance to first pursue a claim under the third-party warranty before making a claim under this warranty from WesTech. WesTech Engineering, LLC gives no warranty with respect to parts, accessories, or components purchased other than through WesTech. The warranties which apply to such items are those offered by the respective manufacturers.

This warranty is expressly given by WesTech and accepted by purchaser in lieu of all other warranties whether written, oral, express, implied, statutory, or otherwise, including without limitation, warranties of merchantability and fitness for particular purpose. WesTech neither accepts nor authorizes any other person to assume for it any other liability with respect to its equipment. WesTech shall not be liable for normal wear and tear, corrosion, or any contingent, incidental, or consequential damage or expense due to partial or complete inoperability of its equipment for any reason whatsoever. The purchaser's exclusive and only remedy for breach of this warranty shall be the repair and or replacement of the defective part or parts within a reasonable time of WesTech's accepting the validity of a warranty claim made by the purchaser.





Terms and Conditions

Terms and Conditions appearing in any order based on this proposal which are inconsistent herewith shall not be binding on WesTech Engineering, LLC. The sale and purchase of equipment described herein shall be governed exclusively by the foregoing proposal and the following provisions:

- 1. SPECIFICATIONS:** WesTech Engineering, LLC is furnishing its standard equipment as outlined in the proposal and as will be covered by final approved drawings. The equipment may not be in strict compliance with the Engineer's/Owner's plans, specifications, or addenda as there may be deviations. The equipment will, however, meet the general intention of the mechanical specifications of these documents.
 - 2. ITEMS INCLUDED:** This proposal includes only the equipment specified herein and does not include erection, installation, accessories, nor associated materials such as controls, piping, etc., unless specifically listed.
 - 3. PARTIES TO CONTRACT:** WesTech Engineering, LLC is not a party to or bound by the terms of any contract between WesTech Engineering, LLC's customer and any other party. WesTech Engineering, LLC's undertakings are limited to those defined in the contract between WesTech Engineering, LLC and its direct customers.
 - 4. PRICE AND DELIVERY:** All selling prices quoted are subject to change without notice after 30 days from the date of this proposal unless specified otherwise. Unless otherwise stated, all prices are F.O.B. WesTech Engineering, LLC or its supplier's shipping points. All claims for damage, delay or shortage arising from such equipment shall be made by Purchaser directly against the carrier. When shipments are quoted F.O.B. job site or other designation, Purchaser shall inspect the equipment shipped, notifying WesTech Engineering, LLC of any damage or shortage within forty-eight hours of receipt, and failure to so notify WesTech Engineering, LLC shall constitute acceptance by Purchaser, relieving WesTech Engineering, LLC of any liability for shipping damages or shortages.
 - 5. PAYMENTS:** All invoices are net 30 days. Delinquencies are subject to a 1.5 percent service charge per month or the maximum permitted by law, whichever is less on all past due accounts. Pro rata payments are due as shipments are made. If shipments are delayed by the Purchaser, invoices shall be sent on the date when WesTech Engineering, LLC is prepared to make shipment and payment shall become due under standard invoicing terms. If the work to be performed hereunder is delayed by the Purchaser, payments shall be based on the purchase price and percentage of completion. Products held for the Purchaser shall be at the risk and expense of the Purchaser. Unless specifically stated otherwise, prices quoted are for equipment only. These terms are independent of and not contingent upon the time and manner in which the Purchaser receives payment from the owner.
 - 6. PAYMENT TERMS:** Credit is subject to acceptance by WesTech Engineering, LLC's Credit Department. If the financial condition of the Purchaser at any time is such as to give WesTech Engineering, LLC, in its judgment, doubt concerning the Purchaser's ability to pay, WesTech Engineering, LLC may require full or partial payment in advance or may suspend any further deliveries or continuance of the work to be performed by the WesTech Engineering, LLC until such payment has been received.
 - 7. ESCALATION:** If between the proposal date and actual procurement and through no fault of the Seller, the relevant cost of labor, material, freight, tariffs, and other Seller costs combined relating to the contract, increase by greater than 2.5% of the overall contract price, then the contract price shall be subject to escalation and increased. Such increase shall be verified by documentation and the amount of contract price escalation shall be calculated as either the actual increased cost to the Seller or, if agreed by the Parties, the equivalent increase of a relevant industry recognized third-party index, and in both cases without any additional profit or margin being added.
 - 8. APPROVAL:** If approval of equipment submittals by Purchaser or others is required, a condition precedent to WesTech Engineering, LLC supplying any equipment shall be such complete approval.
 - 9. INSTALLATION SUPERVISION:** Prices quoted for equipment do not include installation supervision. WesTech Engineering, LLC recommends and will, upon request, make available, at WesTech Engineering, LLC's then current rate, an experienced installation supervisor to act as the Purchaser's employee and agent to supervise installation of the equipment. Purchaser shall at its sole expense furnish all necessary labor equipment, and materials needed for installation.
- Responsibility for proper operation of equipment, if not installed by WesTech Engineering, LLC or installed in accordance with WesTech Engineering, LLC's instructions, and inspected and accepted in writing by WesTech Engineering, LLC, rests entirely with Purchaser; and any work performed by WesTech Engineering, LLC personnel in making adjustment or changes must be paid for at WesTech Engineering, LLC's then current per diem rates plus living and traveling expenses.
- WesTech Engineering, LLC will supply the safety devices described in this proposal or shown in WesTech Engineering, LLC's drawings furnished as part of this order but excepting these, WesTech Engineering, LLC shall not be required to supply or install any safety devices whether required by law or otherwise. The Purchaser hereby agrees to indemnify and hold harmless WesTech Engineering, LLC from any claims or losses arising due to alleged or actual insufficiency or inadequacy of the safety devices offered or supplied hereunder, whether specified by WesTech Engineering, LLC or Purchaser, and from any damage resulting from the use of the equipment supplied hereunder.
- 10. ACCEPTANCE OF PRODUCTS:** Products will be deemed accepted without any claim by Purchaser unless written notice of non-acceptance is received by WesTech Engineering, LLC within 30 days of delivery if shipped F.O.B. point of shipment, or 48 hours of delivery if shipped F.O.B. point of destination. Such written notice shall not be considered received by WesTech Engineering, LLC unless it is accompanied by all freight bills for said shipment, with Purchaser's notations as to damages, shortages and conditions of equipment, containers, and seals. Non-accepted products are subject to the return policy stated below.
 - 11. TAXES:** Any federal, state, or local sales, use or other taxes applicable to this transaction, unless specifically included in the price, shall be for Purchaser's account.



Terms and Conditions

12. TITLE: The equipment specified herein, and any replacements or substitutes therefore shall, regardless of the manner in which affixed to or used in connection with realty, remain the sole and personal property of WesTech Engineering, LLC until the full purchase price has been paid. Purchaser agrees to do all things necessary to protect and maintain WesTech Engineering, LLC's title and interest in and to such equipment; and upon Purchaser's default, WesTech Engineering, LLC may retain as liquidated damages any and all partial payments made and shall be free to enter the premises where such equipment is located and remove the same as its property without prejudice to any further claims on account of damages or loss which WesTech Engineering, LLC may suffer from any cause.

13. INSURANCE: From date of shipment until the invoice is paid in full, Purchaser agrees to provide and maintain at its expense, but for WesTech Engineering, LLC's benefit, adequate insurance including, but not limited to, builders risk insurance on the equipment against any loss of any nature whatsoever.

14. SHIPMENTS: Any shipment of delivery dates recited represent WesTech Engineering, LLC's best estimate but no liability, direct or indirect, is assumed by WesTech Engineering, LLC for failure to ship or deliver on such dates.

WesTech Engineering, LLC shall have the right to make partial shipments; and invoices covering the same shall be due and payable by Purchaser in accordance with the payment terms thereof. If Purchaser defaults in any payment when due hereunder, WesTech Engineering, LLC may, without incurring any liability therefore to Purchaser or Purchaser's customers, declare all payments immediately due and payable with maximum legal interest thereon from due date of said payment, and at its option, stop all further work and shipments until all past due payments have been made, and/or require that any further deliveries be paid for prior to shipment.

If Purchaser requests postponements of shipments, the purchase price shall be due and payable upon notice from WesTech Engineering, LLC that the equipment is ready for shipment; and thereafter any storage or other charge WesTech Engineering, LLC incurs on account of the equipment shall be for the Purchaser's account.

If delivery is specified at a point other than WesTech Engineering, LLC or its supplier's shipping points, and delivery is postponed or prevented by strike, accident, embargo, or other cause beyond WesTech Engineering, LLC's reasonable control and occurring at a location other than WesTech Engineering, LLC or its supplier's shipping points, WesTech Engineering, LLC assumes no liability in delivery delay. If Purchaser refuses such delivery, WesTech Engineering, LLC may store the equipment at Purchaser's expense. For all purposes of this agreement such tender of delivery or storage shall constitute delivery.

15. WARRANTY: WesTech Engineering, LLC warrants equipment it supplies only in accordance with the attached WesTech Warranty. This warranty is expressly given by WesTech and accepted by purchaser in lieu of all other warranties whether written, oral, express, implied, statutory or otherwise, including without limitation, warranties of merchantability and fitness for particular purpose. WesTech neither accepts nor authorizes any other person to assume for it any other liability with respect to its equipment. WesTech shall not be liable for normal wear and tear, corrosion, or any contingent, incidental, or consequential damage or expense due to partial or complete inoperability of its equipment for any reason whatsoever. The purchaser's exclusive and only remedy for breach of this warranty shall be the repair and or replacement of the defective part or parts within a reasonable time of WesTech's accepting the validity of a warranty claim made by the purchaser.

16. PATENTS: WesTech Engineering, LLC agrees that it will, at its own expense, defend all suits or proceedings instituted against Purchaser and pay any award of damages assessed against it in such suits or proceedings, so far as the same are based on any claim that the said equipment or any part thereof constitutes an infringement of any apparatus patent of the United States issued at the date of this Agreement, provided WesTech Engineering, LLC is given prompt notice in writing of the institution or threatened institution of any suit or proceeding and is given full control of the defense, settlement, or compromise of any such action; and Purchaser agrees to give WesTech Engineering, LLC needed information, assistance, and authority to enable WesTech Engineering, LLC so to do. In the event said equipment is held or conceded to infringe such a patent, WesTech Engineering, LLC shall have the right at its sole option and expense to a) modify the equipment to be non-infringing, b) obtain for Purchaser the license to continue using said equipment, or c) accept return of the equipment and refund to the Purchaser the purchase price thereof less a reasonable charge for the use thereof. WesTech Engineering, LLC will reimburse Purchaser for actual out-of-pocket expenses, exclusive of legal fees, incurred in preparing such information and rendering such assistance at WesTech Engineering, LLC's request. The foregoing states the entire liability of WesTech Engineering, LLC, with respect to patent infringement; and except as otherwise agreed to in writing, WesTech Engineering, LLC assumes no responsibility for process patent infringement.

17. SURFACE PREPARATION AND PAINTING: If furnished, shop primer paint is intended to serve only as minimal protective finish. WesTech Engineering, LLC will not be responsible for the condition of primed or finish painted surfaces after equipment leaves its shops. Purchasers are invited to inspect paint in shops for proper preparation and application prior to shipment. WesTech Engineering, LLC assumes no responsibility for field surface preparation or touch-up of shipping damage to paint. Painting of fasteners and other touch-up to painted surfaces will be by Purchaser's painting contractor after mechanism installation.

Motors, gear motors, and other components not manufactured by WesTech Engineering, LLC will be painted with that manufacturer's standard paint system. It is WesTech Engineering, LLC's intention to ship major steel components as soon as fabricated, often before drive, motors, and other manufactured components. Unless Purchaser can ensure that shop primed steel shall be field painted within thirty (30) days after arrival at the job site, WesTech Engineering, LLC encourages the Purchaser to order these components without primer.

WesTech Engineering, LLC's prices are based on paints and surface preparations as outlined in the main body of this proposal. In the event that an alternate paint system is selected, WesTech Engineering, LLC requests that Purchaser's order advise of the paint



Terms and Conditions

selection. WesTech Engineering, LLC will then either adjust the price as may be necessary to comply or ship the material unpainted if compliance is not possible due to application problems or environmental controls.

18. CANCELLATION, SUSPENSION, OR DELAY: After acceptance by WesTech Engineering, LLC, this proposal, or Purchaser's order based on this proposal, shall be a firm agreement and is not subject to cancellation, suspension, or delay except upon payment by Purchaser of appropriate charges which shall include all costs incurred by WesTech Engineering, LLC to date of cancellation, suspension, or delay plus a reasonable profit. Additionally, all charges related to storage and/or resumption of work, at WesTech Engineering, LLC's plant or elsewhere, shall be for Purchaser's sole account; and all risks incidental to storage shall be assumed by Purchaser.

19. FORCE MAJEURE: Neither party hereto shall be liable to the other for default or delay in delivery caused by extreme weather or other act of God, strike or other labor shortage or disturbance, fire, accident, war or civil disturbance, act of government, pandemic, delay of carriers, failure of normal sources of supply, complete or partial shutdown of plant by reason of inability to attain sufficient raw materials or power, and/or other similar contingency beyond the reasonable control of the respective parties. The time for delivery specified herein shall be extended during the continuance of such conditions, or any other cause beyond such party's reasonable control. Escalation resulting from a Force Majeure event shall be equitably adjusted per the escalation policy stated above.

20. RETURN OF PRODUCTS: No products may be returned to WesTech Engineering, LLC without WesTech Engineering, LLC's prior written permission. Said permission may be withheld by WesTech Engineering, LLC at its sole discretion.

21. BACKCHARGES: WesTech Engineering, LLC will not approve or accept backcharges for labor, materials, or other costs incurred by Purchaser or others in modification, adjustment, service, or repair of WesTech Engineering, LLC furnished materials unless such back charge has been authorized in advance in writing by a WesTech Engineering, LLC purchase order, or work requisition signed by WesTech Engineering, LLC.

22. INDEMNIFICATION: Purchaser agrees to indemnify WesTech Engineering, LLC from all costs incurred, including but not limited to court costs and reasonable attorney fees, from enforcing any provisions of this contract, including but not limited to breach of contract or costs incurred in collecting monies owed on this contract.

23. ENTIRE AGREEMENT: This proposal expresses the entire agreement between the parties hereto superseding any prior understandings, and is not subject to modification except by a writing signed by an authorized officer of each party.

24. MOTORS AND MOTOR DRIVES: In order to avoid shipment delays of WesTech Engineering, LLC equipment, motors and drives may be sent directly to the job site for installation by the equipment installer. Minor fit-up may be required.

25. EXTENDED STORAGE: Extended storage instructions will be part of information provided to shipment. If equipment installation and start-up is delayed more than 30 days, the provisions of the storage instructions must be followed to keep WARRANTY in force.

26. LIABILITY: Professional liability insurance, including but not limited to, errors and omissions insurance, is not included. In any event, liability for errors and omissions shall be limited to the lesser of \$100,000 USD or the value of the particular piece of equipment (not the value of the entire order) supplied by WesTech Engineering, LLC against which a claim is sought.

27. ARBITRATION NEGOTIATION: Any controversy or claim arising out of or relating to the performance of any contract resulting from this proposal or contract issued, or the breach thereof, shall be settled by arbitration in accordance with the Construction Industry Arbitration Rules of the American Arbitration Association, and judgment upon the award rendered by the arbitrator(s) may be entered to any court having jurisdiction.

ACCEPTED BY PURCHASER

Customer Name: _____

Customer Address: _____

Contact Name: _____

Contact Phone: _____ Contact Email: _____

Signature: _____ Printed Name: _____

Date: _____ Title: _____



Proposal – Clarifier #2

Bullhead City WWTP

Arizona

Representative
Dan Bertschman
Goble Sampson Associates
Mesa, Arizona
dbertschman@goblesampson.com
(480) 969-3667

Representative
John Deogracias
Goble Sampson Associates
Mesa, Arizona
jdeogracias@goblesampson.com
(480) 220-2327

Contact

Adrian Williams
awilliams@westechwater.com
(801) 290-6403

Andrew Avati
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(801) 703-0107

Proposal: 2560072.F_Rev01
Wednesday, March 26, 2025

WESTECH®





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- Item A – One (1) Clarifier Mechanism, Model COPC1A
- Item B – Install One (1) WesTech Clarifier



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Commercial Proposal



- Bidder's Contact Information
- Pricing
- Payment Terms
- Schedule
- Freight



Warranty



Terms and Conditions





Technical Proposal – Clarifier #2

Item A – Clarifier Mechanism, Model COPC1A

General Scope of Supply

Item	Unit	Value/Description
Number of Mechanisms	Each	1
Application	-	Activated Sludge Secondary
Tank Diameter	ft	90
Tank Side Wall Depth	ft	16.72
Tank Side Water Depth	ft	14.72
Tank Bottom Slope	-	0.9375:12
Average Flow Rate	MGD	1.5**
Design Flow Rate	MGD	2.00
Max Flow Rate	MGD	3.0**
Peak Flow Rate	MGD	4.0**
Influent MLSS Concentration	mg/L	3000**
SVI	mL/g	130**

**Assumed Values





Technical Proposal – Clarifier #2

Detailed Scope of Supply – Each Mechanism Includes the Following

Item	Qty	Size/Description	Material
Walkway Bridge	1	36" wide Beam Bridge	Steel
Walkway Handrail	-	2 Rail Component Handrail, Machine Screw	Aluminum
Walkway Flooring	-	1.25" Grating	Aluminum
Drive Platform	1	24" Minimum Drive Clearance	Steel
Platform Handrail	-	2 Rail Component Handrail, Machine Screw	Aluminum
Platform Flooring	-	0.25" Checker Plate	Aluminum
Center Column	1	24" dia. x 0.25" thick	Steel
Center Cage	1	3' Square	Steel
Dual Gate EDI	1	8' dia. x 3' deep x 0.1875" plate	Steel
Feedwell	1	16' dia. x 5' deep x 0.1875" plate	Steel
Full Radius Rake Arms	2	Box Truss w/ Spiral Scrapers	Steel
Sludge Withdrawal Ring	1	20% Tank Diameter w/ Evenly Spaced Ports	Steel
Skimmer Blade & Supports	2	Extends from feedwell to hinged skimmer	Steel
Hinged Skimmer Assembly	2	With neoprene wipers	HDG/304 SS/Alum
Scum Box & Supports	1	5' Scum Box with Pipe Connection	Steel
Scum Flushing Valve	1	Skimmer Actuated	Polymer/SS
Anti-Rotation Baffle	1	With Neoprene Skirt	Steel/Neopr.
Effluent Weir	1	9" deep x 0.25" thick	FRP
Scum Baffle & Supports	1	12" deep x 0.25" thick	FRP
Density Current Baffle	1	0.025" thick	FRP
Electrical Control Panel	1	NEMA 4X	304 SS
Drive Unit	1	See Drive Unit Table for description	
Anchor Bolts & Fasteners	-	-	304 SS



Technical Proposal – Clarifier #2

Electrical Control Panel

The clarifier controls will be housed in a single NEMA 4X, wall-mount, stainless steel enclosure with painted steel back panel, and mounting feet. Hand/Off/Auto switch, run light, motor overload light, drive cutout light, alarm silence and reset pushbuttons are provided on the door. The panel will contain a magnetic combination motor starter with externally reset thermal overloads, a main circuit breaker with rotary disconnect handle, fuses, fuse blocks, relays, timer, and other supporting hardware. A control power transformer will provide 120VAC for internal controls. The transformer will have both primary legs fused, and one secondary leg on a circuit breaker.

A top mounted, amber strobing alarm light and horn shall provide indication of a high torque condition. A door mounted reset pushbutton clears all interlocks after the high torque conditions have been removed.

The control panel is wired to accept a single 480VAC, 3 phase, 60 Hertz power feed from the customer. A 3-pole molded case circuit breaker with pad-lockable disconnect handle is provided for short circuit protection. All wiring for field connections will be brought to a terminal strip. All interconnecting wiring is to be by others.

Drive Unit

Description	Unit	Value/Description
Drive Type	C31	Cage Drive w/ Precision Bearing
Housing Material	-	Fabricated Steel
Continuous Rated Torque	ft-lbs	19,000
Momentary Peak Torque	ft-lbs	38,000
Rake Speed	RPM	0.05
Motor Size	HP	1
Motor Voltage/Frequency/Phase	V / Hz / Phase	460 / 60 / 3
Torque Control Settings	Alarm: ft-lbs	100%: 19,000
	Motor Cutout: ft-lbs	120%: 22,800
Main Gear and Pinion Lubrication	-	Grease
Main Bearing and Reducer Lubrication	-	Grease





Technical Proposal – Clarifier #2

Surface Preparation and Coating

Application Surfaces	Surface Preparation	Finish
Submerged	SSPC-SP10	One (1) Coat Tnemec N140-1255, 4-6 mils DFT, and One (1) Coat Tnemec N140-B5712, 4-6 mils DFT
Non-Submerged	SSPC-SP10	One (1) Coat Tnemec N140-1255, 4-6 mils DFT, and One (1) Coat Tnemec 1094, 3-5 mils DFT
Drive Unit	SSPC-SP10	One (1) coat Tnemec Series 21-1255 Epoxy, 4-8 mils DFT, and one (1) coat Tnemec Endura-Shield 1090-B5712 Polyurethane, 3-5 mils DFT

Approximate Weights

Item	Weight	Unit
Center Column	2050	lbs
Center Cage, Rake Arms, Spiral Rake Blades, Sludge Withdrawal Ring	8500	lbs
Dual Gate EDI, Feedwell, Feedwell Supports	6250	lbs
Standard Skimmer, Scum Box & Supports	2850	lbs
Bridge & Platform	2850	lbs
Drive Unit	4000	lbs
Heaviest Single Item (Drive Unit)	4000	lbs





Technical Proposal – Clarifier #2

Additional Services and Equipment

WesTech has included on-site technical assistance for inspection, observation of torque testing, startup, and instruction of plant personnel. Additional on-site services may be purchased at standard WesTech daily rates plus travel and living expenses.

On-Site Technical Service

Item	Quantity
Total Number of Trips	1
Total Number of Days	1

Items Not Included in WesTech's Base Scope of Supply (unless specifically noted)

- Access Stairs and Landings
- Concrete/Grout work
- Concrete and Anchor Reinforcement
- Conduits and Wiring
- Density Current Baffle
- Erection or Assembly
- Field Paint, Touch-up, and Repair to Shop Painted Surfaces
- Lubricants
- Piping, Valves, or Fittings
- Unloading or Storage
- Temporary Drive Installation
- Wiring





Technical Proposal – Clarifier #2

Item B – Install One (1) COP Clarifier #2 Mechanism

WesTech shall provide the manpower, supervision, and tools to remove the existing mechanism and install the new WesTech equipment on a 90- foot diameter WesTech COP Clarifier Model COPC1A at Bullhead City WWTP in Bullhead City, Arizona.

Installation of Equipment

On-Site Removal & Erection

Details	Description
Site Location	Bullhead City WWTP
Equipment Location	Tank Open with Close Crane Access to the Tank
Labor Type	Non-union – The foreman will be the crew lead for quality and safety
Work Schedule	50 hours/week, 5 days/week, day shift – site access 24/7
Scope of Items Erected	QTY (1) Clarifier #2 Mechanism– Remove existing & install new

Item	Task	Owner	WesTech
1.00	Project Services		
1.20	GA Drawings		✓
1.30	Project Management		✓
1.35	Civil work – Pipe / underground protection	✓	
1.37	Site Training – ½ day allowed	✓	
1.40	Mobilization / Demobilization		✓
1.60	Supervision & Quality control		✓
1.70	Safety and Coordination – any dedicated safety personnel	✓	
1.71	Operation & Maintenance Manuals		✓
1.73	Equipment Check-out and Calibration (if power is connected)		✓
1.78	Storing / Receiving / Transporting to work area	✓	
2.00	Site Work		
2.10	Permits – any necessary	✓	
2.11	Gaskets & bolts for interconnecting piping to WesTech nozzles	✓	
2.12	Grouting of floor (if required)	✓	
2.13	Electrical power 440V at 120A or 110V at 240A + 110V at 60A	✓	
2.14	Provide safe working environment	✓	



Technical Proposal – Clarifier #2

2.15	Power line spotter if necessary	✓	
2.16	Roll-off dumpsters and disposal of demolished materials	✓	
2.17	Lift plans	✓	
2.18	Removal of existing unit		✓
2.19	Installation of new unit		✓
2.20	Hydro test water, connections & disposal	✓	
2.21	Tenting, heating – cold weather items	✓	
2.3	Security and/or fencing for job site, including lay down area	✓	
11.00	Equipment		
11.3.1	Engineering & Design		✓
11.60	Cranes, forklifts for remove /installation		✓
16.00	Electrical		
16.1.0	Electrical Equipment	✓	
16.1.6	System control panel	✓	
16.1.7	Disconnect / Hook-ups / Electrical Wiring, Conduit	✓	

Clarifications/Comments

- WesTech considers the construction area around the tanks to be used for access to the tank and construction site.
- Any damage to roadways will be considered normal wear and tear and will be repaired by others.
- Assumed total access to the tank prior to arriving, including, if applicable, the ability to get a crane in a safe position for removal and installation of equipment.



Clarifications and Exceptions

General Clarifications

Terms & Conditions: This proposal, including all terms and conditions contained herein, shall become part of any resulting contract or purchase order. Changes to any terms and conditions, including but not limited to submittal and shipment days, payment terms, and escalation clause shall be negotiated at order placement, otherwise the proposal terms and conditions contained herein shall apply.

Escalation: If between the proposal date and actual procurement and through no fault of the Seller, the relevant cost of labor, material, freight, tariffs, and other Seller costs combined relating to the contract, increase by greater than 2.5% of the overall contract price, then the contract price shall be subject to escalation and increased. Such increase shall be verified by documentation and the amount of contract price escalation shall be calculated as either the actual increased cost to the Seller or, if agreed by the Parties, the equivalent increase of a relevant industry recognized third-party index, and in both cases without any additional profit or margin being added.

Build America, Buy America Act (BABAA) and Other Domestic Content Requirements: WesTech is U.S. based and proudly manufactures many products available to meet various domestic procurement requirements. Due to variability in legislation, products, and project-based specifications, WesTech is unable to guarantee compliance with domestic content requirements unless stated otherwise in our official project proposal. For products where domestic sourcing is not currently available, WesTech can provide documentation to support application for relevant waivers (Non-Availability, De Minimis, or others).

USA Tariffs and Current Trade Laws: All prices are based on current USA and North America tariffs and trade laws / agreements as of January 1, 2025. Any changes in costs due to USA Tariffs and trade laws / agreements will be passed through to the purchaser at cost.

Paint: If your equipment has paint included in the price, please take note to the following. Primer paints are designed to provide only a minimal protection from the time of application (usually for a period not to exceed 30 days). Therefore, it is imperative that the finish coat be applied within 30 days of shipment on all shop primed surfaces. Without the protection of the final coatings, primer degradation may occur after this period, which in turn may require renewed surface preparation and coating. If it is impractical or impossible to coat primed surfaces within the suggested time frame, WesTech strongly recommends the supply of bare metal, with surface preparation and coating performed in the field. All field surface preparation, field paint, touch-up, and repair to shop painted surfaces are not by WesTech.

Exceptions

Not applicable



Commercial Proposal

Proposal Name: Bullhead City WWTP

Proposal Number: 2560072

Wednesday, March 26, 2025

1. Bidder's Contact Information

Company Name	WesTech Engineering, LLC
Primary Contact Name	Adrian Williams
Phone	(801) 265-1000
Email	awilliams@westechwater.com
Address: Number/Street	3665 S West Temple
Address: City, State, Zip	Salt Lake City, UT 84115

2. Firm Pricing

Currency: USD

Scope of Supply

A	One (1) 90' Diameter Clarifier #2 Mechanism Model COPC1A	\$527,593
B	Install One (1) COP Clarifier #2 Mechanism	\$217,452
Taxes (sales, use, VAT, IVA, IGV, duties, import fees, etc.)		Not Included

Prices are valid for a period not to exceed 30 days from date of proposal.

Additional Field Service

Daily Rate (Applicable Only to Field Service Not Included in Scope)	\$1,350

Pricing does not include field service unless noted in scope of supply but is available at the daily rate plus expenses. The greater of a two week notice or visa procurement time is required prior to departure date. Our field service policy is subject to change and can be provided upon request.

3. Payment Terms

Purchase Order Acceptance and Contract Execution	0%
Submittals Provided by WesTech	25%
Release for Fabrication	35%
Notification of Ready to Ship	40%
Installation Completion (Item B)	100%

All payments are net 30 days. Partial shipments are allowed. An approved Letter of Credit is required if Incoterms CIF, CFR, DAP, CIP, or CPT are applicable. Payment is required in full for all other Incoterms prior to international shipment. Other terms per WesTech proforma invoice. Please note that the advising bank must be named as: Wells Fargo Bank, International Department, 9000 Flair Drive, 3rd Floor, El Monte, California 91731, USA.

Payment Terms - Install

Service: Due Net 30 after completion of service	100%

All payments are net 30 days. Partial shipments are allowed. An approved Letter of Credit is required if Incoterms CIF, CFR, DAP, CIP, or CPT are applicable. Payment is required in full for all other Incoterms prior to international shipment. Other terms per WesTech proforma invoice. Please note that the advising bank must be named as: Wells Fargo Bank, International Department, 9000 Flair Drive, 3rd Floor, El Monte, California 91731, USA.

4. Schedule

Submittals, after Purchase Order Acceptance and Contract Execution	10 to 12 weeks
Ready to Ship, after Receipt of Final Submittal Approval	26 to 28 weeks
Estimated Weeks, Ready to Ship	36 to 40 weeks*

*Customer submittal approval is typically required to proceed with equipment fabrication and is not accounted for in the schedule above. Project schedule will be extended to account for time associated with receipt of customer submittal approval. Due to supply chain disruptions and volatility, delivery schedule is a best estimate only and may be improved or hampered based on date of contract execution, scope selection, and materials availability.



One-Year Warranty

Equipment manufactured or sold by WesTech Engineering, LLC, once paid for in full, is backed by the following warranty:

Subject to the terms below, WesTech warrants all new equipment manufactured or sold by WesTech Engineering, LLC to be unencumbered and free from defects in material and workmanship, and WesTech will replace or repair, F.O.B. its factories or other location it chooses, any part or parts returned to WesTech which WesTech's examination and analysis determine have failed within the warranty period because of defects in material and workmanship. The warranty period is either, one calendar year immediately following start-up, or eighteen (18) months from when WesTech sent its ready-to-ship notification to the purchaser, whichever expires sooner. All repair or replacement parts qualifying under this warranty shall be free of charge. Purchaser will provide timely written notice to WesTech of any defects it believes should be repaired or replaced under this warranty. WesTech will reject as untimely any warranty defect claim that purchaser submits more than thirty (30) days after the possible warranty defect first occurred. Unless specifically stated otherwise, this warranty does not cover normal wear, consumables, or coatings. Purchasers are invited to inspect the equipment in the shop for proper surface preparation and coating application prior to shipment. This warranty is not transferable.

This warranty shall be void and shall not apply where the equipment or any part thereof

- has been dismantled, modified, repaired, or connected to other equipment, outside of a WesTech factory, or without WesTech's written approval, or
- has not been installed in complete adherence to all WesTech's or parts manufacturer's requirements, recommendations, and procedures, or
- has been subject to misuse, abuse, neglect, or accident, or has not at all times been operated and maintained in strict compliance with all of WesTech's requirements and recommendations therefor, including, but not limited to, the relevant WesTech Operations & Maintenance Manual and any other of WesTech's specified guidelines & procedures, or
- has been subject to force majeure events; use of chemicals not approved in writing by WesTech; electrical surges; overloading; significant power, water or feed supply fluctuations; or non-compliance with agreed feedwater or chemical volumes, specifications or procedures.

In any case where a part or component of equipment under this warranty is or may be faulty and the component or part is also covered under the warranty of a third party then the purchaser shall provide reasonable assistance to first pursue a claim under the third-party warranty before making a claim under this warranty from WesTech. WesTech Engineering, LLC gives no warranty with respect to parts, accessories, or components purchased other than through WesTech. The warranties which apply to such items are those offered by the respective manufacturers.

This warranty is expressly given by WesTech and accepted by purchaser in lieu of all other warranties whether written, oral, express, implied, statutory, or otherwise, including without limitation, warranties of merchantability and fitness for particular purpose. WesTech neither accepts nor authorizes any other person to assume for it any other liability with respect to its equipment. WesTech shall not be liable for normal wear and tear, corrosion, or any contingent, incidental, or consequential damage or expense due to partial or complete inoperability of its equipment for any reason whatsoever. The purchaser's exclusive and only remedy for breach of this warranty shall be the repair and or replacement of the defective part or parts within a reasonable time of WesTech's accepting the validity of a warranty claim made by the purchaser.



Terms and Conditions

Terms and Conditions appearing in any order based on this proposal which are inconsistent herewith shall not be binding on WesTech Engineering, LLC. The sale and purchase of equipment described herein shall be governed exclusively by the foregoing proposal and the following provisions:

- 1. SPECIFICATIONS:** WesTech Engineering, LLC is furnishing its standard equipment as outlined in the proposal and as will be covered by final approved drawings. The equipment may not be in strict compliance with the Engineer's/Owner's plans, specifications, or addenda as there may be deviations. The equipment will, however, meet the general intention of the mechanical specifications of these documents.
 - 2. ITEMS INCLUDED:** This proposal includes only the equipment specified herein and does not include erection, installation, accessories, nor associated materials such as controls, piping, etc., unless specifically listed.
 - 3. PARTIES TO CONTRACT:** WesTech Engineering, LLC is not a party to or bound by the terms of any contract between WesTech Engineering, LLC's customer and any other party. WesTech Engineering, LLC's undertakings are limited to those defined in the contract between WesTech Engineering, LLC and its direct customers.
 - 4. PRICE AND DELIVERY:** All selling prices quoted are subject to change without notice after 30 days from the date of this proposal unless specified otherwise. Unless otherwise stated, all prices are F.O.B. WesTech Engineering, LLC or its supplier's shipping points. All claims for damage, delay or shortage arising from such equipment shall be made by Purchaser directly against the carrier. When shipments are quoted F.O.B. job site or other designation, Purchaser shall inspect the equipment shipped, notifying WesTech Engineering, LLC of any damage or shortage within forty-eight hours of receipt, and failure to so notify WesTech Engineering, LLC shall constitute acceptance by Purchaser, relieving WesTech Engineering, LLC of any liability for shipping damages or shortages.
 - 5. PAYMENTS:** All invoices are net 30 days. Delinquencies are subject to a 1.5 percent service charge per month or the maximum permitted by law, whichever is less on all past due accounts. Pro rata payments are due as shipments are made. If shipments are delayed by the Purchaser, invoices shall be sent on the date when WesTech Engineering, LLC is prepared to make shipment and payment shall become due under standard invoicing terms. If the work to be performed hereunder is delayed by the Purchaser, payments shall be based on the purchase price and percentage of completion. Products held for the Purchaser shall be at the risk and expense of the Purchaser. Unless specifically stated otherwise, prices quoted are for equipment only. These terms are independent of and not contingent upon the time and manner in which the Purchaser receives payment from the owner.
 - 6. PAYMENT TERMS:** Credit is subject to acceptance by WesTech Engineering, LLC's Credit Department. If the financial condition of the Purchaser at any time is such as to give WesTech Engineering, LLC, in its judgment, doubt concerning the Purchaser's ability to pay, WesTech Engineering, LLC may require full or partial payment in advance or may suspend any further deliveries or continuance of the work to be performed by the WesTech Engineering, LLC until such payment has been received.
 - 7. ESCALATION:** If between the proposal date and actual procurement and through no fault of the Seller, the relevant cost of labor, material, freight, tariffs, and other Seller costs combined relating to the contract, increase by greater than 2.5% of the overall contract price, then the contract price shall be subject to escalation and increased. Such increase shall be verified by documentation and the amount of contract price escalation shall be calculated as either the actual increased cost to the Seller or, if agreed by the Parties, the equivalent increase of a relevant industry recognized third-party index, and in both cases without any additional profit or margin being added.
 - 8. APPROVAL:** If approval of equipment submittals by Purchaser or others is required, a condition precedent to WesTech Engineering, LLC supplying any equipment shall be such complete approval.
 - 9. INSTALLATION SUPERVISION:** Prices quoted for equipment do not include installation supervision. WesTech Engineering, LLC recommends and will, upon request, make available, at WesTech Engineering, LLC's then current rate, an experienced installation supervisor to act as the Purchaser's employee and agent to supervise installation of the equipment. Purchaser shall at its sole expense furnish all necessary labor equipment, and materials needed for installation.
- Responsibility for proper operation of equipment, if not installed by WesTech Engineering, LLC or installed in accordance with WesTech Engineering, LLC's instructions, and inspected and accepted in writing by WesTech Engineering, LLC, rests entirely with Purchaser; and any work performed by WesTech Engineering, LLC personnel in making adjustment or changes must be paid for at WesTech Engineering, LLC's then current per diem rates plus living and traveling expenses.
- WesTech Engineering, LLC will supply the safety devices described in this proposal or shown in WesTech Engineering, LLC's drawings furnished as part of this order but excepting these, WesTech Engineering, LLC shall not be required to supply or install any safety devices whether required by law or otherwise. The Purchaser hereby agrees to indemnify and hold harmless WesTech Engineering, LLC from any claims or losses arising due to alleged or actual insufficiency or inadequacy of the safety devices offered or supplied hereunder, whether specified by WesTech Engineering, LLC or Purchaser, and from any damage resulting from the use of the equipment supplied hereunder.
- 10. ACCEPTANCE OF PRODUCTS:** Products will be deemed accepted without any claim by Purchaser unless written notice of non-acceptance is received by WesTech Engineering, LLC within 30 days of delivery if shipped F.O.B. point of shipment, or 48 hours of delivery if shipped F.O.B. point of destination. Such written notice shall not be considered received by WesTech Engineering, LLC unless it is accompanied by all freight bills for said shipment, with Purchaser's notations as to damages, shortages and conditions of equipment, containers, and seals. Non-accepted products are subject to the return policy stated below.
 - 11. TAXES:** Any federal, state, or local sales, use or other taxes applicable to this transaction, unless specifically included in the price, shall be for Purchaser's account.



Terms and Conditions

12. TITLE: The equipment specified herein, and any replacements or substitutes therefore shall, regardless of the manner in which affixed to or used in connection with realty, remain the sole and personal property of WesTech Engineering, LLC until the full purchase price has been paid. Purchaser agrees to do all things necessary to protect and maintain WesTech Engineering, LLC's title and interest in and to such equipment; and upon Purchaser's default, WesTech Engineering, LLC may retain as liquidated damages any and all partial payments made and shall be free to enter the premises where such equipment is located and remove the same as its property without prejudice to any further claims on account of damages or loss which WesTech Engineering, LLC may suffer from any cause.

13. INSURANCE: From date of shipment until the invoice is paid in full, Purchaser agrees to provide and maintain at its expense, but for WesTech Engineering, LLC's benefit, adequate insurance including, but not limited to, builders risk insurance on the equipment against any loss of any nature whatsoever.

14. SHIPMENTS: Any shipment of delivery dates recited represent WesTech Engineering, LLC's best estimate but no liability, direct or indirect, is assumed by WesTech Engineering, LLC for failure to ship or deliver on such dates.

WesTech Engineering, LLC shall have the right to make partial shipments; and invoices covering the same shall be due and payable by Purchaser in accordance with the payment terms thereof. If Purchaser defaults in any payment when due hereunder, WesTech Engineering, LLC may, without incurring any liability therefore to Purchaser or Purchaser's customers, declare all payments immediately due and payable with maximum legal interest thereon from due date of said payment, and at its option, stop all further work and shipments until all past due payments have been made, and/or require that any further deliveries be paid for prior to shipment.

If Purchaser requests postponements of shipments, the purchase price shall be due and payable upon notice from WesTech Engineering, LLC that the equipment is ready for shipment; and thereafter any storage or other charge WesTech Engineering, LLC incurs on account of the equipment shall be for the Purchaser's account.

If delivery is specified at a point other than WesTech Engineering, LLC or its supplier's shipping points, and delivery is postponed or prevented by strike, accident, embargo, or other cause beyond WesTech Engineering, LLC's reasonable control and occurring at a location other than WesTech Engineering, LLC or its supplier's shipping points, WesTech Engineering, LLC assumes no liability in delivery delay. If Purchaser refuses such delivery, WesTech Engineering, LLC may store the equipment at Purchaser's expense. For all purposes of this agreement such tender of delivery or storage shall constitute delivery.

15. WARRANTY: WesTech Engineering, LLC warrants equipment it supplies only in accordance with the attached WesTech Warranty. This warranty is expressly given by WesTech and accepted by purchaser in lieu of all other warranties whether written, oral, express, implied, statutory or otherwise, including without limitation, warranties of merchantability and fitness for particular purpose. WesTech neither accepts nor authorizes any other person to assume for it any other liability with respect to its equipment. WesTech shall not be liable for normal wear and tear, corrosion, or any contingent, incidental, or consequential damage or expense due to partial or complete inoperability of its equipment for any reason whatsoever. The purchaser's exclusive and only remedy for breach of this warranty shall be the repair and or replacement of the defective part or parts within a reasonable time of WesTech's accepting the validity of a warranty claim made by the purchaser.

16. PATENTS: WesTech Engineering, LLC agrees that it will, at its own expense, defend all suits or proceedings instituted against Purchaser and pay any award of damages assessed against it in such suits or proceedings, so far as the same are based on any claim that the said equipment or any part thereof constitutes an infringement of any apparatus patent of the United States issued at the date of this Agreement, provided WesTech Engineering, LLC is given prompt notice in writing of the institution or threatened institution of any suit or proceeding and is given full control of the defense, settlement, or compromise of any such action; and Purchaser agrees to give WesTech Engineering, LLC needed information, assistance, and authority to enable WesTech Engineering, LLC so to do. In the event said equipment is held or conceded to infringe such a patent, WesTech Engineering, LLC shall have the right at its sole option and expense to a) modify the equipment to be non-infringing, b) obtain for Purchaser the license to continue using said equipment, or c) accept return of the equipment and refund to the Purchaser the purchase price thereof less a reasonable charge for the use thereof. WesTech Engineering, LLC will reimburse Purchaser for actual out-of-pocket expenses, exclusive of legal fees, incurred in preparing such information and rendering such assistance at WesTech Engineering, LLC's request. The foregoing states the entire liability of WesTech Engineering, LLC, with respect to patent infringement; and except as otherwise agreed to in writing, WesTech Engineering, LLC assumes no responsibility for process patent infringement.

17. SURFACE PREPARATION AND PAINTING: If furnished, shop primer paint is intended to serve only as minimal protective finish. WesTech Engineering, LLC will not be responsible for the condition of primed or finish painted surfaces after equipment leaves its shops. Purchasers are invited to inspect paint in shops for proper preparation and application prior to shipment. WesTech Engineering, LLC assumes no responsibility for field surface preparation or touch-up of shipping damage to paint. Painting of fasteners and other touch-up to painted surfaces will be by Purchaser's painting contractor after mechanism installation.

Motors, gear motors, and other components not manufactured by WesTech Engineering, LLC will be painted with that manufacturer's standard paint system. It is WesTech Engineering, LLC's intention to ship major steel components as soon as fabricated, often before drive, motors, and other manufactured components. Unless Purchaser can ensure that shop primed steel shall be field painted within thirty (30) days after arrival at the job site, WesTech Engineering, LLC encourages the Purchaser to order these components without primer.

WesTech Engineering, LLC's prices are based on paints and surface preparations as outlined in the main body of this proposal. In the event that an alternate paint system is selected, WesTech Engineering, LLC requests that Purchaser's order advise of the paint



Terms and Conditions

selection. WesTech Engineering, LLC will then either adjust the price as may be necessary to comply or ship the material unpainted if compliance is not possible due to application problems or environmental controls.

18. CANCELLATION, SUSPENSION, OR DELAY: After acceptance by WesTech Engineering, LLC, this proposal, or Purchaser's order based on this proposal, shall be a firm agreement and is not subject to cancellation, suspension, or delay except upon payment by Purchaser of appropriate charges which shall include all costs incurred by WesTech Engineering, LLC to date of cancellation, suspension, or delay plus a reasonable profit. Additionally, all charges related to storage and/or resumption of work, at WesTech Engineering, LLC's plant or elsewhere, shall be for Purchaser's sole account; and all risks incidental to storage shall be assumed by Purchaser.

19. FORCE MAJEURE: Neither party hereto shall be liable to the other for default or delay in delivery caused by extreme weather or other act of God, strike or other labor shortage or disturbance, fire, accident, war or civil disturbance, act of government, pandemic, delay of carriers, failure of normal sources of supply, complete or partial shutdown of plant by reason of inability to attain sufficient raw materials or power, and/or other similar contingency beyond the reasonable control of the respective parties. The time for delivery specified herein shall be extended during the continuance of such conditions, or any other cause beyond such party's reasonable control. Escalation resulting from a Force Majeure event shall be equitably adjusted per the escalation policy stated above.

20. RETURN OF PRODUCTS: No products may be returned to WesTech Engineering, LLC without WesTech Engineering, LLC's prior written permission. Said permission may be withheld by WesTech Engineering, LLC at its sole discretion.

21. BACKCHARGES: WesTech Engineering, LLC will not approve or accept backcharges for labor, materials, or other costs incurred by Purchaser or others in modification, adjustment, service, or repair of WesTech Engineering, LLC furnished materials unless such back charge has been authorized in advance in writing by a WesTech Engineering, LLC purchase order, or work requisition signed by WesTech Engineering, LLC.

22. INDEMNIFICATION: Purchaser agrees to indemnify WesTech Engineering, LLC from all costs incurred, including but not limited to court costs and reasonable attorney fees, from enforcing any provisions of this contract, including but not limited to breach of contract or costs incurred in collecting monies owed on this contract.

23. ENTIRE AGREEMENT: This proposal expresses the entire agreement between the parties hereto superseding any prior understandings, and is not subject to modification except by a writing signed by an authorized officer of each party.

24. MOTORS AND MOTOR DRIVES: In order to avoid shipment delays of WesTech Engineering, LLC equipment, motors and drives may be sent directly to the job site for installation by the equipment installer. Minor fit-up may be required.

25. EXTENDED STORAGE: Extended storage instructions will be part of information provided to shipment. If equipment installation and start-up is delayed more than 30 days, the provisions of the storage instructions must be followed to keep WARRANTY in force.

26. LIABILITY: Professional liability insurance, including but not limited to, errors and omissions insurance, is not included. In any event, liability for errors and omissions shall be limited to the lesser of \$100,000 USD or the value of the particular piece of equipment (not the value of the entire order) supplied by WesTech Engineering, LLC against which a claim is sought.

27. ARBITRATION NEGOTIATION: Any controversy or claim arising out of or relating to the performance of any contract resulting from this proposal or contract issued, or the breach thereof, shall be settled by arbitration in accordance with the Construction Industry Arbitration Rules of the American Arbitration Association, and judgment upon the award rendered by the arbitrator(s) may be entered to any court having jurisdiction.

ACCEPTED BY PURCHASER

Customer Name: _____

Customer Address: _____

Contact Name: _____

Contact Phone: _____ Contact Email: _____

Signature: _____ Printed Name: _____

Date: _____ Title: _____

Proposal Clarifier #3

Bullhead City

Arizona

Representative

Josh Queen

Goble Sampson Associates

Arvada, Colorado

jqueen@goblesampson.com

(303) 770-6418

Engineer

Morrison-Maierle

Kalispell, Montana

(406) 752-2216

Contact

Adrian Williams

awilliams@westechwater.com

(801) 290-6403

David Kaiser

dkaiser@westechwater.com

(801) 290-5668

Proposal: 2160254.F_Rev02

Friday, March 28, 2025

WESTECH[®]

 SWIRE WATER



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Technical Proposal Clarifier #3



Item A – Clarifier Mechanism, Model COPC1G
Item B – Installation

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A-1 – Adder for FRP Density Current Baffle



Clarifications and Exceptions



Commercial Proposal



Bidder's Contact Information
Pricing
Payment Terms
Schedule
Freight



Warranty



Terms and Conditions





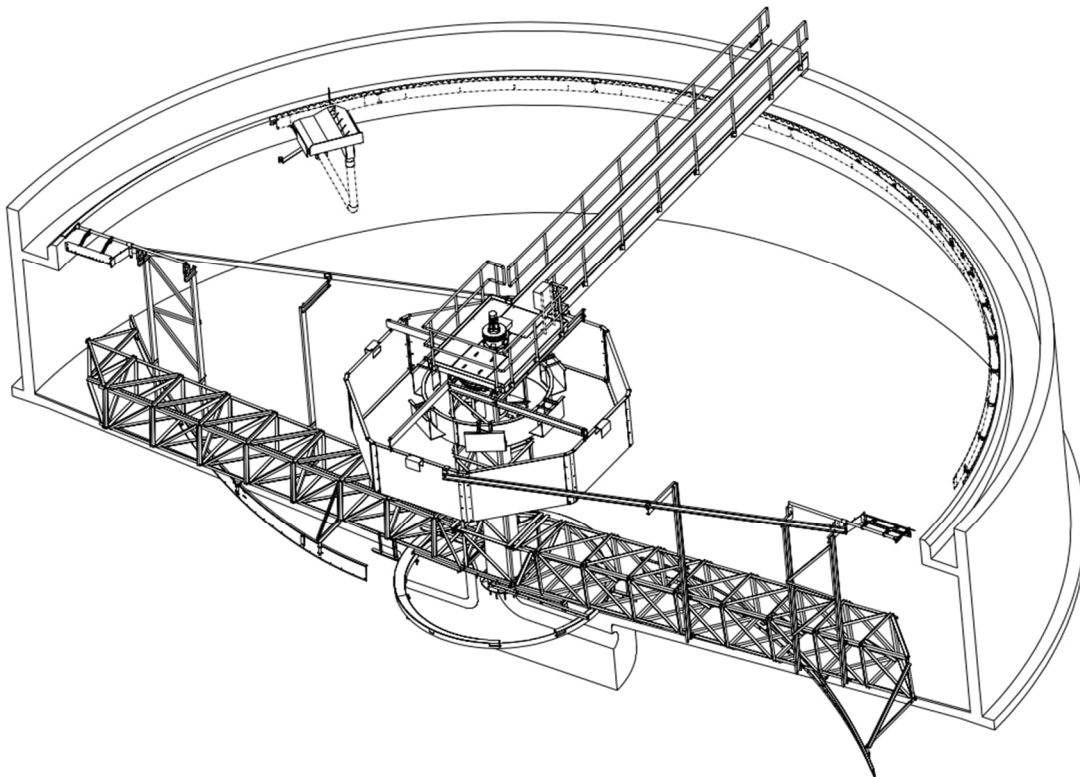
Technical Proposal

Item A – Clarifier Mechanism, Model COPC1G

General Scope of Supply

Item	Unit	Value/Description
Number of Mechanisms	Each	1
Application	-	Activated Sludge Secondary
Tank Diameter	ft	90
Tank Side Wall Depth	ft	17
Tank Side Water Depth	ft	15
Tank Bottom Slope	-	1:12
Average Flow Rate	MGD	2.89**
Design Flow Rate	MGD	3.61**
Max Flow Rate	MGD	5.78**
Peak Flow Rate	MGD	7.22**
Influent MLSS Concentration	mg/L	3000-4500
SVI	mL/g	130**

**Assumed Values



The WesTech COPC1G Clarifier mechanism includes a Sludge Ring and Dual Gate EDI





Technical Proposal

Detailed Scope of Supply – Each Mechanism Includes the Following

Item	Qty	Size/Description	Material
Walkway Bridge	1	36" wide Truss Bridge	Steel
Walkway Handrail	-	Truss Serves as Handrail	Steel
Walkway Flooring	-	1.25" Grating	Aluminum
Drive Platform	1	24" Minimum Drive Clearance	Steel
Platform Handrail	-	2 Rail Component Handrail, Machine Screw	Aluminum
Platform Flooring	-	0.25" Checker Plate	Aluminum
Center Column	1	36" dia. x 0.25" thick	Steel
Center Cage	1	4' Square	Steel
Dual Gate EDI	1	9' dia. x 3' deep x 0.1875" plate	Steel
Feedwell	1	24' dia. x 6' deep x 0.1875" plate	Steel
Full Radius Rake Arms	2	Box Truss w/ Spiral Scrapers	Steel
Sludge Withdrawal Ring	1	20% Tank Diameter w/ Evenly Spaced Ports	Steel
Skimmer Blade & Supports	2	Extends from feedwell to hinged skimmer	Steel
Hinged Skimmer Assembly	2	With neoprene wipers	HDG/304 SS/Alum
Scum Box & Supports	1	5' Scum Box	Steel
Scum Flushing Valve	1	Skimmer Actuated	Polymer/SS
Effluent Weir	1	9" deep x 0.25" thick	FRP
Scum Baffle & Supports	1	12" deep x 0.25" thick	FRP
Electrical Control Panel	1	NEMA 4X	304 SS
Drive Unit	1	See Drive Unit Table for description	
Anchor Bolts & Fasteners	-	-	304 SS





Technical Proposal

Electrical Control Panel

The clarifier controls will be housed in a single NEMA 4X, wall-mount, stainless steel enclosure with painted steel back panel, and mounting feet. Hand/Off/Auto switch, run light, motor overload light, drive cutout light, alarm silence and reset pushbuttons are provided on the door. The panel will contain a magnetic combination motor starter with externally reset thermal overloads, a main circuit breaker with rotary disconnect handle, fuses, fuse blocks, relays, timer, and other supporting hardware. A control power transformer will provide 120VAC for internal controls. The transformer will have both primary legs fused, and one secondary leg on a circuit breaker.

A top mounted, amber strobing alarm light and horn shall provide indication of a high torque condition. A door mounted reset pushbutton clears all interlocks after the high torque conditions have been removed.

The control panel is wired to accept a single 480VAC, 3 phase, 60 Hertz power feed from the customer. A 3-pole molded case circuit breaker with pad-lockable disconnect handle is provided for short circuit protection. All wiring for field connections will be brought to a terminal strip. All interconnecting wiring is to be by others.

Drive Unit

Description	Unit	Value/Description
Drive Type	C42	Cage Drive w/ Precision Bearing
Housing Material	-	Fabricated Steel
Continuous Rated Torque	ft-lbs	39,000
Momentary Peak Torque	ft-lbs	78,000
Rake Tip Speed	ft/min	11.5
Motor Size	HP	1
Motor Voltage/Frequency/Phase	V / Hz / Phase	460 / 60 / 3
Torque Control Settings	Alarm: ft-lbs	100%: 39,000
	Motor Cutout: ft-lbs	120%: 46,800
Main Gear and Pinion Lubrication	-	Oil
Main Bearing and Reducer Lubrication	-	Grease

Surface Preparation and Coating

Application Surfaces	Surface Preparation	Finish
Submerged	SSPC-SP10	One (1) Coat Tnemec N140-1255, 4-6 mils DFT, and One (1) Coat Tnemec N140-B5712, 4-6 mils DFT
Non-Submerged	SSPC-SP10	One (1) Coat Tnemec N140-1255, 4-6 mils DFT, and One (1) Coat Tnemec 1074U-B5712, 3-5 mils DFT
Drive Unit	SSPC-SP10	One (1) coat Tnemec Series 21-1255 Epoxy, 4-8 mils DFT, and one (1) coat Tnemec Endura-Shield 1090-B5712 Polyurethane, 3-5 mils DFT



Technical Proposal

Approximate Weights

Item	Weight	Unit
Center Column	2550	lbs
Center Cage, Rake Arms, Spiral Rake Blades, Sludge Withdrawal Ring	8550	lbs
Dual Gate EDI, Feedwell, Feedwell Supports	7850	lbs
Standard Skimmer, Scum Box & Supports	2900	lbs
Bridge & Platform	3200	lbs
Drive Unit	4000	lbs
Heaviest Single Item (Drive Unit)	4000	lbs

Additional Services and Equipment

WesTech has included on-site technical assistance for inspection, observation of torque testing, startup, and instruction of plant personnel. Additional on-site services may be purchased at standard WesTech daily rates plus travel and living expenses.

On-Site Technical Service

Item	Quantity
Total Number of Trips	1
Total Number of Days	2

Items Not Included in WesTech's Base Scope of Supply (unless specifically noted)

- Access Stairs and Landings
- Concrete/Grout
- Concrete and Anchor Reinforcement
- Conduits and Wiring
- Density Current Baffle
- Erection or Assembly
- Lubricants
- Piping, Valves, or Fittings
- Unloading or Storage

Optional Items

Item	Description
A-1	Adder for FRP Density Current Baffle



Technical Proposal

Item B - Installation

Installation of Equipment

On-Site Erection

Details	Description
Site Location	Bullhead City WWTP
Equipment Location	Tank Open with Close Crane Access to the Tank
Labor Type	Non-union – The foreman will be the crew lead for quality and safety
Work Schedule	50 hours/week, 5 days/week, day shift – site access 24/7
Scope of Items Erected	QTY (1) Clarifier Mechanism– Install new

Item	Task	Owner	WesTech
1.00	Project Services		
1.20	GA Drawings		✓
1.30	Project Management		✓
1.35	Civil work – Pipe / underground protection	✓	
1.37	Site Training – ½ day allowed	✓	
1.40	Mobilization / Demobilization		✓
1.60	Supervision & Quality control		✓
1.70	Safety and Coordination – any dedicated safety personnel	✓	
1.71	Operation & Maintenance Manuals		✓
1.73	Equipment Check-out and Calibration (if power is connected)		✓
1.78	Storing / Receiving / Transporting to work area	✓	
2.00	Site Work		
2.10	Permits – any necessary	✓	
2.11	Gaskets & bolts for interconnecting piping to WesTech nozzles	✓	
2.12	Grouting of floor (if required)	✓	
2.13	Electrical power 440V at 120A or 110V at 240A + 110V at 60A	✓	
2.14	Provide safe working environment	✓	
2.15	Power line spotter if necessary	✓	
2.16	Roll-off dumpsters and disposal of demolished materials	✓	
2.17	Lift plans	✓	



Technical Proposal

2.18	Tank preparation for new unit – anchors, etc.	✓
2.19	Installation of new unit	✓
2.20	Hydro test water, connections & disposal	✓
2.21	Tenting, heating – cold weather items	✓
2.3	Security and/or fencing for job site, including lay down area	✓
11.00	Equipment	
11.3.1	Engineering & Design	✓
11.60	Cranes, forklifts for installation	✓
16.00	Electrical	
16.1.0	Electrical Equipment	✓
16.1.6	System control panel	✓
16.1.7	Disconnect / Hook-ups / Electrical Wiring, Conduit	✓

Clarifications/Comments

- WesTech considers the construction area around the tanks to be used for access to the tank and construction site.
- Any damage to roadways will be considered normal wear and tear and will be repaired by others.
- Assumed total access to the tank prior to arriving, including, if applicable, the ability to get a crane in a safe position for removal and installation of equipment.





Clarifications and Exceptions

General Clarifications

Terms & Conditions: This proposal, including all terms and conditions contained herein, shall become part of any resulting contract or purchase order. Changes to any terms and conditions, including but not limited to submittal and shipment days, payment terms, and escalation clause shall be negotiated at order placement, otherwise the proposal terms and conditions contained herein shall apply.

Escalation: If between the proposal date and actual procurement and through no fault of the Seller, the relevant cost of labor, material, freight, tariffs, and other Seller costs combined relating to the contract, increase by greater than 2.5% of the overall contract price, then the contract price shall be subject to escalation and increased. Such increase shall be verified by documentation and the amount of contract price escalation shall be calculated as either the actual increased cost to the Seller or, if agreed by the Parties, the equivalent increase of a relevant industry recognized third-party index, and in both cases without any additional profit or margin being added.

Build America, Buy America Act (BABAA) and Other Domestic Content Requirements: WesTech is U.S. based and proudly manufactures many products available to meet various domestic procurement requirements. Due to variability in legislation, products, and project-based specifications, WesTech is unable to guarantee compliance with domestic content requirements unless stated otherwise in our official project proposal. For products where domestic sourcing is not currently available, WesTech can provide documentation to support application for relevant waivers (Non-Availability, De Minimis, or others).

USA Tariffs and Current Trade Laws: All prices are based on current USA and North America tariffs and trade laws/agreements as of Jan 1, 2025. Any changes in costs due to USA Tariffs and trade laws/agreements will be passed through to the purchaser at cost.

Exceptions

WesTech shall provide a scum box and standard skimmers in lieu of the rotating scum pipe and ducking skimmers of similar clarifiers already on site.

WesTech has not included a density current baffle, as shown on drawings of similar clarifiers already on site, in this proposal.

All FRP shall be Type 1, isophthalic polyester resin.



Commercial Proposal

Proposal Name: Bullhead City

Proposal Number: 2160254

Friday, March 28, 2025

1. Bidder's Contact Information

Company Name	WesTech Engineering, LLC
Primary Contact Name	Adrian Williams
Phone	(801) 265-1000
Email	awilliams@westechwater.com
Address: Number/Street	3665 S West Temple
Address: City, State, Zip	Salt Lake City, UT 84115

2. Firm Pricing

Currency: USD

Scope of Supply

A	One (1) 90' Diameter Clarifier Mechanism, Model COPC1G	\$503,680
B	Installation	\$211,744

Optional Items

A-1	Adder for FRP Density Current Baffle	\$58,981
	Taxes (sales, use, VAT, IVA, IGV, duties, import fees, etc.)	Not Included

Prices are valid for a period not to exceed 30 days from date of proposal.

Additional Field Service

Daily Rate (Applicable Only to Field Service Not Included in Scope)	\$1,350

Pricing does not include field service unless noted in scope of supply but is available at the daily rate plus expenses. The greater of a two week notice or visa procurement time is required prior to departure date. Our field service policy is subject to change and can be provided upon request.

3. Payment Terms

Purchase Order Acceptance and Contract Execution	0%
Submittals Provided by WesTech	25%
Release for Fabrication	35%
Notification of Ready to Ship	40%
Installation Completion (Item B)	100%

All payments are net 30 days. Partial shipments are allowed. An approved Letter of Credit is required if Incoterms CIF, CFR, DAP, CIP, or CPT are applicable. Payment is required in full for all other Incoterms prior to international shipment. Other terms per WesTech proforma invoice. Please note that the advising bank must be named as: Wells Fargo Bank, International Department, 9000 Flair Drive, 3rd Floor, El Monte, California 91731, USA.

4. Schedule

Submittals, after Purchase Order Acceptance and Contract Execution	10 to 12 weeks
Ready to Ship, after Receipt of Final Submittal Approval	26 to 28 weeks

Estimated Weeks to Ready to Ship	36 to 40 weeks*

*Customer submittal approval is typically required to proceed with equipment fabrication and is not accounted for in the schedule above. Project schedule will be extended to account for time associated with receipt of customer submittal approval. Due to supply chain disruptions and volatility, delivery schedule is a best estimate only and may be improved or hampered based on date of contract execution, scope selection, and materials availability.

5. Freight

Domestic	FOB Shipping Point - Full Freight Allowed to Jobsite (FSP-FFA)	
From	Final Destination	Number of Trucks / Containers
WesTech Shops	Bullhead City, AZ	Approximately 5

WESTECH[®]

 SWIRE WATER

Proposal: 2160254.F_Rev02

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One-Year Warranty

Equipment manufactured or sold by WesTech Engineering, LLC, once paid for in full, is backed by the following warranty:

Subject to the terms below, WesTech warrants all new equipment manufactured or sold by WesTech Engineering, LLC to be unencumbered and free from defects in material and workmanship, and WesTech will replace or repair, F.O.B. its factories or other location it chooses, any part or parts returned to WesTech which WesTech's examination and analysis determine have failed within the warranty period because of defects in material and workmanship. The warranty period is either, one calendar year immediately following start-up, or eighteen (18) months from when WesTech sent its ready-to-ship notification to the purchaser, whichever expires sooner. All repair or replacement parts qualifying under this warranty shall be free of charge. Purchaser will provide timely written notice to WesTech of any defects it believes should be repaired or replaced under this warranty. WesTech will reject as untimely any warranty defect claim that purchaser submits more than thirty (30) days after the possible warranty defect first occurred. Unless specifically stated otherwise, this warranty does not cover normal wear, consumables, or coatings. Purchasers are invited to inspect the equipment in the shop for proper surface preparation and coating application prior to shipment. This warranty is not transferable.

This warranty shall be void and shall not apply where the equipment or any part thereof

- has been dismantled, modified, repaired, or connected to other equipment, outside of a WesTech factory, or without WesTech's written approval, or

- has not been installed in complete adherence to all WesTech's or parts manufacturer's requirements, recommendations, and procedures, or

- has been subject to misuse, abuse, neglect, or accident, or has not at all times been operated and maintained in strict compliance with all of WesTech's requirements and recommendations therefor, including, but not limited to, the relevant WesTech Operations & Maintenance Manual and any other of WesTech's specified guidelines & procedures, or

- has been subject to force majeure events; use of chemicals not approved in writing by WesTech; electrical surges; overloading; significant power, water or feed supply fluctuations; or non-compliance with agreed feedwater or chemical volumes, specifications or procedures.

In any case where a part or component of equipment under this warranty is or may be faulty and the component or part is also covered under the warranty of a third party then the purchaser shall provide reasonable assistance to first pursue a claim under the third-party warranty before making a claim under this warranty from WesTech. WesTech Engineering, LLC gives no warranty with respect to parts, accessories, or components purchased other than through WesTech. The warranties which apply to such items are those offered by the respective manufacturers.

This warranty is expressly given by WesTech and accepted by purchaser in lieu of all other warranties whether written, oral, express, implied, statutory, or otherwise, including without limitation, warranties of merchantability and fitness for particular purpose. WesTech neither accepts nor authorizes any other person to assume for it any other liability with respect to its equipment. WesTech shall not be liable for normal wear and tear, corrosion, or any contingent, incidental, or consequential damage or expense due to partial or complete inoperability of its equipment for any reason whatsoever. The purchaser's exclusive and only remedy for breach of this warranty shall be the repair and or replacement of the defective part or parts within a reasonable time of WesTech's accepting the validity of a warranty claim made by the purchaser.



Terms and Conditions

Terms and Conditions appearing in any order based on this proposal which are inconsistent herewith shall not be binding on WesTech Engineering, LLC. The sale and purchase of equipment described herein shall be governed exclusively by the foregoing proposal and the following provisions:

- 1. SPECIFICATIONS:** WesTech Engineering, LLC is furnishing its standard equipment as outlined in the proposal and as will be covered by final approved drawings. The equipment may not be in strict compliance with the Engineer's/Owner's plans, specifications, or addenda as there may be deviations. The equipment will, however, meet the general intention of the mechanical specifications of these documents.
 - 2. ITEMS INCLUDED:** This proposal includes only the equipment specified herein and does not include erection, installation, accessories, nor associated materials such as controls, piping, etc., unless specifically listed.
 - 3. PARTIES TO CONTRACT:** WesTech Engineering, LLC is not a party to or bound by the terms of any contract between WesTech Engineering, LLC's customer and any other party. WesTech Engineering, LLC's undertakings are limited to those defined in the contract between WesTech Engineering, LLC and its direct customers.
 - 4. PRICE AND DELIVERY:** All selling prices quoted are subject to change without notice after 30 days from the date of this proposal unless specified otherwise. Unless otherwise stated, all prices are F.O.B. WesTech Engineering, LLC or its supplier's shipping points. All claims for damage, delay or shortage arising from such equipment shall be made by Purchaser directly against the carrier. When shipments are quoted F.O.B. job site or other designation, Purchaser shall inspect the equipment shipped, notifying WesTech Engineering, LLC of any damage or shortage within forty-eight hours of receipt, and failure to so notify WesTech Engineering, LLC shall constitute acceptance by Purchaser, relieving WesTech Engineering, LLC of any liability for shipping damages or shortages.
 - 5. PAYMENTS:** All invoices are net 30 days. Delinquencies are subject to a 1.5 percent service charge per month or the maximum permitted by law, whichever is less on all past due accounts. Pro rata payments are due as shipments are made. If shipments are delayed by the Purchaser, invoices shall be sent on the date when WesTech Engineering, LLC is prepared to make shipment and payment shall become due under standard invoicing terms. If the work to be performed hereunder is delayed by the Purchaser, payments shall be based on the purchase price and percentage of completion. Products held for the Purchaser shall be at the risk and expense of the Purchaser. Unless specifically stated otherwise, prices quoted are for equipment only. These terms are independent of and not contingent upon the time and manner in which the Purchaser receives payment from the owner.
 - 6. PAYMENT TERMS:** Credit is subject to acceptance by WesTech Engineering, LLC's Credit Department. If the financial condition of the Purchaser at any time is such as to give WesTech Engineering, LLC, in its judgment, doubt concerning the Purchaser's ability to pay, WesTech Engineering, LLC may require full or partial payment in advance or may suspend any further deliveries or continuance of the work to be performed by the WesTech Engineering, LLC until such payment has been received.
 - 7. ESCALATION:** If between the proposal date and actual procurement and through no fault of the Seller, the relevant cost of labor, material, freight, tariffs, and other Seller costs combined relating to the contract, increase by greater than 2.5% of the overall contract price, then the contract price shall be subject to escalation and increased. Such increase shall be verified by documentation and the amount of contract price escalation shall be calculated as either the actual increased cost to the Seller or, if agreed by the Parties, the equivalent increase of a relevant industry recognized third-party index, and in both cases without any additional profit or margin being added.
 - 8. APPROVAL:** If approval of equipment submittals by Purchaser or others is required, a condition precedent to WesTech Engineering, LLC supplying any equipment shall be such complete approval.
 - 9. INSTALLATION SUPERVISION:** Prices quoted for equipment do not include installation supervision. WesTech Engineering, LLC recommends and will, upon request, make available, at WesTech Engineering, LLC's then current rate, an experienced installation supervisor to act as the Purchaser's employee and agent to supervise installation of the equipment. Purchaser shall at its sole expense furnish all necessary labor equipment, and materials needed for installation.
- Responsibility for proper operation of equipment, if not installed by WesTech Engineering, LLC or installed in accordance with WesTech Engineering, LLC's instructions, and inspected and accepted in writing by WesTech Engineering, LLC, rests entirely with Purchaser; and any work performed by WesTech Engineering, LLC personnel in making adjustment or changes must be paid for at WesTech Engineering, LLC's then current per diem rates plus living and traveling expenses.
- WesTech Engineering, LLC will supply the safety devices described in this proposal or shown in WesTech Engineering, LLC's drawings furnished as part of this order but excepting these, WesTech Engineering, LLC shall not be required to supply or install any safety devices whether required by law or otherwise. The Purchaser hereby agrees to indemnify and hold harmless WesTech Engineering, LLC from any claims or losses arising due to alleged or actual insufficiency or inadequacy of the safety devices offered or supplied hereunder, whether specified by WesTech Engineering, LLC or Purchaser, and from any damage resulting from the use of the equipment supplied hereunder.
- 10. ACCEPTANCE OF PRODUCTS:** Products will be deemed accepted without any claim by Purchaser unless written notice of non-acceptance is received by WesTech Engineering, LLC within 30 days of delivery if shipped F.O.B. point of shipment, or 48 hours of delivery if shipped F.O.B. point of destination. Such written notice shall not be considered received by WesTech Engineering, LLC unless it is accompanied by all freight bills for said shipment, with Purchaser's notations as to damages, shortages and conditions of equipment, containers, and seals. Non-accepted products are subject to the return policy stated below.
 - 11. TAXES:** Any federal, state, or local sales, use or other taxes applicable to this transaction, unless specifically included in the price, shall be for Purchaser's account.



Terms and Conditions

12. TITLE: The equipment specified herein, and any replacements or substitutes therefore shall, regardless of the manner in which affixed to or used in connection with realty, remain the sole and personal property of WesTech Engineering, LLC until the full purchase price has been paid. Purchaser agrees to do all things necessary to protect and maintain WesTech Engineering, LLC's title and interest in and to such equipment; and upon Purchaser's default, WesTech Engineering, LLC may retain as liquidated damages any and all partial payments made and shall be free to enter the premises where such equipment is located and remove the same as its property without prejudice to any further claims on account of damages or loss which WesTech Engineering, LLC may suffer from any cause.

13. INSURANCE: From date of shipment until the invoice is paid in full, Purchaser agrees to provide and maintain at its expense, but for WesTech Engineering, LLC's benefit, adequate insurance including, but not limited to, builders risk insurance on the equipment against any loss of any nature whatsoever.

14. SHIPMENTS: Any shipment of delivery dates recited represent WesTech Engineering, LLC's best estimate but no liability, direct or indirect, is assumed by WesTech Engineering, LLC for failure to ship or deliver on such dates.

WesTech Engineering, LLC shall have the right to make partial shipments; and invoices covering the same shall be due and payable by Purchaser in accordance with the payment terms thereof. If Purchaser defaults in any payment when due hereunder, WesTech Engineering, LLC may, without incurring any liability therefore to Purchaser or Purchaser's customers, declare all payments immediately due and payable with maximum legal interest thereon from due date of said payment, and at its option, stop all further work and shipments until all past due payments have been made, and/or require that any further deliveries be paid for prior to shipment.

If Purchaser requests postponements of shipments, the purchase price shall be due and payable upon notice from WesTech Engineering, LLC that the equipment is ready for shipment; and thereafter any storage or other charge WesTech Engineering, LLC incurs on account of the equipment shall be for the Purchaser's account.

If delivery is specified at a point other than WesTech Engineering, LLC or its supplier's shipping points, and delivery is postponed or prevented by strike, accident, embargo, or other cause beyond WesTech Engineering, LLC's reasonable control and occurring at a location other than WesTech Engineering, LLC or its supplier's shipping points, WesTech Engineering, LLC assumes no liability in delivery delay. If Purchaser refuses such delivery, WesTech Engineering, LLC may store the equipment at Purchaser's expense. For all purposes of this agreement such tender of delivery or storage shall constitute delivery.

15. WARRANTY: WesTech Engineering, LLC warrants equipment it supplies only in accordance with the attached WesTech Warranty. This warranty is expressly given by WesTech and accepted by purchaser in lieu of all other warranties whether written, oral, express, implied, statutory or otherwise, including without limitation, warranties of merchantability and fitness for particular purpose. WesTech neither accepts nor authorizes any other person to assume for it any other liability with respect to its equipment. WesTech shall not be liable for normal wear and tear, corrosion, or any contingent, incidental, or consequential damage or expense due to partial or complete inoperability of its equipment for any reason whatsoever. The purchaser's exclusive and only remedy for breach of this warranty shall be the repair and or replacement of the defective part or parts within a reasonable time of WesTech's accepting the validity of a warranty claim made by the purchaser.

16. PATENTS: WesTech Engineering, LLC agrees that it will, at its own expense, defend all suits or proceedings instituted against Purchaser and pay any award of damages assessed against it in such suits or proceedings, so far as the same are based on any claim that the said equipment or any part thereof constitutes an infringement of any apparatus patent of the United States issued at the date of this Agreement, provided WesTech Engineering, LLC is given prompt notice in writing of the institution or threatened institution of any suit or proceeding and is given full control of the defense, settlement, or compromise of any such action; and Purchaser agrees to give WesTech Engineering, LLC needed information, assistance, and authority to enable WesTech Engineering, LLC so to do. In the event said equipment is held or conceded to infringe such a patent, WesTech Engineering, LLC shall have the right at its sole option and expense to a) modify the equipment to be non-infringing, b) obtain for Purchaser the license to continue using said equipment, or c) accept return of the equipment and refund to the Purchaser the purchase price thereof less a reasonable charge for the use thereof. WesTech Engineering, LLC will reimburse Purchaser for actual out-of-pocket expenses, exclusive of legal fees, incurred in preparing such information and rendering such assistance at WesTech Engineering, LLC's request. The foregoing states the entire liability of WesTech Engineering, LLC, with respect to patent infringement; and except as otherwise agreed to in writing, WesTech Engineering, LLC assumes no responsibility for process patent infringement.

17. SURFACE PREPARATION AND PAINTING: If furnished, shop primer paint is intended to serve only as minimal protective finish. WesTech Engineering, LLC will not be responsible for the condition of primed or finish painted surfaces after equipment leaves its shops. Purchasers are invited to inspect paint in shops for proper preparation and application prior to shipment. WesTech Engineering, LLC assumes no responsibility for field surface preparation or touch-up of shipping damage to paint. Painting of fasteners and other touch-up to painted surfaces will be by Purchaser's painting contractor after mechanism installation.

Motors, gear motors, and other components not manufactured by WesTech Engineering, LLC will be painted with that manufacturer's standard paint system. It is WesTech Engineering, LLC's intention to ship major steel components as soon as fabricated, often before drive, motors, and other manufactured components. Unless Purchaser can ensure that shop primed steel shall be field painted within thirty (30) days after arrival at the job site, WesTech Engineering, LLC encourages the Purchaser to order these components without primer.

WesTech Engineering, LLC's prices are based on paints and surface preparations as outlined in the main body of this proposal. In the event that an alternate paint system is selected, WesTech Engineering, LLC requests that Purchaser's order advise of the paint



Terms and Conditions

selection. WesTech Engineering, LLC will then either adjust the price as may be necessary to comply or ship the material unpainted if compliance is not possible due to application problems or environmental controls.

18. CANCELLATION, SUSPENSION, OR DELAY: After acceptance by WesTech Engineering, LLC, this proposal, or Purchaser's order based on this proposal, shall be a firm agreement and is not subject to cancellation, suspension, or delay except upon payment by Purchaser of appropriate charges which shall include all costs incurred by WesTech Engineering, LLC to date of cancellation, suspension, or delay plus a reasonable profit. Additionally, all charges related to storage and/or resumption of work, at WesTech Engineering, LLC's plant or elsewhere, shall be for Purchaser's sole account; and all risks incidental to storage shall be assumed by Purchaser.

19. FORCE MAJEURE: Neither party hereto shall be liable to the other for default or delay in delivery caused by extreme weather or other act of God, strike or other labor shortage or disturbance, fire, accident, war or civil disturbance, act of government, pandemic, delay of carriers, failure of normal sources of supply, complete or partial shutdown of plant by reason of inability to attain sufficient raw materials or power, and/or other similar contingency beyond the reasonable control of the respective parties. The time for delivery specified herein shall be extended during the continuance of such conditions, or any other cause beyond such party's reasonable control. Escalation resulting from a Force Majeure event shall be equitably adjusted per the escalation policy stated above.

20. RETURN OF PRODUCTS: No products may be returned to WesTech Engineering, LLC without WesTech Engineering, LLC's prior written permission. Said permission may be withheld by WesTech Engineering, LLC at its sole discretion.

21. BACKCHARGES: WesTech Engineering, LLC will not approve or accept backcharges for labor, materials, or other costs incurred by Purchaser or others in modification, adjustment, service, or repair of WesTech Engineering, LLC furnished materials unless such back charge has been authorized in advance in writing by a WesTech Engineering, LLC purchase order, or work requisition signed by WesTech Engineering, LLC.

22. INDEMNIFICATION: Purchaser agrees to indemnify WesTech Engineering, LLC from all costs incurred, including but not limited to court costs and reasonable attorney fees, from enforcing any provisions of this contract, including but not limited to breach of contract or costs incurred in collecting monies owed on this contract.

23. ENTIRE AGREEMENT: This proposal expresses the entire agreement between the parties hereto superseding any prior understandings, and is not subject to modification except by a writing signed by an authorized officer of each party.

24. MOTORS AND MOTOR DRIVES: In order to avoid shipment delays of WesTech Engineering, LLC equipment, motors and drives may be sent directly to the job site for installation by the equipment installer. Minor fit-up may be required.

25. EXTENDED STORAGE: Extended storage instructions will be part of information provided to shipment. If equipment installation and start-up is delayed more than 30 days, the provisions of the storage instructions must be followed to keep WARRANTY in force.

26. LIABILITY: Professional liability insurance, including but not limited to, errors and omissions insurance, is not included. In any event, liability for errors and omissions shall be limited to the lesser of \$100,000 USD or the value of the particular piece of equipment (not the value of the entire order) supplied by WesTech Engineering, LLC against which a claim is sought.

27. ARBITRATION NEGOTIATION: Any controversy or claim arising out of or relating to the performance of any contract resulting from this proposal or contract issued, or the breach thereof, shall be settled by arbitration in accordance with the Construction Industry Arbitration Rules of the American Arbitration Association, and judgment upon the award rendered by the arbitrator(s) may be entered to any court having jurisdiction.

ACCEPTED BY PURCHASER

Customer Name: _____

Customer Address: _____

Contact Name: _____

Contact Phone: _____ Contact Email: _____

Signature: _____ Printed Name: _____

Date: _____ Title: _____

DIVISION 46 – WATER AND WASTEWATER EQUIPMENT

PART 1 GENERAL

1.01 WORK INCLUDED

- A. This section covers the work necessary to furnish and install top entry tank mixers with mounting system and accessories as specified herein.
- B. Related Section:
 - 1. The work of the following sections is related to the work of this section. Other sections not referenced below, may also be related to the proper performance of this work. It is the Contractor's responsibility to perform and coordinate all the work required by the Contract Documents.
 - a. Division 26 – ELECTRICAL

1.02 GENERAL

- A. See the GENERAL CONDITIONS and Division 1, GENERAL REQUIREMENTS, which contain information and requirements that apply to the work specified herein and are mandatory for this project.

1.03 QUALITY ASSURANCE

- A. The equipment covered by these specifications shall be the product of a single Manufacturer regularly engaged in the production of equipment for the specified use. The Manufacturer shall have the sole responsibility for the proper functioning of the equipment as furnished.
- B. The mixer Manufacturer shall have equipment of a similar type in satisfactory operating condition for not less than 5 years.

1.04 SUBMITTALS DURING CONSTRUCTION

- A. Submittals shall be made as required in Section 01 33 00, SUBMITTALS. In addition, the following specific information shall be provided:
 - 1. Complete specifications, drawings, and descriptive literature on the equipment and any exceptions to these Specifications. At a minimum, the following shall be included:
 - a. Make, model, dimensions, and weight for each mixer.
 - b. Detailed information for the mounting system.
 - c. Certification that mixer size and propeller design are adequate to meet the intent of these specifications.

DIVISION 46 – WATER AND WASTEWATER EQUIPMENT

- d. Submit a reference list of similar installations, including date of installation, location, and contact information.
- e. Provide a list of Manufacturer supplied spare parts.
- 2. Submit factory and field test results as required in this Specification.

1.05 OPERATION AND MAINTENANCE MANUALS

- A. Operation and Maintenance Manuals and Maintenance Summary Sheets for the equipment specified herein shall be furnished as specified in Section 01 77 00, CONTRACT CLOSEOUT.
- B. The O&M manuals shall contain at a minimum full descriptions of the mixers, spare parts lists, and detailed instructions for all operation and maintenance tasks to be performed by the operator.
- C. A spare manual shall be shipped with the equipment in order to allow for proper installation and operation of the equipment prior to the release of all final installation, operation, and maintenance manuals

1.06 MANUFACTURERS' SERVICES

- A. Manufacturer's services shall be provided in accordance with Section 01 66 40, MANUFACTURER'S SERVICES and the following:
 - 1. A qualified Manufacturer's representative for the equipment specified shall certify proper installation and operation.
 - 2. The Manufacturer's representative shall provide operator training.
 - 3. If there are difficulties in operation of the equipment due to the Manufacturer's fabrication or Contractor's installation, additional service shall be provided at no extra cost to the Owner.

1.07 MANUFACTURER'S WARRANTY

- A. The Manufacturer shall warrant each mixer and motor against defects in workmanship and materials for 1 year from the date of Substantial Completion.
- B. The Manufacturer shall pay the cost of replacement parts and labor required at Manufacturer's plant to cure any defects in workmanship or materials discovered during the warranty period.
- C. This warranty shall not be encumbered nor limited by the number of hours of mixer running time. Warranties that restrict coverage to operating conditions or limitations on hours of running time shall not be acceptable.

DIVISION 46 – WATER AND WASTEWATER EQUIPMENT

Operating conditions shall be a minimum of continuous running capability without thermal or overload interruption.

PART 2 PRODUCTS

2.01 GENERAL

- A. The structure and appurtenant facilities have been designed around the first named Manufacturer. Equipment furnished by all qualified interested Manufacturers will be considered, provided the necessary structural, electrical, and mechanical changes required are submitted in conformance with the requirements of the GENERAL CONDITIONS and Division 1, GENERAL REQUIREMENTS. The Contractor shall bear all costs for necessary changes for a complete and satisfactory installation. The Contractor shall be responsible for all design changes associated with other manufacturers' equipment.

2.02 EQUIPMENT MANUFACTURERS

- A. Fusion Fluid Equipment
- B. Or approved equal.

2.03 SERVICE CONDITIONS AND PERFORMANCE REQUIREMENTS

- A. This mixer will be installed in the secondary effluent manhole and will serve to mix injected aluminum sulfate with effluent from the clarifiers. Flow enters and exits the manhole at the bottom.
- B. Secondary effluent flow rates vary from 3.6 mgd to 9.6 mgd
- C. Liquid is treated and settled effluent.
- D. Water Temperature: 10°C to 20°C
- E. Ambient Temperature: 40°F – 125°F.

2.04 MIXER DESCRIPTION

- A. Mixer shall be top entry type mixer, gear-driven, plate mounted, and suitable for continuous, year-round outdoors operation.
- B. Propeller and Shaft:
 - 1. The propeller shall be of Type 316L stainless steel.

DIVISION 46 – WATER AND WASTEWATER EQUIPMENT

2. The propeller shall be hydrofoil type with three blades and minimum diameter of 40 inches. The propeller shall be configured to provide downflow action.
3. Propeller blades shall be bolted with a minimum of 4 bolts and shall have hook key to prevent propeller blades from falling into the tank.
4. Hollow bore shaft shall be Type 316L stainless steel, precision ground. Length as shown on the Drawings.

C. Gearbox:

1. The gearbox shall be an industrial duty, parallel shaft gearbox with a cast iron frame. The gearbox shall have helical cut two stage reduction and be lubricated with full synthetic oil. The connection to the motor shall be via an enclosed flexible coupling. Gearbox output bearings shall have a service factor of 4.8 per AGMA 3+. Gearbox output speed shall be 70 rpm.

D. Motor:

1. The motor shall be 1.5 hp, 480VAC, 3-ph, 60 Hz, 1,750 rpm, TEFC with a cast iron frame.

2.05 POWER AND CONTROL CABLE

- A. Power and control cables shall be furnished in lengths to run un-spliced from the mixer to the control panel or disconnect as shown on the Drawings and as specified herein. Cables shall terminate with conductor sleeves that bundle the entire group of strands of each phase to improve termination at the pump control panel. The sleeves shall be provided to confirm that all strands of each conductor is terminated properly.

2.06 ELECTRICAL AND CONTROLS

- A. Local operator stations and power shall be provided by the Division 16 contractor.
- B. Control shall be provided by the Plant Control System as described in Section 13020, PROCESS CONTROL NARRATIVES and other applicable sections of Division 13 – INSTRUMENTATION AND CONTROLS.

2.07 FACTORY COATING

- A. Provide Manufacturer's standard coating on all metal components except for stainless steel.

DIVISION 46 – WATER AND WASTEWATER EQUIPMENT

2.08 MOUNTING SYSTEM

- A. Contractor shall coordinate mounting system with the Manufacturer.
 - 1. Provide a mounting system compatible with the mixer supports shown on the Drawings.

2.09 SPARE PARTS AND SPECIAL TOOLS

- A. All spare parts and special tools required to maintain operation of the mixers shall be provided. At a minimum, the following spare parts and special tools shall be furnished. All parts and tools shall be suitably marked and packed in a single, hinged-cover box for each mixer model.
 - 1. Sufficient oil for one complete oil change.
 - 2. One (1) set of any special tools required for maintenance and operation.

PART 3 EXECUTION

3.01 PREPARATION FOR SHIPMENT, STORAGE, AND PROTECTION

- A. Equipment and materials shall be prepared and protected for shipment and shipped in accordance with the requirements of Division 1, GENERAL REQUIREMENTS.
- B. The contractor shall be responsible for receiving the equipment, unloading it from the common carrier, and storing it safely until it is ready to be installed.

3.02 INSTALLATION

- A. Mixers shall be installed in accordance with the Manufacturer's recommendations and as shown on the Drawings.

3.03 FACTORY TESTS

- A. Mixers shall be factory tested for proper alignment and rotation, quiet operation, proper connections, and satisfactory performance. Provide written certification of these tests to the Engineer prior to shipping the mixers.

DIVISION 46 – WATER AND WASTEWATER EQUIPMENT

3.04 FIELD TESTING

A. Field Testing:

1. Coordinate Manufacturer's field services and equipment testing with Owner:
2. Run mixer continuously for a minimum of 4 hours to check for quiet operation, vibration, and overall performance. Remedy any defects found during field testing.

3.05 MANUFACTURER'S CERTIFICATE

A. Provide a certificate of proper installation in accordance with Section 01640, MANUFACTURER'S SERVICES in Division 1, GENERAL REQUIREMENTS.

1. Certificate shall also include all results and testing data recorded during field testing.

END OF SECTION 46 41 41