FINAL Design Specifications

Volume 3

American River Common Features Natomas Basin – Riverside Canal Phase 2 Relocation Project and Reach B Project

Division 02, 03, 05, 07, 09, 10, 13, 26, 31, 32, 33, 35, and 40 Technical Specifications

Sacramento County, California

USACE W91238-17-D-0027

May 30, 2019

U.S. Army Corps of Engineers, Sacramento District

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DIVISION 02 - EXISTING CONDITIONS

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SUBSURFACE DATA

12/02

-- End of Section Table of Contents --

SECTION 02 02 00

SUBSURFACE DATA
12/02

PART 1 GENERAL

Not Used.

PART 2 PRODUCTS

Not Used.

PART 3 EXECUTION

3.1 AVAILABLE SUBSURFACE SOIL DATA

3.1.1 Geotechnical Reports

A Geotechnical Data Report (GDR) has been prepared for this project and is included in electronic format in the reference section of these specifications for information only.

3.1.2 Subsurface Explorations and Laboratory Testing

Subsurface explorations along the project are included as an attachment of this specification (Section 3.2.3). Explorations provided are included for general site assessment purposes. Stick logs are inclusive of explorations performed for this project and those from previous studies may not be representative of the general conditions, since they are based on discrete locations.

3.1.3 Subsurface Conditions

Boring logs are presented in the contract specifications. Any data on subsurface conditions shown in the specifications may not be representative of the General Conditions, since they are based on discrete locations. The water levels shown on the logs of explorations are those measured at the time of drilling. As the water table is related to the river stage and irrigation practices, the water table is expected to change during the construction period.

3.2 ADDITIONAL INVESTIGATION

3.2.1 Attachment A

Attahcment A - Plans and Profiles along Reach B.

-- End of Section --

Appendix A Geologic Plans and Profiles

Appendix A includes the following information:

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A-2b	Plan and Profile Station 650+00 to Station 675+00
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A-3b	Plan and Profile Station 675+00 to Station 700+00
A-4a	Plan and Profile Station 700+00 to Station 725+00
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A-5a	Plan and Profile Station 725+00 to Station 750+00
A-5b	Plan and Profile Station 725+00 to Station 750+00
A-6a	Plan and Profile Station 750+00 to Station 775+00
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Plan and Profile Index and Legend

American River Common Features Project, Natomas Basin, Reach B

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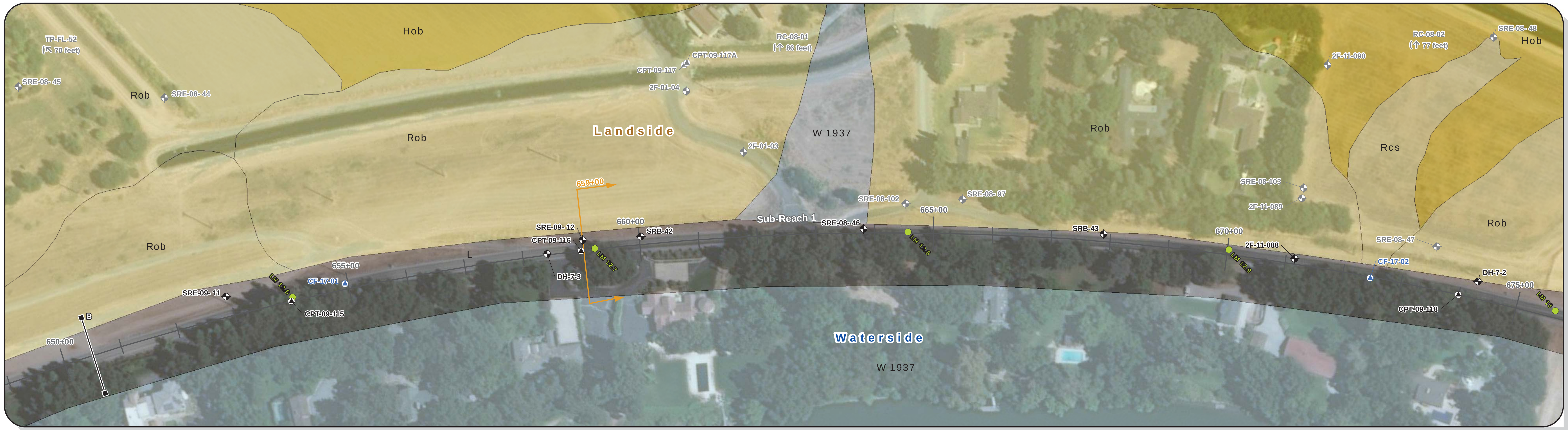
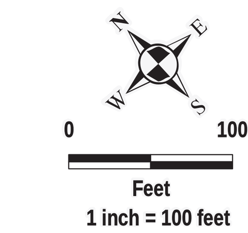
Appendix A
1





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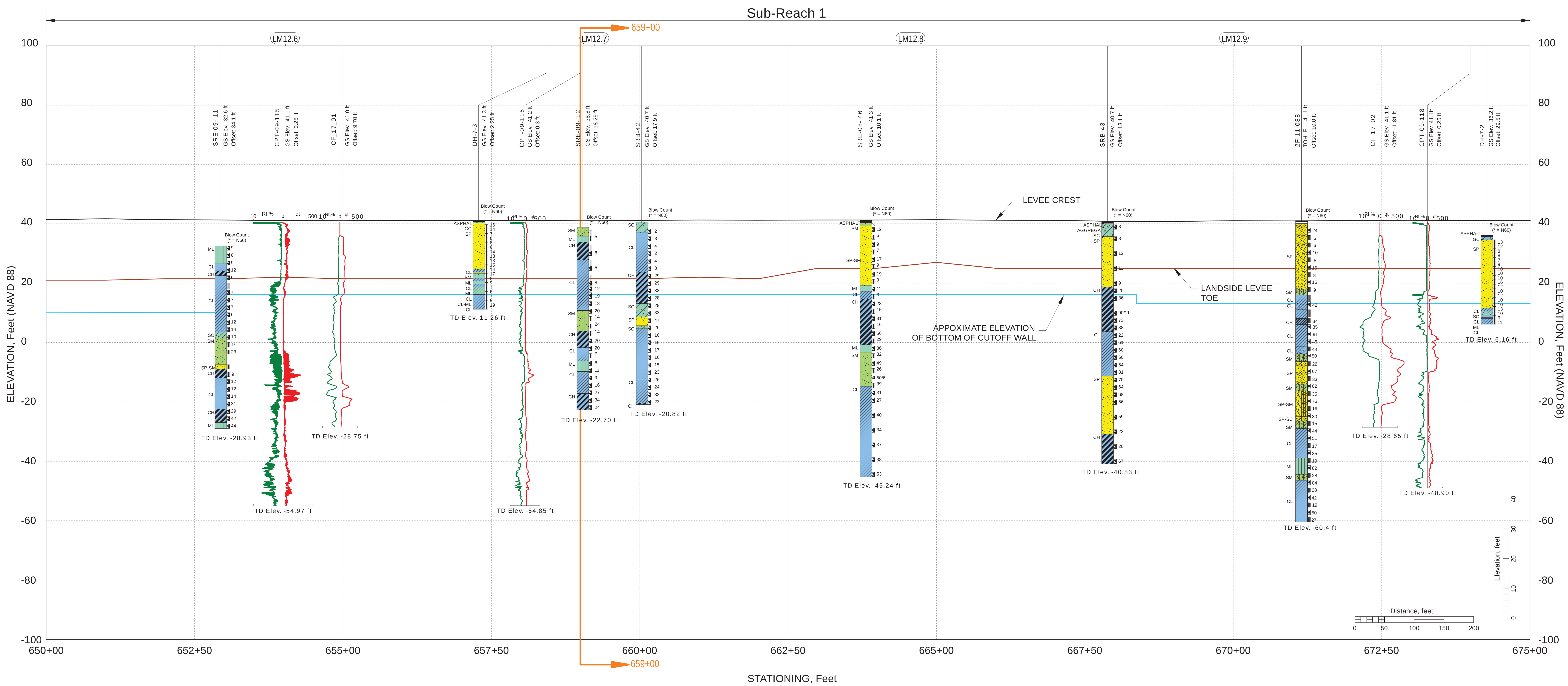

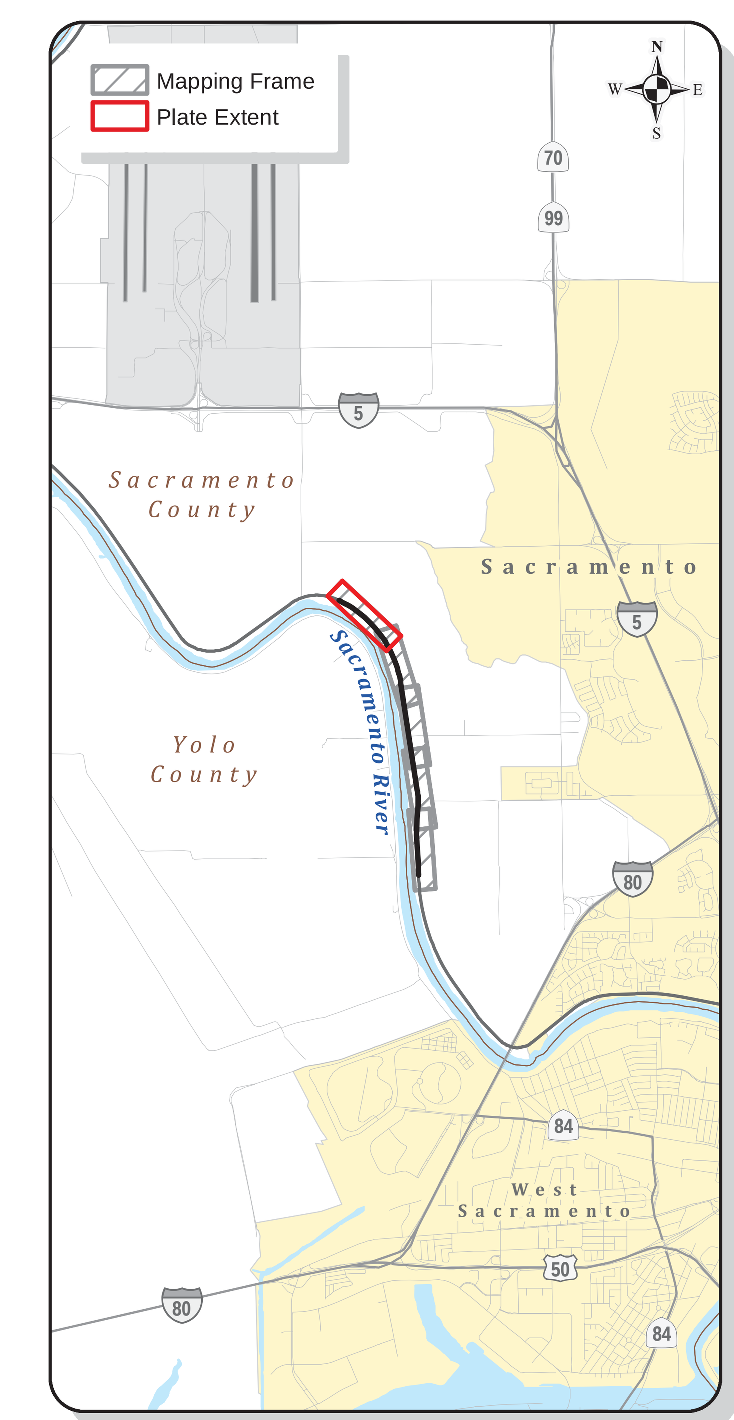

Plan and Profile
Station 650+00 to Station 675+00

American River Common Features Project,
Natomas Basin, Reach B

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Appendix A
2a

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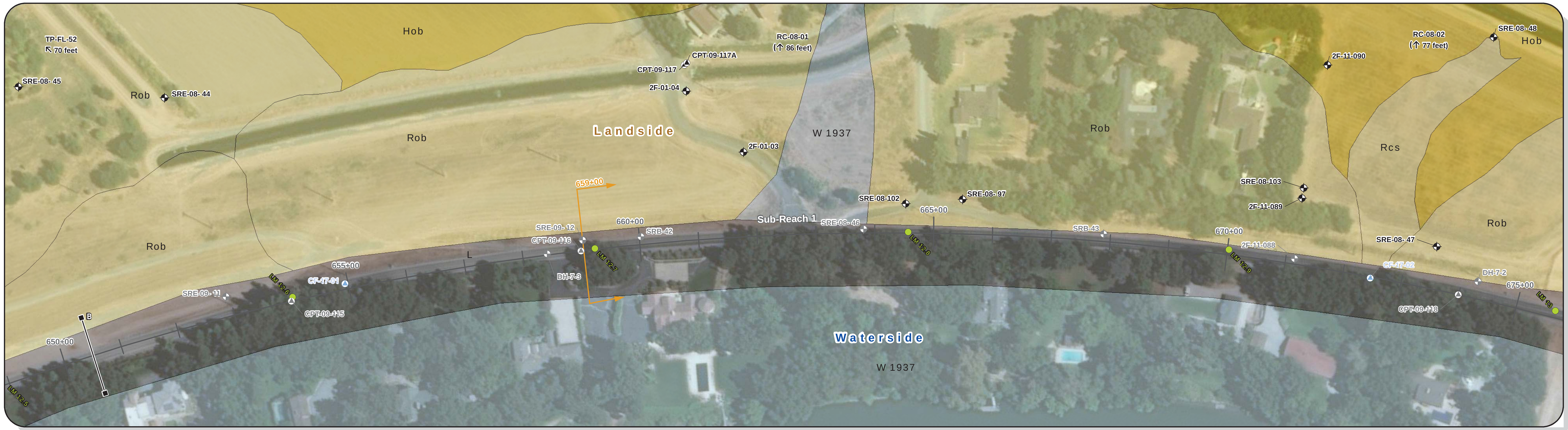

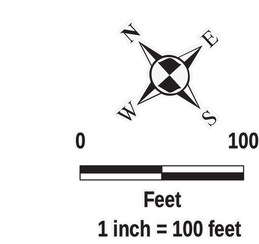

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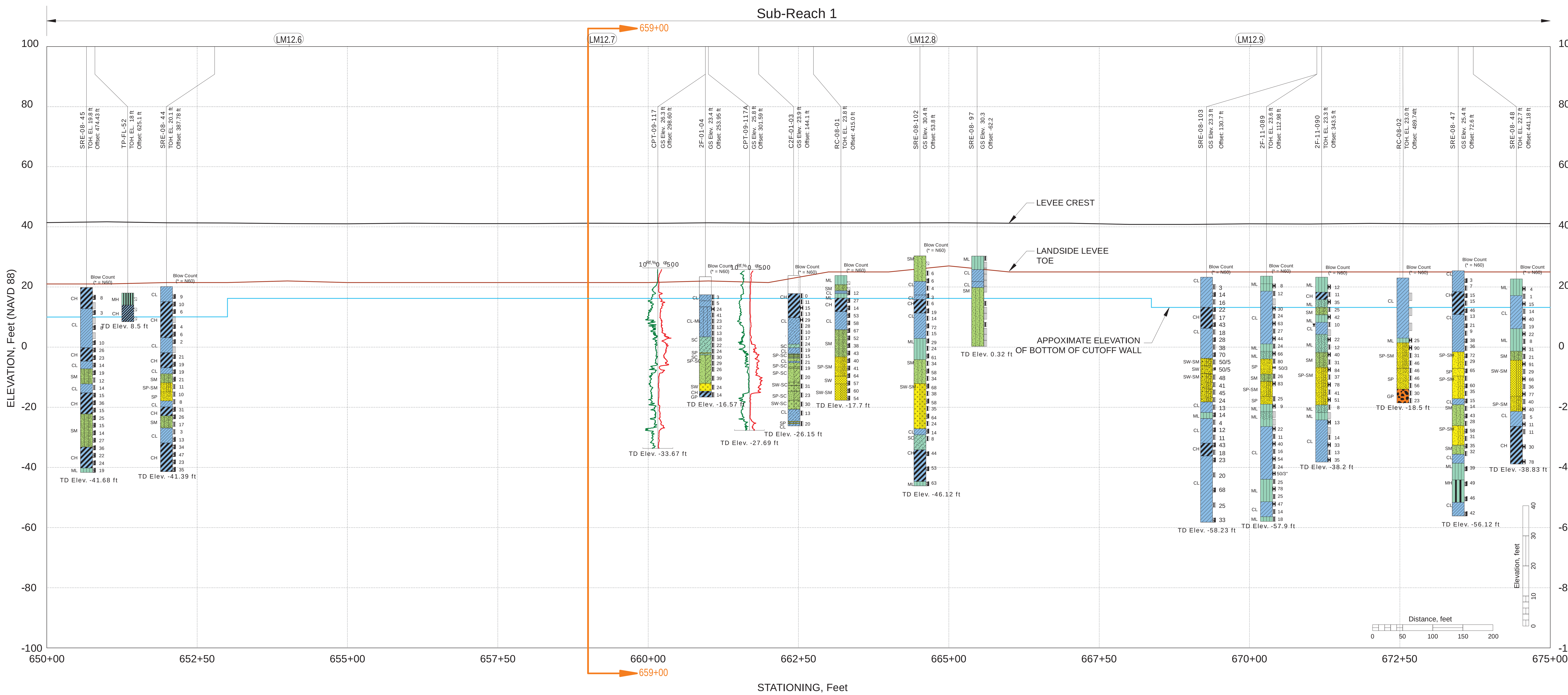

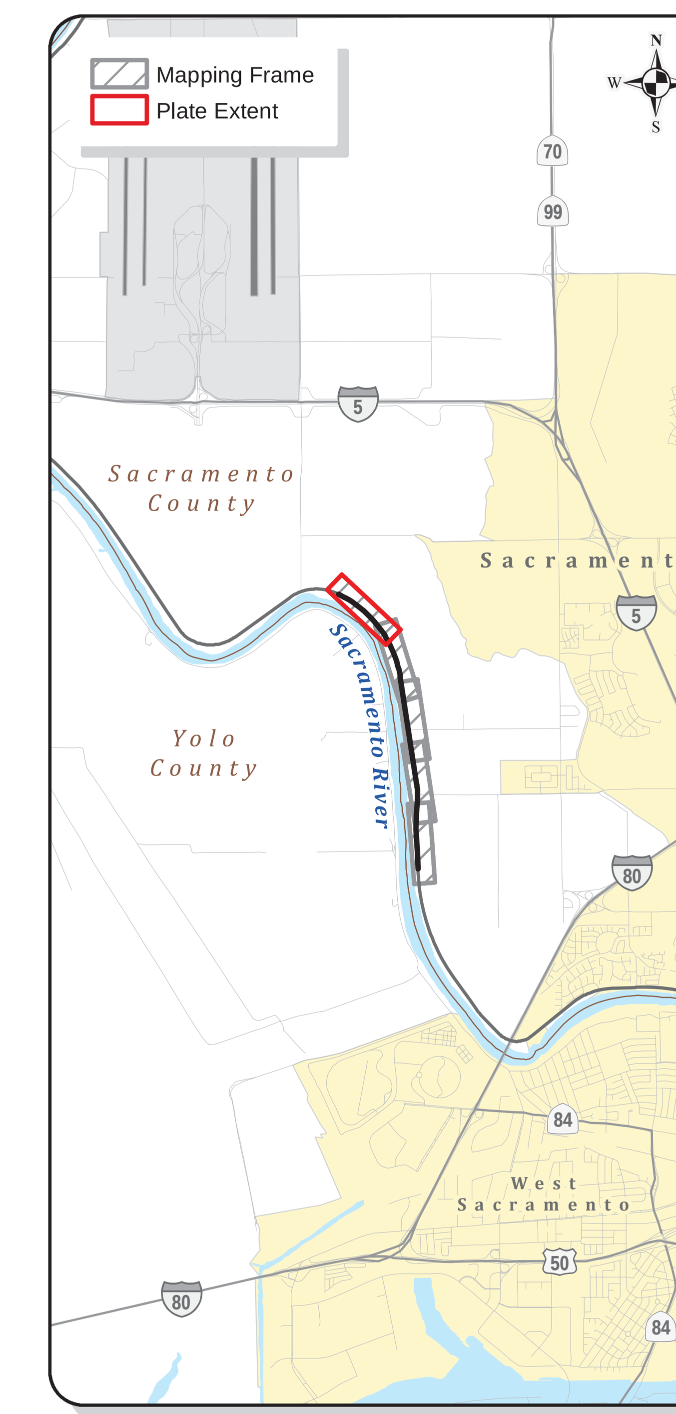

Plan and Profile
Station 650+00 to Station 675+00

American River Common Features Project,
Natomas Basin, Reach B

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Appendix A
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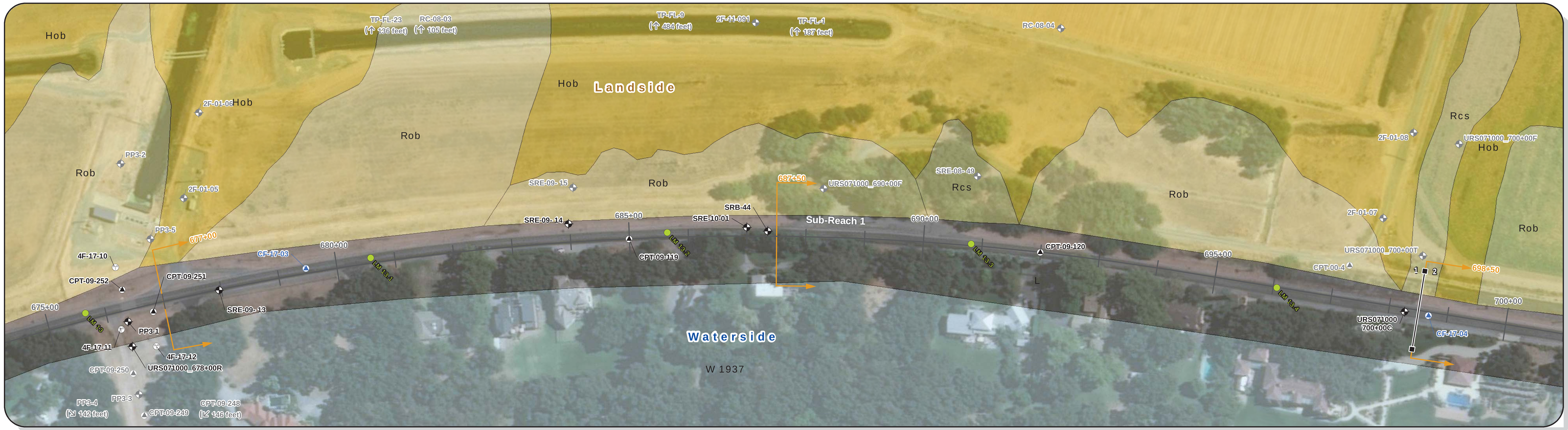

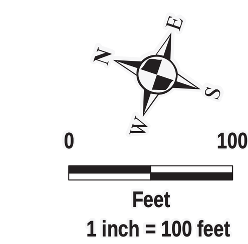

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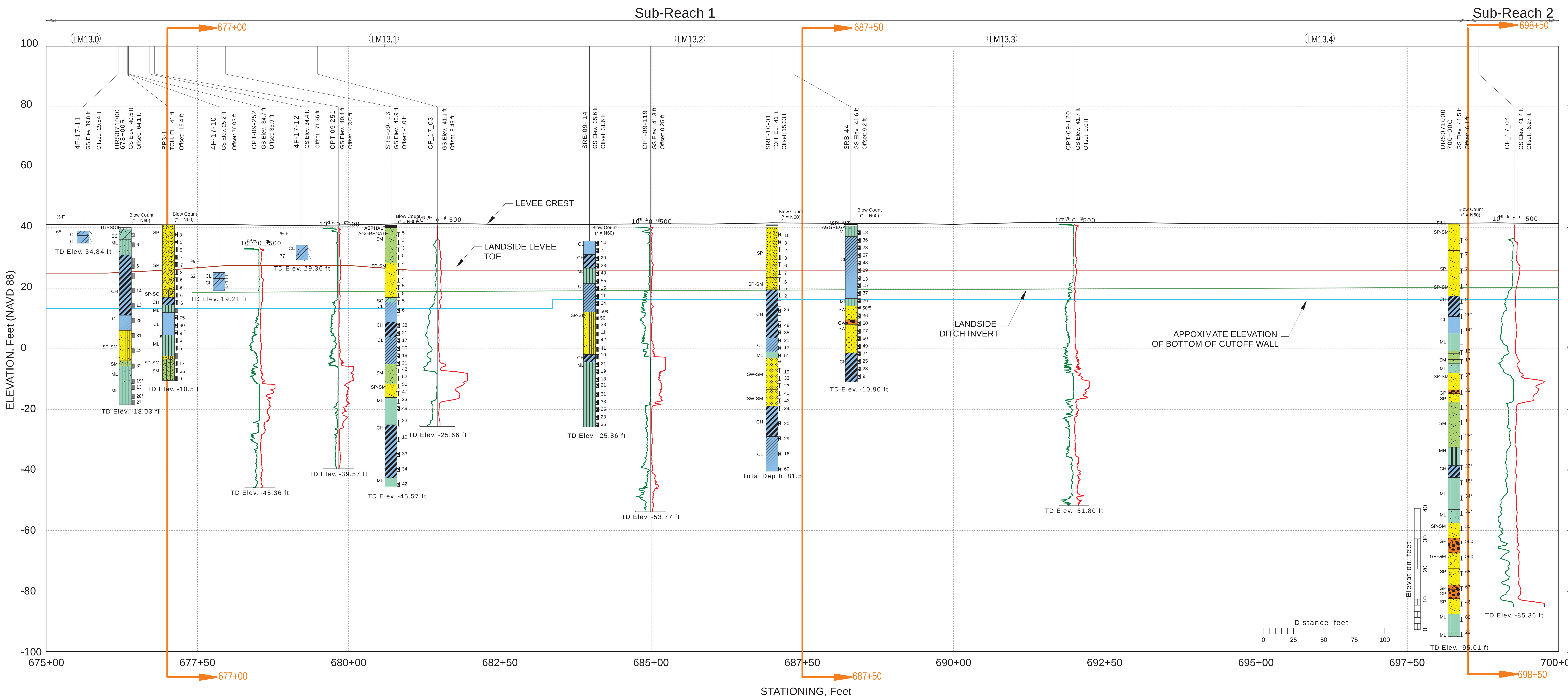

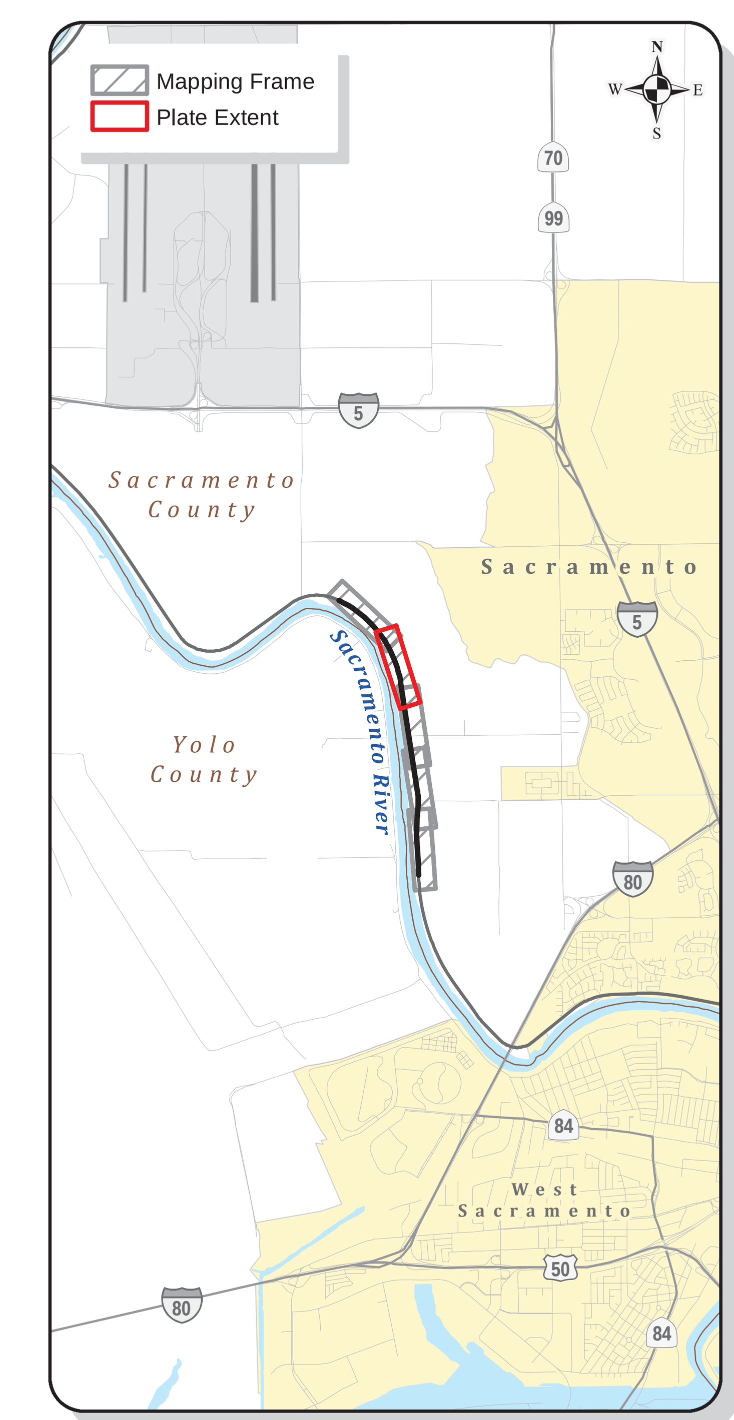

Plan and Profile
Station 675+00 to Station 700+00

AMERICAN RIVER COMMON FEATURES PROJECT, NATOMAS BASIN, REACH B

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Appendix A
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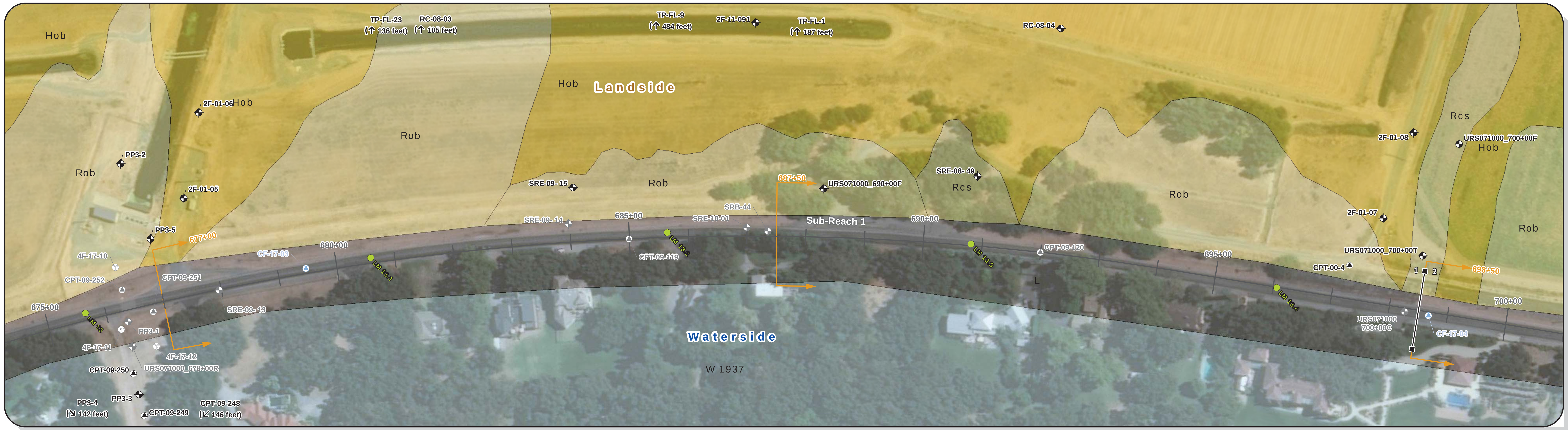

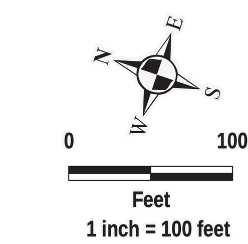

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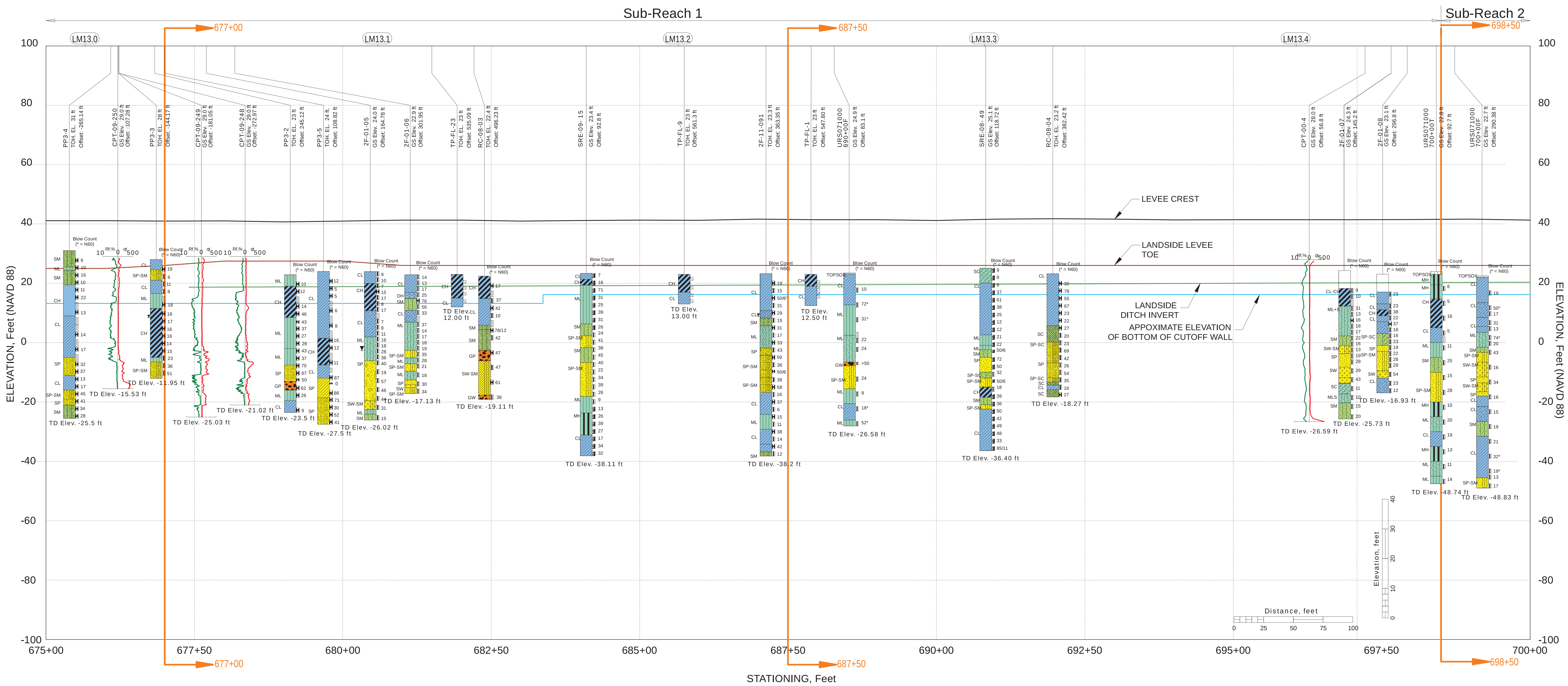

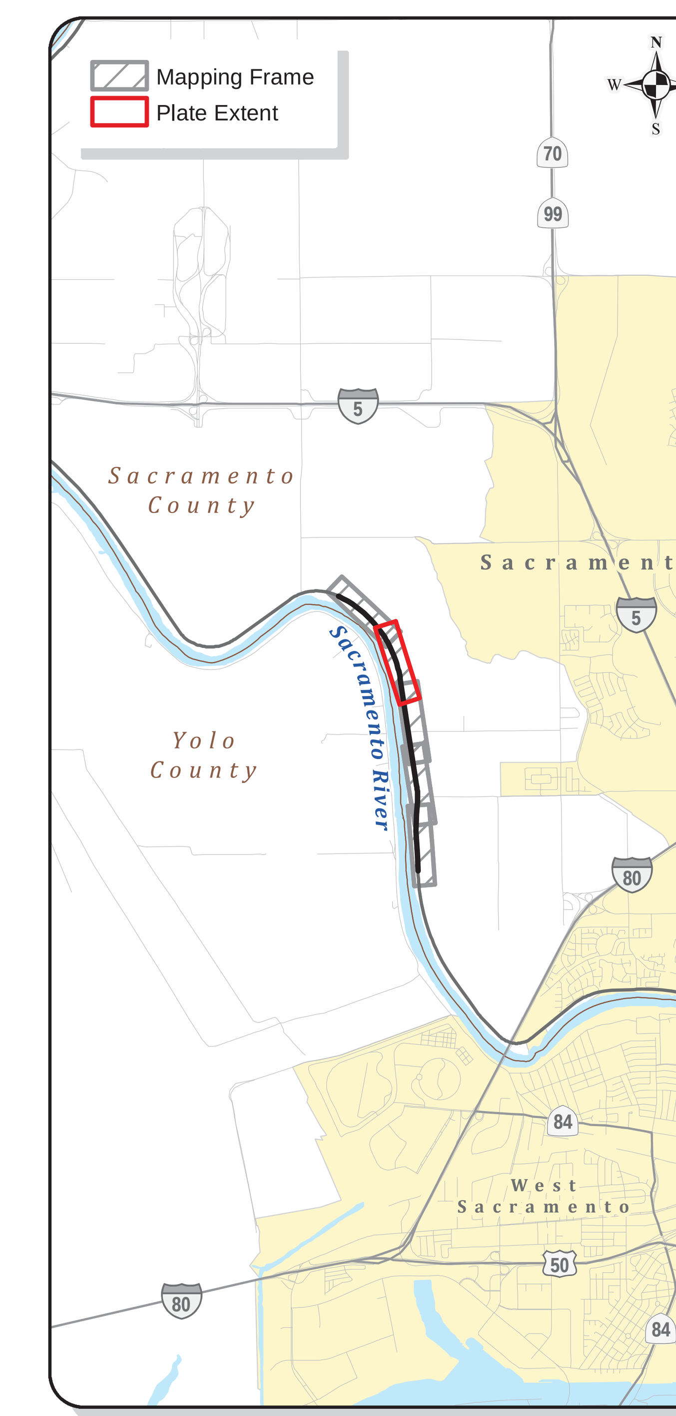

Plan and Profile
Station 675+00 to Station 700+00

American River Common Features Project,
Natomas Basin, Reach B

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Appendix A
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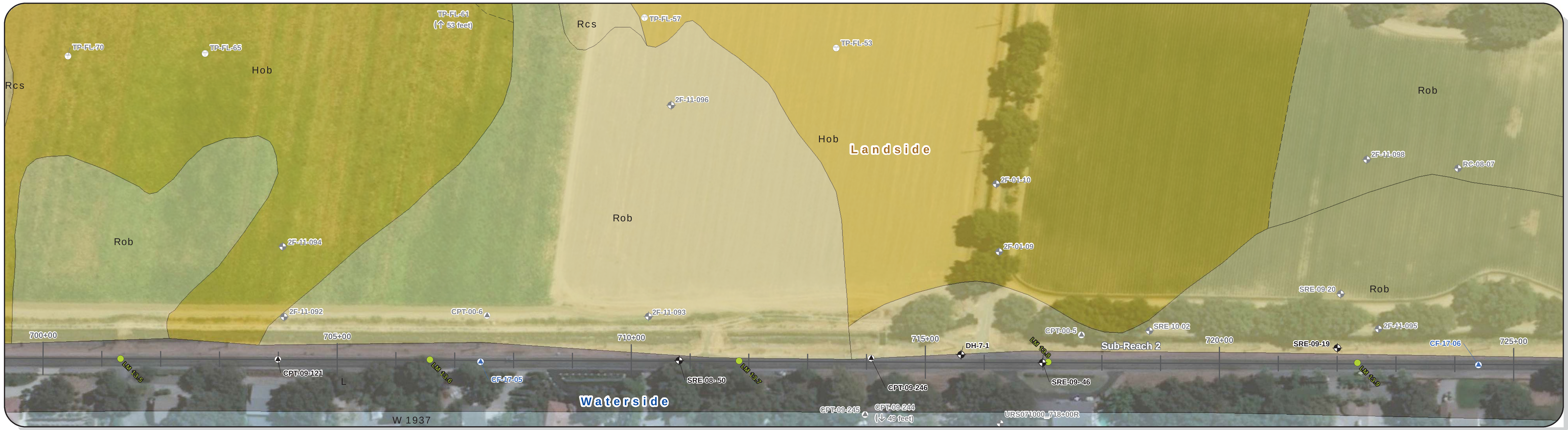

0 100
Feet
1 inch = 100 feet

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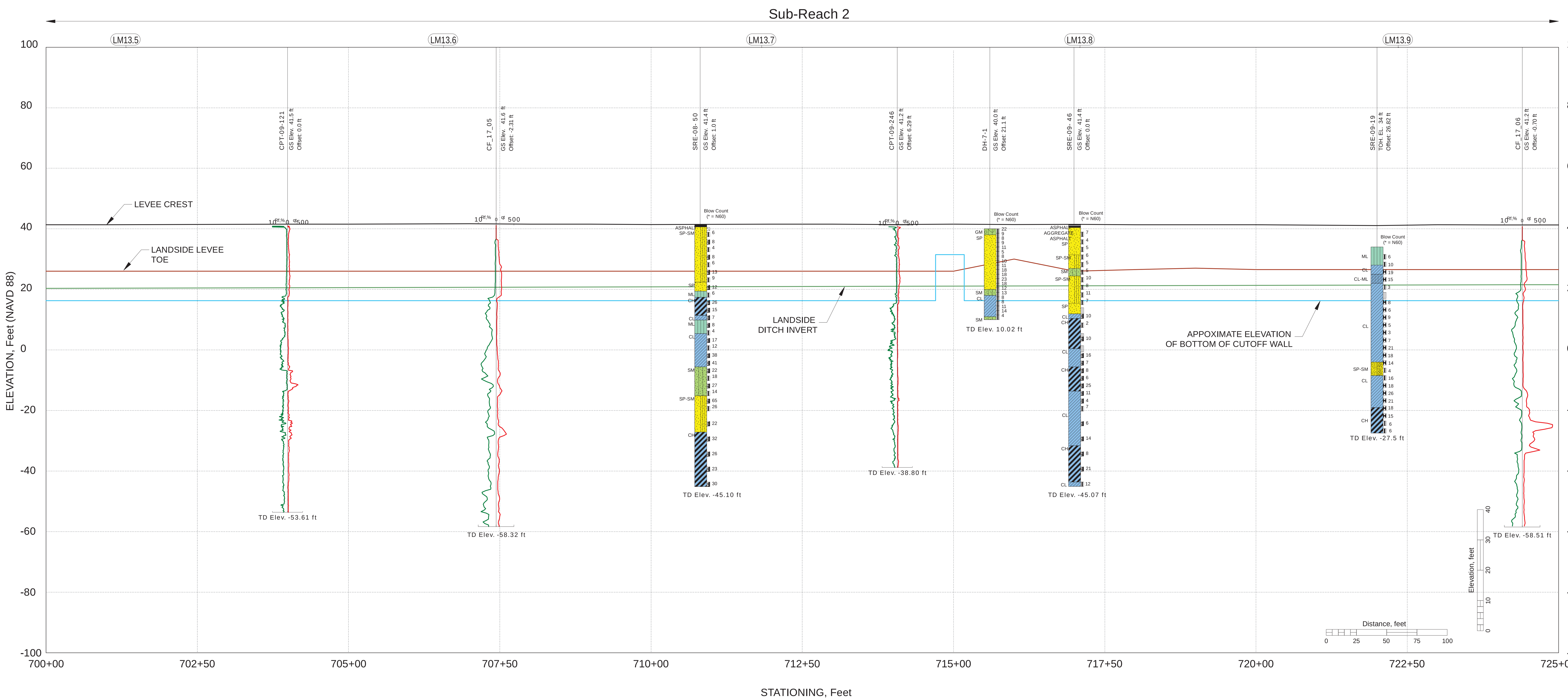

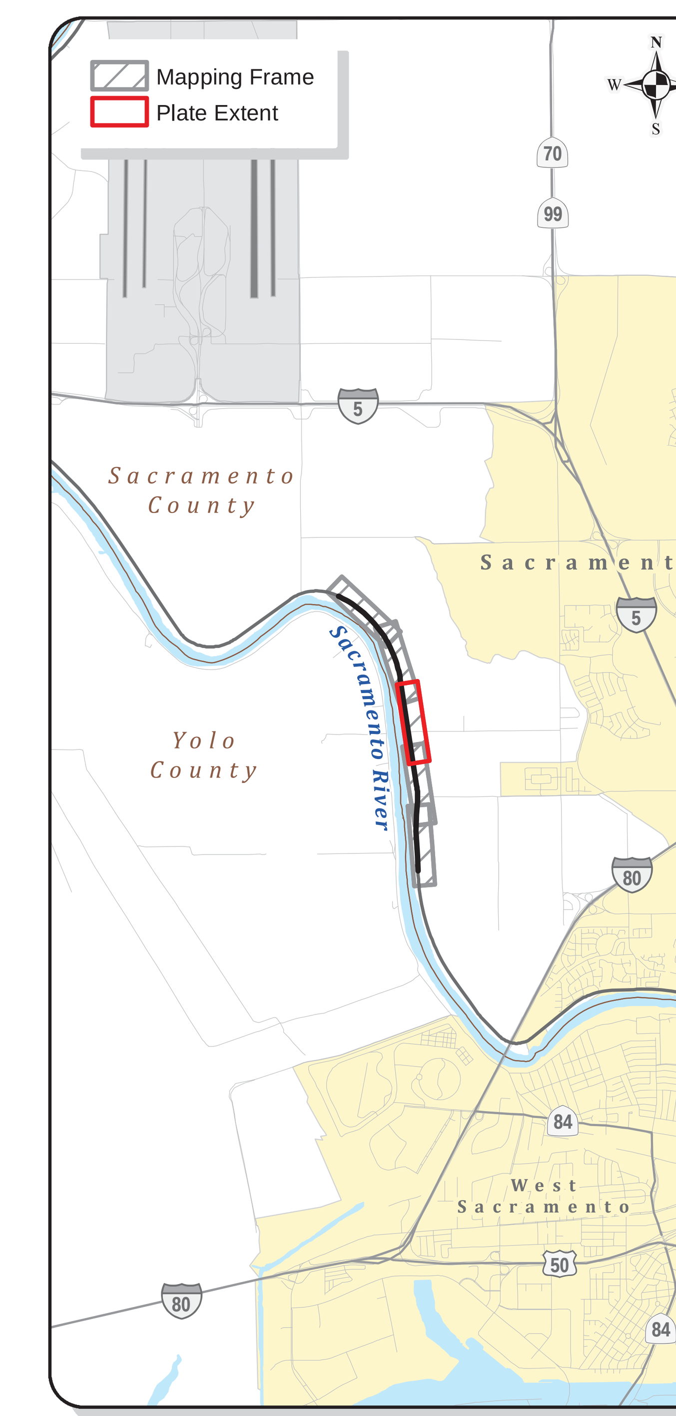

Plan and Profile
Station 700+00 to Station 725+00

American River Common Features Project, Natomas Basin, Reach B

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Appendix A
4a

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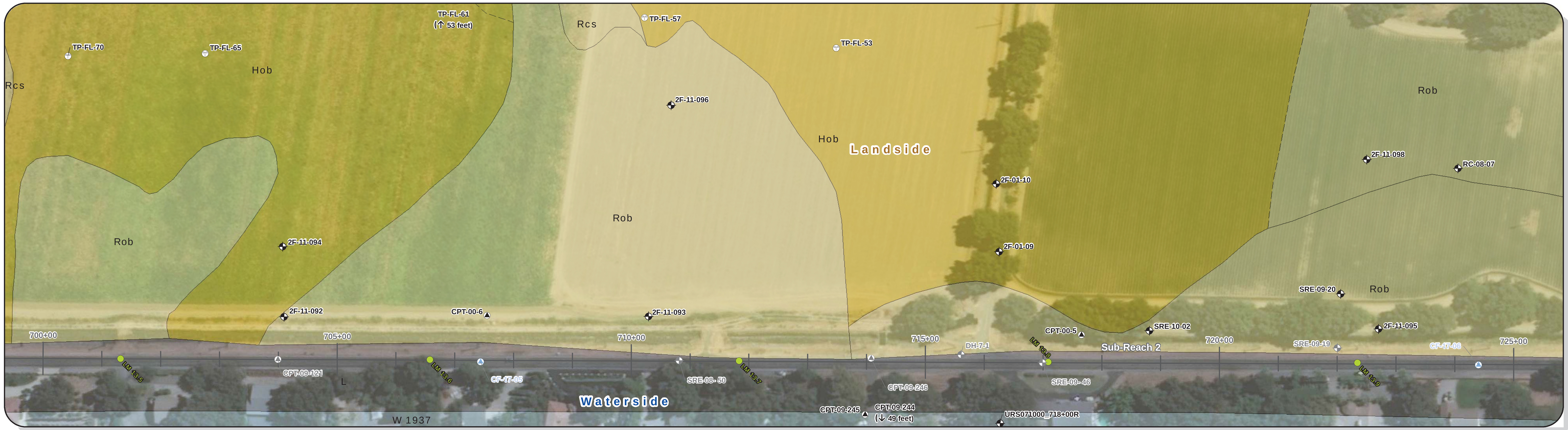

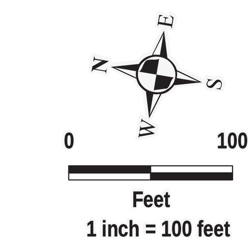

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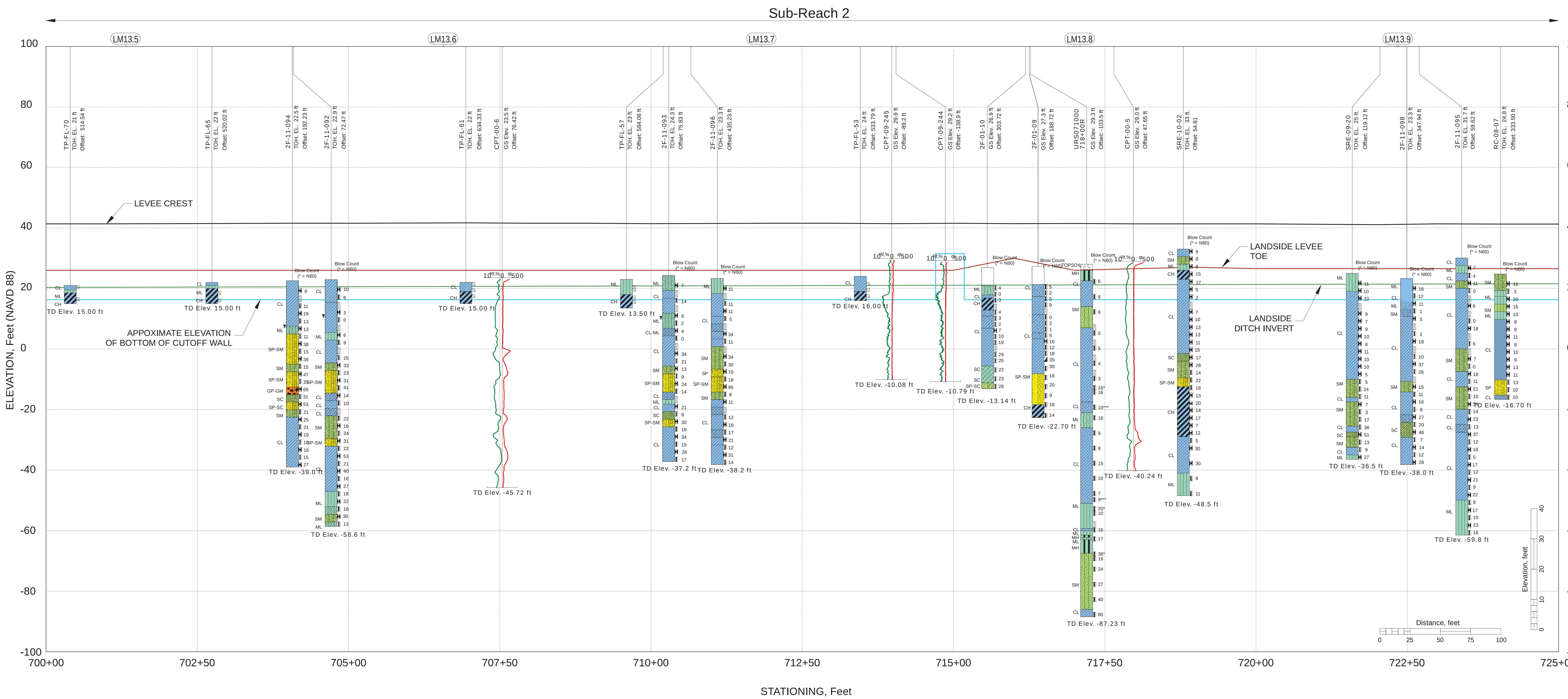

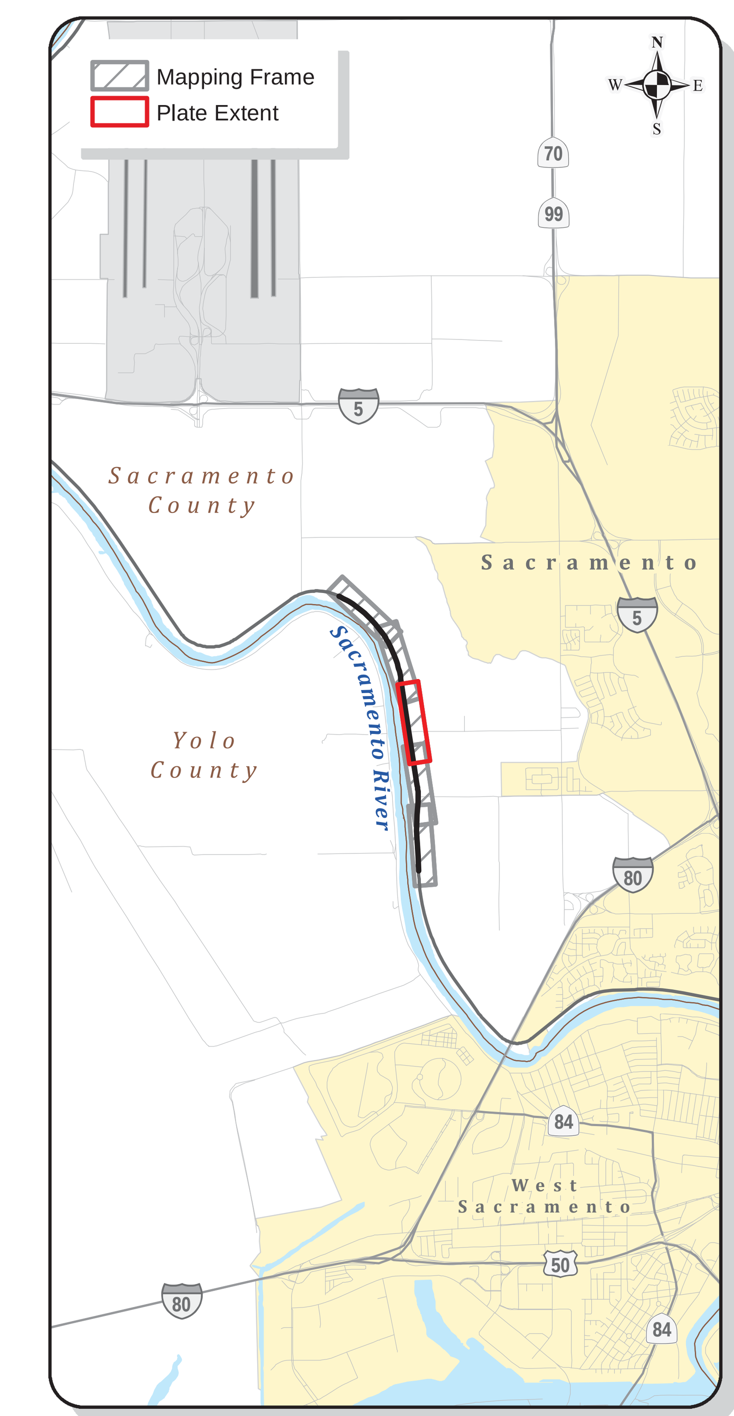

Plan and Profile
Station 700+00 to Station 725+00

AMERICAN RIVER COMMON FEATURES PROJECT, NATOMAS BASIN, REACH B

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Appendix A
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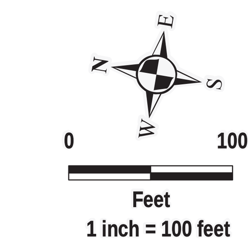

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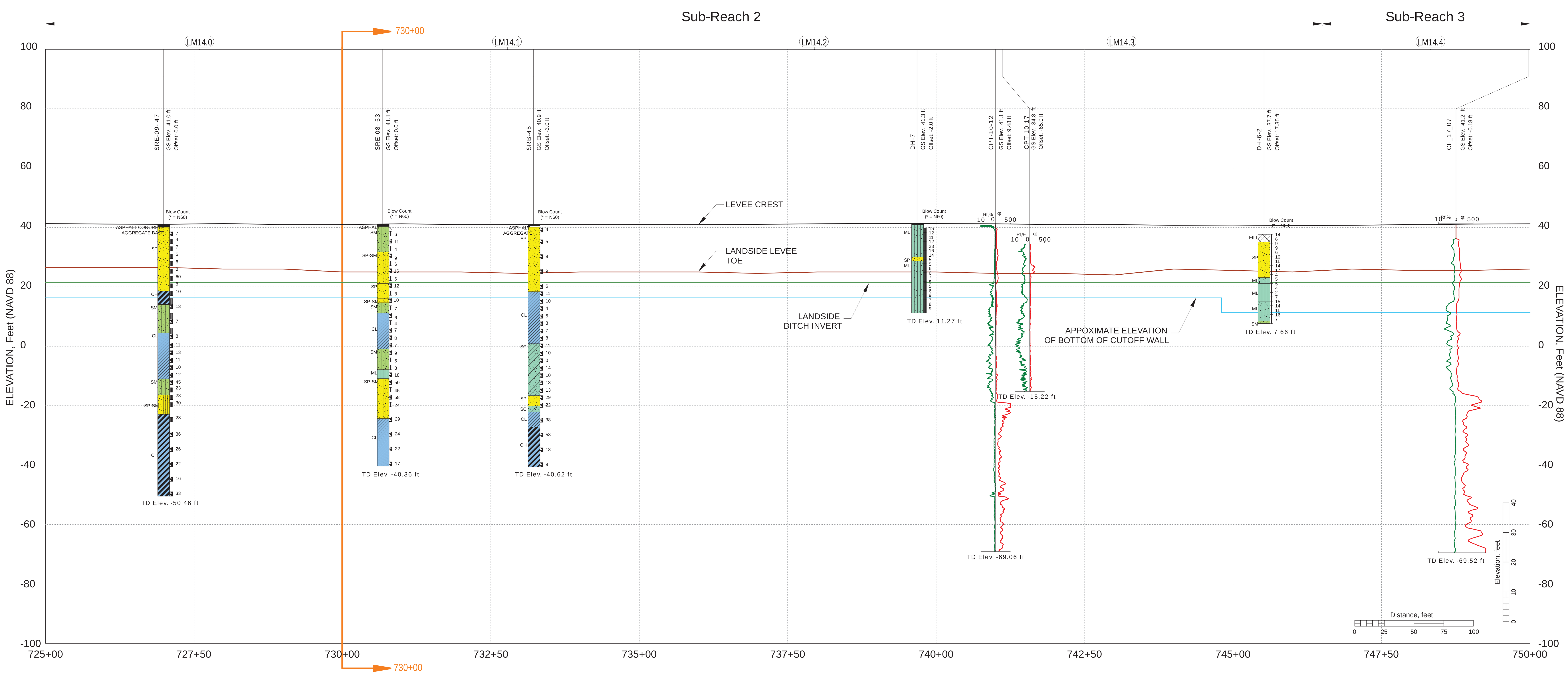

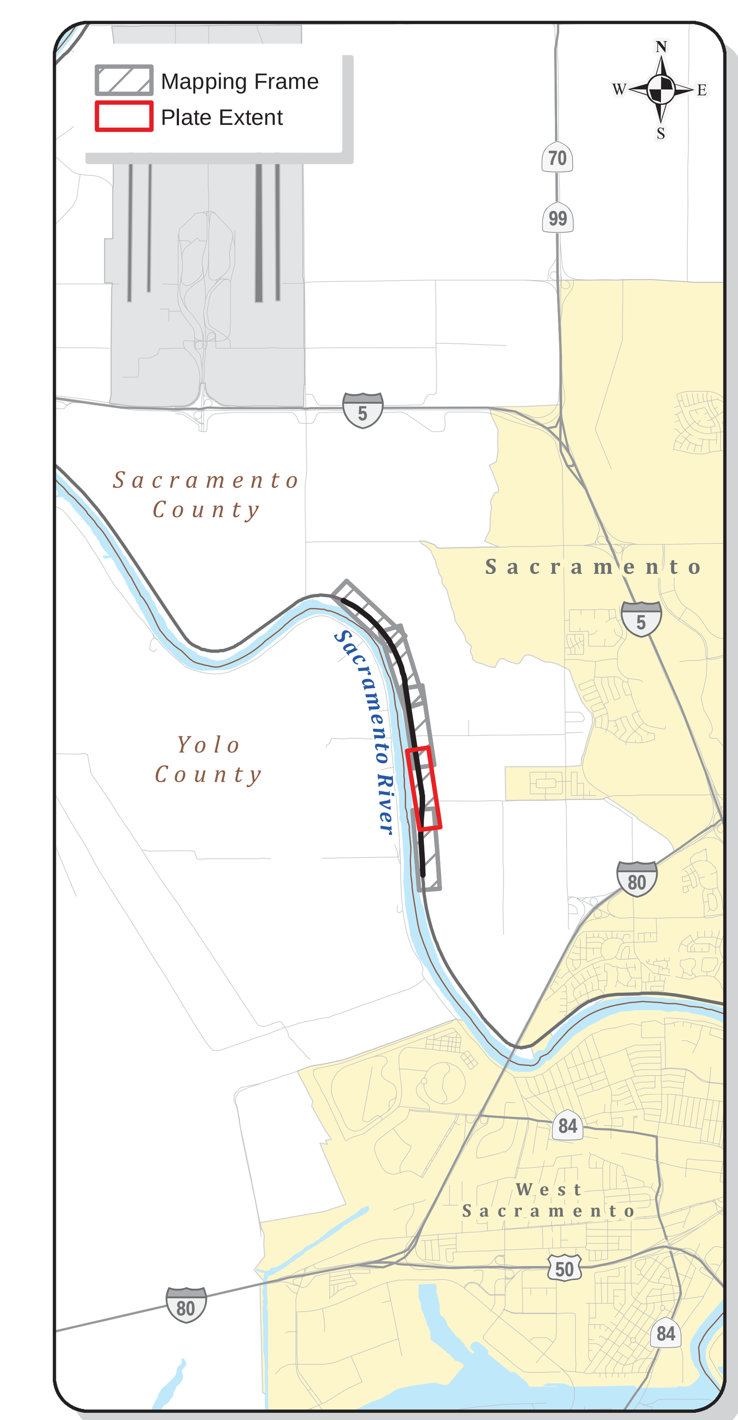

Plan and Profile
Station 725+00 to Station 750+00

American River Common Features Project, Natomas Basin, Reach B

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Appendix A
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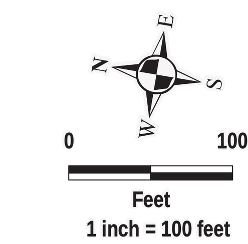

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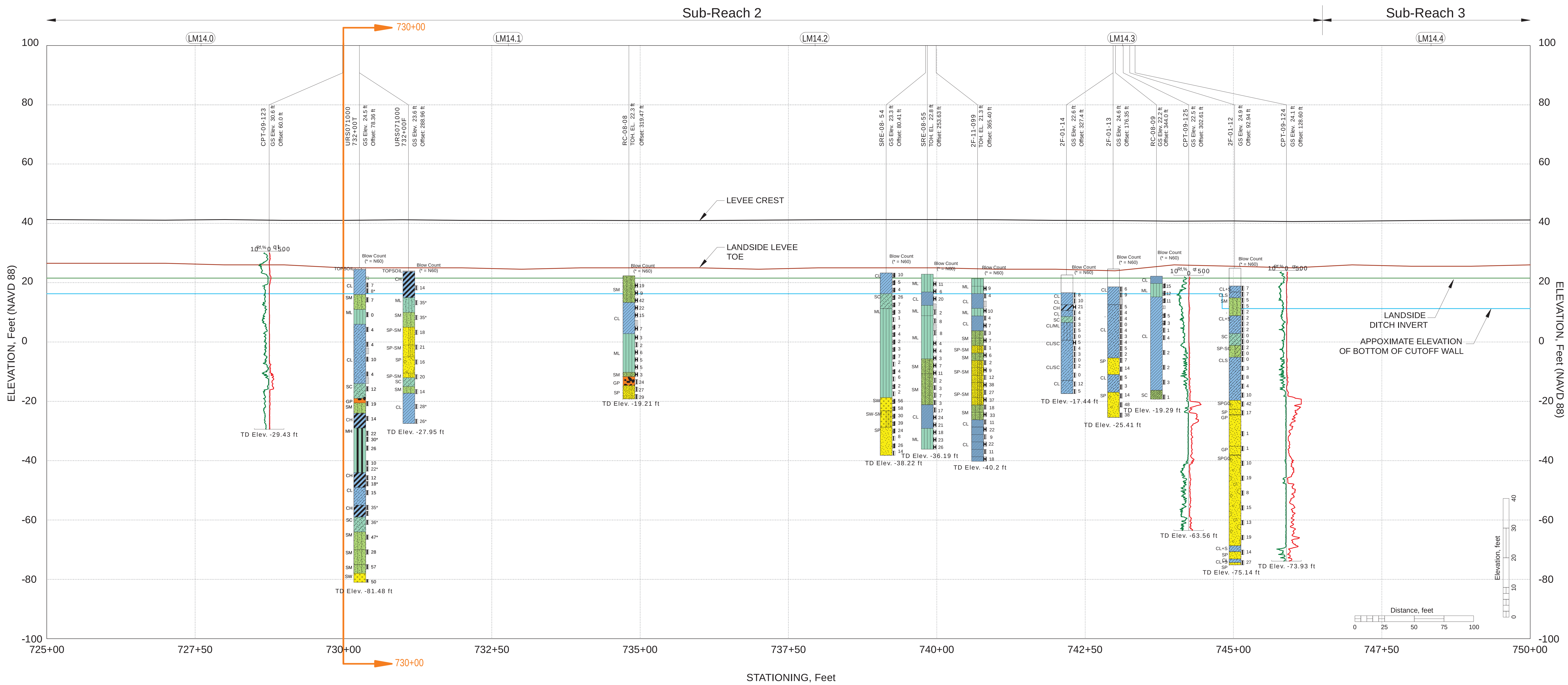

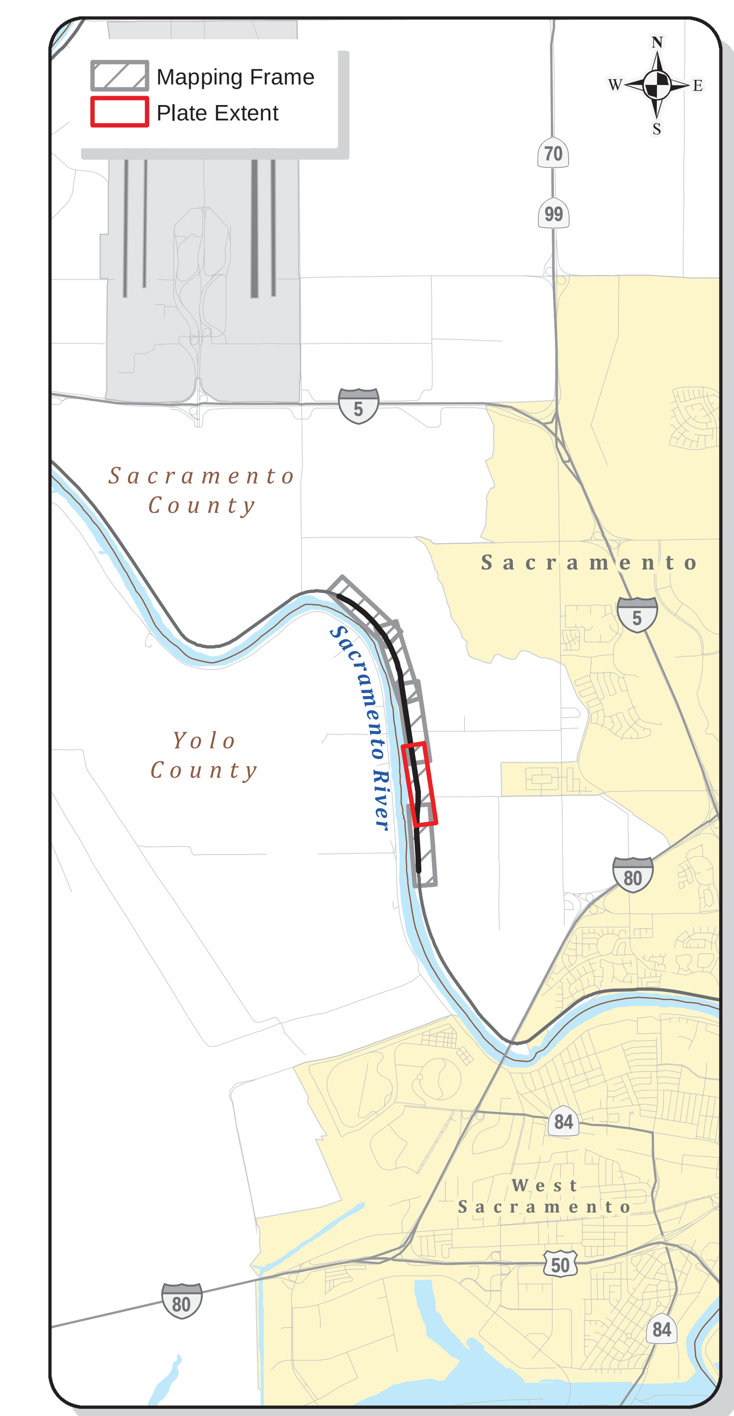

Plan and Profile
Station 725+00 to Station 750+00

AMERICAN RIVER COMMON FEATURES PROJECT,
NATOMAS BASIN, REACH B

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Appendix A
5b

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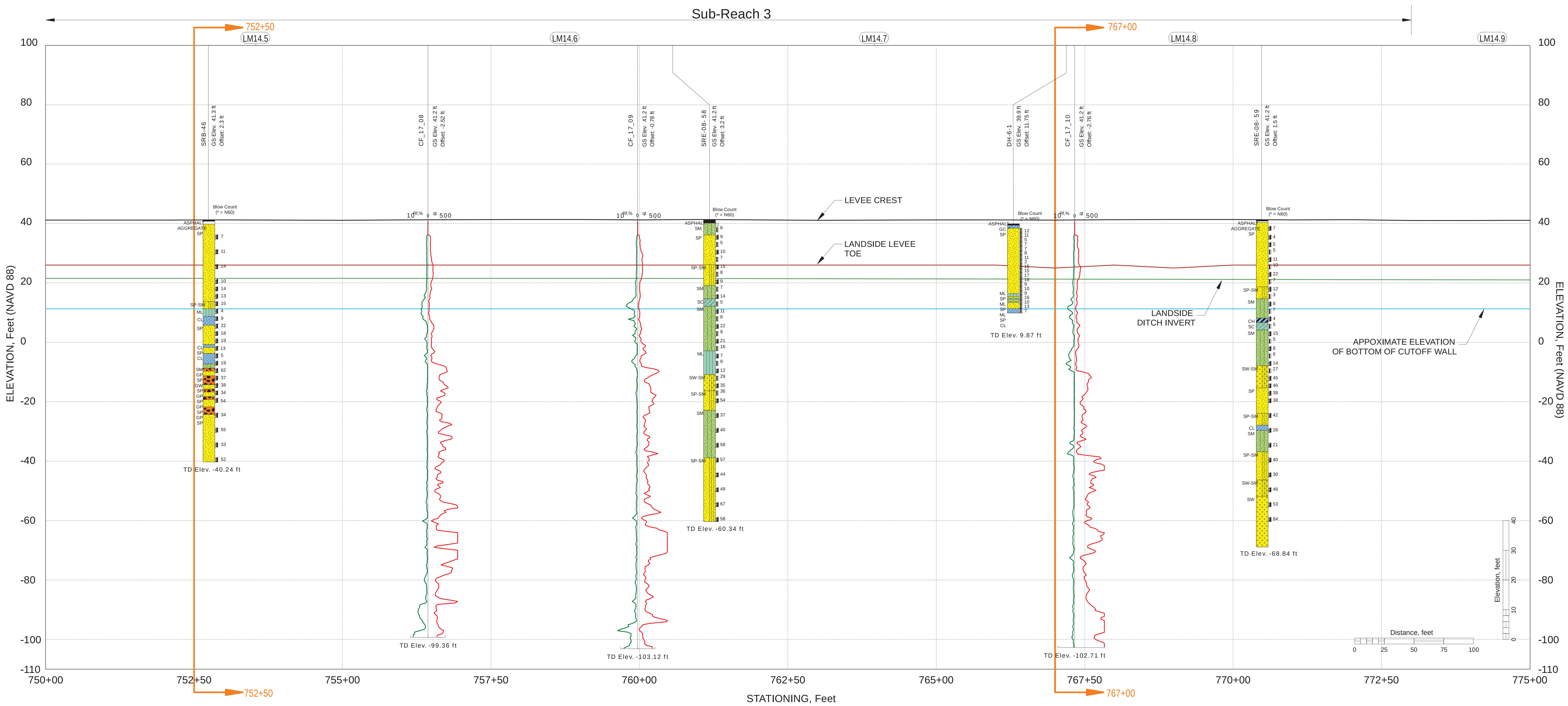
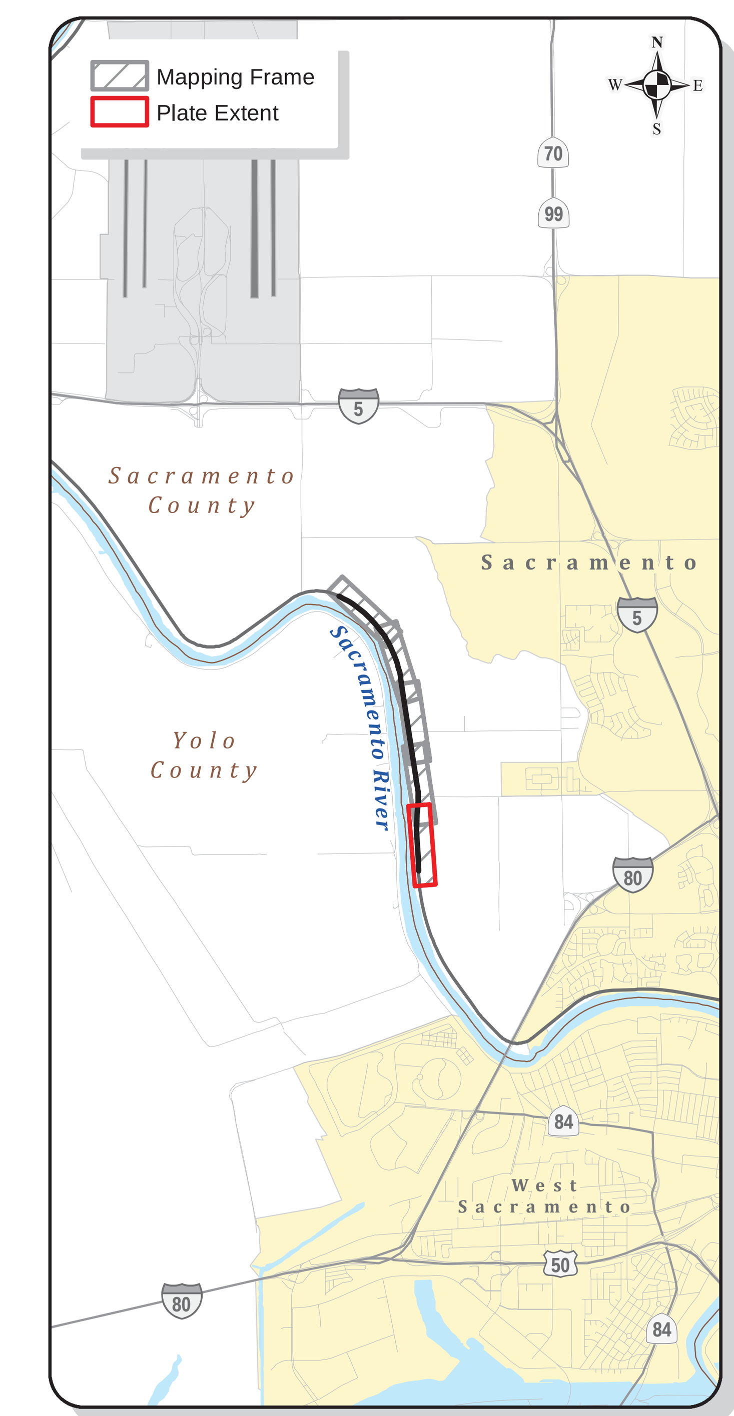
0 100
Feet
1 inch = 100 feet

NOTES:

1. Elevations and locations of levee crown, landside toe, and waterside toe are approximate. These elevations are based on LiDAR data obtained by DWR's CVFPP (Central Valley Flood Protection Program).
2. Where water was present in the ditch at the time LiDAR was flown, the ditch bottom was estimated.
3. Stick logs represent general soil conditions encountered at the time of exploration. For more detailed information on the materials encountered, refer to boring and CPT logs in the Geotechnical Data Report. No warranty is provided regarding the continuity of soil conditions between individual explorations.
4. When reported, N60 (ASTM), refers to N60 (ASTM) = N field * Hammer Efficiency (%). See Geotechnical Data Report for hammer efficiency data for individual borings.
5. Historical boring locations and profiles are based on available information.
6. USCS classification labels are not presented on the profiles for soil lenses (thickness less than 1.5 feet).
7. The information provided in these plans and stick-log plates has been compiled from a variety of sources. AECOM does not attest to the accuracy, completeness, or reliability of geotechnical exploration and other subsurface data by others that are included or referenced in these plates.
8. Only exploration locations within the station limits defined below are shown.
9. Exploration locations in bold are shown in the profile view. Refer to alternate plate for additional explorations within station limits defined below.
10. This is a color figure. Black and white reproduction should not be relied upon as data will be lost.
11. To prevent scale distortion, this map should be printed on a 34 x 22 size sheet.
12. These plan and profile drawings are for the use and benefit of USACE, and their consultants in connection with the execution of the Natomas Basin Reach B Levee Improvement project. Use by any other party is at their own discretion and risk.





Plan and Profile
Station 750+00 to Station 775+00

American River Common Features Project,
Natomas Basin, Reach B

US Army Corps of Engineers® Sacramento District

AECOM

Appendix A
6a

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Feet
1 inch = 100 feet

NOTES:

1. Elevations and locations of levee crown, landside toe, and waterside toe are approximate. These elevations are based on LiDAR data obtained by DWR's CVFPP (Central Valley Flood Protection Program).
2. Where water was present in the ditch at the time LiDAR was flown, the ditch bottom was estimated.
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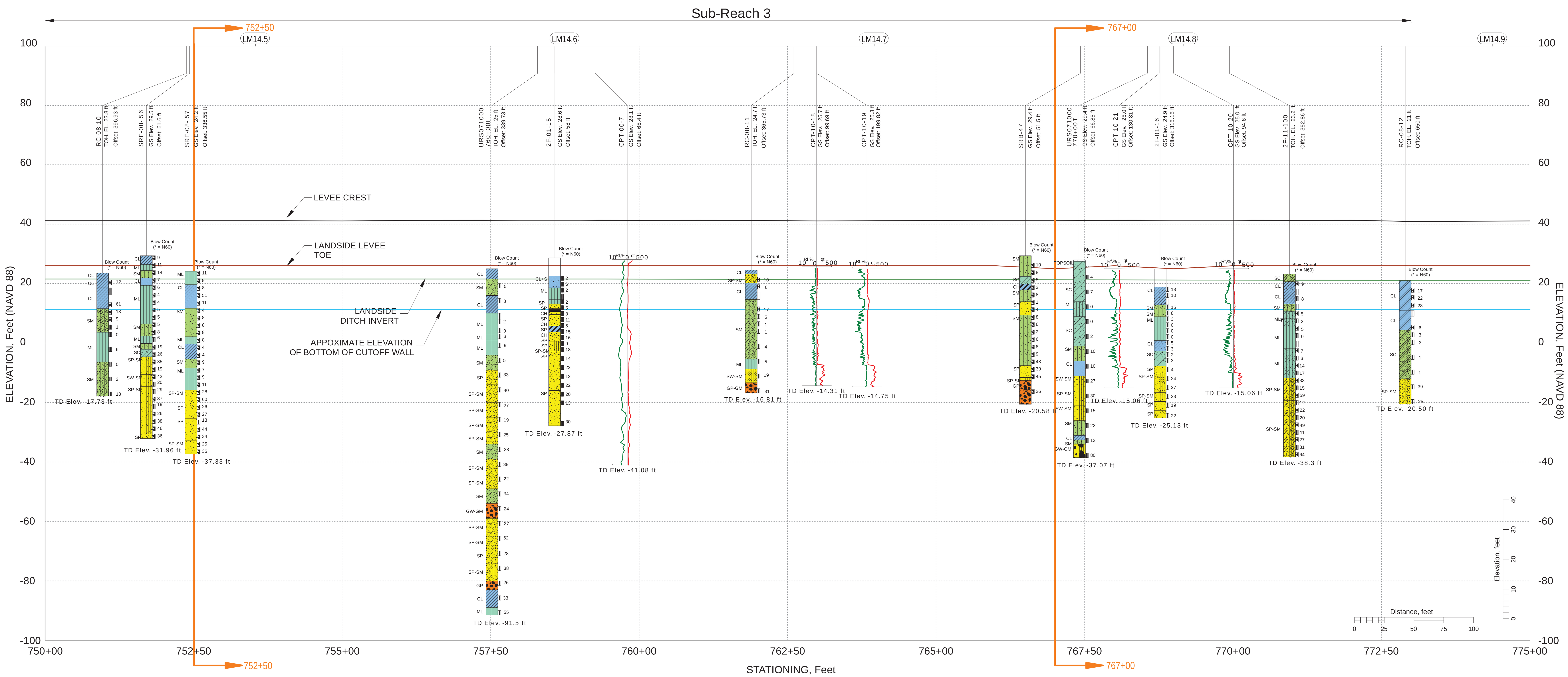

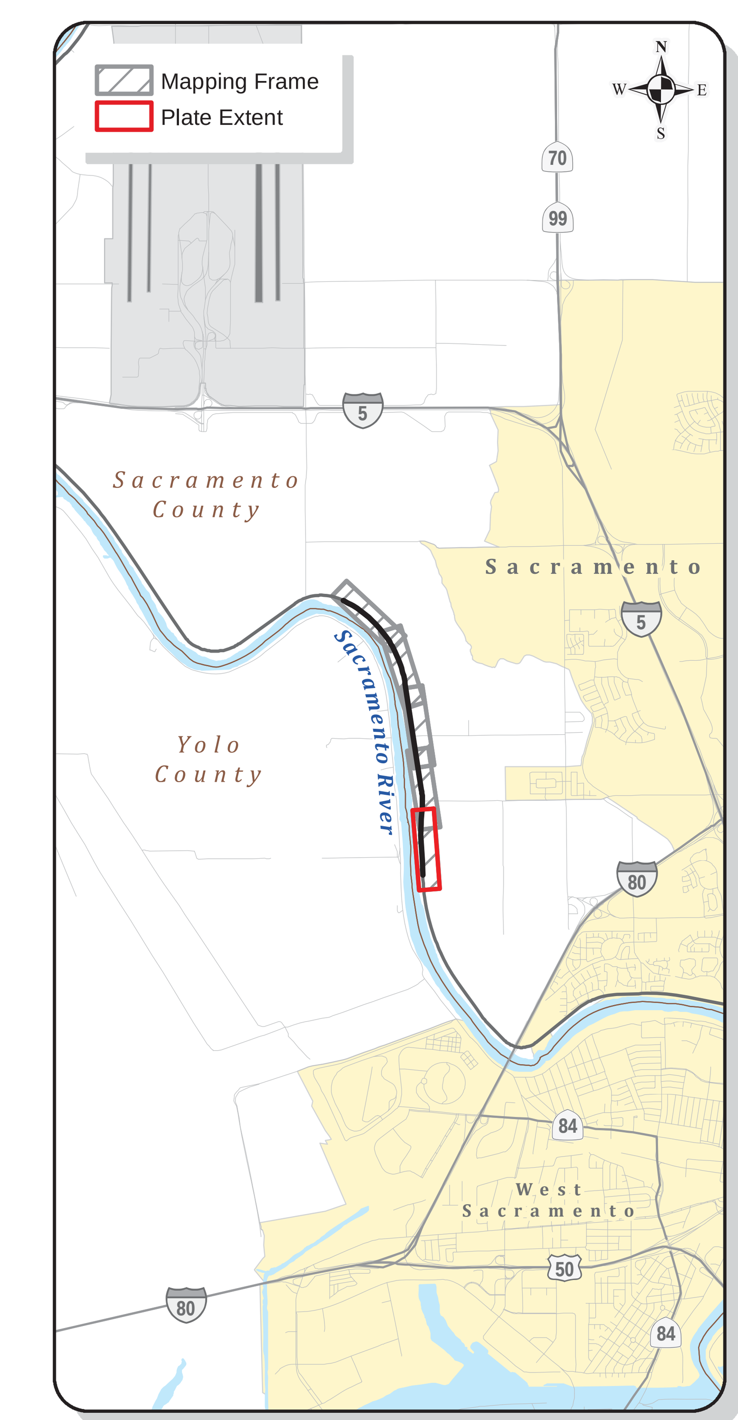

Plan and Profile
Station 750+00 to Station 775+00

American River Common Features Project,
Natomas Basin, Reach B

US Army Corps of Engineers® Sacramento District

AECOM

Appendix A
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SECTION TABLE OF CONTENTS

DIVISION 02 - EXISTING CONDITIONS

SECTION 02 32 00

SUBSURFACE DRILLING, SAMPLING, AND TESTING

05/10

-- End of Section Table of Contents --

SECTION 02 32 00

SUBSURFACE DRILLING, SAMPLING, AND TESTING
05/10

PART 1 GENERAL

1.1 REFERENCES

The publications listed below form a part of this specification to the extent referenced. The publications are referred to within the text by the basic designation only.

ASTM INTERNATIONAL (ASTM)

ASTM D1452/D1452M	(2016) Standard Practice for Soil Exploration and Sampling by Auger Borings
ASTM D1586	(2011) Penetration Test and Split-Barrel Sampling of Soils
ASTM D1587/D1587M	(2015) Thin-Walled Tube Sampling of Soils for Geotechnical Purposes
ASTM D2487	(2017) Standard Practice for Classification of Soils for Engineering Purposes (Unified Soil Classification System)
ASTM D6913	(2017) Particle-Size Distribution of Soils using Sieve Analysis
ASTM D7928	(2017) Standard Test Method for Particle-Size Distribution (Gradation) of Fine-Grained Soils Using the Sedimentation (Hydrometer) Analysis

STATE OF CALIFORNIA DEPARTMENT OF TRANSPORTATION (CALTRANS)

CDT Std Specs	(2015) State of California Department of Transportation (CALTRANS) Standard Specifications

U.S. ARMY CORPS OF ENGINEERS (USACE)

EM 1110-1-1084	(2001) Geotechnical Investigations
ER 1110-1-1807	(2014) Drilling in Earth Embankment Dams and Levees

1.2 SYSTEM DESCRIPTION

Provide the data to determine the type, nature, and characteristics of subsurface materials and the extent and conditions of the various materials as they exist to the depths and at the locations specified. This is to be accomplished by means of auger borings, drive sample borings, undisturbed sample borings, and test pit excavation.

Contractor shall minimize the use of drilling fluid such as air, gas, water, mud, polymers, slurries or any other drilling fluid that could pressurize borehole soil during drilling through the levee embankment.

1.2.1 Auger Borings and Sampling

An auger boring is any boring made in unconsolidated soils with a conventional manually or power-driven earth auger for the purpose of obtaining samples of subsurface materials. Auger boring and sampling shall be performed in accordance with ASTM D1452/D1452M, or as directed by the Contracting Officer.

1.2.2 Drive Sample Borings and Sampling

A drive sample boring is a boring made through unconsolidated or partly consolidated sediments or decomposed rock by means of a mechanically driven sampler. The purpose of these borings is to obtain knowledge of the composition, the thickness, the depth, the sequence, the structure, and the pertinent physical properties of foundation or borrow materials. Drive sample boring and sampling shall be performed in accordance with ASTM D1587/D1587M or as directed by the Contracting Officer. Standard Penetration Tests (SPT) shall be performed in accordance with ASTM D1586.

1.2.3 Undisturbed Sample Borings and Sampling

An undisturbed sample boring is a boring made to obtain soil samples which, when tested, will show properties as close to the in situ (in place) properties as any sample which can be obtained. All undisturbed sampling shall be accomplished in accordance with ASTM D1587/D1587M or as directed by the Contracting Officer.

1.2.4 Test Pit Excavation and Sampling

A test pit is any excavation in soil, hardpan, decomposed rock, or other unconsolidated or partially consolidated overburden materials which has an open cross-sectional area large enough to permit efficient excavation and shoring/lining, engineering and geological inspection and photographing of the subsurface soils and manual undisturbed sampling from within the test pit. All test pits shall be excavated, dewatered (if necessary), shored/lined and protected from surface water drainage in accordance with all applicable Federal, State, local, Corps of Engineers, and OSHA safety regulations.

1.2.5 Sequencing and Scheduling

1.2.5.1 Schedule of Drilling, Sampling, and Testing

Prior to starting work, submit a plan for drilling, sampling, testing, and safety. The plan shall include, but shall not be limited to, the proposed method of drilling and sampling including a description of the equipment and sampling tools that will be used, a listing of any subContractors to include a description of how the subContractors will be used and a description of all methods and procedures that will be utilized to insure a safe operation and to protect the environment. No work shall be performed until this plan has been approved and no deviation from the approved plan will be permitted without prior approval by the Contracting Officer.

1.2.5.2 Order of Work

The order in which the work is to be accomplished will be determined in the field by the Contracting Officer.

1.2.5.2.1 Numerical Sequence

It is intended that the drilling be accomplished in the numerical sequence indicated in the list in paragraph SCHEDULE OF DRILLING, SAMPLING, AND TESTING; however, the Contracting Officer may vary the order whenever and in whatever manner is deemed best for accomplishing the work.

1.2.5.2.2 Reporter

Provide a qualified, licensed Geologist experienced in subsurface exploration for each drill unit to oversee all drilling, sampling, and field testing operations. This individual shall be responsible for the preparation of a separate log and/or report for each boring, pressure test, or test pit. This individual shall also be responsible for the preparation of all soil and rock samples for delivery to the designated point.

1.2.5.2.3 Government Oversight

The presence of a Government representative or the keeping of separate drilling records by the Contracting Officer shall not relieve the Contractor of the responsibility for the work specified in this specification.

1.3 SUBMITTALS

Government approval is required for submittals with a "G" designation; submittals not having a "G" designation are for information only. When used, a designation following the "G" designation identifies the office that will review the submittal for the Government. Submit the following in accordance with Section 01 33 00 SUBMITTAL PROCEDURES:

SD-01 Preconstruction Submittals

Drilling Program Plan in accordance with ER 1110-1-1807 Drilling in Earth Embankment Dams and Levees; G

SD-02 Shop Drawings

Drilling Log; G

SD-03 Product Data

Permits, Certifications, and Licenses
Schedule of Drilling, Sampling, and Testing; G

1.3.1 Drilling Program Plan

Drilling Program Plan must be submitted to the district office at least six weeks in advance of drilling.

1.4 QUALITY ASSURANCE

Comply with all Federal, State and local laws, regulations and ordinances relating to the performance of this work. Procure all required permits, certifications and licenses required by Federal, State, and local law for the execution of this work. Submit copies of all permits, certifications, and licenses prior to starting work. This submittal shall also include a statement of the prior experience, in the type of work described in these specifications, of the person or persons designated to perform the work specified herein.

1.5 DELIVERY, STORAGE, AND HANDLING

1.5.1 General

The Contractor is solely responsible for preserving all samples in good condition. Samples shall be kept from freezing and from undue exposure to the weather, and shall keep all descriptive labels and designations on sample jars, tubes, and boxes clean and legible until final delivery of samples to, and acceptance by, the Contracting Officer. Except as otherwise specified, deliver samples to the Contracting Officer. Samples shall be delivered within the time limits specified for each type of investigation or in accordance with schedules prepared by the Contracting Officer.

1.5.2 Undisturbed Samples

Take every precaution to avoid damage to samples as a result of careless handling and undue delay in shipping. Samples shall be shipped in containers approved by the Contracting Officer and shall be of sufficient durability to protect the samples from any damage during shipment. The sample tubes shall be well packed in vermiculite or other equal material approved by the Contracting Officer to protect the samples against vibration. Avoid exposing sealed and crated samples to precipitation, direct sunlight, freezing and temperatures in excess of 100 degrees F. Samples permitted to freeze, even partially, shall be replaced by the Contractor. In general, no undisturbed samples shall remain on the site of sampling for more than one week before shipment. Samples shall be stored and shipped with the tube in a vertical position in order to prevent consolidation and segregation or change of water content.

1.6 PROJECT/SITE CONDITIONS

1.6.1 Environmental Requirements

In order to prevent and to provide for abatement and control of any environmental pollution arising from Contractor activities in the performance of this contract, the Contractor and its subContractors shall comply with all applicable Federal, State, and local laws, regulations, and ordinances concerning environmental pollution control and abatement.

a. The Contractor is responsible for keeping informed of all updates and changes in all applicable laws, regulations, and ordinances.

b. Do not pollute lakes, ditches, rivers, springs, canals, waterways, groundwaters, or reservoirs with drill fluids, fuels, oils, bitumens, calcium chloride, insecticides, herbicides, or other materials that may be harmful to the environment or a detriment to outdoor recreation.

PART 2 PRODUCTS

2.1 CONTAINERS

The Contractor shall furnish jars, tubes, plastic bags, and boxes for the storage and shipment of samples. Soil samples collected during drilling shall be preserved as per EM 1110-1-1084 and per ASTM D6913 and ASTM D7928 based on their sample group.

2.1.1 Sample Jars

Sample jars shall be 1 pint capacity, wide-mouth glass jars with moisture-tight screw tops.

2.1.2 Shipping Boxes

Boxes for shipping sample jars shall be corrugated cardboard boxes that have the capacity to hold no more than 12 sample jars and the strength to contain and protect the jars and their contents under ordinary handling and environmental conditions.

2.1.3 Tubes and Crates

Undisturbed samples shall be shipped in thin walled Shelby tubes packed in crates.

2.1.4 Plastic Bags

Plastic bags are considered suitable containers for Group A and B samples. Disturbed samples to be used for soil classifications tests may be stored in plastic bags, sealed to maintain in situ moisture characteristics to the maximum extent practicable. Plastic bags shall be labeled directly on the bag with the required information for identification during laboratory testing.

2.2 LABELS

2.2.1 Sample Jar Labels

A printed or type-written, fade resistant and waterproof label shall be affixed to the outside of each jar and shall contain the following information:

PROJECT	(such as Table Rock Dam)	LOCATION	(such as Borrow Area B)
HOLE NO.		STATION	
JAR NO.		of	______ JARS
TOP ELEVATION OF		DEPTH OF SAMPLE	
DESCRIPTION OF MATERIAL	(such as moist, silty, medium sand)		

2.2.2 Shipping Box Labels

Each box of jar samples shall be identified with weatherproof and wear-proof labels indicating the following:

PROJECT	
LOCATION	
JAR SAMPLES FROM HOLE OR HOLES	

2.3 EQUIPMENT AND SUPPLIES

2.3.1 Auger Boring and Sampling

Furnish the equipment for making auger borings including, but not limited to, standard continuous flight augers and/or standard cup-type earth augers, similar or approved equal to the Iwan Auger and not less than 4 inches in diameter unless otherwise approved. The augers shall be completely equipped with all the accessories necessary for boring and sampling of overburden materials to the depths and diameters specified or shown on the drawings.

2.3.2 Drive Sample Boring and Sampling

Furnish equipment for making drive sample borings including, but not limited to, standard 2-inch OD inch OD split barrel drive samplers and power-driven drilling machinery of a type or types approved by the Contracting Officer, complete with a drive-hammer of 140-pound weight and all other accessories for taking samples of all types of soils or decomposed rock at the locations and to the depths required. The drive shoe for the split barrel samplers shall be of hardened steel and shall be replaced or repaired when it becomes dented or distorted. Supplies shall include, but not be limited to, all casing, drill stem, drill bits, drill fluid and additives, pumps, and power necessary to accomplish the required boring and sampling.

2.3.3 Undisturbed Sample Boring and Sampling

Furnish equipment for making undisturbed sample borings including, but not limited to, power-driven drilling machinery of an approved type or types complete with the special devices and accessories enumerated and described hereinafter. Drilling machinery shall be of the hydraulic feed type. Supplies shall include, but not be limited to, all samplers, casing, drill stem, drill bits, drill fluid and additives, pumps, and power necessary to accomplish the required boring and sampling. Drill casing, if used, shall be of such minimum inside diameter as to allow use of the selected sampler.

2.3.3.1 Sands and Cohesive Soils

The sampling device used to sample fine to medium grain sands and cohesive soils shall be a fixed or stationary piston type that uses a 3-inch diameter thin wall Shelby tube.

2.3.3.2 Stiff and Dense Soils

The sampling device for obtaining samples of stiff and dense soils shall be similar or approved equal to a Denison double tube, swivel head core barrel, or a Pitcher sampler and must be approved by the Contracting Officer prior to use.

2.3.4 Test Pit Excavation and Sampling

Selection of the test pit excavation, shoring/lining and dewatering (if necessary) methods and equipment shall be at the Contractor's discretion but must be approved by the Contracting Officer. When the number of test pits to be excavated is large, and when adaptable mechanical trenching equipment is available, the Contracting Officer may require that such mechanical excavating equipment be used to expedite completion of the pits. The Contractor shall also furnish all materials required for shoring/lining to comply with all applicable safety regulations. The Contracting Officer may require the Contractor to salvage and re-use this shoring/lining material in successive test pits.

PART 3 EXECUTION

3.1 SUBSURFACE DRILLING MOBILIZATION AND DEMOBILIZATION

3.1.1 Mobilization

Mobilization consists of the delivery to the site of all plant, equipment, materials and supplies to be furnished by the Contractor, the complete assembly in satisfactory working order of all such plant and equipment at the jobsite and the satisfactory storage at the site of all such materials and supplies.

3.1.2 Demobilization

Demobilization consists of the removal from the site of all plant, equipment, materials and supplies after completion of the work and also includes, at the direction of the Contracting Officer, the cleanup and removal of all scrap, waste backfill material, waste drilling fluid, soil contaminated with engine/hydraulic oil, backfilling all sumps or excavations resulting from the operations and, in general, returning the site as close to its original condition as possible.

3.2 IDENTIFYING SAMPLES

Sample jars, shipping boxes, and labels shall comply with PART 2, paragraphs SAMPLE JARS, SHIPPING BOXES, and LABELS, respectively. In addition, a moisture proof label containing the project name, hole number and sample number shall be placed inside the jar or this information can be written using a waterproof pen or scribed on the jar lid. Take all precautions required to insure that the shipping boxes are not subjected to rough handling or damaging environmental conditions. A copy of the boring log for the portion of the boring that the samples came from shall be enclosed in the shipping box.

3.3 AUGER BORING AND SAMPLING

Samples shall be labeled in accordance with paragraph IDENTIFYING SAMPLES. Samples shall be obtained for each change of overburden material and at maximum vertical intervals of 2.5 feet. In order to retain the natural moisture content of the material to the fullest extent possible, all samples shall be of sufficient volume to completely fill the sample jars and the samples shall be placed in the sample jars as soon as possible after they are taken from the hole. All sample jars shall be labeled. In general, no sample shall remain on the site of boring for more than 1 week after being taken from the boring and placed in a jar.

3.4 DRIVE SAMPLE BORING AND SAMPLING

Samples shall be labeled in accordance with paragraph IDENTIFYING SAMPLES. Drive sample borings drilled through overburden materials shall be suitably cased to permit obtaining drive samples of the size or sizes specified or as directed. Samples shall be taken either continuously or at maximum vertical intervals of 5 feet or at a change in materials during drilling or as otherwise directed by the Contracting Officer. The sampler shall be driven with the force of the 140 pound drive hammer under a free fall of 30 inches. To minimize the compacting effect of casing driving when casing is used to stabilize a boring, the bottom of the casing shall be kept as high above the soil sampling zone as conditions permit. If hollow stem auger is used as a casing and/or to advance the boring, a plug assembly must be used to keep soil from entering the inside of the auger. Above the water table, samples shall be obtained from a dry hole. Below the water table, water shall be maintained within the hole at or above the groundwater level. Where information on the natural water content of soils above the water table is not needed and when approved by the Contacting Officer, boreholes may be drilled without casing by using a suitable drilling fluid to prevent collapse of sidewalls. When a drilling fluid is used, soil sampling shall be done by such means that will prevent inclusion of drilling fluid in the samples. The samples shall be placed in sample jars as soon as possible after they are taken from the hole and, when possible, the volume of the sample shall be large enough to completely fill the sample jar in order that the natural moisture content of the material may be retained to the fullest extent possible. All samples shall be labeled. No sample shall remain at the site of boring for more than one week after being taken from the hole.

3.5 UNDISTURBED SAMPLE BORING AND SAMPLING

In general, labeling of undisturbed samples shall conform to paragraph IDENTIFYING SAMPLES. Particular care shall be taken to indicate the top and bottom of each sample tube. Tubes and crates for undisturbed samples shall be labeled "DO NOT JAR OR VIBRATE" and "HANDLE, HAUL, AND SHIP IN A VERTICAL POSITION".

3.5.1 Procedure

The procedure for Undisturbed Sample Boring and Sampling shall be the same as outlined in paragraph DRIVE SAMPLE BORING AND SAMPLING, except that the sampling device shall be advanced downward by one continuous, smooth drive using the drill rig's hydraulic feed system. The hydraulic down pressure shall be read and recorded at 6 inch intervals during each sample drive. The sampling device for stiff and dense soils shall be advanced by continuous rotation of the outer cutting barrel in conjunction with use of drill fluid circulation. Driving of any undisturbed sampling device by means such as a drop hammer will not be permitted.

3.5.2 Sealing

Both ends of the soil sample tube/liner obtained with a Denison barrel, or its equivalent, shall be cleaned out to remove all drill fluid contaminated and/or disturbed soil or to a minimum distance of 2 inches from the ends of the tube/liner. Any material removed that is not contaminated with drill fluid shall be placed in a sample jar and labeled in accordance with paragraph IDENTIFYING SAMPLES. The cleaned out ends of the sample liner tube shall then be sealed with microcrystalline wax. A metal or wooden disk, having a diameter just slightly smaller than the inside diameter of the liner tube shall be inserted into the wax to a distance of 1/4-inch from the end of the soil sample. The wax plugs shall be flush with the ends of the tube and a final seal consisting of a metal cap or tape shall be placed over the ends of the tube.

3.6 TEST PIT EXCAVATION AND SAMPLING

3.6.1 Excavation

The test pits shall be excavated in the order scheduled in paragraph SCHEDULE OF DRILLING, SAMPLING, AND TESTING, and shall be excavated to depths and dimensions needed to permit soil classification. Become thoroughly familiar with work site and with all available subsurface data, particularly groundwater conditions, before excavating pits. Regardless of the method of excavation employed, the pits shall be excavated, dewatered and shored/lined in conformance with all applicable safety regulations.

3.6.2 Sampling

Obtain soil samples from each pit at depths determined by the Contracting Officer. A total of 3 samples shall be obtained from each test pit. In obtaining samples from test pits, the undisturbed in situ (in place) natural physical and structural characteristics of the sampled materials shall be preserved insofar as possible both while samples are being taken and during shipment to the point of testing. In cohesive and partially cohesive soils this may be accomplished by isolating the soil column or cube to be sampled by gently trenching around it and knife-trimming it to the required dimensions of the split cylinder or box. A thin coating of melted microcrystalline wax shall then be applied quickly but gently to the sample with a paint brush to seal it against loss of moisture. The metal or wooden sample container, with the top and bottom removed shall then be placed over the wax coated sample such that the sample is centered within the container and the top of the container sides are at least 1 inch above the top of the sample. The spaces between the sample and the side walls of the container shall then be filled with melted wax. After this wax has congealed, the space between the top of the sample container sides and the top of the sample shall be filled with wax. After this wax has congealed, it shall be trimmed so that when the top of the sample container is installed there is no void between the container top and the wax. After the container top is installed, the soil column or cube shall then be cut off a few inches below the container, the sample and container inverted and removed from the pit and the sample trimmed at the base so that the bottom of the sample is at least 1 inch below the bottom of the container. This space shall be filled with wax and, after the wax has congealed, it shall be trimmed so that when the bottom of the container is installed, there shall be no void between the wax and the bottom of the container. Where overburden materials to be sampled are only partially cohesive, it is best not to expose the entire soil column before waxing. By exposing and waxing small sections at a time, the sample will be subjected to less disturbance. Where natural moisture content is an important factor, delay shall be avoided in taking the sample in order that the natural moisture content of the material may be retained to the fullest extent.

3.6.3 Disposition of Samples

Samples shall be packed in vermiculite or a packing material approved by the Contracting Officer and shipped in sturdy wooden boxes of strength and construction sufficient to guarantee against damage during shipment. Boxes should be no larger than is required for shipping two such samples. All sample boxes shall be marked FRAGILE-HANDLE WITH CARE and shall be identified by labels, similar to those as specified in paragraph IDENTIFYING SAMPLES, attached to the outside of each box. Extreme care shall be taken to indicate the top and bottom of each sample. Avoid exposing sealed and crated samples to precipitation and extremes of temperature. Undisturbed samples permitted to freeze, even partially, shall be replaced by the Contractor at its expense. Do not hold these samples at the site for a period in excess of one week. Prior to shipment, each sealed and boxed sample shall be checked for correct labeling.

3.7 BACKFILLING

3.7.1 Drill Holes

Unless otherwise noted in these specifications or directed by the Contracting Officer, all drill holes shall be backfilled and abandoned in accordance with all Federal, State, and local laws, regulations and ordinances. Preserve all holes in good condition until final measurement and until the records and samples have been accepted. As a minimum, all holes shall be grouted from the bottom of the hole to within 2 feet of the ground surface using a grout mixture in accordance with CDT Std Specs Section 41-2.02.B. All grout shall be pumped through a tremie pipe that is inserted to the bottom of the boring to insure that the grout fills the full extent of the hole. The remaining ungrouted top 2 feet of the hole shall be backfilled with local soil and tamped. All backfilling operations shall be performed in the presence of the Contracting Officer and, if required by regulation, Federal, State, and local officials. No separate payment will be made for backfilling drill holes. The cost of this work shall be included in the drilling costs.

3.7.2 Test Pits

Backfill all test pits with local soil compacted to original densities as directed by the Contracting Officer.

3.8 RECORDS

Submit complete, legible copies of DRILLING LOG, ENG FORM 1836 and 1836A, and records to the Contracting Officer within 2 days after a hole or test pit is completed. All such records shall be recorded during the actual performance of the work and shall be preserved in good condition and order until they are delivered and accepted. The Contracting Officer has the right to examine and review all such records at any time prior to their delivery and has the right to request changes to the record keeping procedure. The following information shall be included on the logs or in the records for each hole and test pit:

a. Hole or Test Pit number or designation and elevation of top of hole or test pit.

b. Driller's name and Geologist's name.

c. Make, size, and manufacturer's model designation of drilling, and test-pit excavating equipment.

d. Type of drilling and sampling operation by depth.

e. Hole diameter.

f. Dates and time by depths when test-pit excavation or drilling operations were performed.

g. Time required for drilling each run.

h. Drill action, rotation speed, hydraulic pressure, water pressure, tool drops, and any other unusual and non-ordinary experience which could indicate the subsurface conditions encountered.

i. Depths at which samples were recovered or attempts made to sample including top and bottom depth of each run.

j. Classification or description by depths of the materials penetrated using the Unified Soil Classification System (ASTM D2487) and including a description of moisture conditions, consistency and other appropriate descriptive information. This classification or description shall be made immediately after the samples or cores are retrieved.

k. Indication of penetration resistance such as drive-hammer blows given in blows per foot for driving sample spoons and casing and the pressure in psi applied to push thin-wall or piston-type samplers.

l. Weight of drive hammer.

m. Percentage of sample or core recovered per run.

n. Depth at which groundwater is encountered initially and when stabilized.

o. Depths at which drill water is lost and regained and amounts.

p. Depths at which the color of the drill water return changes.

q. Type and weight of drill fluid.

r. Depth of bottom of hole.

-- End of Section --

SECTION TABLE OF CONTENTS

DIVISION 02 - EXISTING CONDITIONS

SECTION 02 41 00

DEMOLITION AND DECONSTRUCTION

05/10

-- End of Section Table of Contents --

SECTION 02 41 00

DEMOLITION AND DECONSTRUCTION
05/10

PART 1 GENERAL

1.1 REFERENCES

The publications listed below form a part of this specification to the extent referenced. The publications are referred to within the text by the basic designation only.

AMERICAN SOCIETY OF SAFETY ENGINEERS (ASSE/SAFE)

ASSE/SAFE A10.6	(2006) Safety Requirements for Demolition Operations

U.S. ARMY CORPS OF ENGINEERS (USACE)

EM 385-1-1	(2014) Safety and Health Requirements Manual

U.S. NATIONAL ARCHIVES AND RECORDS ADMINISTRATION (NARA)

40 CFR 61	National Emission Standards for Hazardous Air Pollutants

1.2 PROJECT DESCRIPTION

1.2.1 Definitions

1.2.1.1 Demolition

Demolition is the process of wrecking or taking out a facility together with any related handling and disposal operations.

1.2.1.2 Deconstruction

Deconstruction is the process of taking apart a facility with the primary goal of preserving the value of all useful materials.

1.2.1.3 Reset

Reset is the process of deconstruction, including dismantling and re-installation, of a facility or assembly in the same location.

1.2.1.4 Demolition Plan

Demolition Plan is the planned steps and processes for managing demolition activities and identifying the required sequencing activities and disposal mechanisms.

1.2.1.5 Deconstruction Plan

Deconstruction Plan is the planned steps and processes for dismantling all or portions of a structure or assembly, to include managing sequencing activities, storage, re-installation activities, salvage and disposal mechanisms.

1.2.2 Demolition and Deconstruction Plan

Prepare a Demolition and Deconstruction Plan and submit proposed salvage, demolition, deconstruction, and removal procedures for approval before work is started. Include in the plan procedures for careful removal and disposition of materials specified to be salvaged, coordination with other work in progress a detailed description of methods and equipment to be used for each operation and of the sequence of operations. Identify components and materials to be salvaged for reuse or recycling with reference to paragraph Existing Facilities to be removed. Append tracking forms for all removed materials indicating type, quantities, condition, destination, and end use. Coordinate with Waste Management Plan. Provide procedures for safe conduct of the work in accordance with EM 385-1-1. Plan shall be approved by Contracting Officer prior to work beginning.

1.2.3 General Requirements

Do not begin demolition or deconstruction until authorization is received from the Contracting Officer. The work of this section is to be performed in a manner that maximizes the value derived from the salvage and recycling of materials. Remove rubbish and debris from the project site; do not allow accumulations inside or outside the building. The work includes demolition, salvage of identified items and materials, and removal of resulting rubbish and debris. Remove rubbish and debris from Government property daily, unless otherwise directed. Store materials that cannot be removed daily in areas specified by the Contracting Officer. In the interest of occupational safety and health, perform the work in accordance with EM 385-1-1, Section 23, Demolition, and other applicable Sections.

1.3 ITEMS TO REMAIN IN PLACE

Take necessary precautions to avoid damage to existing items to remain in place, to be reused, or to remain the property of the Government. Repair or replace damaged items as approved by the Contracting Officer. Coordinate the work of this section with all other work indicated. Construct and maintain shoring, bracing, and supports as required. Ensure that structural elements are not overloaded. Increase structural supports or add new supports as may be required as a result of any cutting, removal, deconstruction, or demolition work performed under this contract. Provide new supports and reinforcement for existing construction weakened by demolition, deconstruction, or removal work. Repairs, reinforcement, or structural replacement require approval by the Contracting Officer prior to performing such work.

1.3.1 Existing Construction Limits and Protection

Do not disturb existing construction beyond the extent indicated or necessary for installation of new construction. Provide temporary shoring and bracing for support of building components to prevent settlement or other movement. Provide protective measures to control accumulation and migration of dust and dirt in all work areas. Remove dust, dirt, and debris from work areas daily.

1.3.2 Trees

Protect trees within the project site which might be damaged during demolition or deconstruction, and which are indicated to be left in place, by temporary fencing. Erect and secure fence a minimum of 5 feet from the trunk of individual trees or follow the outer perimeter of branches or clumps of trees. Replace any tree designated to remain that is damaged during the work under this contract with like-kind or as approved by the Contracting Officer.

1.3.3 Utility Service

Maintain existing utilities indicated to stay in service and protect against damage during demolition and deconstruction operations. Prior to start of work, the Government will disconnect and seal utilities serving each area of alteration or removal upon written request from the Contractor.

1.4 BURNING

The use of burning at the project site for the disposal of refuse and debris will not be permitted.

1.5 SUBMITTALS

Government approval is required for submittals with a "G" designation; submittals not having a "G" designation are for information only. When used, a designation following the "G" designation identifies the office that will review the submittal for the Government. Submit the following in accordance with Section 01 33 00 SUBMITTAL PROCEDURES:

SD-07 Certificates

Notification; G

SD-11 Closeout Submittals

Receipts

1.6 QUALITY ASSURANCE

Submit timely notification of demolition projects to Federal, State, regional, and local authorities in accordance with 40 CFR 61, Subpart M. Notify the local air pollution control district/agency and the Contracting Officer in writing 10 working days prior to the commencement of work in accordance with 40 CFR 61, Subpart M. Comply with federal, state, and local hauling and disposal regulations. In addition to the requirements of the "Contract Clauses," conform to the safety requirements contained in ASSE/SAFE A10.6. Comply with the Environmental Protection Agency requirements specified. Use of explosives will not be permitted.

1.7 PROTECTION

1.7.1 Traffic Control Signs

a. Where pedestrian and driver safety is endangered in the area of removal work, use traffic barricades with flashing lights. Notify the Contracting Officer prior to beginning such work.

1.7.2 Protection of Personnel

Before, during and after the demolition work continuously evaluate the condition of the structure being demolished and take immediate action to protect all personnel working in and around the project site. No area, section, or component of floors, roofs, walls, columns, pilasters, or other structural element will be allowed to be left standing without sufficient bracing, shoring, or lateral support to prevent collapse or failure while workmen remove debris or perform other work in the immediate area.

1.8 RELOCATION AND RESET

Perform the removal and reinstallation of relocated or reset items as indicated with workmen skilled in the trades involved. Repair or replace items to be relocated or reset which are damaged by the Contractor with new undamaged items as approved by the Contracting Officer.

1.9 EXISTING CONDITIONS

Before beginning any demolition or deconstruction work, survey the site and examine the drawings and specifications to determine the extent of the work. Record existing conditions in the presence of the Contracting Officer showing the condition of structures and other facilities adjacent to areas of alteration or removal. Photographs sized 4 inch will be acceptable as a record of existing conditions. Include in the record the elevation of the top of foundation walls, finish floor elevations, possible conflicting electrical conduits, plumbing lines, alarms systems, the location and extent of existing cracks and other damage and description of surface conditions that exist prior to before starting work. It is the Contractor's responsibility to verify and document all required outages which will be required during the course of work, and to note these outages on the record document. Submit survey results.

PART 2 PRODUCTS

PART 3 EXECUTION

3.1 EXISTING FACILITIES TO BE REMOVED

Inspect and evaluate existing structures onsite for reuse. Existing construction scheduled to be removed for reuse shall be disassembled. Dismantled and removed materials are to be separated, set aside, and prepared as specified, and stored or delivered to a collection point for reuse, remanufacture, recycling, or other disposal, as specified. Materials shall be designated for reuse onsite whenever possible.

3.1.1 Utilities and Related Equipment

3.1.1.1 General Requirements

Do not interrupt existing utilities serving occupied or used facilities, except when authorized in writing by the Contracting Officer. Do not interrupt existing utilities serving facilities occupied and used by the Government except when approved in writing and then only after temporary utility services have been approved and provided. Do not begin demolition or deconstruction work until all utility disconnections have been made. Shut off and cap utilities for future use, as indicated.

3.1.1.2 Disconnecting Existing Utilities

Remove existing utilities as indicated and terminate in a manner conforming to the nationally recognized code covering the specific utility and approved by the Contracting Officer. When utility lines are encountered but are not indicated on the drawings, notify the Contracting Officer prior to further work in that area. Remove meters and related equipment and deliver to a location in accordance with instructions of the Contracting Officer.

3.1.2 Fencing

Remove fence, gates, and other related salvaged items scheduled for removal and transport to designated areas. Remove gates as whole units.

Cut chain link fabric to 25 foot lengths and store in rolls off the ground.

3.1.3 Paving and Slabs

Remove sawcut concrete and asphaltic concrete paving and slabs including aggregate base as indicated to a depth of 24 inches below new finish grade. Provide neat sawcuts at limits of pavement removal as indicated. Pavement and slabs designated to be recycled and utilized in this project shall be moved, ground and stored as directed by the Contracting Officer. Pavement and slabs not to be used in this project shall be removed from the Installation at Contractor's expense.

3.1.4 Concrete

Saw concrete along straight lines to a depth of a minimum 2 inch. Make each cut in walls perpendicular to the face and in alignment with the cut in the opposite face. Break out the remainder of the concrete provided that the broken area is concealed in the finished work, and the remaining concrete is sound. At locations where the broken face cannot be concealed, grind smooth or saw cut entirely through the concrete.

3.1.5 Well Destruction

3.1.5.1 Permits, Bonds, Licenses and Insurance

The Contractor shall procure all permits, bonds, licenses and insurance, pay all charges and fees, and give all notices necessary and incidental to the prosecution of the work.

The Contractor shall prepare and resubmit the permits to the Sacramento County Environmental Management Department (SCEMD) along with all final well destruction plans for approval by SCEMD.

3.1.5.2 Mobilization

Mobilization shall include transportation of personnel, equipment and operating supplies to and from the sites, providing portable sanitary facilities, maintaining fencing and barricades suitable to keep unauthorized persons away from construction activities around the site and other necessary facilities at the site. The Contractor shall maintain all permits and records at the project site and make them accessible to the Contracting Officer or regulatory agency at all times.

3.1.5.3 Inspection of Wells

Prior to the start of any work, each well shall be visually inspected by the use of down-hole video camera to determine the condition, details of construction, and whether any obstructions will interfere with the process of filling and sealing the wells. The Contractor shall provide to the Contracting Officer four (4) DVD copies of each well inspection, narrated to identify findings.

1. The wells shall be cleaned, as needed, so that all undesirable materials, including obstructions to filling and sealing, debris, oil, pollutants and contaminants that could interfere with the well inspection and/or well destruction are removed. As required, the Contractor shall clean out the well(s) by bailing, airlifting, drilling, or other methods approved by the Contracting Officer.

2. All debris, sand, dirt, rock, oil, or other waste products removed from the well shall be off hauled to a licensed disposal facility. Receipts, transportation manifests, or other documents indicating proper disposal of oil or other contaminants originating from the wells shall be provided to the Contracting Officer.

3.1.5.4 Well Perforation

Using a casing cutter, mills knife or other approved cutting tool or method, the Contractor shall perforate the casings from a depth of 20 feet at the full depth of the well. The size and number of perforations shall be sufficient to allow the sealing material to pass through the casing and fill any void space that may exist between the well casing and the borehole of the well. The perforation type and schedule must be pre-approved by the Contracting Officer and SCEMD.

3.1.5.5 Well Sealing Method

A well sealing plan shall be developed by the Contractor for each well to be destroyed. At a minimum the plan shall include the following.

1. A hole shall be excavated around the well casing to a depth of 5 feet below the ground surface and the well casing and existing cement annular seal shall be removed to the bottom of this excavation.

2. A tremie pipe shall be installed in the well to a depth 5 feet above the measured bottom of the well.

3. The sealing material shall be pumped with a cement concrete pump into the well through the tremie pipe to bring the slurry to the surface of the excavated hole and allowed to spill over into the excavation to form a cap. The end of the tremie pipe shall remain submerged below the slurry during the entire sealing procedure.

4. After the sealing material has set (a minimum of 24 hours after placement), the excavation shall be filled to the surface with native soil and compacted in accordance with Section 31 00 00. Compaction testing will be per Section 31 00 00.

3.1.5.6 Removal of Discharge Pipes, Valves, and Distribution Structures

Contractor shall remove the discharge piping, valves, and distribution structures associated with the well.

3.1.5.7 Site Restorations and Cleanup

During the entire duration of the job, the Contractor shall keep the premises free from accumulations of waste materials, rubbish, and other debris resulting from the work, except as is reasonably expected for the specified demolition and destruction work. The Contractor shall remove all miscellaneous concrete, casing, and materials removed from the well at each well site by the conclusion of the project. The Contractor shall restore all areas of the sites to their preconstruction condition except for the demolished facilities.

3.1.6 Well Abandonment

3.1.6.1 General

Prior to abandonment of any well and removal of well pump equipment, Contractor shall obtain written release from Contracting Officer. Domestic well abandonment shall be performed in accordance with the State of California Water Well Standards: State of California Bulletin 74-80 or Supplement 74-90. Additional requirements specific to the County of Sacramento are provided in Destruction of Supply Wells and Exploratory Holes (Borings). Well abandonment shall be in accordance with applicable laws and regulations. Contractor shall obtain permits, pay any permit fees, and obtain the required inspections from Sacramento County Environmental Management Department. Domestic wells shall be fully grouted from the bottom of the well to 5 feet below ground elevation using a tremie pipe.

3.2 CONCURRENT EARTH-MOVING OPERATIONS

Do not begin excavation, filling, and other earth-moving operations that are sequential to demolition or deconstruction work in areas occupied by structures to be demolished or deconstructed until all demolition and deconstruction in the area has been completed and debris removed. Fill holes, open basements and other hazardous openings.

3.3 DISPOSITION OF MATERIAL

3.3.1 Title to Materials

Except for salvaged items specified in related Sections, and for materials or equipment scheduled for salvage, all materials and equipment removed and not reused or salvaged, shall become the property of the Contractor and shall be removed from Government property. Title to materials resulting from demolition and deconstruction, and materials and equipment to be removed, is vested in the Contractor upon approval by the Contracting Officer of the Contractor's demolition, deconstruction, and removal procedures, and authorization by the Contracting Officer to begin demolition and deconstruction. The Government will not be responsible for the condition or loss of, or damage to, such property after contract award. Showing for sale or selling materials and equipment on site is prohibited.

3.4 DISPOSAL OF REMOVED MATERIALS

3.4.1 Regulation of Removed Materials

Dispose of debris, rubbish, scrap, and other nonsalvageable materials resulting from removal operations with all applicable federal, state and local regulations as contractually specified.

3.4.2 Burning on Government Property

Burning of materials removed from demolished and deconstructed structures will not be permitted on Government property.

3.4.3 Removal from Government Property

Transport waste materials removed from demolished and deconstructed structures, except waste soil, from Government property for legal disposal. Dispose of waste soil as directed. Remove waste material from site every 7 to 10 days.

-- End of Section --

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PIPELINE ABANDONMENT

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PIPELINE ABANDONMENT
05/15

PART 1 GENERAL

1.1 SCOPE

This specification covers grouting of pipes for abandonment. The pipes to be abandoned under this specification consists of an existing discharge pipe at Reclamation District 1000's Pumping Plant 3 with a nominal 60-inch diameter made of corrugated metal steel pipe, approximate length of 325 linear feet and as shown on the Drawings.

1.2 REFERENCES

The publications listed below form a part of this specification to the extent referenced. The publications are referred to within the text by the basic designation only.

AMERICAN CONCRETE INSTITUTE INTERNATIONAL (ACI)

ACI 211.5R	(2014) Guide for Submittal of Concrete Proportions
ACI 214R	(2011) Evaluation of Strength Test Results of Concrete
ACI 311.4R	(2005) Guide for Concrete Inspection
ACI MCP SET	(2016) Manual of Concrete Practice

ASTM INTERNATIONAL (ASTM)

ASTM C109/C109M	(2016a) Standard Test Method for Compressive Strength of Hydraulic Cement Mortars (Using 2-in. or (50-mm) Cube Specimens)
ASTM C1107/C1107M	(2014a) Standard Specification for Packaged Dry, Hydraulic-Cement Grout (Nonshrink)
ASTM C150/C150M	(2018) Standard Specification for Portland Cement
ASTM C845/C845M	(2018) Standard Specification for Expansive Hydraulic Cement

1.3 SUBMITTALS

Government approval is required for submittals with a "G" designation; submittals not having a "G" designation are for information only. When used, a designation following the "G" designation identifies the office that will review the submittal for the Government. Submit the following in accordance with Section 01 33 00 SUBMITTAL PROCEDURES:

SD-01 Preconstruction Submittals

Grout Placement Plan; G

Example Inspection Reports; G

Pipe Cleaning Method; G, DO

Method to be used for cleaning the interior of the pipes and containing, collecting, and disposal of the washing water, sediments, and other contaminants.

Video Camera System; G, DO

The video camera system used for inspecting the pipes are to be in accordance with Part 2.2, PRODUCTS, of this specification.

SD-03 Product Data

Video Recording; G, DO

Three (3) copies of digital DVD's for all video camera inspections are to be submitted to the Contracting Officer within 32 hours of performing the inspection.

Grout Mixture Proportioning; G, DO

SD-04 Samples

Expansive Admixtures; G, DO

Submit sample in accordance with ACI 211.5R.

SD-06 Test Reports

Expansion; G, DO

Compressive Strength; G, DO

Bleed Water; G, DO

Grout Placement and Inspection Reports; G, DO

Expansive Grout; G, DO

Portland Cement; G, DO

SD-07 Certificates

Portland Cement; G, DO

Expansive Admixtures; G, DO

Expansive Grout; G, DO

1.4 QUALITY CONTROL

1.4.1 Grout Placement Plan and Inspection Reports

Provide Grout Placement Plan and Example Inspection Reports in accordance with ACI 214R, ACI 211.5R, ACI 311.4R and ACI MCP SET. Show details of proposed methods of application, with written instructions from the manufacturer for the use of expansive admixture at least 45 calendar days prior to the start of pipe abandonment.

Submit data sheets for proposed plugs and details of the bulkheads.

Include a copy of records of inspections and tests as well as the records of corrective action taken. Include descriptions of preparation of cavities for placement of grout; proper mixing, placement, and curing of grout.

PART 2 PRODUCTS

2.1 Nonshrink Flowable Grout

Provide nonshrink Grout Mixture Proportioning conforming to ASTM C1107/C1107M, and a commercial formulation suitable for the proposed application, cement-based flowable grout with self-leveling and non-shrink characteristics. Design the grout mixtures to produce material having an average compressive strength of 3,000 psi at 28 days of age, determined in conformance with ASTM C109/C109M.

2.2 MATERIALS

2.2.1 Portland Cement

Provide portland cement conforming to ASTM C150/C150M for Cement, Type II.

2.2.2 Expansive Hydraulic Cement

Expansive Hydraulic Cement shall conform to ASTM C845/C845M, Type E-1, K.

2.2.3 Water

Provide potable water.

2.2.4 Expansive Admixtures

Submit samples to the Contracting Officer prior to commencement of work for review and acceptance.

2.3 VIDEO CAMERA

Video camera and monitor is to be color and high resolution. The video camera is a closed circuit television (CCTV) video camera. The color image is to be compliant with National Television System Committee format (i.e., a closed circuit television (CCTV) camera format) and have a scan rate of at least 620 lines at 50 HZ, and a resolution of at least 320 lines. The video camera must be capable of operating in a minimum inside pipe diameter of 2.96 inches, nominal 3-inch cast iron Class D pipe. The video camera must be capable of operating inside any pipe with a minimum of 4 hours without fogging or condensation and should be able to operate in wet or dry conditions. A controller and encoder is to be provided and will project onto the color monitor and stamp on the recorded image with the following information in real time: pipe location identification, clock time (resolution to 1/30 second or better) and location (distance and orientation). A DVD recorder, or digital media recorder is to be provided and used to record images captured by the video camera. The video camera system is to be submitted for approval under submittal Video Camera System.

PART 3 EXECUTION

3.1 General

Scheduling of the work is to be coordinated with the Contracting Officer.

3.2 PREPARATION

3.2.1 Pipe Cleaning

Prior to video inspecting the pipes, prepare the interior of the pipes for grouting by cleaning away foreign matter, laitance, dirt, grease or oil. Cleaning method is to include pressure washing system. The wash water, sediments, and other contaminants is to be contained, and collected and disposed offsite at a facility approved for disposal of petroleum and oil based products. The cleaning is to be conducted in a manner that will not damage the pipes. The method of cleaning and wash water and sediment containment, collection, and disposal is to be submitted under Pipe Cleaning Method.

3.2.2 Video Camera Inspection

After cleaning the pipe a video camera inspection is to be performed. The video camera is to be used to verify whether any debris is remaining within the pipe after pipe cleaning. To accommodate conditions where pipes have 90 degree or other bends that prevent camera movement, the video inspection is to resume at the opposite end of the pipe opening. Any debris remaining in a pipe that could have a detrimental effect on grouting is to be clean again and video camera inspected. The video camera inspection recordings is to be submitted under Video Recording.

3.2.3 Mixing

Mix grout ingredients for cementitious grout in accordance with the manufacturer's written mixing instructions and recommendations.

Mix grout materials in proper mechanical mixers. Use concrete or grout pumps capable of continuous delivery at planned placement rate.

Mix grout as close to work area as possible.

3.3 APPLICATION

3.3.1 Placing Grout

Grout Placement Plan and Example Inspection Reports are to be submitted for approval and are to include the following as a minimum. Place flowable grout in accordance with the manufacturer's written installation instructions and recommendations. Place flowable grout using concrete or grout pumps capable of continuous delivery at planned placement rate to fill volume between placement points not to exceed 400 linear ft. at one time. Pump flowable grout through injection points that are connected to the bulkheads using pipes constructed for placement, or other methods. These pipe will be used for injection points or vents during placement. Place grout under pressure into property vented open system until grout emerges from vent pipes indicating pipe is completely filled. Pumping grout must be completed under sufficient pressure to overcome friction and to fill pipe from downstream to upstream end. Collect and dispose of excess grout and other debris in accordance with State and local regulations. Remediate areas where flowable grout did not fill voids in pipes by pressure grouting from inside pipes or from surface if necessary. Plug each end of the pipe being abandoned. Ensure that concrete is encapsulating the plug/bulkhead and encapsulating the pipe end, including bedding material such that it is not penetrable by groundwater and that bedding at this location is not a conduit for groundwater. The method of installation must be able to completely fill the existing pipe and any voids adjacent to it. Do not use grout which has begun to set or if more than one hour has elapsed after initial mixing, or as required by the manufacturer. Provide quantities for computed volume of the pipeline. Record quantities of grout injection within each pipeline. Compare computed volume of pipeline to recorded volumes of grout to verify there are no voids. Submit this information under the submittal Grout Placement and Inspection Reports.

3.4 FIELD QUALITY CONTROL

Provide testing and submit test reports in accordance with ASTM C1107/C1107M for the expansive grout to meet the following performance requirements:

Expansion: 28 calendar days - Percent maximum: 0.20

- Percent minimum: 0.0

Compressive Strength: 3,000 psi
Bleed Water: Percent maximum: 2.0

Take a minimum of three bulk samples during grouting for each pipe near the start, middle and end of grouting.

3.5 PROTECTION

Protect freshly placed grout from premature drying and excessive cold or hot temperatures. Comply with manufacturer's requirements for cold-weather and hot-weather protection during curing.

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STRUCTURAL CAST-IN-PLACE CONCRETE FORMING

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SECTION 03 11 13

STRUCTURAL CAST-IN-PLACE CONCRETE FORMING
05/14

PART 1 GENERAL

1.1 REFERENCES

The publications listed below form a part of this specification to the extent referenced. The publications are referred to within the text by the basic designation only.

AMERICAN CONCRETE INSTITUTE INTERNATIONAL (ACI)

ACI 117	(2010; Errata 2011) Specifications for Tolerances for Concrete Construction and Materials and Commentary
ACI 301	(2016) Specifications for Structural Concrete
ACI 347R	(2014; Errata 1 2017) Guide to Formwork for Concrete

1.2 SUBMITTALS

Government approval is required for submittals with a "G" designation; submittals not having a "G" designation are for information only. When used, a designation following the "G" designation identifies the office that will review the submittal for the Government. Submit the following in accordance with Section 01 33 00 SUBMITTAL PROCEDURES:

SD-02 Shop Drawings

Formwork; G

SD-03 Product Data

Form Materials

SD-05 Design Data

Calculations

SD-06 Test Reports

Inspection

1.3 QUALITY ASSURANCE

Provide Sample Panels of sufficient size to contain joints and not less than 6 feet long and 4 feet wide. The panels shall be of typical wall thickness and constructed containing the full allocation of reinforcing steel that will be used in the structure, with the forming system that duplicates in every detail the one that will be used in construction of the structure. Use the same concrete mixture proportion and materials, the same placement techniques and equipment, and the same finishing techniques and timing that are planned for the structure. Construction of a finish SF-3.0 will not be permitted until sample panels have been approved. Protect sample panels from construction operations in a manner to protect approved finish, and are not to be removed until all surface finish SF-3.0 concrete has been accepted. After shop drawings have been reviewed, submit sample panels for a surface finish SF-3.0 with applied architectural treatment; build panels on the project site where directed.

1.4 DELIVERY, STORAGE, AND HANDLING

Store fiber voids above ground level in a dry location. Keep fiber voids dry until installed and overlaid with concrete.

PART 2 PRODUCTS

2.1 SYSTEM DESCRIPTION

The design, engineering, and construction of the formwork is the responsibility of the Contractor. Design formwork in accordance with methodology of ACI 347R for anticipated loads, lateral pressures, and stresses, and capable of withstanding the pressures resulting from placement and vibration of concrete. Comply with the tolerances specified in Section 03 31 01 CAST-IN-PLACE CONCRETE, paragraph CONSTRUCTION TOLERANCES. However, for surfaces with an ACI Class A surface designation, limit the allowable deflection for facing material between studs, for studs between walers and walers between bracing to 0.0025 times the span. Design the formwork as a complete system with consideration given to the effects of cementitious materials and mixture additives such as fly ash, cement type, plasticizers, accelerators, retarders, air entrainment, and others. Monitor the adequacy of formwork design and construction prior to and during concrete placement as part of the Contractor's approved Quality Control Plan. Submit design analysis and calculations for form design and methodology used in the design. Submit at least 30 days either before fabrication on site or before delivery of prefabricated forms.

2.2 FORM MATERIALS

Submit manufacturer's data, including literature describing form materials, accessories, and form releasing agents.

2.2.1 Formwork

Comply with ACI 301 Section 2. Provide for surfaces not exposed to public view a surface finish SF-1.0. Provide for surfaces exposed to public view a surface finish SF-3.0. Patch holes and defects in accordance with ACI 301. Submit form removal schedule indicating element and minimum length of time for form removal.

2.2.2 Pan-Form Units

Use factory-fabricated pan-form units of the approximate section indicated for one-way or two-way concrete joist and slab construction. Units must consist of steel or molded fiberglass concrete form pans. Furnish closure units as required.

PART 3 EXECUTION

3.1 INSTALLATION

3.1.1 Formwork

Comply with ACI 301 Section 2 with surface tolerances in accordance with ACI 117.

3.2 INSPECTION

Inspect forms and embedded items in sufficient time prior to each concrete placement to certify to the Contracting Officer that they are ready to receive concrete. Report the results of each inspection in writing. Submit field inspection reports for concrete forms and embedded items.

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CONCRETE ACCESSORIES

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PART 1 GENERAL

1.1 REFERENCES

The publications listed below form a part of this specification to the extent referenced. The publications are referred to within the text by the basic designation only.

AMERICAN HARDBOARD ASSOCIATION (AHA)

AHA A135.4	(1995; R 2004) Basic Hardboard

ASTM INTERNATIONAL (ASTM)

ASTM C920	(2018) Standard Specification for Elastomeric Joint Sealants
ASTM D1751	(2004; E 2013; R 2013) Standard Specification for Preformed Expansion Joint Filler for Concrete Paving and Structural Construction (Nonextruding and Resilient Bituminous Types)
ASTM D1752	(2018) Standard Specification for Preformed Sponge Rubber, Cork and Recycled PVC Expansion Joint Fillers for Concrete Paving and Structural Construction
ASTM D2628	(1991; R 2016) Standard Specification for Preformed Polychloroprene Elastomeric Joint Seals for Concrete Pavements
ASTM D2835	(1989; R 2017) Standard Specification for Lubricant for Installation of Preformed Compression Seals in Concrete Pavements
ASTM D471	(2016a) Standard Test Method for Rubber Property - Effect of Liquids
ASTM D5249	(2010; R 2016) Standard Specification for Backer Material for Use with Cold-and Hot-Applied Joint Sealants in Portland-Cement Concrete and Asphalt Joints

U.S. ARMY CORPS OF ENGINEERS (USACE)

COE CRD-C 513	(1974) Corps of Engineers Specifications for Rubber Waterstops
COE CRD-C 572	(1974) Corps of Engineers Specifications for Polyvinylchloride Waterstops

1.2 SUBMITTALS

Government approval is required for submittals with a "G" designation; submittals not having a "G" designation are for information only. When used, a designation following the "G" designation identifies the office that will review the submittal for the Government. Submit the following in accordance with Section 01 33 00 SUBMITTAL PROCEDURES:

SD-02 Shop Drawings

Waterstops; G

SD-03 Product Data

Preformed Expansion Joint Filler
Sealant
Waterstops

SD-04 Samples

Lubricant for Preformed Compression Seals
Field-Molded Type
Waterstops
Splicing Waterstops; G

SD-07 Certificates

Preformed Expansion Joint Filler
Sealant
Waterstops

1.3 DELIVERY, STORAGE, AND HANDLING

Protect material delivered and placed in storage off the ground from moisture, dirt, and other contaminants. Deliver sealants in the manufacturer's original unopened containers. Remove sealants from the site whose shelf life has expired.

PART 2 PRODUCTS

2.1 CONTRACTION JOINT STRIPS

Use 1/8 inch thick tempered hardboard contraction joint strips conforming to AHA A135.4, Class 1. In lieu of hardboard strips, rigid polyvinylchloride (PVC) or high impact polystyrene (HIPS) insert strips specifically designed to induce controlled cracking in slabs on grade may be used. Such insert strips must have removable top section.

2.2 PREFORMED EXPANSION JOINT FILLER

Use preformed expansion joint filler material conforming to ASTM D1751 or ASTM D1752, Type I, or resin impregnated fiberboard conforming to the physical requirements of ASTM D1752. Submit certified manufacturer's test reports for premolded expansion joint filler strips, and compression seals and lubricant to verify compliance with applicable specification. Unless otherwise indicated, filler material must be 3/8 inch thick and of a width applicable for the joint formed. Backer material, when required, must conform to ASTM D5249.

2.3 SEALANT

Joint sealant conforming to the following:

2.3.1 Preformed Polychloroprene Elastomeric Type

ASTM D2628.

2.3.2 Lubricant for Preformed Compression Seals

ASTM D2835. Submit a piece not less than 9 ft of 1 inch nominal width or wider seal or a piece not less than 12 ft of compression seal less than 1 inch nominal width. Provide one quart of lubricant.

2.3.3 Field-Molded Type

ASTM C920. Use Type M, Grade P or NS, Class 50, Use I sealant for horizontal joints. Type M, Grade NS, Class 505, Use I for vertical joints. Type M, Grade P or NS, Class 50, Use T1 for joints not subject to water flow. Use polyethylene tape, coated paper, metal foil or similar type materials as bond breaker. The back-up material must be compressible, non-shrink, nonreactive with sealant, and non-absorptive material type such as extruded butyl or polychloroprene rubber. Submit 1 gallon of field-molded sealant and 1 quart of primer (when primer is recommended by the sealant manufacturer) identified to indicate manufacturer, type of material, quantity, and shipment or lot represented.

2.4 WATERSTOPS

Submit a sample of each material consisting of a piece not less than 12 inches long cut from each 200 feet of finished waterstop furnished, but not less than a total of 4 linear feet of each type and size furnished. For spliced segments of waterstops to be installed in the work, furnish one spliced sample of each size and type for every 50 splices made in the factory and every 10 splices made at the job site for inspection and testing. Make the spliced samples using straight run pieces with the splice located at the mid-length of the sample and finished as required for the installed waterstop; the total length of each spliced sample not less than 12 inches. Submit waterstop materials and splice samples for inspection and testing identified to indicate manufacturer, type of material, size and quantity of material and shipment represented. Submit a shop drawing of the waterstops showing the placement and configuration.

2.4.1 Non-Metallic Materials

Manufacture non-metallic waterstops from a prime virgin resin; reclaimed material is not acceptable. The compound must contain plasticizers, stabilizers, and other additives to meet specified requirements. Rubber waterstops conforming to COE CRD-C 513. Polyvinylchloride waterstops conforming to COE CRD-C 572. Thermoplastic elastomeric rubber waterstops conforming to ASTM D471. Submit a piece not less than 12 inch long cut from each 200 ft of finished waterstop furnished, but not less than a total of 4 ft of each type, size, and lot furnished. One splice sample of each size and type for every 50 splices made in the factory and every 10 splices made at the job site. Make the splice samples using straight run pieces with the splice located at the mid-length of the sample and finished as required for the installed waterstop; the total length of each splice not less than 12 inches long.

2.5 TESTS, INSPECTIONS, AND VERIFICATIONS

2.5.1 Materials Tests

2.5.1.1 Non-Metallic Waterstops

Samples of materials and splices will be visually inspected and tested by and at the expense of the Government for compliance with COE CRD-C 513 or COE CRD-C 572 as applicable. If a sample fails to meet the specification requirements, provide new samples and the cost of retesting will be deducted from payments due the Contractor.

2.5.2 Splicing Waterstops

2.5.2.1 Procedure and Performance Qualifications

Demonstrate procedure and performance qualifications for splicing waterstops in the presence of the Contracting Officer. Submit procedures for splicing waterstops for approval.

2.5.2.2 Non-Metallic Waterstops

Demonstrate procedure and performance qualifications for splicing non-metallic waterstops by the manufacturer at the factory and the Contractor at the job site by each making three spliced samples of each size and type of finished waterstop.

PART 3 EXECUTION

3.1 INSTALLATION

Provide joint locations and details, including materials and methods of installation of joint fillers and waterstops, as specified and indicated. In no case may any fixed metal be continuous through an expansion or contraction joint.

3.1.1 Contraction Joints

Contraction joints may be constructed by inserting tempered hardboard strips or rigid PVC or HIPS insert strips into the plastic concrete using a steel parting bar, when necessary, or by cutting the concrete with a saw after concrete has set. Make joints 1/8 inch to 3/16 inch wide and extend into the slab one-fourth the slab thickness, minimum, but not less than 1 inch.

3.1.1.1 Joint Strips

Provide strips of the required dimensions and as long as practicable. After the first floating, groove the concrete with a tool at the joint locations. Insert the strips in the groove and depress them until the top edge of the vertical surface is flush with the surface of the slab. Float and finish the slab as specified. Work the concrete adjacent to the joint the minimum necessary to fill voids and consolidate the concrete. Where indicated, saw out the top portion of the strip after the curing period to form a recess for sealer. Discard the removable section of PVC or HIPS strips and leave the insert in place. Maintain true alignment of the strips during insertion.

3.1.1.2 Sawed Joints

Saw joints early enough to prevent uncontrolled cracking in the slab, but late enough that this can be accomplished without appreciable spalling. Start cutting as soon as the concrete has hardened sufficiently to prevent raveling of the edges of the saw cut. Complete cutting before shrinkage stresses become sufficient to produce cracking. Use concrete sawing machines that are adequate in number and power, and with sufficient replacement blades to complete the sawing at the required rate. Cut joints to true alignment and in sequence of concrete placement. Remove sludge and cutting debris. Form reservoir for joint sealant.

3.1.1.3 Bond Breaker

Coat joints requiring a bond breaker with curing compound or with bituminous paint. Protect waterstops during application of bond breaking material to prevent them from being coated.

3.1.2 Expansion Joints

Use preformed expansion joint filler in expansion and isolation joints in slabs around columns and between slabs on grade and vertical surfaces where indicated. Extend the filler to the full slab depth, unless otherwise indicated. Neatly finish the edges of the joint with an edging tool of 1/8 inch radius, except where a resilient floor surface will be applied. Where the joint is to receive a sealant, install the filler strips at the proper level below the finished floor with a slightly tapered, dressed and oiled wood strip temporarily secured to the top to form a recess to the size shown on the drawings. Remove the wood strip after the concrete has set. Contractor may opt to use a removable expansion filler cap designed and fabricated for this purpose in lieu of the wood strip. Thoroughly clean the groove of laitance, curing compound, foreign materials, protrusions of hardened concrete, and any dust. If blowing out the groove use oil-free compressed air.

3.1.3 Joint Sealant

Fill sawed contraction joints and expansion joints in slabs with joint sealant, unless otherwise shown. Joint surfaces must be clean, dry, and free of oil or other foreign material which would adversely affect the bond between sealant and concrete. Apply joint sealant as recommended by the manufacturer of the sealant.

3.1.3.1 Joints With Field-Molded Sealant

Do not seal joints when the sealant material, ambient air, or concrete temperature is less than 40 degrees F. Coat joints requiring a bond breaker with curing compound or with bituminous paint. Install bond breaker and back-up material where required. Prime joints and fill flush with joint sealant in accordance with the manufacturer's recommendations.

3.2 WATERSTOPS, INSTALLATION AND SPLICES

Install waterstops at the locations shown to form a continuous water-tight diaphragm. Embed the bottom of each waterstop a minimum of 6 inches in firm rock or sealed to other cut-off systems. Make adequate provision to support and completely protect the waterstops during the progress of the work. Repair or replace any waterstop punctured or damaged. Protect exposed waterstops during application of form release agents to avoid being coated. Provide suitable guards to protect exposed projecting edges and ends of partially embedded waterstops from damage when concrete placement has been discontinued. Accomplish splices with certified trained personnel using approved equipment and procedures.

3.2.1 Non-Metallic

Fittings must be shop made using a machine specifically designed to mechanically weld the waterstop. Use a miter guide, proper fixturing (profile dependant), and portable power saw to miter cut the ends to be joined to ensure good alignment and contact between joined surfaces. Splice straight lengths by squaring the ends to be joined. Maintain continuity of the characteristic features of the cross section of the waterstop (for example, ribs, tabular center axis, protrusions) across the splice.

3.2.1.1 Polyvinyl Chloride Waterstop

Make splices by heat sealing the adjacent waterstop edges together using a thermoplastic splicing iron utilizing a non-stick surface specifically designed for waterstop welding. Use the correct temperature to sufficiently melt without charring the plastic. Reform waterstops at splices with a remolding iron with ribs or corrugations to match the pattern of the waterstop. The spliced area, when cooled, must show no signs of separation, holes, or other imperfections when bent by hand in as sharp an angle as possible.

3.2.1.2 Quality Assurance

Edge welding will not be permitted. Compress or close centerbulbs when welding to non-centerbulb type. Waterstop splicing defects which are unacceptable include, but are not limited to the following: 1) Tensile strength less than 80 percent of parent section. 2) Free lap joints. 3) Misalignment of centerbulb, ribs, and end bulbs greater than 1/16 inch. 4) Misalignment which reduces waterstop cross section more than 15 percent. 5) Bond failure at joint deeper than 1/16 inch or 15 percent of material thickness. 6) Misalignment of waterstop splice resulting in misalignment of waterstop in excess of 1/2 inch in 10 feet. 7) Visible porosity in the weld area, including pin holes. 8) Charred or burnt material. 9) Bubbles or inadequate bonding. 10) Visible signs of splice separation when cooled splice is bent by hand at a sharp angle.

3.3 CONSTRUCTION JOINTS

Treat construction joints coinciding with expansion and contraction joints as expansion or contraction joints as applicable.

-- End of Section --

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SECTION 03 20 00

CONCRETE REINFORCING

05/14

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SECTION 03 20 00

CONCRETE REINFORCING
05/14

PART 1 GENERAL

1.1 REFERENCES

The publications listed below form a part of this specification to the extent referenced. The publications are referred to within the text by the basic designation only.

AMERICAN CONCRETE INSTITUTE INTERNATIONAL (ACI)

ACI 117	(2010; Errata 2011) Specifications for Tolerances for Concrete Construction and Materials and Commentary
ACI 318	(2014; Errata 1-2 2014; Errata 3-5 2015; Errata 6 2016; Errata 7-9 2017) Building Code Requirements for Structural Concrete (ACI 318-14) and Commentary (ACI 318R-14)
ACI SP-66	(2004) ACI Detailing Manual

AMERICAN WELDING SOCIETY (AWS)

AWS D1.4/D1.4M	(2011) Structural Welding Code - Reinforcing Steel

ASTM INTERNATIONAL (ASTM)

ASTM A184/A184M	(2017) Standard Specification for Welded Deformed Steel Bar Mats for Concrete Reinforcement
ASTM A370	(2016) Standard Test Methods and Definitions for Mechanical Testing of Steel Products
ASTM A615/A615M	(2016) Standard Specification for Deformed and Plain Carbon-Steel Bars for Concrete Reinforcement
ASTM A675/A675M	(2014) Standard Specification for Steel Bars, Carbon, Hot-Wrought, Special Quality, Mechanical Properties

1.2 SUBMITTALS

Government approval is required for submittals with a "G" designation; submittals not having a "G" designation are for information only. When used, a designation following the "G" designation identifies the office that will review the submittal for the Government. Submit the following in accordance with Section 01 33 00 SUBMITTAL PROCEDURES:

SD-02 Shop Drawings

Reinforcement; G

SD-03 Product Data

Reinforcing Steel; G

SD-06 Test Reports

Tests, Inspections, and Verifications; G

SD-07 Certificates

Reinforcing Steel
Qualified Welders

1.3 QUALITY ASSURANCE

1.3.1 Welding Qualifications

Welders are required to be qualified in accordance with AWS D1.4/D1.4M. Perform qualification test at the worksite and notify the Contracting Officer 24 hours prior to conducting tests. Special welding procedures and welders qualified by others may be accepted as permitted by AWS D1.4/D1.4M. Submit a list of qualified welders names.

1.4 DELIVERY, STORAGE, AND HANDLING

Store reinforcement and accessories off the ground on platforms, skids, or other supports.

PART 2 PRODUCTS

2.1 DOWELS

Provide dowels conforming to ASTM A675/A675M, Grade 60. Dowel bar ends shall be smooth and without burrs.

2.1.1 Dowels

Dowels shall be single piece bars fabricated or cut to length at the shop or mill before delivery to the site. Dowels shall be free of loose, flaky rust and loose scale and shall be clean and straight. Dowels may be sheared to length provided that the deformation from true shape caused by shearing does not exceed 0.04 inch on the diameter of the dowel and does not extend more than 0.04 inch from the end of the dowel.

2.1.2 Dowel Bar Assemblies

Dowel bar assemblies shall consist of a framework of metal bars or wires arranged to provide rigid support for the dowels throughout the placement operation, with a minimum of four continuous bars or wires extending along the joint line. The dowels shall be welded to the assembly or held firmly by mechanical locking arrangements that will prevent them from rising, sliding out, or becoming distorted during placing operations.

The method used in installing and holding dowels in position shall ensure that the error in alignment of any dowel from its required horizontal and vertical alignment after concrete placement will not be greater than 1/8 inch per foot. Except as otherwise specified below, horizontal spacing of dowels shall be within a tolerance of plus or minus 5/8 inch. The vertical location on the face of the slab shall be within a tolerance of plus or minus 1/2 inch. Dowels across crowns and other joints at grade changes shall be measured to a level surface. Horizontal alignment shall be checked perpendicular to the joint edge. The horizontal alignment shall be checked with a framing square. Dowels shall not be placed closer than 0.6 times the dowel bar length to the planned joint line. If the last regularly spaced dowel is closer than that dimension, it shall be moved away from the joint to a location 0.6 times the dowel bar length, but not closer than 6 inches to its nearest neighbor. Dowel interference at a transverse joint-longitudinal joint intersection shall be resolved by deleting the closest transverse dowel.

2.2 FABRICATED BAR MATS

Fabricated bar mats conforming to ASTM A184/A184M.

2.3 REINFORCING STEEL

Reinforcing steel of deformed bars conforming to ASTM A615/A615M, grades 60 and sizes as indicated, except where indicated otherwise on the plans.

Submit certified copies of mill reports attesting that the reinforcing steel furnished contains no less than 25 percent recycled scrap steel and meets the requirements specified herein, prior to the installation of reinforcing steel.

2.4 WIRE TIES

Use wire ties that are 16 gauge or heavier black annealed steel wire.

2.5 SUPPORTS

Provide bar supports complying with the requirements of ACI SP-66. Provide plastic-coated wire, stainless steel or precast concrete supports for bars in concrete with formed surfaces exposed to view or to be painted. Use wedge-shaped precast concrete supports, not larger than 3-1/2 by 3-1/2 inches, of thickness equal to that indicated for concrete cover and with an embedded hooked tie-wire for anchorage. Bar supports used in precast concrete with formed surfaces exposed to view must be the same quality, texture and color as the finish surfaces.

2.6 TESTS, INSPECTIONS, AND VERIFICATIONS

Perform material tests, specified and required by applicable standards, by an approved laboratory and certified to demonstrate that the materials are in conformance with the specifications. Perform and certify tests, inspections, and verifications and certify. Submit certified tests reports of reinforcement steel showing that the steel complies with the applicable specifications for each steel shipment and identified with specific lots prior to placement. Submit three copies of the heat analyses for each lot of steel furnished certifying that the steel conforms to the heat analyses.

2.6.1 Reinforcement Steel Tests

Perform mechanical testing of steel in accordance with ASTM A370 except as otherwise specified or required by the material specifications. Perform tension tests on full cross-section specimens using a gage length that spans the extremities of specimens with welds or sleeves included. From chemical analyses of steel heats report the percentages of carbon, phosphorous, manganese, sulphur and silicon present in the steel.

2.6.2 Non-Destructive Testing of Welds

Perform non-destructive testing of welds in accordance with AWS D1.4/D1.4M Section 7, except that radiographic testing is not permitted.

PART 3 EXECUTION

3.1 REINFORCEMENT

Fabricate and place reinforcement steel and accessories as specified, as indicated, and as shown on approved shop drawings. Fabrication and placement details of steel and accessories not specified or shown mustl be in accordance with ACI SP-66 and ACI 318. Cold bend reinforcement unless otherwise authorized. Bending may be accomplished in the field or at the mill. Do not bend bars after embedment in concrete. Place safety caps on all exposed ends of vertical concrete reinforcement bars that pose a danger to life safety. Face wire tie ends away from the forms. Submit detail drawings showing reinforcing steel placement, schedules, sizes, grades, and splicing and bending details. Show support details including types, sizes and spacing.

3.1.1 Placement

Reinforcement must be free from loose rust and scale, dirt, oil, or other deleterious coating that could reduce bond with the concrete. Place reinforcement in accordance with ACI 318 at locations indicated plus or minus one bar diameter. Do not continue reinforcement through expansion joints and place as indicated through construction or contraction joints. Cover with concrete coverage as indicated or as required by ACI 318. If bars are moved more than one bar diameter to avoid interference with other reinforcement, conduits or embedded items, the resulting arrangement of bars, including additional bars required to meet structural requirements, requires approval before concrete is placed.

3.1.2 Placing Tolerances

Conform bar spacing and concrete cover to ACI 117.

3.1.3 Splicing

Conform splices of reinforcement to ACI 318 and make only as required or indicated. Bars may be spliced at alternate or additional locations at no additional cost to the Government subject to approval. Splicing must be by lapping or by mechanical or welded butt connection; except that lap splices must not be used for bars larger than No. 11 unless otherwise indicated.

3.1.3.1 Lap Splices

Place lapped bars in contact and securely tied or spaced transversely apart to permit the embedment of the entire surface of each bar in concrete. Do not space lapped bars farther apart than 1/5 the required length of lap or 6 inches.

3.2 DOWEL INSTALLATION

Install dowels in slabs on grade at locations indicated and at right angles to joint being doweled. Accurately position and align dowels parallel to the finished concrete surface before concrete placement. Rigidly support dowels during concrete placement. Coat one end of dowels with a bond breaker.

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SECTION 03 23 00

STRESSED TENDON REINFORCING

05/16

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SECTION 03 23 00

STRESSED TENDON REINFORCING
05/16

PART 1 GENERAL

1.1 REFERENCES

The publications listed below form a part of this specification to the extent referenced. The publications are referred to within the text by the basic designation only.

AMERICAN CONCRETE INSTITUTE (ACI)

ACI 318	(2014; Errata 1-2 2014; Errata 3-5 2015; Errata 6 2016; Errata 7-9 2017) Building Code Requirements for Structural Concrete (ACI 318-14) and Commentary (ACI 318R-14)
ACI SP-66	(2004) ACI Detailing Manual

ASTM INTERNATIONAL (ASTM)

ASTM A722/A722M	(2015) Standard Specification for Uncoated High-Strength Steel Bar for Prestressing Concrete
ASTM C109/C109M	(2016a) Standard Test Method for Compressive Strength of Hydraulic Cement Mortars (Using 2-in. or (50-mm) Cube Specimens)

POST-TENSIONING INSTITUTE (PTI)

PTI DC35.1	(2014) Recommendations for Prestressed Rock and Soil Anchors
PTI M10.3	(2000) Field Procedures Manual for Unbonded Single Strand Tendons
PTI M55.1	(2012; ERTA 2012; Addendum 1 2013) Specification for Grouting of Post-Tensioned Structures
PTI-CRT-20 G1-1015	(2015) Manual for Certification of Plants Producing Unbonded Single Strand Tendons

1.2 SUBMITTALS

Government approval is required for submittals with a "G" designation; submittals not having a "G" designation are for information only. When used, a designation following the "G" designation identifies the office that will review the submittal for the Government. Submit the following in accordance with Section 01 33 00 SUBMITTAL PROCEDURES:

SD-02 Shop Drawings

Installation Drawings; G

Procedures for Grouting Operations; G

SD-03 Product Data

Prestressing Method and Equipment; G

Materials Disposition Records

Recycled Content for Steel; S

SD-06 Test Reports

Stressing Tendons and Accessories

SD-07 Certificates

Tendon Installer Qualifications

1.3 QUALITY ASSURANCE

1.3.1 Tendon Installer Qualifications

1.3.1.1 Unbonded Tendons

Installation crew must have at least two PTI Level 2 certified installers and all other personnel must be PTI Level 1 certified installers. Submit PTI certifications.

1.3.2 Installation Drawings

Submit detailed installation drawings for stressing tendons and accessories approved prior to commencing the work and showing the type and size of stressing tendons and anchorages, tendon profiles, erection methods, sequence of stressing and stressing calculations.

1.3.3 PTI Certified Plants

Fabrication plant must be certified by PTI-CRT-20 G1-1015.

1.4 DELIVERY, STORAGE, AND HANDLING

Deliver materials suitably wrapped, packaged or covered at the factory to prevent being affected by dirt, water and rust. Protect materials against abrasion or damage during shipment and handling. Place materials stored at the site above the ground on elevated, covered platforms.

PART 2 PRODUCTS

2.1 MATERIALS

Stressing tendons and accessories must conform to the requirements of ACI 318 except as specified. Submit certified materials test reports for all required materials tests; note the specific standards followed in the performance of tests, show that materials comply with the applicable specifications for each material shipment, and identified with specific lots prior to use of materials in the work.

2.1.1 Material Recycled Content

For products in this section, where applicable and to extent allowed by performance criteria, provide minimum 75 percent recycled content for steel

2.1.2 Stressing Tendons

High strength steel bar must be clean and free of loose rust, scale and pitting. Permanently protect unbonded steel bar from corrosion in accordance with requirements for Class I anchors as per PTI DC35.1, double corrosion protection system.

2.1.2.1 High-Strength Steel Bars

High-strength steel bars must conform to ASTM A722/A722M, Type I or II, Grade 1035 (150) meeting all supplementary requirements.

2.1.3 Accessories

2.1.3.1 Ducts

Provide tendon ducts of galvanized sheet steel or plastic, capable of transmitting forces from grout to the surrounding concrete, flexible enough to conform to the tendon profile and strong enough to maintain their shape without deforming, sagging, or collapsing during concrete placement and vibration. The inside diameter of the ducts must be large enough to provide an internal area at least two and a half times the gross area of multiple wire, bar or strand assemblies and must be at least 1/2-inch larger than the diameter of a single wire, bar or strand placed in the ducts. Design ducts for watertight connections with all fittings.

2.1.3.2 Anchorages and Couplers

Anchorages and couplers must be metal of proven corrosion resistance and compatible with the stressing tendons, capable of developing 95 percent of the actual breaking strength of the strands. Anchorages must be the button-head, wedge, nut and thread, grip nut, thread-bar, threaded plate or other approved type and must be provided with bearing plates bars, rings, bells or other positive-attaching anchor fittings. Provide couplers with housings long enough to permit the necessary movements and fittings which allow complete grouting of all components. Bar couplers must meet the requirements of ASTM A722/A722M and develop 100 percent of the minimum bar ultimate tensile strength.

2.1.3.3 Grout

Grout for grouting post-tensioned tendons must be a Class B in accordance with PTI M55.1. The minimum 7-day compressive strength of 2-inch grout cubes, molded, cured and tested in accordance with ASTM C109/C109M must be 3000 psi.

2.1.3.4 Encapsulation System

Watertight encapsulation of prestressing strand consisting of the following:

2.1.3.4.1 Sleeves

Attached to anchorage device with positive mechanical connection; overlapped a minimum of 4 inches with sheathing and completely filled with tendon coating.

2.1.3.5 Nonprestressed Steel Bars

Provide reinforcing bars in accordance with Section 03 30 53 MISCELLANEOUS CAST-IN-PLACE CONCRETE. Coordinate placement of nonprestressed steel reinforcement with installation of tendons.

2.2 TESTS, INSPECTIONS, AND VERIFICATIONS

Perform required material tests on stressing tendons and accessories by an approved laboratory to demonstrate that the materials are in conformance with the specifications. These tests are at the Contractor's expense.

PART 3 EXECUTION

3.1 INSTALLATION

Install or place stressing tendons and accessories as specified and as shown on contract and approved installation drawings. Installation details of stressing tendons and accessories not specified or shown must be in accordance with ACI SP-66, ACI 318 and PTI M10.3.

3.1.1 Anchorages

Set anchorages in a plane normal to the axis of the tendons such that uniform bearing on the concrete is assured. Do not switch fixed- and stressing-end anchorage locations from that shown on the approved installation drawings. Use positive connecting anchorages rather than gripping types for anchoring embedded ends of tendons. Permanently protect anchorages and anchor fittings against corrosion. Recess parallel wire anchorage wedges or cores within the members.

3.1.2 Prestressing Method and Equipment

Submit descriptions of the proposed prestressing methods and equipment approved prior to the start of prestressing operations and indicating the manufacturer of all prestressing equipment, including tensioning jacks, stress measurement gages, dynamometers and load cells or other devices for measuring stressing loads. Descriptions must include certified calibration records for each set of jacking equipment and testing curves for stress measurement gages which show that the gages have been calibrated for the jacks for which they are to be used.

3.1.3 Tensioning

Tension stressing high strength steel bars as specified and indicated. Determine the stress induced in the steel bar by any method of tensioning independently by both (1) measurement of steel rod elongation and (2) direct measurement of force using a pressure gauge or load cell. If the results of these two measurements do not check each other and the theoretical values are not within 7 percent, carefully check the operation and determine and correct the source of error before proceeding further. Concrete cylinder tests must indicate a breaking strength of at least 4000 psi before transfer of stress to ensure that the concrete strength is adequate.

3.1.3.1 Post-Tensioning

Do not perform tensioning until the concrete has reached the required strength at transfer of stress. Measure the force corresponding to the initial tension by a dynamometer or other approved method as a starting point in determining final elongation. The units must be tensioned until the proper elongations and jacking pressures are attained and reconciled within the limits stated above.

3.1.4 Grouting Post-Tensioned High Strength Steel Rods

At least four weeks prior to the start of construction submit written procedures for grouting operations for approval. Do not perform grouting if air temperature below 45 degrees F is anticipated within 48 hours after grouting unless an approved method of temperature control is used. Mix the grout in a mechanical mixer of a type that will produce uniformly and thoroughly mixed grout. First, place water in the mixer followed by cement and admixture. Continuously agitate frout until it is pumped. Discard grout that has not been used within 30 minutes of the first addition of water to ensure the flowability of the grout. With the grout vent open at one end of duct, apply grout continuously under moderate pressure at the other end until all entrapped air is forced out as indicated by a uniform flow of grout from the discharge vent. Vent pipe is to be at least 5 feet higher than the grout injection point. Close the injection point by an approved means to prevent any loss of grout.

3.1.5 Accuracy of Stress and Elongation Measurement

3.1.5.1 Stress Measurement

Hydraulic gauges, dynamometers, load cells or other devices for measuring stressing load must have an accuracy of reading within two percent for stress measurement. Gauges are required to have been calibrated for the jacks for which they are used within a period not exceeding six months. Perform recalibration at any time that a gaging system shows indication of erratic results in the opinion of the Contracting Officer. Gauges must indicate loads directly in pounds or be accompanied by a chart which converts dial readings into pounds.

3.1.5.2 Elongation Measurement

After the initial force has been applied to a tendon, establish reference points for measuring elongation due to additional tensioning forces. They must be located according to the method of tensioning and type of equipment. The system used must be capable of measuring the true elongation plus or minus 1/16-inch.

3.2 INSPECTION

The Contractor's facilities must be open for inspection by the Contracting Officer at any time.

3.3 MATERIALS DISPOSITION RECORDS

Compile accurate materials disposition records, identifying all materials incorporated into the work and showing the disposition of specific lots of approved tested materials. Submit records which identify the incorporation of approved materials into the work before completion of the contract.

-- End of Section --

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DIVISION 03 - CONCRETE

SECTION 03 30 53

MISCELLANEOUS CAST-IN-PLACE CONCRETE

05/14

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SECTION 03 30 53

MISCELLANEOUS CAST-IN-PLACE CONCRETE
05/14

PART 1 GENERAL

1.1 SUMMARY

Perform all work in accordance with ACI 318.

1.2 REFERENCES

The publications listed below form a part of this specification to the extent referenced. The publications are referred to within the text by the basic designation only.

AMERICAN CONCRETE INSTITUTE (ACI)

ACI 117	(2010; Errata 2011) Specifications for Tolerances for Concrete Construction and Materials and Commentary
ACI 301	(2016) Specifications for Structural Concrete
ACI 302.1R	(2015) Guide for Concrete Floor and Slab Construction
ACI 304R	(2000; R 2009) Guide for Measuring, Mixing, Transporting, and Placing Concrete
ACI 305R	(2010) Guide to Hot Weather Concreting
ACI 306R	(2016) Guide to Cold Weather Concreting
ACI 318	(2014; Errata 1-2 2014; Errata 3-5 2015; Errata 6 2016; Errata 7-9 2017) Building Code Requirements for Structural Concrete (ACI 318-14) and Commentary (ACI 318R-14)
ACI 347R	(2014; Errata 1 2017) Guide to Formwork for Concrete
ACI SP-66	(2004) ACI Detailing Manual

ASTM INTERNATIONAL (ASTM)

ASTM A1064/A1064M	(2017) Standard Specification for Carbon-Steel Wire and Welded Wire Reinforcement, Plain and Deformed, for Concrete
ASTM A615/A615M	(2016) Standard Specification for Deformed and Plain Carbon-Steel Bars for Concrete Reinforcement

ASTM C1064/C1064M	(2017) Standard Test Method for Temperature of Freshly Mixed Hydraulic-Cement Concrete
ASTM C1260	(2014) Standard Test Method for Potential Alkali Reactivity of Aggregates (Mortar-Bar Method)
ASTM C143/C143M	(2015) Standard Test Method for Slump of Hydraulic-Cement Concrete
ASTM C150/C150M	(2018) Standard Specification for Portland Cement
ASTM C1567	(2013) Standard Test Method for Potential Alkali-Silica Reactivity of Combinations of Cementitious Materials and Aggregate (Accelerated Mortar-Bar Method)
ASTM C1602/C1602M	(2012) Standard Specification for Mixing Water Used in Production of Hydraulic Cement Concrete
ASTM C172/C172M	(2017) Standard Practice for Sampling Freshly Mixed Concrete
ASTM C173/C173M	(2016) Standard Test Method for Air Content of Freshly Mixed Concrete by the Volumetric Method
ASTM C231/C231M	(2017a) Standard Test Method for Air Content of Freshly Mixed Concrete by the Pressure Method
ASTM C260/C260M	(2010a; R 2016) Standard Specification for Air-Entraining Admixtures for Concrete
ASTM C309	(2011) Standard Specification for Liquid Membrane-Forming Compounds for Curing Concrete
ASTM C31/C31M	(2018b) Standard Practice for Making and Curing Concrete Test Specimens in the Field
ASTM C33/C33M	(2018) Standard Specification for Concrete Aggregates
ASTM C39/C39M	(2018) Standard Test Method for Compressive Strength of Cylindrical Concrete Specimens
ASTM C494/C494M	(2017) Standard Specification for Chemical Admixtures for Concrete
ASTM C618	(2017a) Standard Specification for Coal Fly Ash and Raw or Calcined Natural Pozzolan for Use in Concrete

ASTM C685/C685M	(2017) Standard Specification for Concrete Made by Volumetric Batching and Continuous Mixing
ASTM C920	(2018) Standard Specification for Elastomeric Joint Sealants
ASTM C94/C94M	(2017a) Standard Specification for Ready-Mixed Concrete
ASTM D1752	(2018) Standard Specification for Preformed Sponge Rubber, Cork and Recycled PVC Expansion Joint Fillers for Concrete Paving and Structural Construction
ASTM D412	(2016) Standard Test Methods for Vulcanized Rubber and Thermoplastic Elastomers - Tension
ASTM D471	(2016a) Standard Test Method for Rubber Property - Effect of Liquids
ASTM D75/D75M	(2014) Standard Practice for Sampling Aggregates
ASTM E1155	(2014) Standard Test Method for Determining Floor Flatness and Floor Levelness Numbers
ASTM E1155M	(2014) Standard Test Method for Determining Floor Flatness and Floor Levelness Numbers (Metric)
ASTM E1643	(2018a) Standard Practice for Selection, Design, Installation, and Inspection of Water Vapor Retarders Used in Contact with Earth or Granular Fill Under Concrete Slabs
ASTM E1745	(2017) Standard Specification for Water Vapor Retarders Used in Contact with Soil or Granular Fill under Concrete Slabs
ASTM E1993/E1993M	(1998; R 2013; E 2013) Standard Specification for Bituminous Water Vapor Retarders Used in Contact with Soil or Granular Fill Under Concrete Slabs
ASTM E96/E96M	(2016) Standard Test Methods for Water Vapor Transmission of Materials

U.S. ARMY CORPS OF ENGINEERS (USACE)

COE CRD-C 513	(1974) Corps of Engineers Specifications for Rubber Waterstops
COE CRD-C 572	(1974) Corps of Engineers Specifications for Polyvinylchloride Waterstops

U.S. NATIONAL ARCHIVES AND RECORDS ADMINISTRATION (NARA)

40 CFR 247	Comprehensive Procurement Guideline for Products Containing Recovered Materials

1.3 SUBMITTALS

Government approval is required for submittals with a "G" designation; submittals not having a "G" designation are for information only. When used, a designation following the "G" designation identifies the office that will review the submittal for the Government. Submit the following in accordance with Section 01 33 00 SUBMITTAL PROCEDURES:

SD-02 Shop Drawings

Installation Drawings; G

SD-03 Product Data

Air-Entraining Admixture
Water-Reducing or Retarding Admixture
Curing Materials
Expansion Joint Filler Strips, Premolded
Joint Sealants - Field Molded Sealants
Waterstops
Chemical Floor Hardener
Batching and Mixing Equipment
Conveying and Placing Concrete
Formwork
Mix Design Data; G
Ready-Mix Concrete
Curing Compound
Mechanical Reinforcing Bar Connectors

SD-06 Test Reports

Aggregates
Concrete Mixture Proportions; G
Compressive Strength Testing; G
Slump; G
Air Content
Water

SD-07 Certificates

Cementitious Materials
Pozzolan
Aggregates
Delivery Tickets

SD-08 Manufacturer's Instructions

Chemical Floor Hardener
Curing Compound

1.4 QUALITY ASSURANCE

Indicate specific locations of Concrete Placement, Forms, Steel Reinforcement, Accessories, Expansion Joints, Construction Joints, Contraction Joints, Control Joints on installation drawings and include, but not be limited to, square feet of concrete placements, thicknesses and widths, plan dimensions, and arrangement of cast-in-place concrete section.

1.4.1 Flatness and Levelness of Floor Slabs

Conduct floor flatness and levelness test, (FF and FL respectively), on floor slabs in accordance with the provisions set forth in ASTM E1155M or ASTM E1155. Make floor tolerance measurements by the approved laboratory and inspection service within 24 hours after completion of final troweling operation and before forms and shores have been removed. Provide results of floor tolerance tests, including formal notice of acceptance or rejection of the work, to the Contracting Officer within 24 hours after data collection.

PART 2 PRODUCTS

2.1 SYSTEM DESCRIPTION

The Government retains the option to sample and test joint sealer, joint filler material, waterstop, aggregates and concrete to determine compliance with the specifications. Provide facilities and labor as may be necessary to assist the Government in procurement of representative test samples. Obtain samples of aggregates at the point of batching in accordance with ASTM D75/D75M. Sample concrete in accordance with ASTM C172/C172M. Determine slump and air content in accordance with ASTM C143/C143M and ASTM C231/C231M, respectively, when cylinders are molded. Prepare, cure, and transport compression test specimens in accordance with ASTM C31/C31M. Test compression test specimens in accordance with ASTM C39/C39M. Take samples for strength tests not less than once each shift in which concrete is produced from each strength of concrete required. Provide a minimum of five specimens from each sample; two to be tested at 28 days (90 days if pozzolan is used) for acceptance, two will be tested at 7 days for information and one held in reserve.

2.1.1 Strength

Acceptance test results are the average strengths of two specimens tested at 28 days (90 days if pozzolan is used). The strength of the concrete is considered satisfactory so long as the average of three consecutive acceptance test results equal or exceed the specified compressive strength, f'c, but not more than 20 percent, and no individual acceptance test result falls below f'c by more than 500 psi.

2.1.2 Construction Tolerances

Apply a Class "C" finish to all surfaces except those specified to receive a Class "D" finish. Apply a Class "D" finish to all post-construction surfaces which will be permanently concealed. Surface requirements for the classes of finish required are as specified in ACI 117.

2.1.3 Concrete Mixture Proportions

Concrete mixture proportions are the responsibility of the Contractor. Mixture proportions must include the dry weights of cementitious material(s); the nominal maximum size of the coarse aggregate; the specific gravities, absorptions, and saturated surface-dry weights of fine and coarse aggregates; the quantities, types, and names of admixtures; and quantity of water per yard of concrete. Provide materials included in the mixture proportions of the same type and from the same source as will be used on the project. The specified compressive strength f'c is 4,000 psi at 28 days (90 days if pozzolan is used). The maximum nominal size coarse aggregate is 3/4 inch, in accordance with ACI 304R. The air content must be between 4.5 and 7.5 percent with a slump between 2 and 5 inches. The maximum water-cementitious material ratio is 0.45. Submit the applicable test reports and mixture proportions that will produce concrete of the quality required, ten days prior to placement of concrete.

2.2 MATERIALS

Submit manufacturer's literature from suppliers which demonstrates compliance with applicable specifications for the specified materials.

2.2.1 Cementitious Materials

Submit Manufacturer's certificates of compliance, accompanied by mill test reports, attesting that the concrete materials meet the requirements of the specifications in accordance with the Special Clause "CERTIFICATES OF COMPLIANCE". Also, certificates for all material conforming to EPA's Comprehensive Procurement Guidelines (CPG), in accordance with 40 CFR 247. Provide cementitious materials that conform to the appropriate specifications listed:

2.2.1.1 Portland Cement

ASTM C150/C150M, Type II, low alkali including false set requirements with tri-calcium aluminates (C3A) content less than 10 percent and a maximum cement-alkali content of 0.80 percent Na2Oe (sodium oxide) equivalent.

2.2.1.2 Pozzolan

Provide pozzolan that conforms to ASTM C618, Class F, including requirements of Tables 1A and 2A.

2.2.2 Aggregates

For fine and coarse aggregates meet the quality and grading requirements of ASTM C33/C33M and test and evaluate for alkali-aggregate reactivity in accordance with ASTM C1260. Perform evaluation of fine and coarse aggregates separately and in combination, matching the proposed mix design proportioning. All results of the separate and combination testing must have a measured expansion less than 0.08 percent at 28 days after casting. If the test data indicates an expansion of 0.08 percent or greater, reject the aggregate(s) or perform additional testing using ASTM C1260 and ASTM C1567. Perform the additional testing using ASTM C1260 and ASTM C1567 using the low alkali portland cement in combination with ground granulated blast furnace (GGBF) slag, or Class F fly ash. Use GGBF slag in the range of 40 to 50 percent of the total cementitious material by mass. Use Class F fly ash in the range of 25 to 40 percent of the total cementitious material by mass. Submit certificates of compliance and test reports for aggregates showing the material(s) meets the quality and grading requirements of the specifications under which it is furnished.

2.2.3 Admixtures

Provide admixtures, when required or approved, in compliance with the appropriate specification listed. Retest chemical admixtures that have been in storage at the project site, for longer than 6 months or that have been subjected to freezing, at the expense of the Contractor at the request of the Contracting Officer and will be rejected if test results are not satisfactory.

2.2.3.1 Air-Entraining Admixture

Provide air-entraining admixture that meets the requirements of ASTM C260/C260M.

2.2.3.2 Water-Reducing or Retarding Admixture

Provide water-reducing or retarding admixture meeting the requirements of ASTM C494/C494M, Type A, B, or D.

2.2.4 Water

Mixing and curing water in compliance with the requirements of ASTM C1602/C1602M; potable, and free of injurious amounts of oil, acid, salt, or alkali. Submit test report showing water complies with ASTM C1602/C1602M.

2.2.5 Reinforcing Steel

Provide reinforcing bars conforming to the requirements of ASTM A615/A615M, Grade 60, deformed. Provide welded steel wire reinforcement conforming to the requirements of ASTM A1064/A1064M. Detail reinforcement not indicated in accordance with ACI 301 and ACI SP-66. Provide mechanical reinforcing bar connectors in accordance with ACI 301 and provide 125 percent minimum yield strength of the reinforcement bar.

2.2.6 Expansion Joint Filler Strips, Premolded

Expansion joint filler strips, premolded of sponge rubber conforming to ASTM D1752, Type I.

2.2.7 Joint Sealants - Field Molded Sealants

Conform to ASTM C920, Type M, Grade NS, Class 25, use NT for vertical joints and Type M, Grade P, Class 25, use T for horizontal joints. Provide polyethylene tape, coated paper, metal foil, or similar type bond breaker materials. The backup material needs to be compressible, nonshrink, nonreactive with the sealant, and a nonabsorptive material such as extruded butyl or polychloroprene foam rubber. Immediately prior to installation of field-molded sealants, clean the joint of all debris and further cleaned using water, chemical solvents, or other means as recommended by the sealant manufacturer or directed.

2.2.8 Formwork

Design and engineer the formwork as well as its construction in accordance with ACI 301 Section 2 and 5 and ACI 347R. Fabricate of wood, steel, or other approved material. Submit formwork design prior to the first concrete placement.

2.2.9 Form Coatings

Provide form coating in accordance with ACI 301.

2.2.10 Vapor Retarder and Vapor Barrier

ASTM E1745 Class C polyethylene sheeting, minimum 15 mil thickness or ASTM E1993/E1993M bituminous membrane or other equivalent material with a maximum permeance rating of 0.01 perms per ASTM E96/E96M.

Consider plastic vapor retarders and adhesives with a high recycled content, low toxicity low VOC (Volatile Organic Compounds) levels.

2.2.11 Curing Materials

Provide curing materials in accordance with ACI 301, Section 5.

2.3 READY-MIX CONCRETE

Provide ready-mix concrete with mix design data conforming to ACI 301 Part 2. Submit delivery tickets in accordance with ASTM C94/C94M for each ready-mix concrete delivery, include the following additional information: .

a. Type and brand cement

b. Cement content in 94-pound bags per cubic yard of concrete

c. Maximum size of aggregate

d. Amount and brand name of admixture

e. Total water content expressed by water cementitious material ratio

2.4 ACCESSORIES

2.4.1 Waterstops

2.4.1.1 PVC Waterstop

Polyvinylchloride waterstops conforming to COE CRD-C 572.

2.4.1.2 Rubber Waterstop

Rubber waterstops conforming to COE CRD-C 513.

2.4.1.3 Thermoplastic Elastomeric Rubber Waterstop

Thermoplastic elastomeric rubber waterstops conforming to ASTM D471.

2.4.1.4 Hydrophilic Waterstop

Swellable strip type compound of polymer modified chloroprene rubber that swells upon contact with water conforming to ASTM D412 as follows: Tensile strength 420 psi minimum; ultimate elongation 600 percent minimum. Minimum hardness of 50 on the type A durometer and the volumetric expansion ratio in distilled water at 70 degrees F; 3 to 1 minimum.

2.4.2 Chemical Floor Hardener

Provide hardener which is a colorless aqueous solution containing a blend of inorganic silicate or siliconate material and proprietary components combined with a wetting agent; that penetrates, hardens, and densifies concrete surfaces. Submit manufactures instructions for placement of liquid chemical floor hardener.

2.4.3 Curing Compound

Provide curing compound conforming to ASTM C309. Submit manufactures instructions for placing curing compound.

PART 3 EXECUTION

3.1 PREPARATION

Prepare construction joints to expose coarse aggregate. The surface must be clean, damp, and free of laitance. Construct ramps and walkways, as necessary, to allow safe and expeditious access for concrete and workmen. Remove snow, ice, standing or flowing water, loose particles, debris, and foreign matter. Satisfactorily compact earth foundations. Make spare vibrators available. Placement cannot begin until the entire preparation has been accepted by the Government.

3.1.1 Embedded Items

Secure reinforcement in place after joints, anchors, and other embedded items have been positioned. Arrange internal ties so that when the forms are removed the metal part of the tie is not less than 2 inches from concrete surfaces permanently exposed to view or exposed to water on the finished structures. Prepare embedded items so they are be free of oil and other foreign matters such as loose coatings or rust, paint, and scale. The embedding of wood in concrete is permitted only when specifically authorized or directed. Provide all equipment needed to place, consolidate, protect, and cure the concrete at the placement site and in good operating condition.

3.1.2 Formwork Installation

Forms must be properly aligned, adequately supported, and mortar-tight. Provide smooth form surfaces, free from irregularities, dents, sags, or holes when used for permanently exposed faces. Chamfer all exposed joints and edges , unless otherwise indicated.

3.1.3 Vapor Retarder and Vapor Barrier Installation

Install in accordance with ASTM E1643. Apply vapor retarder and barrier over gravel fill. Lap edges not less than 12 inches. Seal all joints with pressure-sensitive adhesive not less than 2 inches wide. Protect the vapor barrier at all times to prevent injury or displacement prior to and during concrete placement.

3.1.4 Production of Concrete

3.1.4.1 Ready-Mixed Concrete

Provide ready-mixed concrete conforming to ASTM C94/C94M except as otherwise specified.

3.1.4.2 Concrete Made by Volumetric Batching and Continuous Mixing

Conform to ASTM C685/C685M.

3.1.4.3 Batching and Mixing Equipment

The option of using an on-site batching and mixing facility is available. The facility must provide sufficient batching and mixing equipment capacity to prevent cold joints. Submit the method of measuring materials, batching operation, and mixer for review, and manufacturer's data for batching and mixing equipment demonstrating compliance with the applicable specifications. Provide an Onsite Plant conforming to the requirements of either ASTM C94/C94M or ASTM C685/C685M.

3.1.5 Waterstops

Install and splice waterstops as directed by the manufacturer.

3.2 CONVEYING AND PLACING CONCRETE

Convey and place concrete in accordance with ACI 301, Section 5.

3.2.1 Cold-Weather Requirements

Place concrete in cold weather in accordance with ACI 306R

3.2.2 Hot-Weather Requirements

Place concrete in hot weather in accordance with ACI 305R

3.3 FINISHING

3.3.1 Temperature Requirement

Do not finish or repair concrete when either the concrete or the ambient temperature is below 50 degrees F.

3.3.2 Finishing Formed Surfaces

Remove all fins and loose materials , and surface defects including filling of tie holes. Repair all honeycomb areas and other defects. Remove all unsound concrete from areas to be repaired. Ream or chip surface defects greater than 1/2 inch in diameter and holes left by removal of tie rods in all surfaces not to receive additional concrete and fill with dry-pack mortar. Brush-coat the prepared area with an approved epoxy resin or latex bonding compound or with a neat cement grout after dampening and filling with mortar or concrete. Use a blend of portland cement and white cement in mortar or concrete for repairs to all surfaces permanently exposed to view shall be so that the final color when cured is the same as adjacent concrete.

3.3.3 Finishing Unformed Surfaces

3.3.3.1 Flat Floor Finishes

In accordance with ACI 302.1R, construct in accordance with one of the methods recommended in Table 7.15.3, "Typical Composite FF/FL Values for Various Construction Methods." ACI 117 for tolerances tested by ASTM E1155M or ASTM E1155. These requirements are based upon the latest FF/FL method.

3.3.3.2 Expansion and Contraction Joints

Make expansion and contraction joints in accordance with the details shown or as otherwise specified. Provide 1/2 inch thick transverse expansion joints where new work abuts an existing concrete. Provide expansion joints at a maximum spacing of 30 feet on center in sidewalks and at a maximum spacing of 40 feet in slabs, unless otherwise indicated. Provide contraction joints at a maximum spacing of 6 linear feet in sidewalks feet in slabs, unless otherwise indicated. Cut contraction joints at a minimum of 1 inch(es) deep with a jointing tool after the surface has been finished.

3.4 CURING AND PROTECTION

Cure and protect in accordance with ACI 301, Section 5.

3.5 FORM WORK

Provide form work in accordance with ACI 301, Section 2 and Section 5.

3.5.1 Removal of Forms

Remove forms in accordance with ACI 301, Section 2.

3.6 STEEL REINFORCING

Reinforcement must be free from loose, flaky rust and scale, and free from oil, grease, or other coating which might destroy or reduce the reinforcement's bond with the concrete.

3.6.1 Fabrication

Shop fabricate steel reinforcement in accordance with ACI 318 and ACI SP-66. Provide shop details and bending in accordance with ACI 318 and ACI SP-66.

3.6.2 Splicing

Perform splices in accordance with ACI 318 and ACI SP-66.

3.6.3 Supports

Secure reinforcement in place by the use of metal or concrete supports, spacers, or ties.

3.7 EMBEDDED ITEMS

Before placing concrete, take care to determine that all embedded items are firmly and securely fastened in place. Provide embedded items free of oil and other foreign matter, such as loose coatings of rust, paint and scale. Embedding of wood in concrete is permitted only when specifically authorized or directed.

3.8 CHEMICAL FLOOR HARDENER

Apply Chemical Floor Hardener where indicated, after curing and drying concrete surface. Dilute liquid hardener with water and apply in three coats. First coat is one-third strength, second coat one-half strength, and third coat two-thirds strength. Apply each coat evenly and allow it to dry 24 hours before applying next coat. Apply proprietary chemical hardeners in accordance with manufacturer's printed directions.

3.9 TESTING AND INSPECTING

Report the results of all tests and inspections conducted at the project site informally at the end of each shift. Submit written reports weekly. Deliver within three days after the end of each weekly reporting period. See Section 01 45 00 QUALITY CONTROL.

3.9.1 Field Testing Technicians

The individuals who sample and test concrete must have demonstrated a knowledge and ability to perform the necessary test procedures equivalent to the ACI minimum guidelines for certification of Concrete Field Testing Technicians, Grade I.

3.9.2 Preparations for Placing

Inspect foundation or construction joints, forms, and embedded items in sufficient time prior to each concrete placement to certify that it is ready to receive concrete.

3.9.3 Sampling and Testing

a. Obtain samples and test concrete for quality control during placement. Sample fresh concrete for testing in accordance with ASTM C172/C172M. Make six test cylinders.

b. Test concrete for compressive strength at 7 and 28 days for each design mix and for every 100 cubic yards of concrete. Test two cylinders at 7 days; two cylinders at 28 days; and hold two cylinders in reserve. Conform test specimens to ASTM C31/C31M. Perform compressive strength testing conforming to ASTM C39/C39M.

c. Test slump at the site of discharge for each design mix in accordance with ASTM C143/C143M. Check slump twice during each shift that concrete is produced.

d. Test air content for air-entrained concrete in accordance with ASTM C231/C231M. Test concrete using lightweight or extremely porous aggregates in accordance with ASTM C173/C173M. Check air content at least twice during each shift that concrete is placed.

e. Determine temperature of concrete at time of placement in accordance with ASTM C1064/C1064M. Check concrete temperature at least twice during each shift that concrete is placed.

3.9.4 Action Required

3.9.4.1 Placing

Do not begin placement until the availability of an adequate number of acceptable vibrators, which are in working order and have competent operators, has been verified. Discontinue placing if any lift is inadequately consolidated.

3.9.4.2 Air Content

Whenever an air content test result is outside the specification limits, adjust the dosage of the air-entrainment admixture prior to delivery of concrete to forms.

3.9.4.3 Slump

Whenever a slump test result is outside the specification limits, adjust the batch weights of water and fine aggregate prior to delivery of concrete to the forms. Make the adjustments so that the water-cementitious material ratio does not exceed that specified in the submitted concrete mixture proportion and the required concrete strength is still met.

-- End of Section --

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DIVISION 03 - CONCRETE

SECTION 03 31 01

CAST-IN-PLACE STRUCTURAL CONCRETE FOR CIVIL WORKS

05/14

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SECTION 03 31 01

CAST-IN-PLACE STRUCTURAL CONCRETE FOR CIVIL WORKS
05/14

PART 1 GENERAL

1.1 REFERENCES

The publications listed below form a part of this specification to the extent referenced. The publications are referred to within the text by the basic designation only.

AMERICAN CONCRETE INSTITUTE (ACI)

ACI 211.1	(1991; R 2009) Standard Practice for Selecting Proportions for Normal, Heavyweight and Mass Concrete

AMERICAN CONCRETE INSTITUTE (ACI)

ACI 117	(2010; Errata 2011) Specifications for Tolerances for Concrete Construction and Materials and Commentary
ACI 301	(2016) Specifications for Structural Concrete
ACI 305R	(2010) Guide to Hot Weather Concreting
ACI 306R	(2016) Guide to Cold Weather Concreting
ACI SP-15	(2011) Field Reference Manual: Standard Specifications for Structural Concrete ACI 301-05 with Selected ACI References

ASTM INTERNATIONAL (ASTM)

ASTM A1064/A1064M	(2017) Standard Specification for Carbon-Steel Wire and Welded Wire Reinforcement, Plain and Deformed, for Concrete
ASTM A615/A615M	(2016) Standard Specification for Deformed and Plain Carbon-Steel Bars for Concrete Reinforcement
ASTM C1064/C1064M	(2017) Standard Test Method for Temperature of Freshly Mixed Hydraulic-Cement Concrete
ASTM C1077	(2017) Standard Practice for Agencies Testing Concrete and Concrete Aggregates for Use in Construction and Criteria for Testing Agency Evaluation

ASTM C1107/C1107M	(2014a) Standard Specification for Packaged Dry, Hydraulic-Cement Grout (Nonshrink)
ASTM C117	(2017) Standard Test Method for Materials Finer than 75-um (No. 200) Sieve in Mineral Aggregates by Washing
ASTM C123/C123M	(2014) Standard Test Method for Lightweight Particles in Aggregate
ASTM C1240	(2014) Standard Specification for Silica Fume Used in Cementitious Mixtures
ASTM C127	(2015) Standard Test Method for Density, Relative Density (Specific Gravity), and Absorption of Coarse Aggregate
ASTM C128	(2015) Standard Test Method for Density, Relative Density (Specific Gravity), and Absorption of Fine Aggregate
ASTM C131/C131M	(2014) Standard Test Method for Resistance to Degradation of Small-Size Coarse Aggregate by Abrasion and Impact in the Los Angeles Machine
ASTM C136/C136M	(2014) Standard Test Method for Sieve Analysis of Fine and Coarse Aggregates
ASTM C142/C142M	(2017) Standard Test Method for Clay Lumps and Friable Particles in Aggregates
ASTM C143/C143M	(2015) Standard Test Method for Slump of Hydraulic-Cement Concrete
ASTM C150/C150M	(2018) Standard Specification for Portland Cement
ASTM C1602/C1602M	(2012) Standard Specification for Mixing Water Used in Production of Hydraulic Cement Concrete
ASTM C172/C172M	(2017) Standard Practice for Sampling Freshly Mixed Concrete
ASTM C231/C231M	(2017a) Standard Test Method for Air Content of Freshly Mixed Concrete by the Pressure Method
ASTM C260/C260M	(2010a; R 2016) Standard Specification for Air-Entraining Admixtures for Concrete
ASTM C295/C295M	(2012) Petrographic Examination of Aggregates for Concrete
ASTM C31/C31M	(2018b) Standard Practice for Making and Curing Concrete Test Specimens in the Field

ASTM C33/C33M	(2018) Standard Specification for Concrete Aggregates
ASTM C39/C39M	(2018) Standard Test Method for Compressive Strength of Cylindrical Concrete Specimens
ASTM C40/C40M	(2016) Standard Test Method for Organic Impurities in Fine Aggregates for Concrete
ASTM C494/C494M	(2017) Standard Specification for Chemical Admixtures for Concrete
ASTM C535	(2016) Standard Test Method for Resistance to Degradation of Large-Size Coarse Aggregate by Abrasion and Impact in the Los Angeles Machine
ASTM C566	(2013) Standard Test Method for Total Evaporable Moisture Content of Aggregate by Drying
ASTM C618	(2017a) Standard Specification for Coal Fly Ash and Raw or Calcined Natural Pozzolan for Use in Concrete
ASTM C666/C666M	(2015) Resistance of Concrete to Rapid Freezing and Thawing
ASTM C87/C87M	(2017) Standard Test Method for Effect of Organic Impurities in Fine Aggregate on Strength of Mortar
ASTM C94/C94M	(2017a) Standard Specification for Ready-Mixed Concrete
ASTM C989/C989M	(2017) Standard Specification for Slag Cement for Use in Concrete and Mortars
ASTM D75/D75M	(2014) Standard Practice for Sampling Aggregates

CONCRETE REINFORCING STEEL INSTITUTE (CRSI)

CRSI 10MSP	(2009; 28th Ed; Errata) Manual of Standard Practice

NATIONAL INSTITUTE OF STANDARDS AND TECHNOLOGY (NIST)

NIST HB 44	(2016) Specifications, Tolerances, and Other Technical Requirements for Weighing and Measuring Devices

NATIONAL READY MIXED CONCRETE ASSOCIATION (NRMCA)

NRMCA CPMB 100	(2000; R 2006) Concrete Plant Standards

U.S. ARMY CORPS OF ENGINEERS (USACE)

COE CRD-C 104	(1980) Method of Calculation of the Fineness Modulus of Aggregate
COE CRD-C 114	(1997) Test Method for Soundness of Aggregates by Freezing and Thawing of Concrete Specimens
COE CRD-C 130	(2001) Standard Recommended Practice for Estimating Scratch Hardness of Coarse Aggregate Particles
COE CRD-C 143	(1962) Specifications for Meters for Automatic Indication of Moisture in Fine Aggregate
COE CRD-C 521	(1981) Standard Test Method for Frequency and Amplitude of Vibrators for Concrete
COE CRD-C 94	(1995) Corps of Engineers Specification for Surface Retarders

1.2 DESIGN REQUIREMENTS

For each portion of the structure, select concrete mixture proportions so that the strength and water/cementitious materials ratio (W/C) requirements are met. Submit concrete mixture proportions as determined by the Contractor and submitted for review and signed by a registered Civil Engineer experienced in concrete mix proportioning. The submission shall be accompanied by test reports from a laboratory complying with ASTM C1077, and that has been validated by the USACE Materials Test Center (MTC) for the applicable methods.

The proportions of all material entering into each concrete mixture will be the responsibility of the Contractor. Adjustments shall be made by the Contractor to the batch weights of aggregates and water as necessary to compensate for free moisture in the aggregates. The quantity of air-entrainment admixture shall be adjusted by the Contractor to maintain the specified air content

Design in accordance with ACI 301, Section 4. Submit concrete mix designs with the following properties.

1.2.1 Concrete Proportioning

The mix design and supporting test data shall show that mix proportions thus selected will produce concrete of the qualities indicated. No substitution shall be made in the source or type of materials used in the work without additional tests to show that the quality of the new materials and concrete are satisfactory. The concrete mixture quantities of all ingredients per cubic yard and nominal maximum coarse aggregate size that will be used in the manufacture of each quality of concrete shall be stated. Proportions shall indicate the mass of cement, pozzolan and ground granulated blast-furnace (GGBF) slag, silica fume or ultrafine fly ash when used, and water; the mass of aggregates in a saturated surface-dry condition; and the quantities of admixtures. Trial batches and testing requirements for various qualities of concrete specified are the responsibility of the Contractor. Obtain samples of aggregates in accordance with the requirements of ASTM D75/D75M. Samples of materials other than aggregate shall be representative of those proposed for the project and shall be accompanied by the manufacturer's test reports indicating compliance with applicable specified requirements. Make trial mixtures having proportions, consistencies, and air content suitable for the work based on methodology described in ACI 211.1, using at least three different water-cement ratios, which will produce a range of strength encompassing those required for the work. The maximum water-cement ratios required in paragraph MAXIMUM WATER-CEMENT (W/C) RATIO below, will be converted to a weight ratio of water to cement plus pozzolan by mass, silica fume, or GGBF slag by mass equivalency as described in ACI 211.1. In the case where GGBF slag is used, include the weight of the slag in the equations for the term P, which is used to denote the mass of pozzolan. If pozzolan is used in the concrete mixture, the minimum pozzolan content shall be 15 percent of the total cementitious material and as otherwise required herein. Proportion trial mixtures for maximum permitted slump and air content with due consideration to the conveying and placement method.

1.2.2 Concrete Composition

Concrete shall be composed of cementitious materials, water, fine and coarse aggregates, and admixtures. The cementitious materials shall be Type II low alkali, Portland cement in combination with pozzolan, or Type II low alkali Portland cement in combination with ground granulated blast-furnace slag. Silica fume or ultrafine fly ash may be used in Abrasion Erosion Resistant Concrete (AERC).

The proportion of GGBS slag and Class F pozzolan shall be as follows:

Required Proportion of Total Cementitious Materials in % by mass	
Proportions	Structural Concrete
GGBF Slag	30 to 50
Class F Pozzolan	15 to 40

The admixtures shall be an air-entraining admixture plus a water-reducing admixture, and for some mixes a high range water-reducing admixture will be required. A retarding mixture may be used at the request of the Contractor when approved. No other chemical admixtures than those listed above shall be used.

Aggregate size shall be as stipulated below.

1.2.3 Nominal Maximum-Size of Aggregate

The nominal maximum-size of coarse aggregate to be used in all concrete work shall be 3/4 inch.

1.2.4 Air Content

Air content between 4 and 7 percent as delivered to the forms and as determined by ASTM C231/C231M, except that when the nominal maximum-size coarse aggregate is 3/4 inch, between 4.5 and 7.5 percent.

1.2.5 Slump

The slump within the range of 1 to 4 inches as determined in accordance with ASTM C143/C143M. Where placement by pump is approved, the slump must not exceed 6 inches. .

1.2.6 Concrete Strength

Provide specified compressive strength f'c as follows:

COMPRESSIVE STRENGTH (PSI)	STRUCTURE OR PORTION OF STRUCTURE
5,000 at 28 days	Abrasion-erosion Resistant Concrete
4,000 at 28 days	All other structures

1.2.7 Maximum Water-Cementitious Material (W/C) Ratio

Maximum W/C allowed as follows:

WATER-CEMENT RATIO, BY MASS	STRUCTURE OR PORTION OF STRUCTURE
0.45	All concrete structures

These W/C's may cause higher strengths than that required by paragraph CONCRETE STRENGTH.

1.2.8 Construction Tolerances

Except as specified otherwise, a plus tolerance increases and a minus tolerance decreases the dimension to which it applies. A tolerance without sign means plus or minus. Where only one sign is specified, there is no limit in the other direction. Tolerances are not cumulative. The most restrictive tolerance will control. Tolerances can not extend the structure beyond legal boundaries.

a. Make level and grade tolerance measurements of slabs as soon as possible after finishing. When forms or shoring are used, make the measurements prior to removal.

b. Construction tolerances must meet the requirements of ACI 117 and any of the following requirements that are applicable.

1.2.8.1 Tunnel Linings, Conduits, Filling & Emptying Culverts

Water Conveying:

Lateral alignment	
Centerline alignment	1/2 inch
Inside dimensions	0.005 times inside dimension
Level alignment	
Profile grade	1/2 inch

Cross-Sectional dimension	
Tunnel and culvert lining	- 0 inch

1.2.8.2 Appearance

Clean permanently exposed surfaces, if stained or otherwise discolored, by a method that does not harm the concrete and that is approved by the Contracting Officer.

1.3 SUBMITTALS

Government approval is required for submittals with a "G" designation; submittals not having a "G" designation are for information only. When used, a designation following the "G" designation identifies the office that will review the submittal for the Government. Submit the following in accordance with Section 01 33 00 SUBMITTAL PROCEDURES:

SD-02 Shop Drawings

Reinforcing steel; G

SD-03 Product Data

Concrete Mix Designs; G
Batch Plant; G
Concrete Mixers
Conveying Equipment
Placing Equipment
Construction Joint Treatment; G
Cold-Weather Requirements; G
Hot-Weather Requirements; G
Cementitious Materials, Admixtures, and Curing Compound; G
Nonshrink Grout
Mechanical Reinforcing Bar Connectors
Abrasion Erosion Resistant Concrete (AERC); G

SD-06 Test Reports

Aggregates; G
Mill Test Reports
Tests and Inspections
Quality of Aggregates; G
Mixer Uniformity
Water

SD-07 Certificates

Concrete Field Testing Technicians
Concrete Construction Inspector (CCI)
Cementitious Materials

SD-08 Manufacturer's Instructions

Curing Compound

1.4 QUALITY ASSURANCE

The Government will sample and test aggregates and concrete to determine compliance with the specifications. Provide facilities and labor as may be necessary for procurement of representative test samples. Samples of aggregates will be obtained at the point of batching in accordance with ASTM D75/D75M. Concrete will be sampled in accordance with ASTM C172/C172M. Do not use a material until the Contracting Officer gives notice that test results are satisfactory. The individuals who sample and test concrete or the constituents of concrete as required in this specification must have demonstrated a knowledge and ability to perform the necessary test procedures equivalent to the ACI minimum guidelines for certification of Concrete Field Testing Technicians, Grade I. The individuals who perform the inspection of concrete construction must have demonstrated a knowledge and ability equivalent to the ACI minimum guidelines for certification of Concrete Construction Inspector (CCI). Submit statements that the concrete testing technicians and the concrete inspectors meet the specified requirements. Maintain a copy of ACI SP-15 and CRSI 10MSP at project site.

1.4.1 Cement and Pozzolan

If cement or pozzolan is to be obtained from more than one source, state the estimated amount to be obtained from each source and the proposed schedule of shipments in the initial notification.

1.4.1.1 Cement

Cement will be sampled by the contractor under the supervision of the Contracting Officer. The cement producer will be required to submit samples for physical and chemical testing, as well as historic quality control data.

No cement shall be used until notice has been given by the Contracting Officer that test results for chemical and physical requirements as well as acceptance testing requirements are satisfactory. Release for shipment and approval for use will be contingent on continuing compliance with these and other requirements of the specifications as allowed by the Contracting Officer. Samples of cement for check testing will be taken at the project site by the Contracting Officer for testing at the expense of the Government. A copy of the test results from the cement manufacturer shall be furnished to the Contracting Officer for each lot

1.4.1.2 Pozzolan

Pozzolan will be sampled by the contractor under the supervision of the Contracting Officer. The pozzolan producer will be required to submit samples for physical and chemical testing, as well as historic quality control data.

No pozzolan shall be used until notice has been given by the Contracting Officer that test results for chemical and physical requirements as well as acceptance testing requirements are satisfactory. Release for shipment and approval for use will be contingent on continuing compliance with these and other requirements of the specifications as allowed by the Contracting Officer. Samples of pozzolan for check testing will be taken at the project site by the Contracting Officer for testing at the expense of the Government. A copy of the test results from the pozzolan manufacturer shall be furnished to the Contracting Officer for each lot.

1.4.1.3 Ground Granulated Blast-Furnace Slag

Ground Granulated Blast Furnace Slag (GGBFS) will be sampled by the contractor under the supervision of the Contracting Officer. The GGBFS producer will be required to submit samples for physical and chemical testing, as well as historic quality control data.

No GGBFS shall be used until notice has been given by the Contracting Officer that test results for chemical and physical requirements as well as acceptance testing requirements are satisfactory. Release for shipment and approval for use will be contingent on continuing compliance with these and other requirements of the specifications as allowed by the Contracting Officer. Samples of GGBFS for check testing will be taken at the project site by the Contracting Officer for testing at the expense of the Government. A copy of the test results from the GGBFS manufacturer shall be furnished to the Contracting Officer for each lot.

1.4.1.4 Silica Fume or Ultrafine Fly Ash (UFFA)

Submit test results in accordance with ASTM C1240 or ASTM C618, for each lot, and manufacturer's certifications. Samples for check testing will be taken at the project site by the Contracting Officer.

1.4.2 Cementitious Materials, Admixtures, and Curing Compound

At least 30 days in advance of concrete placement, notify the Contracting Officer of the sources for cementitious materials, admixtures, and curing compound, along with sampling location, brand name, type, and quantity to be used in the manufacture and/or curing of the concrete. Cementitious Materials, including Cement and Pozzolan, and Ground Granulated Blast-Furnace Slag will be accepted on the basis of the manufacturer's certification of compliance. Do not use cementitious materials until receiving Contracting Officer notice of acceptance. Cementitious materials will be subject to check testing from samples obtained at the source, at transfer points, or at the project site, as scheduled by the Contracting Officer, and such sampling will be by or under the supervision of the Government at its expense. Promptly remove material not meeting specifications from the site of work. Submit samples of materials for Government testing and approval. Submit manufacturer's instructions for placement of curing compound.

1.5 DELIVERY, STORAGE, AND HANDLING

Retest chemical admixtures that have been in storage at the project site for longer than 6 months or that have been subjected to freezing and reject if test results are not satisfactory. Chemical admixtures will be accepted based on compliance with the requirements of paragraph CHEMICAL ADMIXTURES.

PART 2 PRODUCTS

2.1 MATERIALS

Submit mill test reports attesting that materials meet the requirements of the specification under which they are furnished. Certification and mill test reports must be from samples taken from the particular lot furnished. Certify the following for compliance with all specification requirements: Impervious-Sheet Curing Materials, Air-Entraining Admixture, Other Chemical Admixtures, Membrane-Forming Curing Compound.

2.1.1 Cementitious Materials

Cementitious materials are portland cement, portland-pozzolan cement, portland blast-furnace slag cement, portland cement in combination with pozzolan or GGBF slag for all structural concrete and portland cement in combination with silica fume or ultrafina fly ash, for abrasion-erosion resistance concrete conforming to appropriate specifications listed below.

2.1.1.1 Portland Cement

Portland cement shall conform to ASTM C150/C150M, Type II or V, low-alkali

2.1.1.2 Fly Ash

ASTM C618, Class F, except that the maximum allowable loss on ignition must not exceed 6 percent. Class F fly ash for use in mitigating Alkali-Silica Reactivity must have a Calcium Oxide (CaO) content of less than 8 percent and a total equivalent alkali content less than 1.5 percent. Add with cement.

2.1.1.3 Raw or Calcined Natural Pozzolan

Natural pozzolan must be raw or calcined and conform to ASTM C618, Class N, including the optional requirements for uniformity and effectiveness in controlling Alkali-Silica reaction and must have an ignition loss not exceeding 3 percent. Class N pozzolan for use in mitigating Alkali-Silica Reactivity must have a Calcium Oxide (CaO) content of less than 13 percent and total equivalent alkali content less than 3 percent.

2.1.1.4 Ultra Fine Fly Ash and Ultra Fine Pozzolan

Ultra Fine Fly Ash (UFFA) and Ultra Fine Pozzolan (UFP) must conform to ASTM C618, Class F or N, and the following additional requirements:

a. The strength activity index at 28 days of age is at least 95 percent of the control specimens.

b. The average particle size doest not exceed 6 microns.

c. The sum of SiO_2 + Al_2O_3 + Fe_2O_3 is greater than 77 percent.

2.1.1.5 Ground Granulated Blast-Furnace Slag

Conform to ASTM C989/C989M, Grade 120.

2.1.1.6 Silica Fume

Silica fume may be furnished as a dry, densified material or as a slurry. Silica fume, unprocessed, or before processing into a slurry or a densified material, must conform to ASTM C1240 with Table 2 and the Specific Surface Area and Uniformity Requirements in Table 4 invoked. Provide the services of a manufacturer's technical representative, experienced in mixture proportioning, placement procedures, and curing of concrete containing silica fume. Make the manufacturer's representative available for consultation by both the Contractor and the Government during mixture proportioning, planning, and production of silica-fume concrete and, onsite immediately prior to and during at least the first placement of concrete containing silica fume, and at other times if directed.

2.1.2 Aggregates

ASTM C33/C33M, except as modified herein. Furnish aggregates for exposed concrete surfaces from one source. Provide aggregates that do not contain any substance which may be deleteriously reactive with the alkalies in the cement. Submit test report showing compliance with ASTM C33/C33M.

2.1.2.1 Unfavorable Properties

Do not provide aggregates possessing properties or constituents that are known to have specific unfavorable effects in concrete when tested in accordance with ASTM C295/C295M.

2.1.3 Chemical Admixtures

Provide chemical admixtures, when required or permitted, that conform to the appropriate specification listed.

2.1.3.1 Air-Entraining Admixture

Conform to ASTM C260/C260M and consistently cause the concrete to have an air content in the specified ranges under field conditions.

2.1.3.2 Accelerating Admixture

Meet the requirements of ASTM C494/C494M, Type C or E, except that calcium chloride or admixtures containing calcium chloride is not permitted.

2.1.3.3 Water-Reducing or Retarding Admixture

2.1.3.3.1 Water-Reducing or Retarding Admixtures

ASTM C494/C494M, Type A, B, or D, except that the 6-month and 1-year compressive strength tests are waived.

2.1.3.3.2 High-Range Water Reducing Admixture

ASTM C494/C494M, Type F or G except that the 6-month and 1-year strength requirements are waived. The admixture may be used only when approved by the Contracting Officer, such approval being contingent upon particular mixture control as described in the Contractor's Quality Control Plan.

2.1.4 Water

Provide water for mixing and curing compliance with the requirements of ASTM C1602/C1602M; potable, and free of injurious amounts of oil, acid, salt, or alkali. Submit test report showing water complies with ASTM C1602/C1602M.

2.1.5 Reinforcing Steel

Provide reinforcing bars conforming to the requirements of ASTM A615/A615M, Grade 60, deformed. Welded steel wire reinforcement must conform to the requirements of ASTM A1064/A1064M. Detail reinforcement not indicated in accordance with ACI 301. Provide mechanical reinforcing bar connectors in accordance with ACI 301 and with 125 percent minimum yield strength of the reinforcement bar.

2.1.6 Abrasive Aggregates

Fifty-five percent, minimum, aluminum oxide or silicon-dioxide abrasive ceramically bonded together to form a homogeneous material sufficiently porous to provide a good bond with portland paste; or factory-graded emery aggregate consisting of not less than 45 percent aluminum oxide and 25 percent ferric oxide. Provide well graded aggregate from particles retained on the 600-µm (No. 30) sieve to particles passing the 2.36-mm (No. 8) sieve.

2.1.7 PVC Pipe (Weep Hole)

Provide a PVC pipe to connect to the fitting with sufficient length to allow for full penetration through the concrete section as shown in the drawings. The PVC pipe must meet the requirements listed below:

a. Four (4) inch inner diameter.

b. ASTM D1785 Schedule 80 PVC solid wall.

c. Cell classification 12454-B or 12354-C.

d. Wall thickness SDR 35, with solvent/weld or elastomeric joints.

2.2 EQUIPMENT

Submit data on placing equipment and methods. The batching, mixing, conveying, and placing equipment must have a capacity of at least 125 cubic yards per hour. Conform the batch plant to the requirements of NRMCA CPMB 100 and as specified; however, rating plates attached to batch plant equipment are not required. Submit batch plant data forconformance with applicable specifications.

2.2.1 Batching Equipment

Use automatic batching controls. Equip the batching system with an accurate recorder or recorders that meet the requirements of NRMCA CPMB 100. Provide separate bins or compartments for each size group of aggregate and cement, pozzolan, and GGBF slag. Weigh aggregates either in separate weigh batchers with individual scales or cumulatively in one weigh batcher on one scale. Do not weigh aggregate in the same batcher with cement, pozzolan, or GGBF slag. If both cement and pozzolan or GGBF slag are used, they may be batched cumulatively provided that the portland cement is batched first. If measured by mass, do not weigh the mass of the water cumulatively with another ingredient. Interlock water batcher filling and discharging valves so that the discharge valve cannot be opened before the filling valve is fully closed. Provide an accurate mechanical device for measuring and dispensing each admixtured. Interlock each dispenser with the batching and discharging operation of the water so that each admixture is separately batched and discharged automatically in a manner to obtain uniform distribution throughout the batch in the specified mixing period. Do not combine admixtures prior to introduction in water. Arrange the plant to facilitate the inspection of all operations at all times. Provide facilities for obtaining representative samples of aggregates from each bin or compartment. Clearly mark all filling ports for cementitious materials bins or silos with a permanent sign stating the contents.

2.2.2 Scales

Provide equipment for batching by mass conforming to the applicable requirements of NIST HB 44, except that the accuracy is plus or minus 0.2 percent of scale capacity. Provide standard test weights and any other auxiliary equipment required for checking the operating performance of each scale or other measuring devices. Perform tests at the frequency required in paragraph TESTS AND INSPECTIONS, and in the presence of a Government inspector.

2.2.3 Batching Tolerances

a. Weighing Tolerances

MATERIAL	PERCENT OF REQUIRED MASS
Cementitious materials	0 to plus 2
Aggregate	plus or minus 2
Water	plus or minus 1
Chemical admixture	0 to plus 6

b. Volumetric Tolerances - For volumetric batching equipment, the following tolerances apply to the required volume of material being batched:

Water	Plus or minus 1 percent
Chemical admixtures	Zero to plus 6 percent

2.2.4 Moisture Control

The plant must be capable of ready adjustment to compensate for the varying moisture content of the aggregates and to change the masses of the materials being batched. Provide an electric moisture meter complying with the provisions of COE CRD-C 143 for measuring moisture in the fine aggregate. Arrange the sensing element so that the measurement is made near the batcher charging gate of the sand bin or in the sand batcher.

2.2.5 Concrete Mixers

Do not charge the concrete mixers in excess of the capacity recommended by the manufacturer. Operate the mixers at the drum or mixing blade speed designated by the manufacturer. Maintain the mixers in satisfactory operating condition, and keep the mixer drums free of hardened concrete. Should any mixer at any time produce unsatisfactory results, promptly discontinue its use until it is repaired. Submit concrete mixer data including the make, type, and capacity of concrete mixers proposed for mixing concrete.

2.2.5.1 Stationary Mixers

Concrete plant mixers must be tilting, nontilting, horizontal-shaft, vertical-shaft, or pugmill and provided with an acceptable device to lock the discharge mechanism until the required mixing time has elapsed. The mixing time and uniformity must conform to all the requirements in ASTM C94/C94M applicable to central-mixed concrete.

2.2.5.2 Truck Mixers

Truck mixers, the mixing of concrete therein, and concrete uniformity must conform to the requirements of ASTM C94/C94M. A truck mixer may be used either for complete mixing (transit-mixed) or to finish the partial mixing done in a stationary mixer (shrink-mixed). Equip each truck with two counters from which it will be possible to determine the number of revolutions at mixing speed and the number of revolutions at agitating speed.

2.2.6 Conveying Equipment

Submit data on the conveying equipment and methods for transporting, handling, and depositing the concrete. Conform the conveying equipment to the following requirements:

2.2.6.1 Buckets

The interior hopper slope shall be not less than 58 degrees from the horizontal, the minimum dimension of the clear gate opening shall be at least five times the nominal maximum-size aggregate, and the area of the gate opening shall not be less than 2 square feet. The maximum dimension of the gate opening shall not be greater than twice the minimum dimension. The bucket gates shall be essentially grout tight when closed and may be manually, pneumatically, or hydraulically operated except that buckets larger than 2 cubic yards shall not be manually operated. The design of the bucket shall provide means for positive regulation of the amount and rate of deposit of concrete in each dumping position.

2.2.6.2 Transfer Hoppers

Concrete may be charged into nonagitating hoppers for transfer to other conveying devices. Transfer hoppers must be capable of receiving concrete directly from delivery vehicles and have conical-shaped discharge features. Equip the transfer hopper with a hydraulically operated gate and with a means of external vibration to effect complete discharge. Do not hold concrete in nonagitating transfer hoppers more than 30 minutes.

2.2.6.3 Trucks

Truck mixers operating at agitating speed or truck agitators used for transporting plant-mixed concrete shall conform to the requirements of ASTM C94/C94M. Nonagitating equipment may be used for transporting plant-mixed concrete over a smooth road when the hauling time is less than 15 minutes. Bodies of nonagitating equipment shall be smooth, watertight, metal containers specifically designed to transport concrete, shaped with rounded corners to minimize segregation, and equipped with gates that will permit positive control of the discharge of the concrete.

2.2.6.4 Chutes

When concrete can be placed directly from a truck mixer, agitator, or nonagitating equipment, the chutes attached to this equipment by the manufacturer may be used. Use a discharge deflector when required by the Contracting Officer. Separate chutes and other similar equipment will not be permitted for conveying concrete.

2.2.6.5 Belt Conveyors

Design and operate to assure a uniform flow of concrete from mixer to final place of deposit without segregation of ingredients or loss of mortar and provide with positive means for preventing segregation of the concrete at the transfer points and the point of placing. Construct belt conveyors such that the idler spacing does not exceed 36 inches. The belt speed must be a minimum of 300 feet per minute and a maximum of 750 feet per minute. If concrete is to be placed through installed horizontal or sloping reinforcing bars, discharge the conveyor concrete into a pipe or elephant trunk that is long enough to extend through the reinforcing bars.

2.2.6.6 Concrete Pumps

Concrete may be conveyed by positive displacement pump when approved. The pumping equipment must be piston or squeeze pressure. The pipeline must be rigid steel pipe or heavy-duty flexible hose. The inside diameter of the pipe must be at least three times the nominal maximum-size coarse aggregate in the concrete mixture to be pumped but not less than 4 inches. Do not use aluminum pipe.

2.2.7 Vibrators

Use vibrators of the proper size, frequency, and amplitude for the type of work being performed in conformance with the following requirements:

APPLICATION	HEAD DIAMETER (inches)	FREQUENCY (VPM)	AMPLITUDE (inches)
Thin walls, slab, etc.	1-1/4 to 2-1/2	9,000 to 13,500	0.02 to 0.04
General construction	2 to 3-1/2	8,000 to 12,000	0.025 to 0.05

Determine the frequency and amplitude in accordance with COE CRD-C 521.

PART 3 EXECUTION

3.1 PREPARATION FOR PLACING

3.1.1 Embedded Items

Before placement of concrete, take care to determine that all embedded items are firmly and securely fastened in place as indicated on the drawings, or required. Embedded items must be free of oil and other foreign matter such as loose coatings or rust, paint, and scale. The embedding of wood in concrete will be permitted only when specifically authorized or directed. Temproarily fill voids in sleeves, inserts, and anchor slots with readily removable materials to prevent the entry of concrete into voids. Welding, including tack welding, will not be permitted on embedded metals within 2 feet of the surface of the concrete.

3.1.2 Concrete on Earth Foundations

Earth surfaces upon which concrete is to be placed must be clean, damp, and free from debris, frost, ice, and standing or running water. Prior to placement of concrete, compact the earth foundation in accordance with Section 31 00 00 EARTHWORK.

3.1.3 Concrete on Rock Foundations

Rock surfaces upon which concrete is to be placed mustl be clean, free from oil, standing or running water, ice, mud, drummy rock, coating, debris, and loose, semidetached, or unsound fragments. Clean joints in rock to a satisfactory depth, as determined by the Contracting Officer, and to firm rock on the sides. Immediately before the concrete is placed, thoroughly clean all rock surfaces by the use of air-water jets or sandblasting as described in paragraph CONSTRUCTION JOINT TREATMENT. Keep all rock surfaces continuously wet for at least 24 hours immediately prior to placing concrete thereon. Cover all approximately horizontal surfaces immediately before the concrete is placed with a layer of mortar proportioned similar to that in the concrete mixture. Cover the mortar with concrete before the time of initial setting of the mortar.

3.1.4 Construction Joint Treatment

Submit the method and equipment proposed for joint cleanup and waste disposal, for review and approval. Conform construction joint treatment to the following requirements:

3.1.4.1 Joint Preparation

Prepare concrete surfaces to which additional concrete is to be bonded for receiving the next lift or adjacent concrete by cleaning with either air-water cutting, sandblasting, high-pressure water jet, or other approved method. Air-water cutting will not be permitted on formed surfaces or surfaces congested with reinforcing steel. Regardless of the method used, the resulting surfaces must be free from all laitance and inferior concrete so that clean, well bonded coarse aggregate is exposed uniformly throughout the lift surface. Do not undercut the edges of the coarse aggregate. Wash the surface again as the last operation prior to placing the next lift. No standing water is allowed on the surface upon which concrete is placed.

3.1.4.2 Air-Water Cutting

Perform air-water cutting of a construction joint at the proper time and only on horizontal construction joints. The air pressure used in the jet must be 90 to 110 psi, and the water pressure must be just sufficient to bring the water into effective influence of the air pressure. When approved by the Contracting Officer, a retarder complying with the requirements of COE CRD-C 94 may be applied to the surface of the lift to prolong the period of time during which air-water cutting is effective. Prior to receiving approval, furnish samples of the material to be used and demonstrate the method to be used in applications. After cutting, wash and rinse the surface long as there is any trace of cloudiness of the wash water. Where necessary to remove accumulated laitance, coatings, stains, debris, and other foreign material, high-pressure water jet or sandblasting will be required as the last operation before placing the next lift.

3.1.4.3 High-Pressure Water Jet

A stream of water under a pressure of not less than 3,000 psi may be used for cleaning. Delay its use until the concrete is sufficiently hard so that only the surface skin or mortar is removed and there is no undercutting of coarse-aggregate particles. If the water jet is incapable of a satisfactory cleaning, clean the surface by sandblasting.

3.1.4.4 Wet Sandblasting

This method may be used when the concrete has reached sufficient strength to prevent undercutting of the coarse aggregate particles. Then thoroughly wash the surface of the concrete to remove all loose materials.

3.1.4.5 Waste Disposal

Dispose of the waste water employed in cutting, washing, and rinsing of concrete surfaces such that the waste water does not stain, discolor, or affect exposed surfaces of the structures, or damage the environment of the project area. The method of disposal is subject to approval.

3.2 CONVEYING AND PLACING CONCRETE

Convey and place concrete in accordance with ACI 301, Section 5. Do not reconstitute concrete that has begun to solidify.

3.2.1 Cold-Weather Requirements

Place concrete in cold weather in accordance with ACI 306R.

3.2.2 Hot-Weather Requirements

Place concrete in hot weather in accordance with ACI 305R.

For AERC, when the evaporation rate, determined in accordance with ACI 305R, is equal to or greater than 0.1 pounds per square foot per hour, precautions stipulated in ACI 305R and in SECTION 03 35 00 CONCRETE FINISHING, shall be taken.

3.2.3 Prevention of Plastic Shrinkage Cracking

During hot weather with low humidity, and particularly with appreciable wind, the Contractor must be alert to the tendency for plastic shrinkage cracks to develop and must institute measures to prevent this. Take particular care if plastic shrinkage cracking is potentially imminent and especially if it has developed during a previous placement. Conform with the requirement of ACI 305R. In addition the concrete placement must be further protected by erecting shades and windbreaks and by applying fog sprays of water, sprinkling, ponding or wet covering. Plastic shrinkage cracks must not be troweled over or filled with slurry.

3.3 SETTING BASE PLATES AND BEARING PLATES

3.3.1 Setting of Plates

After being plumbed and properly positioned, provide column base plates, bearing plates for beams and similar structural members, and machinery and equipment base plates with full bearing with nonshrink grout. The space between the top of concrete or masonry-bearing surface and the bottom of the plate must be approximately 1/24 of the width of the plate, but not less than 1/2 inch for plates less than 12 inches wide. Concrete surfaces must be rough, clean, and free of oil, grease, and laitance, and damp. Clean metal surfaces free of oil, grease, and rust.

3.3.2 Nonshrink Grout Application

Water content must be the minimum that will provide a flowable mixture and fill the space to be grouted without segregation, bleeding, or reduction of strength.

3.3.2.1 Mixing and Placing of Nonshrink Grout

Mix and place in accordance with the material manufacturer's instructions and as specified. Thoroughly dry-mix ingredients before adding water. After adding water, mix the batch for 3 minutes. Size batches to allow continuous placement of freshly mixed grout. Discard grout not used within 30 minutes after mixing. Fill the space between the top of the concrete or masonry-bearing surface and the plate solid with the grout. Use forms of wood or other equally suitable material for retaining the grout and remove after the grout has set. If grade "A" grout as specified in ASTM C1107/C1107M is used, form all surfaces to provide restraint. Work the placed grout to eliminate voids; however, avoid overworking and breakdown of the initial set. Do not be retemper or subject grout to vibration from any source. Where clearances are unusually small, place under pressure with a grout pump. Maintain temperature of the grout, and of surfaces receiving the grout, at 65 to 85 degrees F until after setting.

3.3.2.2 Treatment of Exposed Surfaces

After the grout has set, cut back the exposed surfaces of those types containing metallic aggregate 1 inch and immediately cover with a parge coat of mortar proportioned by mass of one part portland cement, two parts sand, and sufficient water to make the mixture placeable. The parge coat must have a smooth, dense finish. The exposed surface of other types of nonshrink grout must have a smooth, dense finish.

3.3.2.3 Curing

Cure grout and parge coats in accordance with Section 03 39 00.

3.4 TESTS AND INSPECTIONS

Submit test results and inspection reports, daily and weekly. Tests and inspect in accordance the following:

3.4.1 General

Perform the inspections and tests described below, and, based upon the results of these inspections and tests, take the action required and submit reports as required. When, in the opinion of the Contracting Officer, the concreting operation is out of control, cease concrete placement. Locate the laboratory performing the tests on site and conform with ASTM C1077. The Government will inspect the laboratory, equipment, and test procedures prior to start of concreting operations and at least once per year thereafter for conformance with ASTM C1077.

3.4.2 Testing and Inspection Requirements

3.4.2.1 Fine Aggregate

3.4.2.1.1 Grading

At least once during each shift when the concrete plant is operating, perform one sieve analysis and fineness modulus determination in accordance with ASTM C136/C136M and COE CRD-C 104 for the fine aggregate or for each size range of fine aggregate if it is batched in more than one size or classification. The location at which samples are taken may be selected by the Contractor as the most advantageous for control. However, the Contractor is responsible for delivering fine aggregate to the mixer within specification limits.

3.4.2.1.2 Corrective Action for Fine Aggregate Grading

When the amount passing on any sieve is outside the specification limits, immediately resample and retest the fine aggregate. If there is another failure on any sieve, immediately be report to the Contracting Officer.

3.4.2.1.3 Moisture Content Testing

When in the opinion of the Contracting Officer the electric moisture meter is not operating satisfactorily, perform at least four tests for moisture content in accordance with ASTM C566 during each 8-hour period of mixing plant operation. Randomly select the times for the tests within the 8-hour period. Make an additional test whenever the slump is shown to be out of control or excessive variation in workability is reported by the placing foreman. When the electric moisture meter is operating satisfactorily, make at least two direct measurements of moisture content per week to check the calibration of the meter. Use the results of tests for moisture content to adjust the added water in the control of the batch plant.

3.4.2.1.4 Moisture Content Corrective Action

Whenever the moisture content of the fine aggregate changes by 0.5 percent or more, adjust the scale settings for the fine-aggregate batcher and water batcher (directly or by means of a moisture compensation device) if necessary to maintain the specified slump.

3.4.2.2 Coarse Aggregate

3.4.2.2.1 Grading

At least once during each shift in which the concrete plant is operating, conduct a sieve analysis in accordance with ASTM C136/C136M for each size of coarse aggregate. The location at which samples are taken may be selected by the Contractor as the most advantageous for production control. A test record of samples of aggregate taken at the same locations must show the results of the current test as well as the average results of the five most recent tests including the current test. The Contractor may adopt limits for control which are coarser than the specification limits for samples taken at locations other than as delivered to the mixer to allow for degradation during handling.

3.4.2.2.2 Corrective Action for Grading

When the amount passing any sieve is outside the specification limits, immediately resample and retest the coarse aggregate. If the second sample fails on any sieve, report that fact to the Contracting Officer. Where two consecutive averages of five tests are outside specification limits, consider the operation out of control and report to the Contracting Officer. Stop concreting and take immediate steps to correct the grading.

3.4.2.2.3 Coarse Aggregate Moisture Content

Make a test for moisture content of each size group of coarse aggregate at least twice per week. When two consecutive readings for smallest size coarse aggregate differ by more than 1.0 percent, increase frequency of testing to that specified above for fine aggregate, until the difference falls below 1.0 percent.

3.4.2.2.4 Coarse Aggregate Moisture Corrective Action

Whenever the moisture content of any size of coarse aggregate changes by 0.5 percent or more, adjust the scale setting for the coarse aggregate batcher and the water batcher if necessary to maintain the specified slump.

3.4.2.3 Quality of Aggregates

Submit aggregate quality tests at least 30 days prior to start of concrete placement.

3.4.2.3.1 Frequency of Quality Tests

Thirty days prior to the start of concrete placement, perform all tests for aggregate quality listed below. In addition, after the start of concrete placement, perform tests for aggregate quality in accordance with the frequency schedule shown below. Take amples tested after the start of concrete placement immediately prior to entering the concrete mixer.

FREQUENCY			
PROPERTY	FINE AGGREGATE	COARSE AGGREGATE	TEST
Specific Gravity	Every 3 months	Every 3 months	ASTM C127 ASTM C128
Absorption	Every 3 months	Every 3 months	ASTM C127 ASTM C128
Durability Factor (using Procedure A)	Every 12 months	Every 12 months	COE CRD-C 114 ASTM C666/C666M
Clay Lumps and Friable Particles	Every 3 months	Every 3 months	ASTM C142/C142M
Material Finer than No. 200 Sieve	Not applicable	Every 3 months	ASTM C117
Impurities	Every 3 months	Not applicable	ASTM C40/C40M ASTM C87/C87M
L.A. Abrasion	Not applicable	Every 6 months	ASTM C131/C131M ASTM C535
Soft and Friable (Scratch	Not applicable	Every 6 months	COE CRD-C 130
Chert, less than 2.40 specific gravity	Every 6 months	Every 6 months	ASTM C123/C123M

FREQUENCY			
PROPERTY	FINE AGGREGATE	COARSE AGGREGATE	TEST
Coal and Lignite, less than less than 2.00 specific gravity	Every 6 months	Every 6 months	ASTM C123/C123M
Petrographic Examination	Every 6 months	Every 6 months	ASTM C295/C295M

3.4.2.3.2 Corrective Action for Aggregate Quality

If the result of a quality test fails to meet the requirements for quality immediately prior to start of concrete placement, change production procedures or materials and perform additional tests until the material meets the quality requirements prior to proceeding with either mixture proportioning studies or starting concrete placement. After concrete placement commences, whenever the result of a test for quality fails the requirements, immediately rerun the test. If the second test fails the quality requirement, report the fact to the Contracting Officer and take immediate steps to rectify the situation.

3.4.2.4 Scales

3.4.2.4.1 Weighing Accuracy

Check the accuracy of the scales by test weights prior to start of concrete operations and at least once every 3 months for conformance with the applicable requirements of paragraph BATCHING EQUIPMENT. Also make such tests as directed whenever there are variations in properties of the fresh concrete that could result from batching errors.

3.4.2.4.2 Batching and Recording Accuracy

Once a week check the accuracy of each batching and recording device during a weighing operation by noting and recording the required weight, recorded weight, and the actual weight batched. Confirm that the calibration devices described in paragraph EQUIPMENT, for checking the accuracy of dispensed admixtures, are operating properly.

3.4.2.4.3 Scales Corrective Action

When either the weighing accuracy or batching accuracy does not comply with specification requirements, do not operate the plant until necessary adjustments or repairs have been made. Correct discrepancies in recording accuracies immediately.

3.4.2.5 Batch-Plant Control

Continuously control the measurement of all constituent materials including cementitious materials, each size of aggregate, water, and admixtures. Adjust the aggregate weights and amount of added water as necessary to compensate for free moisture in the aggregates. Adjust the amount of air-entraining agent to control air content within specified limits.

Prepare a report indicating type and source of cement used, type and source of pozzolan or slag used, amount and source of admixtures used, aggregate source, the required aggregate and water weights per cubic yard, amount of water as free moisture in each size of aggregate, and the batch aggregate and water weights per cubic yard for each class of concrete batched during plant operation.

3.4.2.6 Concrete Mixture

3.4.2.6.1 Air Content Testing

Conduct air content tests when test specimens are fabricated. In addition, make at least two tests for air content on randomly selected batches of each separate concrete mixture produced during each 8-hour period of concrete production. Make additional tests when excessive variation in workability is reported by the placing foreman or Government quality assurance representative. Conduct tests in accordance with ASTM C231/C231M. Plot test results on control charts which at all times are readily available to the Government. Keep copies of the current control charts in the field, by the Contractor's quality control representatives, and plotted results as tests are made. When a single test result reaches either the upper or lower action limit immediately conduct a second test. Average the results of the two tests and use this average as the air content of the batch to plot on both the control chart for air content and the control chart for range, and for determining the need for any remedial action. Plot the result of each test, or average as noted in the previous sentence, on a separate chart for each mixture on which an "average line" is set at the midpoint of the specified air content range from paragraph AIR CONTENT. Set an upper warning limit and a lower warning limit line 1.0 percentage point above and below the average line. Set an upper action limit and a lower action limit line 1.5 percentage points above and below the average line, respectively. Plot the range between each two consecutive tests on a control chart for range where an upper warning limit is set at 2.0 percentage points and up upper action limit is set at 3.0 percentage points. Samples for air content may be taken at the mixer, however, the Contractor is responsible for delivering the concrete to the placement site at the stipulated air content. If the materials or transportation methods cause air content loss between the mixer and the placement, take correlation samples at the placement site as required by the Contracting Officer and control the air content at the mixer as directed.

3.4.2.6.2 Air Content Corrective Action

Whenever points on the control chart for percent air reach either warning limit, immediately adjust the amount of air-entraining admixture batched. As soon as is practical after each adjustment, conduct another test to verify the result of the adjustment. Whenever a point on the control chart range reaches the warning limit, recalibrate the admixture dispenser to ensure that it is operating accurately and with good reproducibility. Whenever a point on either control chart reaches an action limit line, the air content is considered out of control and immediately halt the concreting operation until the air content is under control. Make additional air content tests when concreting is restarted.

3.4.2.6.3 Slump Testing

In addition to slump tests made when test specimens are fabricated, make at least four slump tests on randomly selected batches in accordance with

ASTM C143/C143M for each separate concrete mixture produced during each 8-hour or less period of concrete production each day. Also, make additional tests shall when excessive variation in workability is reported by the placing foreman or Government's quality assurance representative. Plot test results on control charts, which are readily available to the Government at all times. Keep copies of the current control charts in the field by the Contractor's quality control representatives and plot results as tests are made. When a single slump test reaches or goes beyond either the upper or lower action limit, immediately make a second test on the same batch of concrete. Average the results of the two tests and use this average as the slump of the batch to plot on both the control chart for percent air and the chart for range, and for determining the need for any remedial action. Set an upper warning limit at 1/2 inch below the maximum allowable slump on separate control charts for percent air used for each type of mixture as specified in paragraph SLUMP, and set an upper action limit line and lower action limit line at the maximum and minimum allowable slumps, respectively, as specified in the same paragraph. Plot the range between each consecutive slump test for each type of mixture on a single control chart for range on which an upper action limit is set at 2 inches. Take samples for slump at the mixer, however, the Contractor is responsible for delivering the concrete to the placement site at the stipulated slump. If the materials or transportation methods cause slump loss between mixer and the placement, take correlation samples at the placement site as required by the Contracting Officer and control the slump at the mixer as directed.

3.4.2.6.4 Slump Corrective Action

Whenever points on the control chart for slump reach the upper warning limit, immediately adjust the batch weights of water and fine aggregate. Make adjustments so that the total water content does not exceed that amount allowed by the maximum W/C specified, based upon aggregates which are in a saturated surface-dry condition. When a single slump reaches the upper or lower action limit, no further concrete may be delivered to the placing site until proper adjustments have been made. Immediately after each adjustment, make another test to verify the correctness of the adjustment. Whenever two consecutive slump tests, made during a period when there was no adjustment of batch weights, produce a point on the control chart for range at or above the upper action limit, immediately halt the concreting operation and take appropriate steps to bring the slump under control. Also, make additional slump tests as directed.

3.4.2.6.5 Temperature

Measure the temperature of the concrete when compressive strength specimens are fabricated. Measure in accordance with ASTM C1064/C1064M. Report the temperature along with the compressive strength data.

3.4.2.6.6 Compressive-Strength Specimens

Obtain samples and test concrete for quality control during placement. Sample fresh concrete for testing in accordance with ASTM C172/C172M. Make six test cylinders. Test concrete for compressive strength at 7 and 28 days for each design mix and for every 100 cubic yards of concrete. Test two cylinders at 7 days; two cylinders at 28 days; and hold two cylinders in reserve. Prepare concrete test specimens in accordance with ASTM C31/C31M. Perform compressive strength testing in accordance with ASTM C39/C39M.

3.4.2.7 Inspection Before Placing

Inspect foundation or construction joints, forms, and embedded items for quality in sufficient time prior to each concrete placement to certify to the Contracting Officer that they are ready to receive concrete. Report the results of each inspection in writing.

3.4.2.8 Placing

3.4.2.8.1 Placing Inspection

The placing foreman supervises all placing operations, determines that the correct quality of concrete or grout is placed in each location as directed and is for measuring and recording concrete temperatures and ambient temperature hourly during placing operations, weather conditions, time of placement, yardage placed, and method of placement.

3.4.2.8.2 Placing Corrective Action

The placing foreman must not permit batching and placing to begin until he has verified that an adequate number of vibrators in working order and with competent operators are available. Discontinue placing if any pile of concrete is inadequately consolidated. If any batch of concrete fails to meet the temperature requirements, take immediate steps to improve temperature controls.

3.4.2.9 Vibrators

3.4.2.9.1 Vibrator Testing and Use

Determine the frequency and amplitude of each vibrator in accordance with COE CRD-C 521 prior to initial use and at least once a month when concrete is being placed. Make sdditional tests as directed when a vibrator does not appear to be adequately consolidating the concrete. Determine the frequency at the same time the vibrator is operating in concrete with the tachometer held against the upper end of the vibrator head while almost submerged and just before the vibrator is withdrawn from the concrete. Determine the amplitude with the head vibrating in air. Take two measurements, one near the tip and another near the upper end of the vibrator head and average these results. Report the make, model, type, and size of the vibrator and frequency and amplitude results in writing.

3.4.2.9.2 Vibrator Corrective Action

Immediately remove any vibrator not meeting the requirements of paragraph VIBRATORS from service and repair or replace.

3.4.2.10 Mixer Uniformity

Submit the results of the initial mixer uniformity tests, at least 5 days prior to the initiation of placing.

3.4.2.10.1 Stationary Mixers

Prior to the start of concrete placing and once every 6 months when concrete is being placed, or once for every 75,000 cubic yards of concrete placed, whichever results in the longest time interval, dtermine uniformity of concrete mixing in accordance with ASTM C94/C94M.

3.4.2.10.2 Truck Mixers

Prior to the start of concrete placing and at least once every 6 months when concrete is being placed, determine uniformity of concrete in accordance with ASTM C94/C94M. Randomly select the truck mixers for testing. When satisfactory performance is found in one truck mixer, the performance of mixers of substantially the same design and condition of the blades may be regarded as satisfactory.

3.4.2.11 Mixer Uniformity Corrective Action

When a mixer fails to meet mixer uniformity requirements, either remove the mixer from service on the work, increase the mixing time, change the batching sequence, reduce the batch size, or adjust the mixer until compliance is achieved.

3.4.3 Reports

Report all results of tests or inspections conducted informally as they are completed and in writing daily. Prepare a weekly report for the updating of control charts covering the entire period from the start of the construction season through the current week. During periods of cold-weather protection, make reports of pertinent temperatures daily. These requirements do not relieve the Contractor of the obligation to report certain failures immediately as required in preceding paragraphs. Confirm such reports of failures and the action taken in writing in the routine reports. The Contracting Officer has the right to examine all test and inspection records.

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SECTION 03 35 00

CONCRETE FINISHING

05/14

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SECTION 03 35 00

CONCRETE FINISHING
05/14

PART 1 GENERAL

1.1 REFERENCES

The publications listed below form a part of this specification to the extent referenced. The publications are referred to within the text by the basic designation only.

AMERICAN CONCRETE INSTITUTE INTERNATIONAL (ACI)

ACI 301	(2016) Specifications for Structural Concrete
ACI 305R	(2010) Guide to Hot Weather Concreting

ASTM INTERNATIONAL (ASTM)

ASTM C1059/C1059M	(2013) Standard Specification for Latex Agents for Bonding Fresh to Hardened Concrete
ASTM C881/C881M	(2015) Standard Specification for Epoxy-Resin-Base Bonding Systems for Concrete

1.2 SUBMITTALS

Government approval is required for submittals with a "G" designation; submittals not having a "G" designation are for information only. When used, a designation following the "G" designation identifies the office that will review the submittal for the Government. Submit the following in accordance with Section 01 33 00 SUBMITTAL PROCEDURES:

SD-03 Product Data

Latex Bonding Compound
Epoxy Resin; G

PART 2 PRODUCTS

2.1 LATEX BONDING COMPOUND

Latex bonding compound agents for bonding fresh to hardened concrete shall conform to ASTM C1059/C1059M. Submit samples as required.

2.2 EPOXY RESIN

Epoxy resin for use in repairs shall conform to ASTM C881/C881M, Type III, Grade I or II. Submit samples as required.

PART 3 EXECUTION

3.1 FINISHING FORMED SURFACES

Forms, form materials, and form construction are specified in Section 03 11 13 STRUCTURAL CAST-IN-PLACE CONCRETE FORMING. Finish formed surfaces as specified herein. Unless another type of architectural or special finish is specified, leave surfaces with the texture imparted by the forms except that defective surfaces must be repaired.
Maintain uniform color of the concrete by use of only one mixture without changes in materials or proportions for any structure or portion of structure that requires a Class A or B finish. Do not reuse forms if there is any evidence of surface wear or defects that would impair the quality of the surface.

3.1.1 Class A Finish

Class A finish is required where indicated on the drawings and in the following areas:

All exposed surfaces of canal subject to flowing water.

3.1.2 Class B Finish

Class B finish is required where indicated on the drawings and in the following areas:

All exposed surfaces of canal not subject to flowing water.

Remove fins, ravelings, and loose material, all surface defects over 1/2 inch in diameter or more than 1/2 inch deep, shall be repaired and, except as otherwise indicated, holes left by removal of form ties shall be reamed and filled.
Defects more than 1/2 inch in diameter shall be cut back to sound concrete, but in all cases at least 1 inch deep. Metal tools shall not be used to finish repairs in Class A surfaces.

3.1.3 Class C and Class D Finish

Class C finish is required where indicated on the drawings and in the following areas:
Interior passageways not explosed to public view.

Class D finish is required where indicated on the drawings and in the following areas:

Slab construction joint, control and expansion joint vertical surfaces.
All surfaces which will be permanently covered with backfill.

Fins, ravelings, and loose material shall be removed, and, except as otherwise indicated, holes left by removal of form ties shall be reamed and filled. Honeycomb and other defects more than 1/2 inch deep or more than 2 inches in diameter shall be repaired. Defects more than 2 inches in diameter shall be cut back to sound concrete, but in all cases at least 1 inch deep.

3.2 REPAIRS

Repair in accordance with ACI 301, Section 5.

3.3 FINISHING UNFORMED SURFACES

The finish of all unformed surfaces must meet the requirements of paragraph CONSTRUCTION TOLERANCES in Section 03 31 01 STRUCTURAL CONCRETE FOR CIVIL WORKS, when tested as specified herein.

3.3.1 General

The ambient temperature of spaces adjacent to unformed surfaces being finished and of the base on which concrete will be placed must not be less than 40 degrees F. In hot weather meet all requirements of Section 03 30 53 MISCELLANEOUS CAST-IN-PLACE CONCRETE paragraphs HOT WEATHER REQUIREMENTS and PREVENTION OF PLASTIC SHRINKAGE CRACKING. In hot weather when the rate of evaporation of surface moisture, as determined by use of Figure 2.1.5 of ACI 305R, may reasonably be expected to exceed 0.2 pounds per square foot per hour. Make provisions for windbreaks, shading, fog spraying, or wet covering with a light-colored material in advance of placement, and take such protective measures as quickly as finishing operations will allow. Float finish unformed surfaces that are not to be covered by additional concrete or backfill, with additional finishing as specified below, and true to the elevation indicated. Bring surfaces to receive additional concrete or backfill to the elevation indicated, properly consolidate, and leave true and regular. Unless otherwise indicated, evenly slope exterior surfaces for drainage. Where drains are provided, evenly slope interior floors to the drains. Carfully make joints with a jointing or edging tool. Protect the finished surfaces from stains or abrasions. Grate tampers or "jitterbugs" cannot be used for any surfaces. The dusting of surfaces with dry cement or other materials or the addition of any water during finishing is not permitted. If bleedwater is present prior to finishing, carefully drag off the excess water or remove by absorption with porous materials such as burlap. During finishing operations, take extreme care to prevent over finishing or working water into the surface; this can cause "crazing" (surface shrinkage cracks which appear after hardening) of the surface. Remove and replace any slabs with surfaces which exhibit significant crazing. During finishing operations, check surfaces with a 10 foot straightedge, applied in both directions at regular intervals while the concrete is still plastic, to detect high or low areas.

3.3.2 Rough Slab Finish

In accordance with ACI 301, Section 5.

3.3.3 Float Finish

In accordance with ACI 301, Section 5.

3.3.4 Trowel Finish

In accordance with ACI 301, Section 5.

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CONCRETE CURING

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SECTION 03 39 00

CONCRETE CURING
05/14

PART 1 GENERAL

1.1 REFERENCES

The publications listed below form a part of this specification to the extent referenced. The publications are referred to within the text by the basic designation only.

AMERICAN CONCRETE INSTITUTE INTERNATIONAL (ACI)

ACI 301	(2016) Specifications for Structural Concrete
ACI 308.1	(2011) Specification for Curing Concrete

ASTM INTERNATIONAL (ASTM)

ASTM C1602/C1602M	(2012) Standard Specification for Mixing Water Used in Production of Hydraulic Cement Concrete

1.2 SUBMITTALS

Government approval is required for submittals with a "G" designation; submittals not having a "G" designation are for information only. When used, a designation following the "G" designation identifies the office that will review the submittal for the Government. Submit the following in accordance with Section 01 33 00 SUBMITTAL PROCEDURES:

SD-03 Product Data

Curing Materials

SD-06 Test Reports

Testing and Inspection for CQC

SD-08 Manufacturer's Instructions

Curing Compound

1.3 DELIVERY, STORAGE, AND HANDLING

Store materials in such a manner as to avoid contamination and deterioration. Materials must be capable of being accurately identified after bundles or containers are opened.

PART 2 PRODUCTS

2.1 CURING MATERIALS

Provide curing materials in accordance with ACI 301 Sections 5 and ACI 308.1 Section 2. Submit product data and manufacturer's instructions for concrete curing compound.

2.2 WATER

Provide water for curing that is fresh, clean, potable, and free of injurious amounts of oil, acid, salt, or alkali, except that non-potable water may be used if it meets the requirements of ASTM C1602/C1602M.

PART 3 EXECUTION

3.1 CURING AND PROTECTION

Cure and protect concrete in accordance with ACI 301 Section 5.

3.2 TESTING AND INSPECTION FOR CQC

Perform the inspection and tests described below and, based upon the results of these inspections and tests, take the action required. Submit certified copies of laboratory test reports, including curing compound proposed for use on this project.

3.2.1 Moist Curing Inspections

At least once each shift, and not less than twice per day on both work and non-work days, inspect all areas subject to moist curing. Note and record the surface moisture condition.

3.2.2 Moist Curing Corrective Actione

When a daily inspection report lists an area of inadequate curing, take immediate corrective action, and extend the required curing period for those areas by 1 day.

3.2.3 Membrane Curing Inspection

Apply no curing compound until the Contractor has verified that the compound is properly mixed and ready for spraying. At the end of each operation, estimate the quantity of compound used by measurement of the container and the area of concrete surface covered, compute the rate of coverage in square feet/gallon, and note whether or not coverage is uniform.

3.2.4 Membrane Curing Corrective Action

When the coverage rate of the curing compound is less than that specified or when the coverage is not uniform, spray the entire surface again.

3.2.5 Sheet Curing Inspection

At least once each shift and once per day on non-work days, inspection all areas being cured using impervious sheets. Note and record the condition of the covering and the tightness of the laps and tapes.

3.2.6 Sheet Curing Corrective Action

When a daily inspection report lists any tears, holes, or laps or joints that are not completely closed, promptly repair the tears and holes or replace the sheets, close the joints, and extend the required curing period for those areas by 1 day.

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SECTION 03 52 01

CONTROLLED LOW STRENGTH MATERIAL (CLSM)

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SECTION 03 52 01

CONTROLLED LOW STRENGTH MATERIAL (CLSM)
03/10

PART 1 GENERAL

1.1 SUMMARY

This section specifies ready-mix Controlled Low Strength Material as shown on the Drawings Controlled Low Strength Material will be used to encapsulate pipes including outside of Garden Highway within the levee, through Garden Highway, and outside of the levee. Partial encapsulation is to be performed on pipes outside of the levee..

1.2 REFERENCES

The publications listed below form a part of this specification to the extent referenced. The publications are referred to within the text by the basic designation only.

AMERICAN CONCRETE INSTITUTE (ACI)

ACI 117	(2010; Errata 2011) Specifications for Tolerances for Concrete Construction and Materials and Commentary
ACI 229R	(2005) Controlled Low Strength Materials
ACI 301	(2016) Specifications for Structural Concrete
ACI 347	(2004; Errata 2008; Errata 2012) Guide to Formwork for Concrete

ASTM INTERNATIONAL (ASTM)

ASTM C494/C494M	(2017) Standard Specification for Chemical Admixtures for Concrete
ASTM C150/C150M	(2018) Standard Specification for Portland Cement
ASTM C231/C231M	(2017a) Standard Test Method for Air Content of Freshly Mixed Concrete by the Pressure Method
ASTM C260/C260M	(2010a; R 2016) Standard Specification for Air-Entraining Admixtures for Concrete
ASTM C33/C33M	(2018) Standard Specification for Concrete Aggregates
ASTM C618	(2017a) Standard Specification for Coal Fly Ash and Raw or Calcined Natural Pozzolan for Use in Concrete

ASTM C94/C94M	(2017a) Standard Specification for Ready-Mixed Concrete
ASTM C940	(2016) Standard Test Method for Expansion and Bleeding of Freshly Mixed Grouts for Preplaced-Aggregate Concrete in the Laboratory
ASTM D4832	(2016; E 2018) Standard Test Method for Preparation and Testing of Controlled Low Strength Material (CLSM) Test Cylinders
ASTM D5084	(2016a) Standard Test Methods for Measurement of Hydraulic Conductivity of Saturated Porous Materials Using a Flexible Wall Permeameter
ASTM D5971	(2013) Standard Practice for Sampling Freshly Mixed Controlled Low-Strength Material
ASTM D6103	Standard Test Method for Flow Consistency of Controlled Low Strength Material (CLSM)

1.3 DEFINITIONS

A. Ready-mix Controlled Low Strength Material is used for utility pipe back fill, and is also known as controlled density fill or flowable fill. Controlled Low Strength Material differs from Portland cement concrete as it contains a low cementitious content to reduce strength development for possible future removal. Chemical admixtures may also be used in Controlled Low Strength Material to modify performance properties of strength, flow, set and permeability. Pumpable mixes are available.

B. Controlled Low Strength Material shall be either machine tool or hand tool excavatable at minimum compressive strength of 100 psi and maximum compressive strength of 300 psi at 28 days.

1.4 SUBMITTALS

The following shall be submitted in accordance with Section 01 33 00 SUBMITTAL PROCEDURES:

SD-01 Preconstruction Submittals

Form Removal Schedule; G

SD-02 Shop Drawings

Formwork; G

SD-03 Product Data

Admixtures; G

SD-05 Design Data

CLSM Mix Design; G

Formwork Calculations

SD-06 Test Reports

Quality Control Testing during Construction; G

SD-07 Certificates

CLSM Testing; G

Cementitious materials; G

Fly Ash; G

Aggregate; G

1.5 QUALITY ASSURANCE

1.5.1 Producer

Controlled Low Strength Material shall be manufactured by a ready-mix concrete producer with a minimum of 5 years experience in the production of similar products.

1.5.2 Design Data

1.5.2.1 Formwork Calculations

ACI 347. Include design calculations indicating arrangement of forms, sizes and grades of supports (lumber), panels, and related components. Furnish drawings and calculations of shoring and re-shoring methods proposed for floor and roof slabs, spandrel beams, and other horizontal concrete members. Calculations must indicate concrete pressure with both live and dead loads, along with material types.

1.5.3 Shop Drawings

1.5.3.1 Formwork

Drawings showing details of formwork including, but not limited to; joints, supports, studding and shoring, and sequence of form and shoring removal. Indicate placement schedule, construction, location and method of forming control joints. Include locations of inserts, conduit, sleeves and other embedded items. Reproductions of contract drawings are unacceptable. Submit form removal schedule indicating element and minimum length of time for form removal.

Design, fabricate, erect, support, brace, and maintain formwork so that it is capable of supporting without failure all vertical and lateral loads that may reasonably be anticipated to be applied to the formwork.

1.6 DELIVERY, STORAGE, AND HANDLING

Deliver and handle in strict compliance with manufacturer's recommendations. Protect from damage due to weather, excessive temperatures, and construction operations.

1.7 PROJECT CONDITIONS

Perform work only when existing and forecasted weather conditions are within the limits established by the manufacturer of the materials and products used.

PART 2 PRODUCTS

2.1 MANUFACTURER

2.1.1 Controlled Low Strength Material

Provide Controlled Low Strength Material manufactured by a ready-mix concrete producer experienced in the design and control of flowable mixtures. Manufacturer shall provide mixtures meeting performance properties specified herein.

2.1.2 Stable-Air Generator Admixture

Provide Stable-Air Generator admixture DaraFill by Grace Construction Products, or Agency reviewed equal, for Controlled Low Strength Material meeting specified requirements. DaraFill addition rate must be 3 oz. dosage per 1 cubic yard; and addition rates must comply with the manufacturer's data sheet

2.2 MATERIALS

The contractor shall be responsible for the CLSM mix proportions, and ensuring the mixture is suitable for the application. The CLSM mixture design shall be accomplished by an approved independent commercial materials testing laboratory. The CLSM Testing results shall be submitted. The CLSM mixture design studies shall include trial design mixtures and testing to verify the proposed CLSM ACI 229R, shall be a self-compacting fill, low permeability, flowable or pumpable mixture. CLSM shall consist of Portland cement, Fly Ash and fine and coarse aggregates, admixtures, and water.

2.2.1 Portland Cement

Portland Cement: ASTM C150/C150M, Type II, meeting the low alkali requirement.

2.2.2 Aggregate

Provide material meeting the requirements of ASTM C33/C33M.

Submit test reports demonstrating aggregates proposed for use conform to specified requirements. Submit with the CLSM Mixture Proportions Submittal.

2.2.3 Fly Ash

Fly ash shall meet ASTM C618 requirements for Class F, meeting the low alkali, drying shrinkage, and uniformity requirements.

Manufacturers certification and current mill test reports attesting that cementitious materials and fly ash proposed for use conform to the specified requirements. Submit with the CLSM Proportions Submittal.

2.2.4 Admixtures

Air-entraining admixtures shall conform to ASTM C260/C260M. Accelerating admixtures shall conform to ASTM C494/C494M, Type C. Water-Reducing or retarding admixtures shall conform to ASTM C494/C494M., Type A, B, or D. High-range water-reducing admixtures shall conform to ASTM C494/C494M, Type F or G. Permeability-reducing admixtures may be used if required and shall be a dry-powdered bentonite used as recommended in ACI 229R limited to 2 percent by volume. Admixtures shall be evaluated in the CLSM mixture design studies.

Submit manufacturers descriptive literature demonstrating the admixtures proposed for use in CLSM mixtures conform to specified requirements. Submit with the CLSM Mixture Proportions submittal.

2.2.5 WATER

Water for mixing shall be fresh, clean, and potable, conforming to ASTM C94/C94M.

2.3 CONTROLLED LOW STRENGTH MATERIAL MIXTURE

CLSM shall contain Portland cement, and shall be proportioned to have a high fly ash content to reduce hydraulic conductivity. The fly ash content shall be between 10 and 20 percent of the total aggregate by weight as determined in the mixture design studies. Fly ash content may be increased as required to achieve the hydraulic conductivity requirement. CLSM mixture shall include air entraining admixtures and water reducing admixtures to reduce mix water requirements and improve flow characteristics. CLSM shall be proportioned to achieve a flowability and hardening time suitable for the application.

2.3.1 CLSM Mix Design

The CLSM mix design shall produce a consistency that will result in a flowable product at the time of placement which does not require manual means to move it into place. Report the proportions of material used for each trial mix and proposed job mixture.

The results of trial mixture design studies, along with a statement giving the maximum nominal coarse aggregate size and the proportions of ingredients that will be used in the manufacture of CLSM, shall be submitted at least 30 days prior to commencing placement operations. Aggregate weights shall be based on the saturated surface dry condition. The statement shall be accompanied by test results from an approved independent commercial testing laboratory, showing that mixture design studies have been made with materials proposed for the project and that the proportions selected will produce CLSM of the quantities specified. No substitutions shall be made in the materials used in the materials used in the mixture design studies without additional tests to show that the quality of the CLSM is satisfactory.

2.3.2 Mix Compressive Strength

Provide mix with compressive strength of minimum 100 psi and maximum 300 psi according to ASTM D4832 at 28 days after placement.

2.3.3 Materials

Materials to be used in controlled low strength material shall meet the requirements of ACI 229R.

2.3.4 Mix Permeability

Provide mix with maximum permeability of $1x10^{-5}$ cm/sec according to ASTM D5084 at twenty-eight (28) days after placement.

2.3.5 Final Bleeding

Controlled Low Strength Material shall have minimal subsidence and bleed water which is measured as a Final Bleeding of less than 2.0 percent (retains 98.0 percent of original height after placement, approximately 1/4 inch per foot of depth) per ASTM C940.

2.3.6 Fresh Unit Weight

The fresh unit weight shall be 90 - 110 lbs/ft3 (1600 - 1760 kg/m3), except where specified, and in the absence of strength data the cementitious content shall be a maximum of 150 lbs/cy (90 kg/m3).

2.3.7 In-Place Yield

Controlled Low Strength Material shall have an in-place yield of 98% of design yield.

2.3.8 Flow Consistency

Controlled low strength material shall have a minimum flowability of 8 inches as determined by ASTM D6103. </TXT>

<TXT> The consistency of the CLSM shall be such that the material flows easily into all openings between the pipe and the lower portion of the trench. When trenches are on a steep slope, a stiffer mix of slurry may be required to prevent CLSM from flowing down the trench. When a stiffer mix is used, vibration shall be performed to ensure that the CLSM slurry completely fills all spaces between the pipe and the lower portion of the trench.

2.4 PIPE BRACING

Provide design of proposed pipe bracing system to prevent pipe flotation during installation of Controlled Low Strength Material. Provide buoyancy calculations and bracing requirements of the resisting members.

PART 3 EXECUTION

3.1 EXAMINATION

Examine conditions of substrates and other conditions under which work is to be performed and notify the Government, in writing, of circumstances detrimental to the proper completion of the work. Do not proceed until unsatisfactory conditions are corrected.

3.2 PLACEMENT OF CONTROL DENSITY FILL

The CLSM shall be placed in a manner that provides complete encapsulation of the pipes. Concrete vibrators such as stick vibrators shall be used along the pipes to ensure no void spaces exist around or near the pipes.

A. Secure pipe to be encased in Controlled Low Strength Material to prevent displacement during placement. The percentage reduction in hydrostatic pressure achieved with the use of a Stable Air Generator may be used to calculate anchorage requirements.

B. The pipe shall be braced as recommended by the pipe manufacturer to prevent flotation when placing the Controlled Low Strength Material.

C. Place Controlled Low Strength Material in separate lifts as recommended by the pipe manufacturer to prevent the pipe from floating during installation.

3.3 FORMS

Provide forms, shoring, and scaffolding for concrete placement in accordance with ACI 301 Section 2 and 5 and ACI 347. Set forms mortar-tight and true to line and grade. Chamfer above grade exposed joints, edges, and external corners of concrete 0.75 inch unless otherwise indicated. Provide formwork with clean-out openings to permit inspection and removal of debris.

3.3.1 Coating

Before concrete placement, coat the contact surfaces of forms with a form release agent.

3.3.2 Reshoring

Reshore concrete elements in accordance with ACI 301 Section 2.

3.3.3 Reuse

Reuse forms providing the structural integrity of concrete and the aesthetics of exposed concrete are not compromised. Wood forms must not be clogged with paste and must be capable of absorbing high water-cementitious material ratio paste.

3.3.4 Forms for Standard Rough Form Finish

Provide formwork in accordance with ACI 301 Section 5 with a surface finish, SF-1.0, for formed surfaces that are to be concealed by other construction.

3.3.5 Forms for Standard Smooth Form Finish

Provide formwork in accordance with ACI 301 Section 5 with a surface finish, SF-3.0, for formed surfaces that are exposed to view.

3.3.6 Form Ties

Provide ties in accordance with ACI 301 section 2.

3.3.7 Tolerances for Form Construction

Construct formwork to ensure that after removal of forms and prior to patching and finishing of formed surfaces, provide concrete surfaces in accordance with tolerances specified in ACI 301 Section 5 and ACI 117.

3.3.8 Removal of Forms and Supports

After placing concrete, removal of forms must be in accordance with ACI 301 Section 2 except as modified by approved form removal schedule.

3.4 PROTECTION

Protect Controlled Low Strength Material from traffic until the material has reached 70% of the design strength.

3.5 QUALITY CONTROL TESTING DURING CONSTRUCTION

Concrete shall be sampled and tested for quality control by the Contractor during the placement of the concrete as follows:

REQUIREMENT	TEST METHOD	NUMBER OF TESTS
Sampling fresh Controlled Low Strength Material	ASTM D5971	As required except modified for each slump test
Flow Consistency Test	ASTM D6103	One for each CLSM load at point of discharge and one for each set of compressive strength tests
Air content by pressure method	ASTM C231/C231M	One for each set of compressive strength tests
Compression test specimens	ASTM D5971	One set of six standard cylinders for each compressive strength test
Controlled Low Strength Material temperature		Hourly when air temperature is 40 degrees F or below and 80 degrees F or above; each time a set of compression test specimens is made
Compressive	ASTM D4832	One set for each 50

strength test		cubic yards or fraction thereof of placed in any one day; two specimens tested at 7 days, three specimens tested at 28 days and one specimen retained in reserve for testing if required
Permeability test	ASTM D5084	One set for each 50 cubic yards or fraction thereof of placed in any one day

Test reports for concrete for Chemical Composition, Mechanical Usability and Soundness shall be submitted by the Contractor meeting all design Specifications as required by referenced standards within this section.

3.6 CLSM ACCEPTANCE

3.6.1 General

Final acceptance of the CLSM will be based upon the Contractor's Quality Control Records as identified in the Contractor's Quality Control test results and the Government's Quality Assurance test results. Both the Contractor's and the Government's testing shall demonstrate that the Contract requirements are met prior to acceptance of the work. If, during the course of construction, the Contractor's Quality Control testing indicates noncompliance with the Specifications, immediately notify the Government in writing. Notification shall include the remedial action to be taken by the Contractor to bring work back into compliance. Remove, dispose of, and replace all CLSM that does not meet the acceptance criteria at no cost to the Government.

3.6.2 Acceptance Criteria Synopsis

The following is a summarization of acceptance criteria for part but not all of the testing and procedural requirements. Refer to the entire Specifications and Plans for all Contract requirements.

a. Compressive strength: Minimum 100 psi and Maximum 300 psi at 28 days.

b. Permeability: Maximum $1x10^{-5}$ cm/sec at 28 days.

-- End of Section --

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MISCELLANEOUS METAL FABRICATIONS

05/17

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SECTION 05 50 13

MISCELLANEOUS METAL FABRICATIONS
05/17

PART 1 GENERAL

1.1 REFERENCES

The publications listed below form a part of this specification to the extent referenced. The publications are referred to within the text by the basic designation only.

AMERICAN CONCRETE INSTITUTE INTERNATIONAL (ACI)

ACI 308.1	(2011) Specification for Curing Concrete
ACI 355.2	(2007) Qualification of Post-Installed Mechanical Anchors in Concrete & Commentary

AMERICAN INSTITUTE OF STEEL CONSTRUCTION (AISC)

AISC 303	(2016) Code of Standard Practice for Steel Buildings and Bridges

AMERICAN SOCIETY OF SAFETY ENGINEERS (ASSE/SAFE)

ASSE/SAFE A10.3	(2013) Operations - Safety Requirements for Powder Actuated Fastening Systems

AMERICAN WELDING SOCIETY (AWS)

AWS D1.1/D1.1M	(2015; Errata 1 2015; Errata 2 2016) Structural Welding Code - Steel

ASME INTERNATIONAL (ASME)

ASME B18.2.1	(2012; Errata 2013) Square and Hex Bolts and Screws (Inch Series)
ASME B18.2.2	(2015) Nuts for General Applications: Machine Screw Nuts, Hex, Square, Hex Flange, and Coupling Nuts (Inch Series)
ASME B18.21.1	(2009; R 2016) Washers: Helical Spring-Lock, Tooth Lock, and Plain Washers (Inch Series)
ASME B18.21.2M	(1999; R 2014) Lock Washers (Metric Series)
ASME B18.22M	(1981; R 2017) Metric Plain Washers
ASME B18.6.2	(1998; R 2010) Slotted Head Cap Screws, Square Head Set Screws, and Slotted Headless Set Screws: Inch Series
ASME B18.6.3	(2013; R 2017) Machine Screws, Tapping

Screws, and Machine Drive Screws (Inch Series)

ASTM INTERNATIONAL (ASTM)

ASTM A123/A123M	(2017) Standard Specification for Zinc (Hot-Dip Galvanized) Coatings on Iron and Steel Products
ASTM A153/A153M	(2016) Standard Specification for Zinc Coating (Hot-Dip) on Iron and Steel Hardware
ASTM A29/A29M	(2016) Standard Specification for General Requirements for Steel Bars, Carbon and Alloy, Hot-Wrought
ASTM A307	(2014; E 2017) Standard Specification for Carbon Steel Bolts, Studs, and Threaded Rod 60 000 PSI Tensile Strength
ASTM A36/A36M	(2014) Standard Specification for Carbon Structural Steel
ASTM A467/A467M	(2007; R 2012) Standard Specification for Machine Coil Chain
ASTM A500/A500M	(2018) Standard Specification for Cold-Formed Welded and Seamless Carbon Steel Structural Tubing in Rounds and Shapes
ASTM A53/A53M	(2018) Standard Specification for Pipe, Steel, Black and Hot-Dipped, Zinc-Coated, Welded and Seamless
ASTM A653/A653M	(2017) Standard Specification for Steel Sheet, Zinc-Coated (Galvanized) or Zinc-Iron Alloy-Coated (Galvannealed) by the Hot-Dip Process
ASTM A780/A780M	(2009; R 2015) Standard Practice for Repair of Damaged and Uncoated Areas of Hot-Dip Galvanized Coatings
ASTM A786/A786M	(2015a) Standard Specification for Hot-Rolled Carbon, Low-Alloy, High-Strength Low-Alloy, and Alloy Steel Floor Plates
ASTM A924/A924M	(2017a) Standard Specification for General Requirements for Steel Sheet, Metallic-Coated by the Hot-Dip Process
ASTM C1513	(2013) Standard Specification for Steel Tapping Screws for Cold-Formed Steel Framing Connections

ICC EVALUATION SERVICE, INC. (ICC-ES)

ICC ES AC193	(2012) AC193 Mechanical Anchors in Concrete Elements

MASTER PAINTERS INSTITUTE (MPI)

MPI 79	(2012) Primer, Alkyd, Anti-Corrosive for Metal

SOCIETY FOR PROTECTIVE COATINGS (SSPC)

SSPC SP 3	(1982; E 2004) Power Tool Cleaning
SSPC SP 6/NACE No.3	(2007) Commercial Blast Cleaning

U.S. ARMY CORPS OF ENGINEERS (USACE)

EM 385-1-1	(2014) Safety and Health Requirements Manual

1.2 SUBMITTALS

Government approval is required for submittals with a "G" designation; submittals not having a "G" designation are for information only. When used, a designation following the "G" designation identifies the office that will review the submittal for the Government. Submit the following in accordance with Section 01 33 00 SUBMITTAL PROCEDURES:

SD-02 Shop Drawings

Cover Plates and Frames, Installation Drawings; G

Gratings, Installation Drawings; G

Bollards/Pipe Guards; G

Embedded Angles and Plates, Installation Drawings; G

SD-03 Product Data

Cover Plates and Frames; G

Gratings; G

Expansion Anchors; G

Adhesive Anchors; G

SD-07 Certificates

Certificates of Compliance; G

1.3 QUALIFICATION OF WELDERS

Qualify welders in accordance with AWS D1.1/D1.1M. Use procedures, materials, and equipment of the type required for the work.

1.4 DELIVERY, STORAGE, AND PROTECTION

Protect from corrosion, deformation, and other types of damage. Store items in an enclosed area free from contact with soil and weather. Remove and replace damaged items with new items.

1.5 MISCELLANEOUS REQUIREMENTS

1.5.1 Fabrication Drawings

Submit fabrication drawings showing layout(s), connections to structural system, and anchoring details as specified in AISC 303.

1.5.2 Installation Drawings

Submit templates, erection, and installation drawings indicating thickness, type, grade, class of metal, and dimensions. Show construction details, reinforcement, anchorage, and installation in relation to the building construction.

PART 2 PRODUCTS

2.1 RECYCLED CONTENT

Provide products with recycled content and provide certificates of compliance.

2.2 MATERIALS

Provide exposed fastenings of compatible materials (avoid contact of dissimilar metals). Coordinate color and finish with the material to which fastenings are applied. Submit the manufacturer's certified mill reports which clearly show the applicable ASTM mechanical and chemical requirements together with the actual test results for the supplied materials.

2.2.1 Structural Carbon Steel

Provide in accordance with ASTM A36/A36M.

2.2.2 Structural Tubing

Provide in accordance with ASTM A500/A500M.

2.2.3 Gratings

a. Provide hot dip galvanized grating, non-slip requirement.

2.2.4 Floor Plates, Patterned

Provide floor plate in accordance with ASTM A786/A786M. Provide steel plate not less than 14 gage.

2.2.5 Anchor Bolts

Provide in accordance with ASTM A307. Where exposed, provide anchor bolts of the same material, color, and finish as the metal to which they are applied.

2.2.5.1 Expansion Anchors, Sleeve Anchors, and Adhesive Anchors

Expansion Anchors and Adhesive Anchors:

a. Mechanical anchors for use in cracked and uncracked concrete shall have been tested and qualified for use in accordance with ACI 355.2 and ICC ES AC193.

Pre-approved mechanical anchors include:

1) KWIK BOLTZ TZ (ICC-ES ESR 1917)by HILTI, INC.
2) TRUBOLT+ (ICC-ES ESR-2427) BY ITW RAMSET/REDHEAD.
3) STRONG BOLT (ICC-ES ESR-1771) AND STRONG BOLT 2 (ICC-ES ESR-3037) BY SIMPSON STRONG TIE ANCHOR SYSTEMS.

b. Adhesive anchors for use in cracked and uncracked concrete shall have been tested and qualified for use in accordance with ACI 308.1

Pre-approved adhesive anchors include:

1) HIT-RE-500 SD (ICC-ES ESR 2322) SYSTEM ADHESIVE ANCHORS BY HILTI, INC.
2) EPCON G5 (ICC-ES-ESR-1137) ADHESIVE ANCHORING SYSTEM BY ITW RAMSET/REDHEAD.
3) SET-XP (ICC-ES ESR-2508) ADHESIVE ANCHORING SYSTEMS BY SIMPSON STRONG TIE ANCHOR SYSTEMS.

2.2.5.2 Lag Screws and Bolts

Provide in accordance with ASME B18.2.1, type and grade best suited for the purpose.

2.2.5.3 Toggle Bolts

Provide in accordance with ASME B18.2.1.

2.2.5.4 Bolts, Nuts, Studs and Rivets

Provide in accordance with ASME B18.2.2 or ASTM A307.

2.2.5.5 Powder Actuated Fasteners

Follow safety provisions in accordance with ASSE/SAFE A10.3.

2.2.5.6 Screws

Provide in accordance with ASME B18.2.1, ASME B18.6.2, ASME B18.6.3 and ASTM C1513.

2.2.5.7 Washers

Provide plain washers in accordance with ASME B18.22M, ASME B18.21.1. Provide beveled washers for American Standard beams and channels, square or rectangular, tapered in thickness, and smooth. Provide lock washers in accordance with ASME B18.21.2M, ASME B18.21.1.

2.2.5.8 Welded Headed Studs

Provide in accordance with ASTM A29/A29M.

2.3 FABRICATION FINISHES

2.3.1 Galvanizing

Hot-dip galvanize items specified to be zinc-coated, after fabrication where practicable. Provide galvanizing in accordance with ASTM A123/A123M, ASTM A153/A153M, ASTM A653/A653M or ASTM A924/A924M, Z275 G90.

2.3.2 Galvanize

Anchor bolts, grating fasteners, washers, and parts or devices necessary for proper installation, unless indicated otherwise.

2.3.3 Repair of Zinc-Coated Surfaces

Repair damaged surfaces with galvanizing repair method and paint in accordance with ASTM A780/A780M or by application of stick or thick paste material specifically designed for repair of galvanizing, as approved by Contracting Officer. Clean areas to be repaired and remove slag from welds. Heat, with a torch, surfaces to which stick or paste material will be applied. Heat to a temperature sufficient to melt the metals in the stick or paste. Spread molten material uniformly over surfaces to be coated and wipe off excess material.

2.3.4 Shop Cleaning and Painting

2.3.4.1 Surface Preparation

Blast clean surfaces in accordance with SSPC SP 6/NACE No.3. Surfaces that will be exposed in spaces above ceiling or in attic spaces, crawl spaces, furred spaces, and chases may be cleaned in accordance with SSPC SP 3 in lieu of being blast cleaned. Wash cleaned surfaces which become contaminated with rust, dirt, oil, grease, or other contaminants with solvents until thoroughly clean. Steel to be embedded in concrete must be free of dirt and grease prior to embed. Do not paint or galvanize bearing surfaces, including contact surfaces within slip critical joints. Shop coat these surfaces with rust prevention.

2.3.4.2 Pretreatment, Priming and Painting

Apply pre-treatment, primer, and paint in accordance with manufacturer's printed instructions. On surfaces concealed in the finished construction or not accessible for finish painting, apply an additional prime coat to a minimum dry film thickness of 1.0 mil. Tint additional prime coat with a small amount of tinting pigment.

2.3.5 Nonferrous Metal Surfaces

Protect by plating, anodic, or organic coatings.

2.4 COVER PLATES AND FRAMES

Fabricate cover plates of 1/4 inch thick rolled steel weighing not more than 100 pounds per plate with a selected raised pattern nonslip top surface. Provide galvanized plate. Reinforce to sustain a live load of 250 pounds per square foot or AASHTO H-20 loading . Provide structural steel shapes and plates for frames, with bent steel bars or headed anchors welded to frame for anchoring to concrete. Miter and weld all corners. Butt joint straight runs. Allow for expansion on straight runs over 15 feet. Provide flush drop handles for removal; form from 1/4 inch round stock. Remove sharp edges and burrs from cover plates and exposed edges of frames. Weld all connections and grind top surface smooth. Weld bar stops every six inches. Provide 1/8 inch clearance at edges and between cover plates.

2.5 GRATINGS

2.5.1 Steel Grating

Hot dip galvanized grating as shown on the drawings.

2.6 BOLLARDS/PIPE GUARDS

Provide galvanized extra strong weight steel pipe in accordance with ASTM A53/A53M, size as shown on the Drawings. Anchor posts in concrete as indicated and fill solidly with concrete with minimum compressive strength of 3000 psi.

2.7 MISCELLANEOUS PLATES AND SHAPES

Provide items that do not form a part of the structural steel framework, such as sill angles, miscellaneous mountings and frames. Provide with connections and fasteners or welds. Construct to have at least 8 in bearing on masonry at each end.

Provide angles and plates in accordance with ASTM A36/A36M, for embedment as indicated. Galvanize embedded items exposed to the elements in accordance with ASTM A123/A123M.

2.8 SAFETY CHAINS

Construct safety chains of galvanized steel, straight link type, minimum 3/16 inch diameter, with a minimum of twelve links per one foot, and snap hooks on each end. Test safety chain in accordance with ASTM A467/A467M, Class CS. Provide boat type snap hooks. Provide galvanized 3/8 inch bolt with 3/4 inch eye diameter for attachment of chain, anchored as indicated. Supply two chains, 4 inches longer than the anchorage spacing, for each guarded area.

PART 3 EXECUTION

3.1 GENERAL INSTALLATION REQUIREMENTS

Install items at locations indicated in accordance with manufacturer's instructions. Verify all field dimensions prior to fabrication. Include materials and parts necessary to complete each assembly, whether indicated or not. Miss-alignment and miss-sizing of holes for fasteners is cause for rejection. Conceal fastenings where practicable. Joints exposed to weather must be watertight.

3.2 WORKMANSHIP

Provide miscellaneous metalwork that is true and accurate in shape, size, and profile. Make angles and lines continuous and straight. Make curves consistent, smooth and unfaceted. Provide continuous welding along the entire area of contact except where tack welding is permitted. Do not tack weld exposed connections. Unless otherwise indicated and approved, provide a smooth finish on exposed surfaces. Provide countersuck rivets where exposed. Provide coped and mitered corner joints aligned flush and without gaps.

3.3 ANCHORAGE, FASTENINGS, AND CONNECTIONS

Provide anchorage as necessary, whether indicated or not, for fastening miscellaneous metal items securely in place. Include slotted inserts, expansion shields, powder-driven fasteners, toggle bolts (when approved for concrete), through bolts for masonry, headed shear studs, machine and carriage bolts for steel, through bolts, lag bolts, and screws for wood. Do not use wood plugs. Provide non-ferrous attachments for non-ferrous metal. Provide exposed fastenings of compatible materials (avoid contact of dissimilar metals), that generally match in color and finish the surfaces to which they are applied. Conceal fastenings where practicable. Provide all fasteners flush with the surfaces they fasten, unless indicated otherwise. Test a minimum of 2 bolt, nut, and washer assemblies from each certified mill batch in a tension measuring device at the job site prior to the beginning of bolting start-up.

3.4 BUILT-IN WORK

Where necessary and not otherwise indicated, form built-in metal work for anchorage with concrete or masonry. Provide built-in metal work in ample time for securing in place as the work progresses.

3.5 WELDING

Perform welding, welding inspection, and corrective welding in accordance with AWS D1.1/D1.1M. Use continuous welds on all exposed connections. Grind visible welds smooth in the finished installation. Provide welded headed shear studs in accordance with AWS D1.1/D1.1M, Clause 7, except as otherwise specified. Provide in accordance with the safety requirements of EM 385-1-1.

3.6 DISSIMILAR METALS IN CONTACT WITH CONCRETE

Where dissimilar metals and concrete are in contact, protect surfaces with a coating in accordance with MPI 79 to prevent galvanic or corrosive action. Clean surfaces with metal shavings from installation at the end of each work day.

3.7 PREPARATION

3.7.1 Material Coatings and Surfaces

Remove rust preventive coating just prior to field erection, using a remover approved by the metal manufacturer. Surfaces, when assembled, must be free of rust, grease, dirt and other foreign matter.

3.7.2 Environmental Conditions

Do not clean or paint surfaces when damp or exposed to foggy or rainy weather, when metallic surface temperature is less than minus 5 degrees F above the dew point of the surrounding air, or when surface temperature is below 45 degrees F or over 95 degrees F, unless approved by the Contracting Officer. Metal surfaces to be painted must be dry for a minimum of 48 hours prior to the application of primer or paint.

3.8 COVER PLATES AND FRAMES

Provide tops of cover plates and frames flush with finished surface. Test for trip hazards and adjust for any encountered lippage.

3.9 INSTALLATION OF BOLLARDS/PIPE GUARDS

Set bollards/pipe guards vertically in concrete piers. Fill hollow cores with concrete having a compressive strength of 3000 psi.

-- End of Section --

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DIVISION 05 - METALS

SECTION 05 51 33

METAL LADDERS

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SECTION 05 51 33

METAL LADDERS
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PART 1 GENERAL

1.1 REFERENCES

The publications listed below form a part of this specification to the extent referenced. The publications are referred to within the text by the basic designation only.

ALUMINUM ASSOCIATION (AA)

AA DAF45	(2003; Reaffirmed 2009) Designation System for Aluminum Finishes

AMERICAN LADDER INSTITUTE (ALI)

ALI A14.3	(2008) Standard for Fixed Ladders and Safety Requirements

AMERICAN SOCIETY OF SAFETY ENGINEERS (ASSE/SAFE)

ASSE/SAFE Z359.16	(2016) Safety Requirements for Climbing Ladder Fall Arrest Systems

AMERICAN WELDING SOCIETY (AWS)

AWS D1.1/D1.1M	(2015; Errata 1 2015; Errata 2 2016) Structural Welding Code - Steel

ASTM INTERNATIONAL (ASTM)

ASTM A123/A123M	(2017) Standard Specification for Zinc (Hot-Dip Galvanized) Coatings on Iron and Steel Products
ASTM A153/A153M	(2016) Standard Specification for Zinc Coating (Hot-Dip) on Iron and Steel Hardware
ASTM A36/A36M	(2014) Standard Specification for Carbon Structural Steel
ASTM A47/A47M	(1999; R 2014) Standard Specification for Ferritic Malleable Iron Castings
ASTM A500/A500M	(2018) Standard Specification for Cold-Formed Welded and Seamless Carbon Steel Structural Tubing in Rounds and Shapes
ASTM A53/A53M	(2018) Standard Specification for Pipe, Steel, Black and Hot-Dipped, Zinc-Coated, Welded and Seamless

ASTM A653/A653M	(2017) Standard Specification for Steel Sheet, Zinc-Coated (Galvanized) or Zinc-Iron Alloy-Coated (Galvannealed) by the Hot-Dip Process
ASTM A780/A780M	(2009; R 2015) Standard Practice for Repair of Damaged and Uncoated Areas of Hot-Dip Galvanized Coatings
ASTM A924/A924M	(2017a) Standard Specification for General Requirements for Steel Sheet, Metallic-Coated by the Hot-Dip Process
ASTM B108/B108M	(2015) Standard Specification for Aluminum-Alloy Permanent Mold Castings
ASTM B209	(2014) Standard Specification for Aluminum and Aluminum-Alloy Sheet and Plate
ASTM B221	(2014) Standard Specification for Aluminum and Aluminum-Alloy Extruded Bars, Rods, Wire, Profiles, and Tubes
ASTM B26/B26M	(2014; E 2015) Standard Specification for Aluminum-Alloy Sand Castings
ASTM D1187/D1187M	(1997; E 2011; R 2011) Asphalt-Base Emulsions for Use as Protective Coatings for Metal

MASTER PAINTERS INSTITUTE (MPI)

MPI 79	(2012) Primer, Alkyd, Anti-Corrosive for Metal

SOCIETY FOR PROTECTIVE COATINGS (SSPC)

SSPC SP 3	(1982; E 2004) Power Tool Cleaning
SSPC SP 6/NACE No.3	(2007) Commercial Blast Cleaning

U.S. NATIONAL ARCHIVES AND RECORDS ADMINISTRATION (NARA)

29 CFR 1910.23	(Nov 2016) Ladders
29 CFR 1910.28	(Nov 2016)Duty to Have Fall Protection and Falling Object Protection
29 CFR 1910.29	(Nov 2016) Fall Protection System and Falling Object Protection - Criteria and Practices

1.2 SUBMITTALS

Government approval is required for submittals with a "G" designation; submittals not having a "G" designation are for Contractor Quality Control approval. Submit the following in accordance with Section 01 33 00 SUBMITTAL PROCEDURES:

SD-02 Shop Drawings

Ladders, Installation Drawings

Ship's Ladder (With or Without Guards), Installation Drawings

SD-03 Product Data

Ladders

Ship's Ladder (With or Without Guards)

Ladder Safety Devices (Climbing Ladder Fall Arrest Systems)

SD-07 Certificates

Fabricator Certification for Ladder Assembly

Fabricator Certification for Ships Ladder Assembly

1.3 CERTIFICATES

Provide fabricator certification for ladder assembly stating that the ladder and associated components have been fabricated according to the requirements of 29 CFR 1910.23.

Provide fabricator certification for ships ladder assembly stating that the ships ladder and associated components have been fabricated according to the requirements of 29 CFR 1910.23.

1.4 QUALIFICATION OF WELDERS

Qualify welders in accordance with AWS D1.1/D1.1M. Use procedures, materials, and equipment of the type required for the work.

1.5 DELIVERY, STORAGE, AND PROTECTION

Protect from corrosion, deformation, and other types of damage. Store items in an enclosed area free from contact with soil and weather. Remove and replace damaged items with new items.

PART 2 PRODUCTS

2.1 MATERIALS

2.1.1 Structural Carbon Steel

ASTM A36/A36M.

2.1.2 Structural Tubing

ASTM A500/A500M.

2.1.3 Steel Pipe

ASTM A53/A53M, Type E or S, Grade B.

2.1.4 Fittings for Steel Pipe

Standard malleable iron fittings ASTM A47/A47M.

2.1.5 Aluminum Alloy Products

Conform to ASTM B209 for sheet plate, ASTM B221 for extrusions and ASTM B26/B26M or ASTM B108/B108M for castings, as applicable. Provide aluminum extrusions at least 1/8 inch thick and aluminum plate or sheet at least 0.050 inch thick.

2.2 FABRICATION FINISHES

2.2.1 Galvanizing

Hot-dip galvanize items specified to be zinc-coated, after fabrication where practicable. Galvanizing: ASTM A123/A123M, ASTM A153/A153M, ASTM A653/A653M or ASTM A924/A924M, G90, as applicable.

2.2.2 Galvanize

Anchor bolts, washers, and parts or devices necessary for proper installation, unless indicated otherwise.

2.2.3 Repair of Zinc-Coated Surfaces

Repair damaged surfaces with galvanizing repair method and paint conforming to ASTM A780/A780M or by application of stick or thick paste material specifically designed for repair of galvanizing, as approved by Contracting Officer. Clean areas to be repaired and remove slag from welds. Heat surfaces to which stick or paste material is applied, with a torch to a temperature sufficient to melt the metallics in stick or paste; spread molten material uniformly over surfaces to be coated and wipe off excess material.

2.2.4 Shop Cleaning and Painting

2.2.4.1 Surface Preparation

Blast clean surfaces in accordance with SSPC SP 6/NACE No.3. Surfaces that will be exposed in spaces above ceiling or in attic spaces, crawl spaces, furred spaces, and chases may be cleaned in accordance with SSPC SP 3 in lieu of being blast cleaned. Wash cleaned surfaces which become contaminated with rust, dirt, oil, grease, or other contaminants with solvents until thoroughly clean.

2.2.4.2 Pretreatment, Priming and Painting

Apply pretreatment, primer, and paint in accordance with manufacturer's printed instructions. On surfaces concealed in the finished construction or not accessible for finish painting, apply an additional prime coat to a minimum dry film thickness of 1.0 mil. Tint additional prime coat with a small amount of tinting pigment.

2.2.5 Nonferrous Metal Surfaces

Protect by plating, anodic, or organic coatings.

2.2.6 Aluminum Surfaces

2.2.6.1 Surface Condition

Before finishes are applied, remove roll marks, scratches, rolled-in scratches, kinks, stains, pits, orange peel, die marks, structural streaks, and other defects which will affect uniform appearance of finished surfaces.

2.2.6.2 Aluminum Finishes

Unexposed plate and extrusions may have mill finish as fabricated. Sandblast castings' finish, medium, AA DAF45. Unless otherwise specified, provide all other aluminum items with standard mill finish. Provide a coating thickness not less than that specified for protective and decorative type finishes for items used in interior locations or architectural Class I type finish for items used in exterior locations in AA DAF45.

2.3 LADDERS

Fabricate vertical ladders conforming to 29 CFR 1910.23 and Section 5 of ALI A14.3. Ladders shall be capable of supporting their maximum intended load. Use 2 1/2 by 3/8 inch steel flats for stringers and 3/4 inch diameter steel rods for rungs. Ladder rungs, step and cleats must be spaced not less than 10 inches and not more than 16 inches wide (measured before installation of ladder safety system), spaced no more than 14 inches apart, plug welded or shouldered and headed into stringers. Install ladders so that the maximum perpendicular distance from the centerline of the steps or rungs, or grab bars, or both, to the nearest permanent object in the back of the ladder or to the finished wall surface will not be less than 7 inches, except for the elevator pit ladders, which have a minimum perpendicular distance of 4.5 inches. Provide heavy clip angles riveted or bolted to the stringer and drilled as indicated. Provide intermediate clip angles not over 48 inches on centers. The top rung of the ladder must be level with the top of the access level, parapet or landing served by the ladder except for hatches or wells. Extend the side rails of through or side step ladders 42 inches above the access level. Provide ladder access protective swing gates at the top of access/egress level. The drawings must indicate ladder locations and details of critical dimensions and materials.

2.3.1 Phasing out of Ladder Cages and Wells (29 CFR 1910.28, Nov 2016)

Conform to 29 CFR 1910.28 (Nov 2016).

Each newly installed ladder over 20 feet in length shall only be equipped with a personal fall arrest system or climbing ladder fall arrest system (ladder safety device), cages and wells are prohibited. When a fixed ladder, cage, or well, or any portion of a section thereof, is replaced, a personal fall arrest system or climbing ladder fall arrest system (ladder safety device) is installed in at least that section of the fixed ladder, cage, or well where the replacement is located. On and after November 18, 2036, all fixed ladders shall only be equipped with a personal fall arrest system or a ladder safety device (climbing ladder Fall Arrest System).

2.3.2 Ladder Safety Devices (Climbing Ladder Fall Arrest Systems)

Conform to 29 CFR 1910.29, Section 7 of ALI A14.3 and ASSE/SAFE Z359.16. Install ladder safety devices on ladders over 20 feet long or more. The ladder safety systems must meet the design requirement of the ladders which they serve. The ladder safety system must be capable of sustaining a minimum static load of 1,000 pounds. The applied loads transferred to the climbing ladder mounting locations as a result of a fall shall be specified by the manufacturer of the climbing ladder fall arrest system. Each ladder safety system must allow the worker to climb up and down using both hands and does not require the employee continuously, hold, push, or pull any part of the system while climbing. The connection between the carrier or lifeline and the point of attachment to the body harness does not exceed 9 inches. The ladder safety system consists of a rigid or flexible carrier. Mountings for the rigid carries are attached at each end of the carrier, with intermediate mountings spaced as necessary, along the entire length of the carrier. Mountings for flexible carrier are attached at each end of the carrier and cable guides for flexible carriers are installed at least 25 feet apart but not more than 40 feet apart along the entire length of the carrier. The design and installation of mountings and cable guides does not reduce the design strength of the ladder.

2.3.3 Ship's Ladder

Fabricate stringers and framing of steel plate or shapes. Bolt, rivet or weld connections and anchor to supporting construction. Provide treads with non-slip surface as specified for safety treads. Design assembly, including tread connections and methods of attachment, to support a live load of 300 pounds per tread. Provide railings as specified for metal handrails.

PART 3 EXECUTION

3.1 GENERAL INSTALLATION REQUIREMENTS

Install items at locations indicated, according to manufacturer's instructions. Verify all measurements and take all field measurements necessary before fabrication. Provide Exposed fastenings of compatible materials, generally matching in color and finish, and harmonize with the material to which fastenings are applied. Include materials and parts necessary to complete each item, even though such work is not definitely shown or specified. Poor matching of holes for fasteners will be cause for rejection. Conceal fastenings where practicable. Thickness of metal and details of assembly and supports must provide strength and stiffness. Formed joints exposed to the weather to exclude water. Items listed below require additional procedures.

3.2 WORKMANSHIP

Metalwork must be well formed to shape and size, with sharp lines and angles and true curves. Drilling and punching must produce clean true lines and surfaces. Continuously weld along the entire area of contact. Do not tack weld exposed connections of work in place. Grid smooth exposed welds. Provide smooth finish on exposed surfaces of work in place, unless otherwise approved. Where tight fits are required, mill joints. Cope or miter corner joints, well formed, and in true alignment. Install in accordance with manufacturer's installation instructions and approved drawings, cuts, and details.

3.3 ANCHORAGE, FASTENINGS, AND CONNECTIONS

Provide anchorage where necessary for fastening metal items securely in place. Include for anchorage not otherwise specified or indicated slotted inserts, expansion anchors, and powder-actuated fasteners, when approved for concrete; toggle bolts and through bolts for masonry; machine bolts, carriage bolts and powder-actuated threaded studs for steel; through bolts, lag bolts, and screws for wood. Do not use wood plugs in any material. Provide non-ferrous attachments for non-ferrous metal. Make exposed fastenings of compatible materials, generally matching in color and finish, to which fastenings are applied. Conceal fastenings where practicable.

3.4 WELDING

Perform welding, welding inspection, and corrective welding, in accordance with AWS D1.1/D1.1M. Use continuous welds on all exposed connections. Grind visible welds smooth in the finished installation.

3.5 FINISHES

3.5.1 Dissimilar Materials

Where dissimilar metals are in contact, protect surfaces with a coat conforming to MPI 79 to prevent galvanic or corrosive action. Where aluminum is in contact with concrete, plaster, mortar, masonry, wood, or absorptive materials subject to wetting, protect with ASTM D1187/D1187M, asphalt-base emulsion.

3.5.2 Field Preparation

Remove rust preventive coating just prior to field erection, using a remover approved by the rust preventive manufacturer. Surfaces, when assembled, must be free of rust, grease, dirt and other foreign matter.

3.5.3 Environmental Conditions

Do not clean or paint surface when damp or exposed to foggy or rainy weather, when metallic surface temperature is less than 5 degrees F above the dew point of the surrounding air, or when surface temperature is below 45 degrees F or over 95 degrees F, unless approved by the Contracting Officer.

3.6 LADDERS

Secure to the adjacent construction with the clip angles attached to the stringer. Install intermediate clip angles not over 48 inches on center. Install brackets as required for securing of ladders welded or bolted to structural steel or built into the masonry or concrete. Ends of ladders must not rest upon finished roof.

-- End of Section --

SECTION TABLE OF CONTENTS

DIVISION 05 - METALS

SECTION 05 52 00

METAL RAILINGS

02/18

-- End of Section Table of Contents --

SECTION 05 52 00

METAL RAILINGS
02/18

PART 1 GENERAL

1.1 REFERENCES

The publications listed below form a part of this specification to the extent referenced. The publications are referred to within the text by the basic designation only.

AMERICAN WELDING SOCIETY (AWS)

AWS D1.1/D1.1M	(2015; Errata 1 2015; Errata 2 2016) Structural Welding Code - Steel

ASME INTERNATIONAL (ASME)

ASME B18.2.1	(2012; Errata 2013) Square and Hex Bolts and Screws (Inch Series)
ASME B18.21.1	(2009; R 2016) Washers: Helical Spring-Lock, Tooth Lock, and Plain Washers (Inch Series)
ASME B18.6.3	(2013; R 2017) Machine Screws, Tapping Screws, and Machine Drive Screws (Inch Series)

ASTM INTERNATIONAL (ASTM)

ASTM A123/A123M	(2017) Standard Specification for Zinc (Hot-Dip Galvanized) Coatings on Iron and Steel Products
ASTM A153/A153M	(2016) Standard Specification for Zinc Coating (Hot-Dip) on Iron and Steel Hardware
ASTM A283/A283M	(2013) Standard Specification for Low and Intermediate Tensile Strength Carbon Steel Plates
ASTM A307	(2014; E 2017) Standard Specification for Carbon Steel Bolts, Studs, and Threaded Rod 60 000 PSI Tensile Strength
ASTM A36/A36M	(2014) Standard Specification for Carbon Structural Steel
ASTM A500/A500M	(2018) Standard Specification for Cold-Formed Welded and Seamless Carbon Steel Structural Tubing in Rounds and Shapes

ASTM A53/A53M	(2018) Standard Specification for Pipe, Steel, Black and Hot-Dipped, Zinc-Coated, Welded and Seamless
ASTM A575	(1996; E 2013; R 2013) Standard Specification for Steel Bars, Carbon, Merchant Quality, M-Grades
ASTM B26/B26M	(2014; E 2015) Standard Specification for Aluminum-Alloy Sand Castings

NATIONAL ASSOCIATION OF ARCHITECTURAL METAL MANUFACTURERS (NAAMM)

NAAMM AMP 521	(2001; R 2012) Pipe Railing Systems Manual

1.2 ADMINISTRATIVE REQUIREMENTS

1.2.1 Preinstallation Meetings

Within 30 days of contract award, submit fabrication drawings to the Contracting Officer for the following items:

a. Iron and steel hardware

b. Steel shapes, plates, bars and strips

c. Steel railings and handrails

d. Anchorage and fastening systems

Submit manufacturer's catalog data, including two copies of manufacturers specifications, load tables, dimension diagrams, and anchor details for the following items:

a. Structural-steel plates, shapes, and bars

b. Structural-steel tubing

c. Hot-rolled carbon steel bars

d. Protective coating

e. Steel railings and handrails

f Anchorage and fastening systems

1.3 SUBMITTALS

Government approval is required for submittals with a "G" designation; submittals not having a "G" designation are for Contractor Quality Control approval. Submit the following in accordance with Section 01 33 00 SUBMITTAL PROCEDURES:

SD-02 Shop Drawings

Fabrication Drawings; G

Iron and Steel Hardware; G

Steel Shapes, Plates, Bars and Strips; G

SD-03 Product Data

Structural-Steel Plates, Shapes, and Bars; G

Structural-Steel Tubing; G

Hot-Rolled Carbon Steel Bars; G

Protective Coating; G

Steel Railings and Handrails; G

Anchorage and Fastening Systems; G

SD-07 Certificates

Welding Procedures; G

Welder Qualification; G

SD-08 Manufacturer's Instructions

Installation Instructions

1.4 QUALITY CONTROL

1.4.1 Welding Procedures

Section 05 50 13 MISCELLANEOUS METAL FABRICATIONS applies to work specified in this section.

Submit results of welding procedures testing in accordance with AWS D1.1/D1.1M made in the presence of the Contracting Officer and by an approved testing laboratory at the Contractor's expense.

1.4.2 Welder Qualification

Submit certified welder qualification by tests in accordance with AWS D1.1/D1.1M, or under an equivalent approved qualification test. In addition, perform tests on test pieces in positions and with clearances equivalent to those actually encountered. If a test weld fails to meet requirements, conduct an immediate retest of two test welds and ensure that each test weld passes. Failure in the immediate retest will require that the welder be retested after further practice or training and make a complete set of test welds.

PART 2 PRODUCTS

2.1 FABRICATION

Preassemble items in the shop to the greatest extent possible. Disassemble units only to the extent necessary for shipping and handling. Clearly mark units for reassembly and coordinated installation.

For the fabrication of work exposed to view, use only materials that are smooth and free of surface blemishes, including pitting, seam marks, roller marks, rolled trade names, and roughness. Remove blemishes by grinding, or by welding and grinding, before cleaning, treating, and applying surface finishes, including zinc coatings.

Provide railing and handrail detail plans and elevations at not less than 1 inch to 1 foot. Provide details of sections and connections at not less than 3 inches to 1 foot. Also detail setting drawings, diagrams, templates for installation of anchorages, including concrete inserts, anchor bolts, and miscellaneous metal items having integral anchors.

Use materials of size and thicknesses indicated or, if not indicated, of the size and thickness necessary to produce adequate strength and durability in the finished product for its intended use. Work the materials to the dimensions indicated on approved detail drawings, using proven details of fabrication and support. Use the type of materials indicated or specified for the various components of work.

Form exposed work true to line and level, with accurate angles and surfaces and straight sharp edges. Ensure that all exposed edges are eased to a radius of approximately 1/32 inch. Bend metal corners to the smallest radius possible without causing grain separation or otherwise impairing the work.

Weld corners and seams continuously and in accordance with the recommendations of AWS D1.1/D1.1M. Grind exposed welds smooth and flush to match and blend with adjoining surfaces.

Form the exposed connections with hairline joints that are flush and smooth, using concealed fasteners wherever possible. Use exposed fasteners of the type indicated or, if not indicated, use countersunk Phillips flathead screws or bolts.

Provide anchorage of the type indicated and coordinated with the supporting structure. Fabricate anchoring devices and space as indicated and as required to provide adequate support for the intended use of the work.

Use hot-rolled steel bars for work fabricated from bar stock unless work is indicated or specified to be fabricated from cold-finished or cold-rolled stock.

2.1.1 Aluminum Railings

Fabrication: Provide fabrication jointing by one of the following methods:

a. Use flush-type rail fittings, welded and ground smooth with splice locks secured with 3/8 inch recessed-head set screws.

b. Ensure that mitered and welded joints made by fitting; post to top rail; intermediate rail to post; and corners, are groove welded and ground smooth. Where allowed by the Contracting Officer, provide butt splices reinforced by a tight-fitting dowel or sleeve not less than 6 inches in length. Tack-weld or epoxy-cement the dowel or sleeve to one side of the splice.

c. Assemble railings using slip-on aluminum-magnesium alloy fittings for joints. Fasten fittings to pipe or tube with 1/4 or 3/8 inch stainless-steel recessed-head setscrews. Provide assembled railings with fittings only at vertical supports or at rail terminations attached to walls. Provide expansion joints at the midpoint of panels. Provide a setscrew in only one side of the slip-on sleeve.

Provide alloy fittings to conform to ASTM B26/B26M.

2.1.2 Steel Handrails

Fabricate joint posts, rail, and corners by one of the following methods:

a. Flush-type rail fittings of commercial standard, welded and ground smooth, with railing splice locks secured with 3/8 inch hexagonal-recessed-head setscrews.

b. Mitered and welded joints made by fitting post to top rail and intermediate rail to post, mitering corners, groove-welding joints, and grinding smooth. Butt railing splices and reinforce them by a tight-fitting interior sleeve not less than 6 inches long.

c. Railings may be bent at corners in lieu of jointing, provided that bends are made in suitable jigs and the pipe is not crushed.

2.1.3 Protective Coating

Provide hot-dipped galvanized steelwork as indicated in accordance with ASTM A123/A123M. Touch up abraded surfaces and cut ends of galvanized members with zinc-dust, zinc-oxide primer, or an approved galvanizing repair compound.

2.2 COMPONENTS

2.2.1 Structural Steel Plates, Shapes And Bars

Provide structural-size shapes and plates, except plates to be bent or cold-formed, conforming to ASTM A36/A36M, unless otherwise noted.

Provide steel plates, to be bent or cold-formed, conforming to ASTM A283/A283M, Grade C.

Provide steel bars and bar-size shapes conforming to ASTM A36/A36M, unless otherwise noted.

2.2.2 Structural-Steel Tubing

Provide structural-steel tubing, hot-formed, welded or seamless, conforming to ASTM A500/A500M, Grade B, unless otherwise noted.

2.2.3 Hot-Rolled Carbon Steel Bars

Provide bars and bar-size shapes conforming to ASTM A575, grade as selected by the fabricator.

2.2.4 Steel Pipe

Provide pipe conforming to ASTM A53/A53M, type as selected, Grade B; primed finish, unless galvanizing is required; standard weight (Schedule 40).

2.2.5 Fasteners

Provide galvanized zinc-coated fasteners in accordance with ASTM A153/A153M used for exterior applications or where built into exterior walls or floor systems. Select fasteners for the type, grade, and class required for the installation of steel stair items.

Provide standard hexagon-head bolts, conforming to ASTM A307, Grade A.

Provide cadmium-plated steel machine screws conforming to ASME B18.6.3.

Provide plain round, general-assembly-grade, carbon steel washers conforming to ASME B18.21.1.

Provide helical spring, carbon steel lockwashers conforming to ASME B18.2.1.

2.2.6 Steel Railings And Handrails

Design handrails to resist a concentrated load of 200 lb in any direction at any point of the top of the rail or 50 lb per foot applied horizontally to the top of the rail, whichever is more severe. NAAMM AMP 521, provide the same size rail and post. Provide pipe collars of the same material and finish as the handrail and posts.

2.2.6.1 Steel Handrails

Provide steel handrails, including inserts in concrete, steel pipe conforming to ASTM A53/A53M or structural tubing conforming to ASTM A500/A500M, Grade A or B of equivalent strength. Provide steel railings of 1 1/2 inch nominal size, hot-dip galvanized shop-painted.

Provide kickplates between railing posts where indicated, and consisting of 1/8 inch steel flat bars not less than 6 inches high. Secure kickplates as indicated.

Galvanize exterior railings, including pipe, fittings, brackets, fasteners, and other ferrous metal components. Provide black steel pipe for interior railings.

Provide galvanized railings, including pipe, fittings, brackets, fasteners, and other ferrous metal components.

PART 3 EXECUTION

3.1 PREPARATION

Adjust stair railings and handrails before securing in place in order to ensure proper matching at butting joints and correct alignment throughout their length. Space posts not more than 4 feet on center. Plumb posts in each direction. Secure posts and rail ends to building construction as follows:

a. Anchor posts in concrete by means of pipe sleeves set and anchored into concrete. Provide sleeves of galvanized, standard-weight, steel pipe, not less than 6 inches long, and having an inside diameter not less than 1/2 inch greater than the outside diameter of the inserted pipe post. Provide steel plate closure secured to the bottom of the sleeve, with closure width and length not less than 1 inch greater than the outside diameter of the sleeve. After posts have been inserted into sleeves, fill the annular space between the post and sleeve with nonshrink grout ora quick-setting hydraulic cement. Cover anchorage joint with a round steel flange welded to the post.

b. Anchor posts to steel with oval steel flanges, angle type or floor type as required by conditions, welded to posts and bolted to the steel supporting members.

c. Anchor rail ends into concrete and masonry with round steel flanges welded to rail ends and anchored into the wall construction with lead expansion shields and bolts.

d. Anchor rail ends to steel with oval or round steel flanges welded to tail ends and bolted to the structural-steel members.

Secure handrails to walls by means of wall brackets and wall return fitting at handrail ends. Provide brackets of malleable iron castings, with not less than 3 inch projection from the finished wall surface to the center of the pipe, drilled to receive one 3/8 inch bolt. Locate brackets not more than 60 inches on center. Provide wall return fittings of cast iron castings, flush type, with the same projection as that specified for wall brackets. Secure wall brackets and wall return fittings to building construction as follows:

Install toe boards and brackets where indicated. Make splices, where required, at expansion joints. Install removable sections as indicated.

3.2 INSTALLATION

Submit manufacturer's installation instructions for the following products to be used in the fabrication of steel stair railing and hand rail work:

a. Structural-steel plates, shapes, and bars

b. Structural-steel tubing

c. Hot-rolled carbon steel bars

d. Protective coating

e. Steel railings and handrails

f. Anchorage and fastening systems

Provide complete, detailed fabrication and installation drawings for all iron and steel hardware, and for all steel shapes, plates, bars, and strips used in accordance with the design specifications cited in this section.

3.2.1 Steel Handrail

Install handrail in pipe sleeves embedded in concrete and filled with nonshrink grout or quick-setting anchoring cement with anchorage covered with standard pipe collar pinned to post. Secure rail ends by steel pipe flanges anchored by expansion shields and bolts.

3.2.2 Touchup Painting

Immediately after installation, clean field welds, bolted connections, abraded areas of the shop paint, and exposed areas painted with the paint used for shop painting. Apply paint by brush or spray to provide a minimum dry-film thickness of 2 mils.

3.3 FIELD QUALITY CONTROL

3.3.1 Field Welding

Ensure that procedures of manual shielded metal arc welding, appearance and quality of welds made, and methods used in correcting welding work comply with AWS D1.1/D1.1M.

-- End of Section --

SECTION TABLE OF CONTENTS

DIVISION 07 - THERMAL AND MOISTURE PROTECTION

SECTION 07 92 00

JOINT SEALANTS

08/16

-- End of Section Table of Contents --

SECTION 07 92 00

JOINT SEALANTS
08/16

PART 1 GENERAL

1.1 REFERENCES

The publications listed below form a part of this specification to the extent referenced. The publications are referred to within the text by the basic designation only.

ASTM INTERNATIONAL (ASTM)

ASTM C1193	(2013) Standard Guide for Use of Joint Sealants
ASTM C1521	(2013) Standard Practice for Evaluating Adhesion of Installed Weatherproofing Sealant Joints
ASTM C920	(2018) Standard Specification for Elastomeric Joint Sealants

1.2 SUBMITTALS

Government approval is required for submittals with a "G" designation; submittals not having a "G" designation are for Contractor Quality Control approval. When used, a designation following the "G" designation identifies the office that will review the submittal for the Government. Submit the following in accordance with Section 01 33 00 SUBMITTAL PROCEDURES:

SD-03 Product Data

Sealants; G

Primers; G

Bond Breakers; G

Backstops; G

SD-06 Test Reports

Field Adhesion; G

1.3 PRODUCT DATA

Include storage requirements, shelf life, curing time, instructions for mixing and application, and accessories. Provide manufacturer's Safety Data Sheets (SDS) for each solvent, primer and sealant material proposed.

1.4 ENVIRONMENTAL CONDITIONS

Apply sealant when the ambient temperature is between 40 and 90 degrees F.

1.5 DELIVERY AND STORAGE

Deliver materials to the jobsite in unopened manufacturers' sealed shipping containers, with brand name, date of manufacture, and material designation clearly marked thereon. Label elastomeric sealant containers to identify type, class, grade, and use. Handle and store materials in accordance with manufacturer's printed instructions. Prevent exposure to foreign materials or subjection to sustained temperatures exceeding 90 degrees F or lower than 0 degrees F. Keep materials and containers closed and separated from absorptive materials such as wood and insulation.

1.6 QUALITY ASSURANCE

1.6.1 Compatibility with Substrate

Verify that each sealant is compatible for use with each joint substrate in accordance with sealant manufacturer's printed recommendations for each application.

1.6.2 Joint Tolerance

Provide joint tolerances in accordance with manufacturer's printed instructions.

1.6.3 Mock-Up

Provide a mock-up of each type of sealant using materials, colors, and techniques approved for use on the project. Approved mock-ups may be incorporated into the Work.

1.6.4 Adhesion

Provide in accordance with ASTM C1193 or ASTM C1521.

PART 2 PRODUCTS

2.1 SEALANTS

Provide sealant products that have been tested, found suitable, and documented as such by the manufacturer for the particular substrates to which they will be applied.

2.1.1 Exterior Sealants

For joints in vertical surfaces, provide ASTM C920, Type S or M, Grade NS, Class 25, Use NT. For joints in horizontal surfaces, provide ASTM C920, Type S or M, Grade P, Class 25, Use T. Provide location(s) and color(s) of sealant as follows. Note, color "as selected" refers to manufacturer's full range of color options:

2.1.2 Floor Joint Sealants

ASTM C920, Type S or M, Grade P, Class 25, Use T. Provide certification of indoor air quality for interior floor joint sealants. Provide location(s) and color(s) of sealant as follows. Note, color "as selected" refers to manufacturer's full range of color options:

2.1.3 Preformed Sealants

Provide preformed sealants of polybutylene or isoprene-butylene based pressure sensitive weather resistant tape or bead sealants capable of sealing out moisture, air and dust when installed as recommended by the manufacturer. At temperatures from minus 30 to plus 160 degrees F, sealants must be non-bleeding and have no loss of adhesion.

2.2 PRIMERS

Non-staining, quick drying type and consistency as recommended by the sealant manufacturer for the particular application. Provide primers for interior applications that meet the indoor air quality requirements of the paragraph SEALANTS above.

2.3 BOND BREAKERS

Type and consistency as recommended by the sealant manufacturer to prevent adhesion of the sealant to the backing or to the bottom of the joint. Provide bond breakers for interior applications that meet the indoor air quality requirements of the paragraph SEALANTS above.

2.4 BACKSTOPS

Provide glass fiber roving, neoprene, butyl, polyurethane, or polyethylene foams free from oil or other staining elements as recommended by sealant manufacturer. Provide 25 to 33 percent oversized backing for closed cell and 40 to 50 percent oversized backing for open cell material, unless otherwise indicated. Provide backstop material that is compatible with sealant. Do not use oakum or other types of absorptive materials as backstops.

2.5 CLEANING SOLVENTS

Provide type(s) recommended by the sealant manufacturer and in accordance with environmental requirements herein. Protect adjacent aluminum and bronze surfaces from solvents. Provide solvents for interior applications that meet the indoor air quality requirements of the paragraph SEALANTS above.

PART 3 EXECUTION

3.1 FIELD QUALITY CONTROL

Perform a field adhesion test in accordance with manufacturer's instructions and ASTM C1193, Method A or ASTM C1521, Method A, Tail Procedure. Remove sealants that fail adhesion testing; clean substrates, reapply sealants, and re-test. Test sealants adjacent to failed sealants. Submit field adhesion test report indicating tests, locations, dates, results, and remedial actions taken.

3.2 SURFACE PREPARATION

Prepare surfaces according to manufacturer's printed installation instructions. Clean surfaces from dirt, frost, moisture, grease, oil, wax, lacquer, paint, or other foreign matter that would destroy or impair adhesion. Remove oil and grease with solvent; thoroughly remove solvents prior to sealant installation. Wipe surfaces dry with clean cloths. When resealing an existing joint, remove existing caulk or sealant prior to applying new sealant. For surface types not listed below, provide in accordance with sealant manufacturer's printed instructions for each specific surface.

3.2.1 Steel Surfaces

Remove loose mill scale by sandblasting or, if sandblasting is impractical or would damage finished work, scraping and wire brushing. Remove protective coatings by sandblasting or using a residue free solvent. Remove resulting debris and solvent residue prior to sealant installation.

3.2.2 Aluminum or Bronze Surfaces

Remove temporary protective coatings from surfaces that will be in contact with sealant. When masking tape is used as a protective coating, remove tape and any residual adhesive prior to sealant application. For removing protective coatings and final cleaning, use non-staining solvents recommended by the manufacturer of the item(s) containing aluminum or bronze surfaces.

3.2.3 Concrete and Masonry Surfaces

Where surfaces have been treated with curing compounds, oil, or other such materials, remove materials by sandblasting or wire brushing. Remove laitance, efflorescence and loose mortar from the joint cavity. Remove resulting debris prior to sealant installation.

3.2.4 Wood Surfaces

Ensure wood surfaces that will be in contact with sealants are free of splinters, sawdust and other loose particles.

3.3 SEALANT PREPARATION

Do not add liquids, solvents, or powders to sealants. Mix multicomponent elastomeric sealants in accordance with manufacturer's printed instructions.

3.4 APPLICATION

3.4.1 Joint Width-To-Depth Ratios

Acceptable Ratios:

JOINT WIDTH	JOINT DEPTH	
	Minimum	Maximum
For metal, glass, or other nonporous surfaces:		
1/4 inch (minimum)	1/4 inch	1/4 inch
over 1/4 inch	1/2 of width	Equal to width
For concrete or masonry:		

JOINT WIDTH	JOINT DEPTH	
	Minimum	Maximum
1/4 inch (minimum)	1/4 inch	1/4 inch
over 1/4 inch to 1/2 inch	1/4 inch	Equal to width
over 1/2 inch to 1 inch	1/2 inch	5/8 inch
Over 1 inch	prohibited	

Unacceptable Ratios: Where joints of acceptable width-to-depth ratios have not been provided, clean out joints to acceptable depths and grind or cut to acceptable widths without damage to the adjoining work. Grinding is prohibited at metal surfaces.

3.4.2 Unacceptable Sealant Use

Do not install sealants in lieu of other required building enclosure weatherproofing components such as flashing, drainage components, and joint closure accessories, or to close gaps between walls, floors, roofs, windows, and doors, that exceed acceptable installation tolerances. Remove sealants that have been used in an unacceptable manner and correct building enclosure deficiencies to comply with contract documents requirements.

3.4.3 Masking Tape

Place masking tape on the finished surface on one or both sides of joint cavities to protect adjacent finished surfaces from primer or sealant smears. Remove masking tape within 10 minutes of joint filling and tooling.

3.4.4 Backstops

Provide backstops dry and free of tears or holes. Tightly pack the back or bottom of joint cavities with backstop material to provide joints in specified depths. Provide backstops where indicated and where backstops are not indicated but joint cavities exceed the acceptable maximum depths specified in JOINT WIDTH-TO-DEPTH RATIOS Table.

3.4.5 Primer

Clean out loose particles from joints immediately prior to application of. Apply primer to joints in concrete masonry units, wood, and other porous surfaces in accordance with sealant manufacturer's printed instructions. Do not apply primer to exposed finished surfaces.

3.4.6 Bond Breaker

Provide bond breakers to surfaces not intended to bond in accordance with, sealant manufacturer's printed instructions for each type of surface and sealant combination specified.

3.4.7 Sealants

Provide sealants compatible with the material(s) to which they are applied. Do not use a sealant that has exceeded its shelf life or has jelled and cannot be discharged in a continuous flow from the sealant gun. Apply sealants in accordance with the manufacturer's printed instructions with a gun having a nozzle that fits the joint width. Work sealant into joints so as to fill the joints solidly without air pockets. Tool sealant after application to ensure adhesion. Apply sealant uniformly smooth and free of wrinkles. Upon completion of sealant application, roughen partially filled or unfilled joints, apply additional sealant, and tool smooth as specified. Apply sealer over sealants in accordance with the sealant manufacturer's printed instructions.

3.5 PROTECTION AND CLEANING

3.5.1 Protection

Protect areas adjacent to joints from sealant smears. Masking tape may be used for this purpose if removed 5 to 10 minutes after the joint is filled and no residual tape marks remain.

3.5.2 Final Cleaning

Upon completion of sealant application, remove remaining smears and stains and leave the work in a clean and neat condition.

a. Masonry and Other Porous Surfaces: Immediately remove fresh sealant that has been smeared on adjacent masonry, rub clean with a solvent, and remove solvent residue, in accordance with sealant manufacturer's printed instructions. Allow excess sealant to cure for 24 hour then remove by wire brushing or sanding. Remove resulting debris.

b. Metal and Other Non-Porous Surfaces: Remove excess sealant with a solvent moistened cloth. Remove solvent residue in accordance with solvent manufacturer's printed instructions.

-- End of Section --

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DIVISION 09 - FINISHES

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PAINTS AND COATINGS

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SECTION 09 90 00

PAINTS AND COATINGS
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PART 1 GENERAL

1.1 REFERENCES

The publications listed below form a part of this specification to the extent referenced. The publications are referred to within the text by the basic designation only.

AMERICAN CONFERENCE OF GOVERNMENTAL INDUSTRIAL HYGIENISTS (ACGIH)

ACGIH 0100	(2015; Suppl 2002-2016) Documentation of the Threshold Limit Values and Biological Exposure Indices

ASTM INTERNATIONAL (ASTM)

ASTM D235	(2002; R 2012) Mineral Spirits (Petroleum Spirits) (Hydrocarbon Dry Cleaning Solvent)
ASTM D4214	(2007; R 2015) Standard Test Method for Evaluating the Degree of Chalking of Exterior Paint Films
ASTM D4263	(1983; R 2012) Indicating Moisture in Concrete by the Plastic Sheet Method
ASTM D523	(2014; R 2018) Standard Test Method for Specular Gloss
ASTM D6386	(2016) Standard Practice for Preparation of Zinc (Hot-Dip Galvanized) Coated Iron and Steel Product and Hardware Surfaces for Painting
ASTM F1869	(2016) Standard Test Method for Measuring Moisture Vapor Emission Rate of Concrete Subfloor Using Anhydrous Calcium Chloride

MASTER PAINTERS INSTITUTE (MPI)

MPI 107	(2012) Primer, Rust-Inhibitive, Water Based
MPI 42	(2012) Textured Coating, Latex, Flat
MPI 77	(2012) Epoxy, Gloss

SCIENTIFIC CERTIFICATION SYSTEMS (SCS)

SCS SP-01	(2000) Environmentally Preferable Product Specification for Architectural and Anti-Corrosive Paints

SOCIETY FOR PROTECTIVE COATINGS (SSPC)

SSPC 7/NACE No.4	(2007; E 2004) Brush-Off Blast Cleaning
SSPC PA 1	(2016) Shop, Field, and Maintenance Coating of Metals
SSPC PA Guide 3	(1982; E 1995) A Guide to Safety in Paint Application
SSPC QP 1	(2012; E 2012) Standard Procedure for Evaluating Painting Contractors (Field Application to Complex Industrial Structures)
SSPC SP 1	(2015) Solvent Cleaning
SSPC SP 10/NACE No. 2	(2007) Near-White Blast Cleaning
SSPC SP 12/NACE No.5	(2002) Surface Preparation and Cleaning of Metals by Waterjetting Prior to Recoating
SSPC SP 2	(1982; E 2000; E 2004) Hand Tool Cleaning
SSPC SP 3	(1982; E 2004) Power Tool Cleaning
SSPC SP 6/NACE No.3	(2007) Commercial Blast Cleaning
SSPC VIS 1	(2002; E 2004) Guide and Reference Photographs for Steel Surfaces Prepared by Dry Abrasive Blast Cleaning
SSPC VIS 3	(2004) Guide and Reference Photographs for Steel Surfaces Prepared by Hand and Power Tool Cleaning
SSPC VIS 4/NACE VIS 7	(1998; E 2000; E 2004) Guide and Reference Photographs for Steel Surfaces Prepared by Waterjetting

U.S. ARMY CORPS OF ENGINEERS (USACE)

EM 385-1-1	(2014) Safety and Health Requirements Manual

U.S. DEPARTMENT OF DEFENSE (DOD)

MIL-STD-101	(2014; Rev C) Color Code for Pipelines and for Compressed Gas Cylinders

U.S. GENERAL SERVICES ADMINISTRATION (GSA)

FED-STD-313	(2014; Rev E) Material Safety Data, Transportation Data and Disposal Data for Hazardous Materials Furnished to Government Activities

U.S. NATIONAL ARCHIVES AND RECORDS ADMINISTRATION (NARA)

29 CFR 1910.1000 Air Contaminants

1.2 SUBMITTALS

Government approval is required for submittals with a "G" designation; submittals not having a "G" designation are for information only. When used, a designation following the "G" designation identifies the office that will review the submittal for the Government. Submit the following in accordance with Section 01 33 00 SUBMITTAL PROCEDURES:

The current MPI, "Approved Product List" which lists paint by brand, label, product name and product code as of the date of contract award, will be used to determine compliance with the submittal requirements of this specification. The Contractor may choose to use a subsequent MPI "Approved Product List", however, only one list may be used for the entire contract and each coating system is to be from a single manufacturer. All coats on a particular substrate must be from a single manufacturer. No variation from the MPI Approved Products List is acceptable.

Samples of specified materials may be taken and tested for compliance with specification requirements.

In keeping with the intent of Executive Order 13101, "Greening the Government through Waste Prevention, Recycling, and Federal Acquisition", products certified by SCS as meeting SCS SP-01 shall be given preferential consideration over registered products. Products that are registered shall be given preferential consideration over products not carrying any EPP designation.

SD-02 Shop Drawings

Piping identification

Submit color stencil codes

SD-03 Product Data

Certification

Coating; G

Manufacturer's Technical Data Sheets; (LEED)

Indicate VOC content.

SD-04 Samples

Color; G

Submit manufacturer's samples of paint colors. Cross reference color samples to color scheme as indicated.

SD-07 Certificates

Applicator's qualifications

Qualification Testing laboratory for coatings; G

SD-08 Manufacturer's Instructions

Application instructions

Mixing

Detailed mixing instructions, minimum and maximum application temperature and humidity, potlife, and curing and drying times between coats.

Manufacturer's Safety Data Sheets

Submit manufacturer's Safety Data Sheets for coatings, solvents, and other potentially hazardous materials, as defined in FED-STD-313.

SD-10 Operation and Maintenance Data

Coatings; G

Preprinted cleaning and maintenance instructions for all coating systems shall be provided.

1.3 APPLICATOR'S QUALIFICATIONS

1.3.1 SSPC QP 1 Certification

All contractors and subcontractors that perform surface preparation or coating application shall be certified by the Society for Protective Coatings (formerly Steel Structures Painting Council) (SSPC) to the requirements of SSPC QP 1 prior to contract award, and shall remain certified while accomplishing any surface preparation or coating application. The painting contractors and painting subcontractors must remain so certified for the duration of the project. If a contractor's or subcontractor's certification expires, the firm will not be allowed to perform any work until the certification is reissued. Requests for extension of time for any delay to the completion of the project due to an inactive certification will not be considered and liquidated damages will apply. Notify the Contracting Officer of any change in contractor certification status.

1.4 QUALITY ASSURANCE

1.4.1 Field Samples and Tests

The Contracting Officer may choose up to two coatings that have been delivered to the site to be tested at no cost to the Government. Take samples of each chosen product as specified in the paragraph "Sampling Procedures." Test each chosen product as specified in the paragraph "Testing Procedure." Products which do not conform, shall be removed from the job site and replaced with new products that conform to the referenced specification. Testing of replacement products that failed initial testing shall be at no cost to the Government.

1.4.1.1 Sampling Procedure

The Contracting Officer will select paint at random from the products that have been delivered to the job site for sample testing. The Contractor shall provide one quart samples of the selected paint materials. The samples shall be taken in the presence of the Contracting Officer, and labeled, identifying each sample. Provide labels in accordance with the paragraph "Packaging, Labeling, and Storage" of this specification.

1.4.1.2 Testing Procedure

Provide Batch Quality Conformance Testing for specified products, as defined by and performed by MPI. As an alternative to Batch Quality Conformance Testing, the Contractor may provide Qualification Testing for specified products above to the appropriate MPI product specification, using the third-party laboratory approved under the paragraph "Qualification Testing" laboratory for coatings. The qualification testing lab report shall include the backup data and summary of the test results. The summary shall list all of the reference specification requirements and the result of each test. The summary shall clearly indicate whether the tested paint meets each test requirement. Note that Qualification Testing may take 4 to 6 weeks to perform, due to the extent of testing required.

Submit name, address, telephone number, FAX number, and e-mail address of the independent third party laboratory selected to perform testing of coating samples for compliance with specification requirements. Submit documentation that laboratory is regularly engaged in testing of paint samples for conformance with specifications, and that employees performing testing are qualified. If the Contractor chooses MPI to perform the Batch Quality Conformance testing, the above submittal information is not required, only a letter is required from the Contractor stating that MPI will perform the testing.

1.5 REGULATORY REQUIREMENTS

1.5.1 Environmental Protection

In addition to requirements specified elsewhere for environmental protection, provide coating materials that conform to the restrictions of the local Air Pollution Control District and regional jurisdiction. Notify Contracting Officer of any paint specified herein which fails to conform.

1.5.2 Lead Content

Do not use coatings having a lead content over 0.06 percent by weight of nonvolatile content.

1.5.3 Chromate Content

Do not use coatings containing zinc-chromate or strontium-chromate.

1.5.4 Asbestos Content

Materials shall not contain asbestos.

1.5.5 Mercury Content

Materials shall not contain mercury or mercury compounds.

1.5.6 Silica

Abrasive blast media shall not contain free crystalline silica.

1.5.7 Human Carcinogens

Materials shall not contain ACGIH 0100 confirmed human carcinogens (A1) or suspected human carcinogens (A2).

1.6 PACKAGING, LABELING, AND STORAGE

Paints shall be in sealed containers that legibly show the contract specification number, designation name, formula or specification number, batch number, color, quantity, date of manufacture, manufacturer's formulation number, manufacturer's directions including any warnings and special precautions, and name and address of manufacturer. Pigmented paints shall be furnished in containers not larger than 5 gallons. Paints and thinners shall be stored in accordance with the manufacturer's written directions, and as a minimum, stored off the ground, under cover, with sufficient ventilation to prevent the buildup of flammable vapors, and at temperatures between 40 to 95 degrees F. Do not store paint, polyurethane, varnish, or wood stain products in occupied spaces.

1.7 SAFETY AND HEALTH

Apply coating materials using safety methods and equipment in accordance with the following:

Work shall comply with applicable Federal, State, and local laws and regulations, and with the ACCIDENT PREVENTION PLAN, including the Activity Hazard Analysis as specified in Section 01 35 26 GOVERNMENT SAFETY REQUIREMENTS and in Appendix A of EM 385-1-1. The Activity Hazard Analysis shall include analyses of the potential impact of painting operations on painting personnel and on others involved in and adjacent to the work zone.

1.7.1 Safety Methods Used During Coating Application

Comply with the requirements of SSPC PA Guide 3.

1.7.2 Toxic Materials

To protect personnel from overexposure to toxic materials, conform to the most stringent guidance of:

a. The applicable manufacturer's Safety Data Sheets (SDS) or local regulation.

b. 29 CFR 1910.1000.

c. ACGIH 0100, threshold limit values.

1.8 ENVIRONMENTAL CONDITIONS

Comply, at minimum, with manufacturer recommendations for space ventilation during and after installation. Isolate area of application from rest of building when applying high-emission paints or coatings.

1.8.1 Coatings

Do not apply coating when air or substrate conditions are:

a. Less than 5 degrees F above dew point;

b. Below 50 degrees F or over 95 degrees F, unless specifically pre-approved by the Contracting Officer and the product manufacturer. Under no circumstances shall application conditions exceed manufacturer recommendations.

1.8.2 Post-Application

Vacate space for as long as possible after application. Wait a minimum of 48 hours before occupying freshly painted rooms. Maintain one of the following ventilation conditions during the curing period, or for 72 hours after application:

a. Supply 100 percent outside air 24 hours a day.

b. Supply airflow at a rate of 6 air changes per hour, when outside temperatures are between 55 degrees F and 85 degrees F and humidity is between 30 percent and 60 percent.

c. Supply airflow at a rate of 1.5 air changes per hour, when outside air conditions are not within the range stipulated above.

1.9 LOCATION AND SURFACE TYPE TO BE PAINTED

1.9.1 Painting Included

Where a space or surface is indicated to be painted, include the following unless indicated otherwise.

a. Surfaces behind portable objects and surface mounted articles readily detachable by removal of fasteners, such as screws and bolts.

b. New factory finished surfaces that require identification or color coding and factory finished surfaces that are damaged during performance of the work.

c. Existing coated surfaces that are damaged during performance of the work.

1.9.1.1 Exterior Painting

Includes new surfaces, existing coated surfaces, and existing uncoated surfaces, of the building(s) and appurtenances. Also included are existing coated surfaces made bare by cleaning operations.

1.9.1.2 Interior Painting

Includes new surfaces, existing uncoated surfaces, and existing coated surfaces of the building(s) and appurtenances as indicated and existing coated surfaces made bare by cleaning operations. Where a space or surface is indicated to be painted, include the following items, unless indicated otherwise.

a. Exposed columns, girders, beams, joists, and metal deck; and

b. Other contiguous surfaces.

1.9.2 Painting Excluded

Do not paint the following unless indicated otherwise.

a. Surfaces concealed and made inaccessible by panelboards, fixed ductwork, machinery, and equipment fixed in place.

b. Surfaces in concealed spaces. Concealed spaces are defined as enclosed spaces above suspended ceilings, furred spaces, attic spaces, crawl spaces, elevator shafts and chases.

c. Steel to be embedded in concrete.

d. Copper, stainless steel, aluminum, brass, and lead except existing coated surfaces.

e. Hardware, fittings, and other factory finished items.

1.9.3 Mechanical and Electrical Painting

Includes field coating of interior and exterior new and existing surfaces.

a. Where a space or surface is indicated to be painted, include the following items unless indicated otherwise.

(1) Exposed piping, conduit, and ductwork;

(2) Supports, hangers, air grilles, and registers;

(3) Miscellaneous metalwork and insulation coverings.

b. Do not paint the following, unless indicated otherwise:

(1) New zinc-coated, aluminum, and copper surfaces under insulation

(2) New aluminum jacket on piping

(3) New interior ferrous piping under insulation.

1.9.4 Definitions and Abbreviations

1.9.4.1 Qualification Testing

Qualification testing is the performance of all test requirements listed in the product specification. This testing is accomplished by MPI to qualify each product for the MPI Approved Product List, and may also be accomplished by Contractor's third party testing lab if an alternative to Batch Quality Conformance Testing by MPI is desired.

1.9.4.2 Batch Quality Conformance Testing

Batch quality conformance testing determines that the product provided is the same as the product qualified to the appropriate product specification. This testing shall only be accomplished by MPI testing lab.

1.9.4.3 Coating

A film or thin layer applied to a base material called a substrate. A coating may be a metal, alloy, paint, or solid/liquid suspensions on various substrates (metals, plastics, wood, paper, leather, cloth, etc.). They may be applied by electrolysis, vapor deposition, vacuum, or mechanical means such as brushing, spraying, calendaring, and roller coating. A coating may be applied for aesthetic or protective purposes or both. The term "coating" as used herein includes emulsions, enamels, stains, varnishes, sealers, epoxies, and other coatings, whether used as primer, intermediate, or finish coat. The terms paint and coating are used interchangeably.

1.9.4.4 DFT or dft

Dry film thickness, the film thickness of the fully cured, dry paint or coating.

1.9.4.5 DSD

Degree of Surface Degradation, the MPI system of defining degree of surface degradation. Five (5) levels are generically defined under the Assessment sections in the MPI Maintenance Repainting Manual.

1.9.4.6 EPP

Environmentally Preferred Products, a standard for determining environmental preferability in support of Executive Order 13101.

1.9.4.7 EXT

MPI short term designation for an exterior coating system.

1.9.4.8 INT

MPI short term designation for an interior coating system.

1.9.4.9 micron / microns

The metric measurement for 0.001 mm or one/one-thousandth of a millimeter.

1.9.4.10 mil / mils

The English measurement for 0.001 in or one/one-thousandth of an inch, equal to 25.4 microns or 0.0254 mm.

1.9.4.11 mm

The metric measurement for millimeter, 0.001 meter or one/one-thousandth of a meter.

1.9.4.12 MPI Gloss Levels

MPI system of defining gloss. Seven (7) gloss levels (G1 to G7) are generically defined under the Evaluation sections of the MPI Manuals. Traditionally, Flat refers to G1/G2, Eggshell refers to G3, Semigloss refers to G5, and Gloss refers to G6.

Gloss levels are defined by MPI as follows:

Gloss Level	Description	Units at 60 degrees	Units at 85 degrees
G1	Matte or Flat	0 to 5	10 max
G2	Velvet	0 to 10	10 to 35
G3	Eggshell	10 to 25	10 to 35
G4	Satin	20 to 35	35 min
G5	Semi-Gloss	35 to 70	
G6	Gloss	70 to 85	
G7	High Gloss		

Gloss is tested in accordance with ASTM D523. Historically, the Government has used Flat (G1 / G2), Eggshell (G3), Semi-Gloss (G5), and Gloss (G6).

1.9.4.13 MPI System Number

The MPI coating system number in each Division found in either the MPI Architectural Painting Specification Manual or the Maintenance Repainting Manual and defined as an exterior (EXT/REX) or interior system (INT/RIN). The Division number follows the CSI Master Format.

1.9.4.14 Paint

See Coating definition.

1.9.4.15 REX

MPI short term designation for an exterior coating system used in repainting projects or over existing coating systems.

1.9.4.16 RIN

MPI short term designation for an interior coating system used in repainting projects or over existing coating systems.

PART 2 PRODUCTS

2.1 MATERIALS

Conform to the coating specifications and standards referenced in PART 3. Submit manufacturer's technical data sheets for specified coatings and solvents. Comply with applicable regulations regarding toxic and hazardous materials.

PART 3 EXECUTION

3.1 PROTECTION OF AREAS AND SPACES NOT TO BE PAINTED

Prior to surface preparation and coating applications, remove, mask, or otherwise protect, hardware, hardware accessories, machined surfaces, radiator covers, plates, lighting fixtures, public and private property, and other such items not to be coated that are in contact with surfaces to be coated. Following completion of painting, workmen skilled in the trades involved shall reinstall removed items. Restore surfaces contaminated by coating materials, to original condition and repair damaged items.

3.2 SURFACE PREPARATION

Remove dirt, splinters, loose particles, grease, oil, disintegrated coatings, and other foreign matter and substances deleterious to coating performance as specified for each substrate before application of paint or surface treatments. Oil and grease shall be removed prior to mechanical cleaning. Cleaning shall be programmed so that dust and other contaminants will not fall on wet, newly painted surfaces. Exposed ferrous metals such as nail heads on or in contact with surfaces to be painted with water-thinned paints, shall be spot-primed with a suitable corrosion-inhibitive primer capable of preventing flash rusting and compatible with the coating specified for the adjacent areas.

3.2.1 Additional Requirements for Preparation of Surfaces With Existing Coatings

Before application of coatings, perform the following on surfaces covered by soundly-adhered coatings, defined as those which cannot be removed with a putty knife:

a. Test existing finishes for lead before sanding, scraping, or removing. If lead is present, refer to paragraph Toxic Materials.

b. Wipe previously painted surfaces to receive solvent-based coatings, except stucco and similarly rough surfaces clean with a clean, dry cloth saturated with mineral spirits, ASTM D235. Allow surface to dry. Wiping shall immediately precede the application of the first coat of any coating, unless specified otherwise.

c. Sand existing glossy surfaces to be painted to reduce gloss. Brush, and wipe clean with a damp cloth to remove dust.

d. The requirements specified are minimum. Comply also with the application instructions of the paint manufacturer.

e. Previously painted surfaces or damaged during construction shall be thoroughly cleaned of all grease, dirt, dust or other foreign matter.

f. Blistering, cracking, flaking and peeling or other deteriorated coatings shall be removed.

g. Chalk shall be removed so that when tested in accordance with ASTM D4214, the chalk resistance rating is no less than 8.

h. Slick surfaces shall be roughened. Damaged areas such as, but not limited to, nail holes, cracks, chips, and spalls shall be repaired with suitable material to match adjacent undamaged areas.

i. Edges of chipped paint shall be feather edged and sanded smooth.

j. Rusty metal surfaces shall be cleaned as per SSPC requirements. Solvent, mechanical, or chemical cleaning methods shall be used to provide surfaces suitable for painting.

k. New, proposed coatings shall be compatible with existing coatings.

3.3 PREPARATION OF METAL SURFACES

3.3.1 Existing and New Ferrous Surfaces

a. Ferrous Surfaces including Shop-coated Surfaces and Small Areas That Contain Rust, Mill Scale and Other Foreign Substances: Solvent clean or detergent wash in accordance with SSPC SP 1 to remove oil and grease. Where shop coat is missing or damaged, clean according to SSPC SP 2, SSPC SP 3, SSPC SP 6/NACE No.3, or SSPC SP 10/NACE No. 2. Brush-off blast remaining surface in accordance with SSPC 7/NACE No.4; Water jetting to SSPC SP 12/NACE No.5 WJ-4 may be used to remove loose coating and other loose materials. Use inhibitor as recommended by coating manufacturer to prevent premature rusting. Shop-coated ferrous surfaces shall be protected from corrosion by treating and touching up corroded areas immediately upon detection.

b. Surfaces With More Than 20 Percent Rust, Mill Scale, and Other Foreign Substances: Clean entire surface in accordance with SSPC SP 6/NACE No.3 /SSPC SP 12/NACE No.5 WJ-3 .

c. Metal Floor Surfaces to Receive Nonslip Coating: Clean in accordance with SSPC SP 10/NACE No. 2.

3.3.2 Final Ferrous Surface Condition:

For tool cleaned surfaces, the requirements are stated in SSPC SP 2 and SSPC SP 3. As a visual reference, cleaned surfaces shall be similar to photographs in SSPC VIS 3.

For abrasive blast cleaned surfaces, the requirements are stated in SSPC 7/NACE No.4, SSPC SP 6/NACE No.3, and SSPC SP 10/NACE No. 2. As a visual reference, cleaned surfaces shall be similar to photographs in SSPC VIS 1.

For waterjet cleaned surfaces, the requirements are stated in SSPC SP 12/NACE No.5. As a visual reference, cleaned surfaces shall be similar to photographs in SSPC VIS 4/NACE VIS 7.

3.3.3 Galvanized Surfaces

a. New or Existing Galvanized Surfaces With Only Dirt and Zinc Oxidation Products: Clean with solvent, non-alkaline detergent solution in accordance with SSPC SP 1. If the galvanized metal has been passivated or stabilized, the coating shall be completely removed by brush-off abrasive blast. New galvanized steel to be coated shall not be "passivated" or "stabilized" If the absence of hexavalent stain inhibitors is not documented, test as described in ASTM D6386, Appendix X2, and remove by one of the methods described therein.

b. Galvanized with Slight Coating Deterioration or with Little or No Rusting: Water jetting to SSPC SP 12/NACE No.5 WJ3 to remove loose coating from surfaces with less than 20 percent coating deterioration and no blistering, peeling, or cracking. Use inhibitor as recommended by the coating manufacturer to prevent rusting.

c. Galvanized With Severe Deteriorated Coating or Severe Rusting: Water jet to SSPC SP 12/NACE No.5 WJ3 degree of cleanliness.

3.3.4 Non-Ferrous Metallic Surfaces

Aluminum and aluminum-alloy, lead, copper, and other nonferrous metal surfaces.

Surface Cleaning: Solvent clean in accordance with SSPC SP 1 and wash with mild non-alkaline detergent to remove dirt and water soluble contaminants.

3.3.5 Terne-Coated Metal Surfaces

Solvent clean surfaces with mineral spirits, ASTM D235. Wipe dry with clean, dry cloths.

3.3.6 Existing Surfaces with a Bituminous or Mastic-Type Coating

Remove chalk, mildew, and other loose material by washing with a solution of 1/2 cup trisodium phosphate, 1/4 cup household detergent, one quart 5 percent sodium hypochlorite solution and 3 quarts of warm water.

3.4 PREPARATION OF CONCRETE AND CEMENTITIOUS SURFACE

3.4.1 Concrete and Masonry

a. Curing: Concrete, stucco and masonry surfaces shall be allowed to cure at least 30 days before painting, except concrete slab on grade, which shall be allowed to cure 90 days before painting.

b. Surface Cleaning: Remove the following deleterious substances.

   (1) Dirt, Grease, and Oil: Wash new and existing uncoated surfaces with a solution composed of 1/2 cup trisodium phosphate, 1/4 cup household detergent, and 4 quarts of warm water. Then rinse thoroughly with fresh water. For large areas, water blasting may be used.

   (2) Fungus and Mold: Wash new , existing coated, and existing uncoated surfaces with a solution composed of 1/2 cup trisodium phosphate, 1/4 cup household detergent, 1 quart 5 percent sodium hypochlorite solution and 3 quarts of warm water. Rinse thoroughly with fresh water.

   (3) Paint and Loose Particles: Remove by wire brushing.

   (4) Efflorescence: Remove by scraping or wire brushing followed by washing with a 5 to 10 percent by weight aqueous solution of hydrochloric (muriatic) acid. Do not allow acid to remain on the surface for more than five minutes before rinsing with fresh water. Do not acid clean more than 4 square feet of surface, per workman, at one time.

   (5) Removal of Existing Coatings: For surfaces to receive textured coating MPI 42, remove existing coatings including soundly adhered coatings if recommended by textured coating manufacturer.

c. Cosmetic Repair of Minor Defects: Repair or fill mortar joints and minor defects, including but not limited to spalls, in accordance with manufacturer's recommendations and prior to coating application.

d. Allowable Moisture Content: Latex coatings may be applied to damp surfaces, but not to surfaces with droplets of water. Do not apply epoxies to damp vertical surfaces as determined by ASTM D4263 or horizontal surfaces that exceed 3 lbs of moisture per 1000 square feet in 24 hours as determined by ASTM F1869. In all cases follow manufacturers recommendations. Allow surfaces to cure a minimum of 30 days before painting.

3.5 APPLICATION

3.5.1 Coating Application

Painting practices shall comply with applicable federal, state and local laws enacted to insure compliance with Federal Clean Air Standards. Apply coating materials in accordance with SSPC PA 1. SSPC PA 1 methods are applicable to all substrates, except as modified herein.

At the time of application, paint shall show no signs of deterioration. Uniform suspension of pigments shall be maintained during application.

Unless otherwise specified or recommended by the paint manufacturer, paint may be applied by brush, roller, or spray. Use trigger operated spray nozzles for water hoses. Rollers for applying paints and enamels shall be of a type designed for the coating to be applied and the surface to be coated. Wear protective clothing and respirators when applying oil-based paints or using spray equipment with any paints.

Paints, except water-thinned types, shall be applied only to surfaces that are completely free of moisture as determined by sight or touch.

Thoroughly work coating materials into joints, crevices, and open spaces. Special attention shall be given to insure that all edges, corners, crevices, welds, and rivets receive a film thickness equal to that of adjacent painted surfaces.

Each coat of paint shall be applied so dry film shall be of uniform thickness and free from runs, drops, ridges, waves, pinholes or other voids, laps, brush marks, and variations in color, texture, and finish. Hiding shall be complete.

Touch up damaged coatings before applying subsequent coats.

a. Drying Time: Allow time between coats, as recommended by the coating manufacturer, to permit thorough drying, but not to present topcoat adhesion problems. Provide each coat in specified condition to receive next coat.

b. Primers, and Intermediate Coats: Do not allow primers or intermediate coats to dry more than 30 days, or longer than recommended by manufacturer, before applying subsequent coats. Follow manufacturer's recommendations for surface preparation if primers or intermediate coats are allowed to dry longer than recommended by manufacturers of subsequent coatings. Each coat shall cover surface of preceding coat or surface completely, and there shall be a visually perceptible difference in shades of successive coats.

c. Finished Surfaces: Provide finished surfaces free from runs, drops, ridges, waves, laps, brush marks, and variations in colors.

d. Thermosetting Paints: Topcoats over thermosetting paints (epoxies and urethanes) should be applied within the overcoating window recommended by the manufacturer.

e. Floors: For nonslip surfacing on ramps, provide MPI 77 with non-skid additive, applied by roller in accordance with manufacturer's instructions.

3.5.2 Mixing and Thinning of Paints

Reduce paints to proper consistency by adding fresh paint, except when thinning is mandatory to suit surface, temperature, weather conditions, application methods, or for the type of paint being used. Obtain written permission from the Contracting Officer to use thinners. The written permission shall include quantities and types of thinners to use.

When thinning is allowed, paints shall be thinned immediately prior to application with not more than 1 pint of suitable thinner per gallon. The use of thinner shall not relieve the Contractor from obtaining complete hiding, full film thickness, or required gloss. Thinning shall not cause the paint to exceed limits on volatile organic compounds. Paints of different manufacturers shall not be mixed.

3.5.3 Two-Component Systems

Two-component systems shall be mixed in accordance with manufacturer's instructions. Any thinning of the first coat to ensure proper penetration and sealing shall be as recommended by the manufacturer for each type of substrate.

3.5.4 Coating Systems

a. Systems by Substrates: Apply coatings that conform to the respective specifications listed in the following Tables:

<u>Table</u>

Division 3. Exterior Concrete Paint Table
Division 4. Exterior Concrete Masonry Units Paint Table
Division 5. Exterior Metal, Ferrous and Non-Ferrous Paint Table
Division 6. Exterior Wood; Dressed Lumber, Paneling, Decking, Shingles Paint Table
Division 9: Exterior Stucco Paint Table
Division 10. Exterior Cloth Coverings and Bituminous Coated Surfaces Paint Table

Division 3. Interior Concrete Paint Table
Division 4. Interior Concrete Masonry Units Paint Table
Division 5. Interior Metal, Ferrous and Non-Ferrous Paint Table
Division 6. Interior Wood Paint Table
Division 9: Interior Plaster, Gypsum Board, Textured Surfaces Paint Table

b. Minimum Dry Film Thickness (DFT): Apply paints, primers, varnishes, enamels, undercoats, and other coatings to a minimum dry film thickness of 1.5 mil each coat unless specified otherwise in the Tables. Coating thickness where specified, refers to the minimum dry film thickness.

c. Coatings for Surfaces Not Specified Otherwise: Coat surfaces which have not been specified, the same as surfaces having similar conditions of exposure.

d. Existing Surfaces Damaged During Performance of the Work, Including New Patches In Existing Surfaces: Coat surfaces with the following:

(1) One coat of primer.

(2) One coat of undercoat or intermediate coat.

(3) One topcoat to match adjacent surfaces.

e. Existing Coated Surfaces To Be Painted: Apply coatings conforming to the respective specifications listed in the Tables herein, except that pretreatments, sealers and fillers need not be provided on surfaces where existing coatings are soundly adhered and in good condition. Do not omit undercoats or primers.

3.6 COATING SYSTEMS FOR METAL

Apply coatings of Tables in Division 5 for Exterior and Interior.

a. Apply specified ferrous metal primer on the same day that surface is cleaned, to surfaces that meet all specified surface preparation requirements at time of application.

b. Inaccessible Surfaces: Prior to erection, use one coat of specified primer on metal surfaces that will be inaccessible after erection.

c. Shop-primed Surfaces: Touch up exposed substrates and damaged coatings to protect from rusting prior to applying field primer.

d. Surface Previously Coated with Epoxy or Urethane: Apply MPI 101, 1.5 mils DFT immediately prior to application of epoxy or urethane coatings.

e. Pipes and Tubing: The semitransparent film applied to some pipes and tubing at the mill is not to be considered a shop coat, but shall be overcoated with the specified ferrous-metal primer prior to application of finish coats.

f. Exposed Nails, Screws, Fasteners, and Miscellaneous Ferrous Surfaces. On surfaces to be coated with water thinned coatings, spot prime exposed nails and other ferrous metal with latex primer MPI 107.

3.7 COATING SYSTEMS FOR CONCRETE AND CEMENTITIOUS SUBSTRATES

Apply coatings of Tables in Division 3, 4 and 9 for Exterior and Interior.

3.8 PIPING IDENTIFICATION

Piping Identification, Including Surfaces In Concealed Spaces: Provide in accordance with MIL-STD-101. Place stenciling in clearly visible locations. On piping not covered by MIL-STD-101, stencil approved names or code letters, in letters a minimum of 1/2 inch high for piping and a minimum of 2 inches high elsewhere. Stencil arrow-shaped markings on piping to indicate direction of flow using black stencil paint.

3.9 INSPECTION AND ACCEPTANCE

In addition to meeting previously specified requirements, demonstrate mobility of moving components, including swinging and sliding doors, cabinets, and windows with operable sash, for inspection by the Contracting Officer. Perform this demonstration after appropriate curing and drying times of coatings have elapsed and prior to invoicing for final payment.

3.10 WASTE MANAGEMENT

As specified in the Waste Management Plan and as follows. Do not use kerosene or any such organic solvents to clean up water based paints. Properly dispose of paints or solvents in designated containers. Close and seal partially used containers of paint to maintain quality as necessary for reuse. Store in protected, well-ventilated, fire-safe area at moderate temperature. Place materials defined as hazardous or toxic waste in designated containers.

3.11 PAINT TABLES

All DFT's are minimum values. Acceptable products are listed in the MPI Green Approved Products List, available at http://www.specifygreen.com/APL/ProductIdxByMPInum.asp.

-- End of Section --

SECTION TABLE OF CONTENTS

DIVISION 09 - FINISHES

SECTION 09 97 13

COATING OF STEEL WATERFRONT STRUCTURES, ZERO VOC, (SZC) SPLASH ZONE COATING

02/16

-- End of Section Table of Contents --

SECTION 09 97 13

COATING OF STEEL WATERFRONT STRUCTURES, ZERO VOC, (SZC) SPLASH ZONE COATING
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PART 1 GENERAL

1.1 1.1 REFERENCES

The publications listed below form a part of this specification to the extent referenced. The publications are referred to within the text by the basic designation only.

ASTM INTERNATIONAL (ASTM)

ASTM A36/A36M	(2014) Standard Specification for Carbon Structural Steel
ASTM B117	(2016) Standard Practice for Operating Salt Spray (Fog) Apparatus
ASTM C920	(2018) Standard Specification for Elastomeric Joint Sealants
ASTM D1475	(2013) Standard Test Method for Density of Liquid Coatings, Inks, and Related Products
ASTM D1640	(2003; R 2009) Drying, Curing, or Film Formation of Organic Coatings at Room Temperature
ASTM D1654	(2008; R 2016; E 2017) Standard Test Method for Evaluation of Painted or Coated Specimens Subjected to Corrosive Environments
ASTM D2240	(2015; E 2017) Standard Test Method for Rubber Property - Durometer Hardness
ASTM D2369	(2010; R 2015; E 2015) Volatile Content of Coatings
ASTM D2370	(1998; R 2010) Tensile Properties of Organic Coatings
ASTM D2698	(2005) Standard Test Method for Determination of the Pigment Content of Solvent-Reducible Paints by High-Speed Centrifuging
ASTM D2794	(1993; R 2010) Resistance of Organic Coatings to the Effects of Rapid Deformation (Impact)
ASTM D2805	(2011) Standard Test Method for Hiding Power of Paints by Reflectometry

ASTM D3276	(2015; E 2016) Standard Guide for Painting Inspectors (Metal Substrates)
ASTM D3278	(1996; R 2011) Flash Point of Liquids by Small Scale Closed-Cup Apparatus
ASTM D3335	(1985a; R 2014) Low Concentrations of Lead, Cadmium, and Cobalt in Paint by Atomic Absorption Spectroscopy
ASTM D3718	(1985a; R 2015) Low Concentrations of Chromium in Paint by Atomic Absorption Spectroscopy
ASTM D3925	(2002; R 2015) Sampling Liquid Paints and Related Pigmented Coatings
ASTM D3960	(2005; R 2013) Determining Volatile Organic Compound (VOC) Content of Paints and Related Coatings
ASTM D4060	(2014) Abrasion Resistance of Organic Coatings by the Taber Abraser
ASTM D4285	(1983; R 2012) Indicating Oil or Water in Compressed Air
ASTM D4400	(1999; E 2012; R 2012) Sag Resistance of Paints Using a Multinotch Applicator
ASTM D4541	(2017) Standard Test Method for Pull-Off Strength of Coatings Using Portable Adhesion Testers
ASTM D4940	(2015) Standard Test Method for Conductimetric Analysis of Water Soluble Ionic Contamination of Blast Cleaning Abrasives
ASTM D512	(2012) Chloride Ion in Water
ASTM D522	(1993a; R 2008) Mandrel Bend Test of Attached Organic Coatings
ASTM D523	(2014; R 2018) Standard Test Method for Specular Gloss
ASTM D56	(2016a) Standard Test Method for Flash Point by Tag Closed Cup Tester
ASTM D575	(1991; R 2012) Rubber Properties in Compression
ASTM D610	(2008; R 2012) Evaluating Degree of Rusting on Painted Steel Surfaces
ASTM D6944	(2015) Standard Practice for Determining the Resistance of Cured Coatings to Thermal Cycling

ASTM D7091	(2013) Standard Practice for Nondestructive Measurement of Dry Film Thickness of Nonmagnetic Coatings Applied to Ferrous Metals and Nonmagnetic, Nondestructive Coatings Applied to Non-Ferrous Metals
ASTM D714	(2002; R 2017) Standard Test Method for Evaluating Degree of Blistering of Paints
ASTM D7588	(2011) Standard Guide for FT-IR Fingerprinting of a Non-Aqueous Liquid Paint as Supplied in the Manufacturer's Container
ASTM D93	(2016) Standard Test Methods for Flash-Point by Pensky-Martens Closed Cup Tester

INTERNATIONAL ORGANIZATION FOR STANDARDIZATION (ISO)

ISO 9001	(2008; Corr 1 2009) Quality Management Systems- Requirements

NACE INTERNATIONAL (NACE)

NACE WJ-1	(2012) Waterjet Cleaning of Metals—Clean to Bare Substrate

SOCIETY FOR PROTECTIVE COATINGS (SSPC)

SSPC 7/NACE No.4	(2007; E 2004) Brush-Off Blast Cleaning
SSPC AB 1	(2015; E 2017) Mineral and Slag Abrasives
SSPC AB 2	(2015; E 2016) Cleanliness of Recycled Ferrous Metallic Abrasive
SSPC AB 3	(2003; E 2004) Ferrous Metallic Abrasive
SSPC Guide 10	(1994; E 2001) Guide to Specifying Coatings Conforming to Volatile Organic Compound (VOC) Content Requirements
SSPC Guide 12	(1998; E 2004) Guide for Illumination of Industrial Painting Projects
SSPC Guide 15	(2013) Field Methods for Extraction and Analysis of Soluble Salts on Steel and Other Nonporous Substrates
SSPC Guide 6	(2015) Guide for Containing Surface Preparation Debris Generated During Paint Removal Operations
SSPC PA 1	(2016) Shop, Field, and Maintenance Coating of Metals

SSPC PA 17	(2012; E 2012) Procedure for Determining Conformance to Steel Profile/Surface Roughness/Peak Count Requirements
SSPC PA 2	(2015; E 2017) Procedure for Determining Conformance to Dry Coating Thickness Requirements
SSPC QP 1	(2012; E 2012) Standard Procedure for Evaluating Painting Contractors (Field Application to Complex Industrial Structures)
SSPC QP 2	(2009; E 2013) Standard for Evaluating Painting Contractors (Removal of Hazardous Coatings from Industrial/Marine Structures)
SSPC QP 3	(2010) Standard Procedure for Evaluating Qualifications of Shop Painting Applicators
SSPC QP 5	(2012) Standard Procedure for Evaluating the Qualifications of Coating and Lining Inspection Companies
SSPC QS 1	(2015) Standard Procedure for Evaluating a Contractor's Advanced Quality Management System
SSPC SP 1	(2015) Solvent Cleaning
SSPC SP 10/NACE No. 2	(2007) Near-White Blast Cleaning
SSPC SP 5/NACE No. 1	(2007) White Metal Blast Cleaning
SSPC SP 6/NACE No.3	(2007) Commercial Blast Cleaning
SSPC SP COM	(2016; E 2017) Surface Preparation Commentary for Steel and Concrete Substrates
SSPC VIS 1	(2002; E 2004) Guide and Reference Photographs for Steel Surfaces Prepared by Dry Abrasive Blast Cleaning

U.S. GENERAL SERVICES ADMINISTRATION (GSA)

CID A-A-1689	(Rev B) Tape, Pressure-Sensitive Adhesive, (Plastic Film)
FED-STD-595	(Rev C; Notice 1) Colors Used in Government Procurement

U.S. NATIONAL ARCHIVES AND RECORDS ADMINISTRATION (NARA)

29 CFR 1910.1000	Air Contaminants
29 CFR 1910.134	Respiratory Protection
29 CFR 1926.59	Hazard Communication

1.2 1.2 DEFINITIONS

Definitions are provided throughout this Section, generally in the paragraph where used, and denoted by capital letters.

1.3 1.3 SUBMITTALS

Government approval is required for submittals with a "G" designation; submittals not having a "G" designation are for information only. When used, a designation following the "G" designation identifies the office that will review the submittal for the Government. Submit the following in accordance with Section 01 33 00 SUBMITTAL PROCEDURES:

SD-05 Design Data

Containment System

SD-06 Test Reports

Coatings Qualification Test Reports

Non-metallic Abrasive Qualification Test Reports; G

Metallic Abrasive Qualification Test Reports

Coating Sample Test Reports

Abrasive Sample Test Reports

Inspection Report Forms

Daily Inspection Reports

Recycled Metallic Abrasive Field Test Reports (Daily and Weekly)

SD-07 Certificates

Contract Errors, Omissions, and Other Discrepancies

Corrective Action Procedures

Implement Corrective Action

Coating Work Plan

Coating Materials

Non-metallic Abrasive

Metallic Abrasive

Qualifications of Certified Industrial Hygienist (CIH)

Qualifications Of Individuals Performing Abrasive Blasting

Qualifications of Certified Protective Coatings Specialist (PCS)

Qualifications of Individuals Applying Coatings

Qualifications of Individuals Operating Plural Component Equipment

Qualifications of Coating Inspection Company

Qualifications of QC Specialist Coating Inspector

Qualifications of Testing Laboratory for Coatings

Qualifications of Testing Laboratory for Abrasive Media

Qualifications of Coating Contractors or Shop

Joint Sealant Materials

Pre-Application Meeting

SD-08 Manufacturer's Instructions

Joint Sealant Instructions

Coating System Instructions

SD-11 Closeout Submittals

Disposal of Used Abrasive; G

Inspection Logbook; G

1.4 QUALITY ASSURANCE

1.4.1 Contract Errors, Omissions, and Other Discrepancies

Submit all errors, omissions, and other discrepancies in contract documents the Contracting Officer within 30 days of contract award for all work covered in this Section, other than the work that will not be uncovered until a later date. All such discrepancies must be addressed and resolved, and the Coating Work Plan modified, prior to beginning the Initial and Follow-Up phases of work. Discrepancies that become apparent only after work is uncovered must be identified at the earliest discoverable time and submitted for resolution. Schedule time (Float) should be built into the project schedule at those points where old work is to be uncovered or where access is not available during the first 30 days after award, to allow for resolution of contract discrepancies.

1.4.2 Corrective Action (CA)

CA must be included in the Quality Control Plan.

1.4.2.1 Corrective Action Procedures

Develop procedures for determining the root cause of each non-compliance, developing a plan to eliminate the root cause so that the non-compliance does not recur, and following up to ensure that the root cause was eliminated. Develop Corrective Action Request (CAR) forms for initiating CA, and for tracking and documenting each step.

1.4.2.2 Implement Corrective Action

The Contractor must take action to identify and eliminate the root cause of each non-compliance so as to prevent recurrence. These procedures must apply to non-compliance in the work, and to non-compliance in the QC System. Corrective actions must be appropriate to the effects of the non-compliance encountered. Each CAR must be serialized, tracked in a Log to completion and acceptance by the Contracting Officer, and retained in project records. The Corrective Action Log, showing status of each CAR, must be submitted to the Contracting Officer monthly. A CAR may be initiated by either the Contractor or the Contracting Officer. The Contracting Officer must approve each CAR at the root cause identification stage, the plan for elimination stage, and the close out stage after verification that the root cause has been eliminated.

1.4.3 Coating Work Plan

a. This work plan must be considered as part of the Quality Control Plan.

b. Provide procedures for reviewing contract documents immediately after award to identify errors, omissions, and discrepancies so that any such issues can be resolved prior to project planning and development of detailed procedures.

c. Provide procedures for verification of key processes during Initial Phase to ensure that contract requirements can be met. Key processes must include surface preparation, coating application and curing, inspection, and documentation, and any other process that might adversely impact orderly progression of work.

d. Provide procedures for all phases of coating operations, including planned work, rework, repair, inspection, and documentation. Address mobilization and setup, surface preparation, coating application, coating initial cure, tracking and correction of non-compliant work, and demobilization. Coordinate work processes with health and safety plans and confined space entry plans. For each process, provide procedures that include appropriate work instructions, material and equipment requirements, personnel qualifications, controls, and process verification procedures. Provide procedures for inspecting work to verify and document compliance with contract requirements, including inspection forms and checklists, and acceptance and rejection criteria.

e. Provide procedures for determining the existing surface profile under paint, and procedures for ensuring that the profile is not increased beyond the maximum profile specified herein.

f. Provide procedures for correcting non-compliant work. Detailed procedures are required in advance to avoid delays in meeting overcoat windows as well as to avoid delays in production. Provide procedures for repairing defects in the coating film, such as runs, drips, sags, holidays, overspray, as well as how to correct coating thickness non-compliance, any other areas of repair or rework that might be adversely affected by delays in preparing and approving new procedures.

g. If a procedure is based on a proposed or approved request for deviation, the deviation must be referenced. Changes to procedures must be noted by submittal number and date approved, clearly delineating old requirements and new requirements, so that the records provide a continuous log of requirements and procedures.

1.4.4 Design Data

1.4.4.1 Containment System

Submit complete design drawings and calculations for the scaffolding and containment system, including an analysis of the loads which will be added to the structure by the containment system and waste materials. A registered engineer must approve calculations and scaffold system design.

1.4.5 Test Reports

1.4.5.1 Coatings Qualification Test Reports

Submit test results from independent laboratory of representative samples of each coating material. U.S. Department of Defense laboratories are considered to be independent laboratories for purposes of compliance with "QUALIFICATION INSPECTION" requirements herein. Samples must have been tested within the last two years. Submit results for SZC material as required in Table II, COATING QUALIFICATION INSPECTION REQUIREMENTS/COATING QUALIFICATION INSPECTION REQUIREMENTS TEST PANEL PREPARATION AND TEST and as revised by paragraph COATING SYSTEM herein. Note that requirements for QUALIFICATION INSPECTION is a pre-qualification requirement, and involves the same testing required for listing as an approved source for these respective materials.

1.4.5.2 Metallic Abrasive Qualification Test Reports

Submit results for abrasive as required in paragraph 4 REQUIREMENTS of SSPC AB 3. Submit test results from independent laboratory of representative samples of each abrasive to be used on the jobsite. Samples must have been tested within the last three years. Note that this testing is for the purpose of prequalifying the abrasive.

1.4.5.3 Recycled Metallic Abrasive Field Test Reports (Daily and Weekly)

Submit test results from independent laboratory of daily and weekly Quality Control testing required by SSPC AB 2, as modified in paragraph ABRASIVE.

1.4.5.4 Non-metallic Abrasive Qualification Test Reports

Submit results for abrasive as required in paragraph 4 REQUIREMENTS of SSPC AB 1. Submit test results from independent laboratory of representative samples of each abrasive to be used on the jobsite. Samples must have been tested within the last three years. Note that this testing is for the purpose of prequalifying the abrasive.

1.4.6 Qualifications

1.4.6.1 Qualifications of Certified Industrial Hygienist (CIH)

Submit name, address, telephone number, FAX number, and e-mail address of the independent third party CIH. Submit documentation that hygienist is certified by the American Board of Industrial Hygiene in comprehensive practice, including certification number and date of certification/recertification. Provide evidence of experience with hazards involved in industrial coating application work.

1.4.6.2 Qualifications of Certified Protective Coatings Specialist (PCS)

Submit name, address, telephone number, FAX number, and e-mail address of the independent third party PCS. Submit documentation that specialist is certified by SSPC: The Society for Protective Coatings (SSPC) as a PCS, including certification number and date of certification/recertification. If the PCS is employed by the same coating inspection company to which the coating inspector is employed, this does not violate the independent third-party requirements. The PCS must remain certified during the entire project, and the Contracting Officer must be notified of any change in certification status within 10 days of the change. The PCS must not be the designated coating inspector.

1.4.6.3 Qualifications of Coating Inspection Company

Submit documentation that the coating inspection company performing all coating inspection functions is certified by SSPC to the requirements of SSPC QP 5 prior to contract award. The coating inspection company submitted and approved must remain and not changed through completion of the contract. The coating inspection company must remain so certified for the duration of the project. If a coating inspection company's certification expires, the firm will not be allowed to perform any inspection functions, and all surface preparation and coating application work must stop, until the certification is reissued. Requests for extension of time for any delay to the completion of the project due to an inactive certification will not be considered and liquidated damages will apply. Notify the Contracting Officer of any change in coating inspection company certification status. Notify the Contracting Officer of all scheduled and unannounced on site inspections from SSPC and furnish a copy of all inspection reports.

1.4.6.4 Qualifications of QC Specialist Coating Inspector

Submit documentation that each coating inspector is employed, and qualified to SSPC QP 5, Level III, by the selected coating inspection company. Each inspector must remain employed by the coating inspection company while performing any coating inspection functions. In addition to the handwritten records, the inspector must employ the electronic reporting program TruQC or equivalent as outlined in Table III. The Administrator must be the designated Government Representative for the project.

1.4.6.5 Qualifications Of Individuals Performing Abrasive Blasting

Submit name, address, and telephone number of each person that will be performing abrasive blasting. Submit documentation that each blaster is qualified by SSPC to the SSPC C 7 Abrasive Blaster or the SSPC CAS Coating Application Specialist Level 2 Certification Program (Interim Status. Each blaster must remain certified during the entire period of abrasive blasting, and the Contracting Officer must be notified of any change in qualification status.

1.4.6.6 Qualifications of Individuals Applying Coatings

Submit name, address, telephone number, of each person that will be operating plural component equipment. Submit documentation that each operator is qualified by SSPC to the SSPC C 12 Spray Application Certification meeting the NAVSEA 009-32 requirements or the SSPC CAS Coating Application Specialist Level 2 Certification Program (Interim Status). Each operator must remain certified during the entire period of coating application and the Contracting Officer must be notified of any change in qualification status.

1.4.6.7 Qualifications of Individuals Operating Plural Component Equipment

Submit name, address, telephone number, of each person that will be operating plural component equipment. Submit documentation that each operator is qualified by SSPC to the SSPC C 14 Marine Plural Component Program(MPCAC-C14). Each operator must remain certified during the entire period of coating application and the Contracting Officer must be notified of any change in qualification status.

1.4.6.8 Qualifications of Testing Laboratory for Coatings

Submit name, address, telephone number, FAX number, and e-mail address of the independent third party laboratory selected to perform testing of coating samples for compliance with specification requirements. Submit documentation that laboratory is regularly engaged in testing of paint samples for conformance with specifications, and that persons performing analyses are qualified.

1.4.6.9 Qualifications of Testing Laboratory for Abrasive Media

Submit name, address, telephone number, FAX number, and e-mail address of the independent third party laboratory selected to perform testing of abrasive for compliance with specification requirements. Submit documentation that laboratory has experience in testing samples of abrasive for conformance with specifications, and that persons performing analyses are qualified.

1.4.6.10 Qualifications of Coating Contractors or Shop

All Contractors and Subcontractors that perform surface preparation or coating application must be certified to SSPC QP 1 and SSPC QS 1 for field application and SSPC QP 3 and SSPC QS 1 for shop applications, prior to contract award and must remain certified while accomplishing any surface preparation or coating application. The painting Contractors, painting Subcontractors or Shop must remain so certified for the duration of the project. If a Contractor's, Subcontractor's or Shop's certification expires, the firm will not be allowed to perform any work until the certification is reissued. Requests for extension of time for any delay to the completion of the project due to an inactive certification will not be considered and liquidated damages will apply. Notify the Contracting Officer of any change in Contractor or Shop certification status. Notify the Contracting Officer of all scheduled and unannounced on site audits from SSPC and furnish a copy of all audit reports.

1.4.6.11 Joint Sealant Materials

Provide manufacturer's certification of conformance to contract requirements.

1.4.6.12 Coating Materials

Provide manufacturer's certification of conformance to contract requirements.

1.4.6.13 Non-metallic Abrasive

Provide manufacturer's certification that the materials are currently approved by the Naval Sea Systems Command and listed on the Qualified Products Lists (QPL) for the specified materials.

1.4.6.14 Metallic Abrasive

Provide manufacturer's certification of conformance to contract requirements and provide copies of test results.

1.4.7 Protective Coating Specialist (PCS)

The PCS must be considered a QC Specialist and must report to the QC Manager, as specified in Section 01 45 00 QUALITY CONTROL. The PCS must approve all submittals prior to submission to the QC Manager for approval or submission to the government for approval.

1.4.8 Pre-Application Meeting

After approval of submittals but prior to the initiation of coating work, Contractor representatives, including at a minimum, project superintendent and QC manager, paint foreman, coating inspector, and PCS must have a pre-application coating preparatory meeting. This meeting must be in addition to the pre-construction conference. Specific items addressed must include: corrective action requirements and procedures, coating work plan, safety plan, coordination with other Sections, inspection standards, inspection requirements and tools, test procedures, environmental control system, and test logs. Notify Contracting Officer at least ten days prior to meeting.

1.5 PRODUCT DATA

1.5.1 Joint Sealant Instructions

Submit manufacturer's printed instructions including detailed application procedures, minimum and maximum application temperatures, and curing procedures. Include Safety Data Sheets (SDS) for materials to be used at the job site in accordance with 29 CFR 1926.59.

1.5.2 Coating System Instructions

Submit manufacturer's printed instructions including detailed mixing and application procedures, number and types of coats required, minimum and maximum application temperatures, and curing procedures. Include Safety Data Sheets (SDS) for materials to be used at the job site in accordance with 29 CFR 1926.59.

1.6 DELIVERY AND STORAGE

Ship, store, and handle materials in accordance with SSPC PA 1, and as modified in this Section. Maintain temperature in storage spaces between 40 and 100 degrees F, and air temperature more than 5 degrees F above the dew-point at all times. Inspect materials for damage prior to use and return non-compliant materials to manufacturer. Remove materials with expired shelf life from government property immediately and notify the Contracting Officer.

If materials are approaching shelf life expiration and an extension is desired, samples may be sent to the manufacturer, along with complete records of storage conditions, with a request for shelf life extension. If the manufacturer finds the samples and storage data suitable for shelf life extension, the manufacturer may issue an extension, referencing the product evaluation and the review of storage records. Products may not be extended longer than allowed in the product specification.

1.7 COATING HAZARDS

Ensure that employees are trained in all aspects of the safety plan. Specified coatings may have potential health hazards if ingested or improperly handled. The coating manufacturer's written safety precautions must be followed throughout mixing, application, and curing of the coatings. During all cleaning, cleanup, surface preparation, and paint application phases, ensure that employees are protected from toxic and hazardous chemical agents which exceed concentrations in 29 CFR 1910.1000. Comply with respiratory protection requirements in 29 CFR 1910.134. The CIH must approve work procedures and personal protective equipment.

1.8 JOB SITE REFERENCES

Make available to the Contracting Officer at least one copy each of ASTM D3276, ASTM D3925, ASTM D4285, ASTM D7091, FED-STD-595, ISO 9001, SSPC AB 2, SSPC AB 3, SSPC Guide 6, SSPC Guide 10, SSPC Guide 12, SSPC Guide 15, SSPC PA 1, SSPC PA 2, SSPC PA 17, SSPC QP 1, SSPC QP 2, SSPC QP 3, SSPC QP 5, SSPC QS 1, SSPC SP COM, SSPC SP 1, SSPC SP 6/NACE No.3, SSPC 7/NACE No.4, SSPC SP 10/NACE No. 2, NACE WJ-1, SSPC VIS 1, and an SSPC Certified Contractor Evaluation Form at the job site.

PART 2 PRODUCTS

2.1 JOINT SEALANT

ASTM C920, Type M, Grade NS, Class 25, Use NT, I, M, G, A, O. Must be manufactured or supported by the coating system manufacturer.

2.2 COATING SYSTEM

Alternate systems or products will not be considered. All SZC materials must be supplied by one supplier. The entire SZC system is intended to be applied in the field for in-situ maintenance. Alternatively, on new construction projects, surface preparation and coating application may be accomplished in a SSPC QP 3 shop, following all temperature, humidity, preparation, application of the coating system and testing requirements listed herein. Upon completion of installation in the field all damaged surfaces must be inspected and repaired. Remove all damaged surfaces by means of the specified surface preparation followed by re-application of the SZC system. The final surface of any repairs must meet all requirements of the specifications and the manufacturer.

The specification material in this Section require approval prior to contract award. Testing of products by an Independent laboratory to the QUALIFICATION INSPECTION REQUIREMENTS of Table II prior to contract award or must be listed as an approved material herein. See specific submittal requirements in paragraph QUALITY ASSURANCE.

2.2.1 Self-Priming SZC Coating Material

2.2.1.1 Chevron Phillips Chemical Co. TZ 904

2.2.1.2 PolySpec LPE 5100

2.2.1.3 Premier Coating Systems, Inc. PCS 1200 TA

2.3 COATING SAMPLE COLLECTION

Provide 2 kits that contains one quart can for the base and activator of each SZC material, an appropriately sized can for each activator, dipping cups for each component to be sampled, a shipping box sized for the samples to to be shipped, and packing material. Extract 2 samples of each component, mark cans for the appropriate components including manufacturers name, address, batch numbers, batch size shipped to the project sight and date of manufacture. Store in QC Manager's office until completion of project. If unforeseen coating issues arise ship 1 complete sample (including base and activator) with all batch information to the pre-chosen approved Independent laboratory for evaluation. Include all pertinent information from the project. The QC Manager is to arrange pick-up and shipping to the approved coating testing laboratory.

2.4 ABRASIVE SAMPLE COLLECTION AND SHIPPING KIT

Provide a kit that contains one suitable plastic bag or container for each sample to be collected. Mark containers for the appropriate component. Provide shipping documents, including either pre-paid shipping or a shipper number that can be used by the QC Manager to arrange pickup, addressed to the approved coating testing laboratory.

2.5 TEST KITS

2.5.1 Test Kit for Measuring Chloride, Sulfate and Nitrate Ions on Steel and Coated Surfaces

Provide test kits called CHLOR*TEST CSN Salts, as manufactured by CHLOR*RID International Inc. of Chandler, Arizona (www.chlor-rid.com) or equal. An "equal" test kit must meet the following requirements:

a. Kit contains all materials,supplies, tools and instructions for field testing and on-site quantitative evaluation of chloride, sulfate and nitrate ions;

b. Kit extract solution is acidic, factory pre-measured, pre-packaged, and of uniform concentration;

c. Kit components and solutions are mercury free and environmentally friendly;

d. Kit contains new materials and solutions for each test extraction;

e. Extraction test container (vessel or sleeve or cell) creates a sealed, encapsulated environment during salt ion extraction;

f. Test extract container is suitable for testing the following steel surfaces: horizontal (up/down configuration), vertical, flat, curved, smooth, pitted, and rough;

g. All salt ion concentrations are directly measured in micrograms per square centimeter.

2.5.2 Test Kit for Measuring Chlorides in Abrasives

Provide test kits called CHLOR*TEST-A, as manufactured by CHLOR*RID International Inc. of Chandler, Arizona (www.chlor-rid.com), or equal. To be considered for approval as an "equal" test kit, each proposed test kit must:

a. Be a completely self-contained test kit with all materials, supplies, tools and instructions to take tests and identify results;

b. Use identifiable, consistent, factory pre-measured test extract solution;

c. Provide for testing equal volumes of abrasive and test solution;

d. Provide for taking direct measurements of the chloride ion in parts per million (PPM), without using conversion charts or tables;

e. Provide all new components for extraction and titration for each test;

f. Provide a factory sealed titration device for each test;

g. Use the extract sampling container as the titration container.

2.6 ABRASIVE

The referenced abrasive specifications have maximum limits for soluble salts contamination, however, this maximum level of contamination does not guarantee that contamination will not be transferred to the steel surface during abrasive blasting. Other factors such as on-site handling and recycling can allow contamination of abrasive. Contractors are cautioned to verify that the chosen abrasive, along with work and storage processes, allow the final surface cleanliness requirements to be achieved. Successful testing of chlorides in abrasive does not negate the final acceptance testing of steel surfaces.

2.6.1 Non-metallic Abrasive

Conform to SSPC AB 1, Class A except that:

a. The gross gamma radioactivity must not exceed 5 picocuries per gram.

b. The maximum allowable chloride content is 7 parts per million (ppm) as measured with the test kit described in the paragraph TEST KIT FOR MEASURING CHLORIDES IN ABRASIVES. Modify the requirements of SSPC AB 2 to substitute requirement for one chloride test for each "WATER SOLUBLE CONTAMINANTS" test required.

c. The maximum allowable Chromium and Cadmium content of the work mix must be less than 0.1 percent by wt. when tested in accordance with ASTM D3718 for Chromium and ASTM D3335 for Cadmium. Modify the requirements of SSPC AB 2 to add requirement for one Chromate test and one Cadmium test for each "LEAD" test required.

Use abrasive that is specifically selected and graded to provide a sharp, angular profile to the specified depth. Do not use ungraded abrasive. Make adjustments to processes or abrasive gradation to achieve specified surface profile. Recycled non-metallic abrasive must meet all requirements of the specification each time that it is placed in the blast pot.

2.6.2 Metallic Abrasive

2.6.2.1 New and Remanufactured Steel Grit

Conform to the chemical and physical properties of SSPC AB 3 Class 1 (Steel) only, except that the gross gamma radioactivity must not exceed 5 picocuries per gram. Class 2 (Iron) abrasive must not be used.

To develop a suitable work mix from new steel abrasive, a minimum of 200 - 400 recycles is required, therefore, it is advantageous for a Contractor to use remanufactured steel grit or grit reclaimed from a previous project. Such grit must be considered to conform if it can be traced to new grit conforming to SSPC AB 3 Class 1 and it meets all cleanliness requirements of SSPC AB 3 Class 1 when brought to the current jobsite. Submit one representative sample of this work mix to the laboratory for testing, along with samples of new material. Acceptance and use of this work mix must not be used to justify any deviation from surface preparation requirements.

2.6.2.2 Recycled Steel Grit

Abrasive media must conform to the chemical and physical properties of SSPC AB 2 except that:

a. The maximum allowable chloride content is 7 parts per million (ppm) as measured with the test kit described in the paragraph TEST KIT FOR MEASURING CHLORIDES IN ABRASIVES. Modify the requirements of SSPC AB 2 to substitute requirement for one chloride test for each "WATER SOLUBLE CONTAMINANTS" test required.

b. The maximum allowable Chromium and Cadmium content of the work mix must be 0.1 percent by wt. when tested in accordance with ASTM D3718 for Chromium and ASTM D3335 for Cadmium. Modify the requirements of SSPC AB 2 to add requirement for one Chromate test and one Cadmium test for each "LEAD" test required.

PART 3 EXECUTION

Perform all work, rework, and repair in accordance with approved procedures in the Coating Work Plan.

3.1 COATING AND ABRASIVE SAMPLE COLLECTION AND TESTING

Sample and test materials delivered to the jobsite. Notify Contracting Officer three days in advance of sampling. The QC Manager and either the PCS or coating inspector must witness all sampling.

3.1.1 Coating Sample Collection

Provide 2 sample collection kits as required in paragraph COATING SAMPLE COLLECTION AND SHIPPING KIT. From each lot, obtain 2 one quart sample of each base material, and proportional samples of each activator based on mix ratio, by random selection from sealed containers in accordance with ASTM D3925. Prior to sampling, mix contents of each sealed container to ensure uniformity. As an alternative to collecting small samples from kits, entire kits may be randomly selected and held if the need to ship to laboratory arises, observing all requirements for witnessing and traceability. For purposes of quality conformance inspection, a lot is defined as that quantity of materials from a single, uniform batch produced and offered for delivery at one time. A batch is defined as that quantity of material processed by the manufacturer at one time and identified by number on the label. Identify samples by designated name, specification number, batch number, project contract number, sample date, intended use, and quantity involved. The QC manager will take possession of the packaged samples and hold until instructed to contact a shipping company to arrange for pickup, and relinquish the samples only to the shipping representative for shipment to the approved laboratory for testing as required by paragraph COATING SAMPLE TEST REPORTS.

3.1.2 Abrasive Sample Collection

Provide a sample collection kit as required in paragraph ABRASIVE SAMPLE COLLECTION AND SHIPPING KIT. For purposes of quality conformance inspection, a lot must consist of all abrasive materials of the same type from a single, uniform batch produced and offered for delivery at one time. Obtain samples of each abrasive lot using the sampling techniques and schedule of the relevant SSPC AB standard reference. The addition of any substance to a batch must constitute a new lot. Identify samples by designated name, specification number, lot number, project contract number, sample date, intended use, and quantity involved. The QC manager will take possession of the packaged samples, contact the shipping company to arrange for pickup, and relinquish the samples only to the shipping representative for shipment to the approved laboratory for testing as required by the paragraph ABRASIVE SAMPLE TEST REPORTS.

3.1.3 Coating Sample Test Reports

Submit test results for each lot of coating material delivered to the jobsite. Test samples of prime, and topcoat materials for compliance with requirements of Table I. Reject entire lot represented by samples that fail one or more tests, select new lots, and test samples.

3.1.4 Abrasive Sample Test Reports

Submit test results for each lot of abrasive delivered to the jobsite. Test samples of metallic abrasive to the requirements of paragraph REQUIREMENTS of SSPC AB 3, except paragraph 4.1.5 DURABILITY. Test samples of non-metallic abrasive to the requirements of paragraph REQUIREMENTS of SSPC AB 1. Reject entire lot represented by samples that fail one or more tests, select new lots, and test samples.

3.2 SURFACES TO BE COATED

Coat exterior surfaces of entire steel waterfront structure including joints, lap joints and any other appurtenances.

3.3 LIGHTING

Provide lighting for all work areas as prescribed in SSPC Guide 12.

3.4 ENVIRONMENTAL CONDITIONS

3.4.1 Containment

Design and provide a containment system for the capture, containment, collection, storage and disposal of the waste materials generated by the work under this Section, to meet the requirements of SSPC Guide 6. Vapor concentrations must be kept at or below 10 percent of Lower Explosive Limit (LEL) at all times. Containment may be designed as fixed containment for complete structure or portable containment for sections of structure, however, containment must remain in any one place from beginning of abrasive blasting through initial cure of coating. Waste materials covered by this paragraph must not include any material or residue from removal of coatings containing lead, chromium, cadmium, PCB, or any other hazardous material.

It is the Contractors responsibility to insure the feasibility and workability of the containment system. The Contractor must perform his operations and work schedule in a manner as to minimize leakage of the containment system. The containment system must be properly maintained and must not deviate from the approved drawings. If the containment system fails to function satisfactorily, the Contractor must suspend all operations, except those required to minimize adverse impact on the environment or government property. Operations must not resume until modifications have been made to correct the cause of the failure.

3.4.2 Automated Monitoring Requirements, Field and Shop Applications

Provide continuous monitoring of temperature, relative humidity, and dew point data at pertinent points on the structure substrate, during surface preparation, coating application, and initial cure. Locate sensors to provide pertinent data for the surface preparation and coat application being performed. Monitor any heating, cooling, or dehumidification equipment used. Make data available to the Contracting Officer through Internet access. Provide monitoring equipment to perform as follows:

a. Data is collected in the field unit or shop unit in one minute increments, and available for download (on-site) in a standard format. Contractor must collect this data and make available to the Contracting Officer;

b. Monitoring equipment must have backup power such that data collection and transmission to web server will be uninterrupted during the entire period of the dehumidification requirement;

c. Monitoring equipment must have capability to measure surface temperatures at a minimum of four locations;

d. Monitoring equipment must have capability to measure dry bulb temperature (DB), relative humidity (RH), and dewpoint temperature (DP);

e. Data must be available continuously through secure Internet connection, using widely available web browsers;

f. Internet accessible data must be collected and stored in maximum 15 minute increments, and lag time between data collection and online availability must be no greater than 70 minutes;

g. Internet accessible data must be available for viewing online in tabular format, and graphical format using selected data;

h. Internet accessible data must be available for download in user-defined segments, or entire project to date, in a standard format usable by Microsoft Excel and other spreadsheet programs.

i. Internet-based controls must provide alerts to pre-designated parties through email messaging;

j. Internet-based controls must monitor data uploads from field unit or shop unit and issue alert if data not initiated within 60 minutes of last upload;

k. Internet-based controls must monitor operation of DH equipment and issues alert when power remains off for more than 15 seconds, or if pre-determined temperature, RH, or DP conditions are exceeded;

There is no requirement for connectivity of the monitoring system to control the DH equipment, therefore, any combination of equipment having the required functionality will be accepted.

3.5 SURFACE PREPARATION

3.5.1 Abrasive Blasting and Waterjetting Equipment

Use abrasive blasting equipment of conventional air, force-feed, or pressure type. Maintain a minimum pressure of 95 psig at nozzle. Confirm that air supply for abrasive blasting is free of oil and moisture when tested in accordance with ASTM D4285. Test air quality at each startup, but in no case less often than every five operating hours.

Use waterjetting equipment capable of Low-Pressure Water Cleaning (LP WC) at pressures up to 5,000 psi, High-Pressure Waterjetting (HP WJ) at pressures between 10,000 and 30,000 psi and Ultrahigh-Pressure Waterjetting (UHP WJ) at pressures greater than 30,000 psi.

3.5.2 Operational Evaluation of Abrasive

Test abrasive for salt contamination and oil contamination as required by the appropriate abrasive specification daily at startup and every five operating hours thereafter.

3.5.3 Surface Standard

Inspect surfaces to be coated, and select plate with similar properties and surface characteristics for use as a surface standard. Blast clean one or more 1 foot square steel panels as specified in paragraph SURFACE PREPARATION. Record blast nozzle type and size, air pressure at nozzle and compressor, distance of nozzle from panel, and angle of blast to establish procedures for blast cleaning. Measure surface profile in accordance with SSPC PA 17 using Rmax as the measure of profile height. When the surface standard complies with all specified requirements, seal with a clearcoat protectant. Use the surface standard for comparison to abrasive blasted surfaces throughout the course of work.

3.5.4 Pre-Preparation Testing for Surface Contamination

Perform testing, water jetting, abrasive blasting, and testing in the prescribed order.

3.5.4.1 Pre-Preparation Testing for Oil and Grease Contamination

Inspect all surfaces for oil and grease contamination using two or more of the following inspection techniques: 1) Visual inspection, 2) WATER BREAK TEST, 3) CLOTH RUB TEST. Reject oil or grease contaminated surfaces, clean using a water based pH neutral degreaser in accordance with SSPC SP 1, and recheck for contamination until surfaces are free of oil and grease.

WATER BREAK TEST - Spray atomized mist of distilled water onto surface, and observe for water beading. If water "wets" surface rather than beading up, surface can be considered free of oil or grease contamination. Beading of water (water forms droplets) is evidence of oil or grease contamination.

CLOTH RUB TEST - Rub a clean, white, lint free, cotton cloth onto surface and observe for discoloration. To confirm oil or grease contamination in lightly stained areas, a non-staining solvent may be used to aid in oil or grease extraction. Any visible discoloration is evidence of oil or grease contamination.

3.5.4.2 Pre-Preparation Testing for Soluble Salts Contamination

Test surfaces for soluble salts, and wash as required, prior to abrasive blasting. Soluble salt testing is also required in paragraph PRE-APPLICATION TESTING FOR SOLUBLE SALTS CONTAMINATION as a final acceptance test of prepared surfaces after abrasive blasting, and successful completion of this phase does not negate that requirement. This phase is recommended since pre-preparation testing and washing are generally more advantageous than attempting to remove soluble salt contamination after abrasive blasting. Effective removal of soluble salts will require removal of any barrier to the steel surface, including rust. This procedure may necessitate combinations of wet abrasive blasting, high pressure water rinsing, and cleaning using a solution of water washing and soluble salts remover. The soluble salts remover must be acidic, biodegradable, nontoxic, noncorrosive, and after application, will not interfere with primer adhesion. Delays between testing and preparation, or testing and coating application, may allow for the formation of new contamination. Use potable water, or potable water modified with soluble salt remover, for all washing or wet abrasive blasting. Test methods and equipment used in this phase are selected at the Contractor's discretion.

3.5.5 Water Jetting and Abrasive Blasting

On previously coated and prepared surfaces Waterjet all steel surfaces to a NACE WJ-1(< 33 percent rust staining), NV-3 (<50 µg/cm^2 chlorides) condition employing Ultrahigh-Pressure Waterjetting (UHP WJ) at more than 30,000 psi. If mutually agreed upon by the government and contractor at the pre-application meeting, waterjetting must be followed by abrasive blasting the steel surfaces to near-white metal in accordance with SSPC SP 10/NACE No. 2. Provide a 3 to 8 mil surface profile. Reject profile greater than 8 mils, discontinue abrasive blasting, and modify processes and materials to provide the specified profile. Prepared surfaces must conform to SSPC VIS 1 and must match the prepared test-panels. Measure surface profile in accordance with SSPC PA 17, using Rmax as the measure of profile height. Record all measurements required in this standard. Measure profile at rate of three test areas for the first 1000 square feet plus one test area for each additional 1000 square feet or part thereof. Provide two additional measurements for each non-compliant measurement. When surfaces are reblasted for any reason, retest profile as specified. Following abrasive blasting, remove dust and debris by vacuum cleaning. Do not attempt to wipe surface clean.

On in shop applications or field applications of new surfaces provide a 3 to 5 mil surface profile. Reject profile greater than 5 mils, discontinue abrasive blasting, and modify processes and materials to provide the specified profile. Prepared surfaces must conform to SSPC VIS 1 and must match the prepared test-panels. Measure surface profile in accordance with SSPC PA 17, using Rmax as the measure of profile height. Record all measurements required in this standard. Measure profile at rate of three test areas for the first 1000 square feet plus one test area for each additional 1000 square feet or part thereof. Provide two additional measurements for each non-compliant measurement. When surfaces are reblasted for any reason, retest profile as specified. Following abrasive blasting, remove dust and debris by vacuum cleaning. Do not attempt to wipe surface clean.

3.5.6 Disposal of Used Abrasive

Dispose of used abrasive off Government property in accordance with Federal, State, and Local mandated regulations.

3.5.7 Pre-Application Testing For Surface Contamination

3.5.7.1 Pre-Application Testing for Oil and Grease Contamination

Ensure surfaces are free of contamination as described in paragraph PRE-PREPARATION TESTING FOR OIL AND GREASE CONTAMINATION, except that only questionable areas need be checked for beading of water misted onto surface.

3.5.7.2 Pre-Application Testing for Soluble Salts Contamination

Test surfaces for chloride contamination using the Test Kit described in TEST KIT FOR MEASURING CHLORIDE, SULFATE AND NITRATE IONS ON STEEL AND COATED SURFACES. Test all surfaces at rate of three tests for the first 1000 square feet plus one test for each additional 2000 square feet or part thereof. Concentrate testing of bare steel at areas of coating failure to bare steel and areas of corrosion pitting. Perform 30 percent of tests on bare steel at welds, divided equally between horizontal and vertical welds. One or more readings greater than 3 micrograms per square centimeter of chlorides or 10 micrograms per square centimeter of sulfates or 5 micrograms per square centimeter of nitrates is evidence of soluble salt contamination. Reject contaminated surfaces, wash as discussed in paragraph PRE-PREPARATION TESTING FOR SOLUBLE SALTS CONTAMINATION, allow to dry, and re-test until all required tests show allowable results. Reblast tested and cleaned areas as required. Label all test tubes and retain for test verification.

3.5.7.3 Pre-Application Testing for Surface Cleanliness

Apply coatings to dust free surfaces. To test surfaces, apply strip of clear adhesive tape to surface and rub onto surface with finger. When removed, the tape should show little or no dust, blast abrasive, or other contaminant. Reject contaminated surfaces and retest. Test surfaces at rate of three tests for the first 1000 square feet plus one test for each additional 1000 square feet or part thereof. Provide two additional tests for each failed test or questionable test. Attach test tapes to Daily Inspection Reports.

3.6 MIXING AND APPLICATION OF SEALANT AND COATING SYSTEM

3.6.1 Preparation of Coating Materials for Application

Each of the SZC materials are a two-component material supplied in separate containers.

3.6.1.1 Mixing Materials

Self Priming SZC Coatings are designed for Plural Component application. Mix in accordance with manufacturer's instructions, which may differ for each product and manufacturer. Do not mix partial kits, or alter mix ratios. Mix materials in same temperature and humidity conditions specified in paragraph DELIVERY AND STORAGE. DO NOT ADD SOLVENT without specific written recommendation from the manufacturer.

3.6.1.2 Pot Life

Self Priming SZC Coatings have very short pot life. For small touch-ups apply mixed products within stated pot life for each product manufacturer. Stop applying when material becomes difficult to apply in a smooth, uniform wet film.

3.6.1.3 Application Conditions and Recoat Windows

The application condition requirements for the SZC system are intended to avoid the delamination problems frequently found on industrial structures. Plan coating application to ensure that specified temperature, humidity, and condensation conditions are met. If conditions do not allow for orderly application of the coating system use appropriate means of controlling air and surface temperatures, as required. Partial or total enclosures, insulation, heating or cooling, or other appropriate measures may be required to control conditions to allow for orderly application of all required coats.

Maintain air and steel surface temperature between 50 and 100 degrees F during application and the first 30 minutes of cure. Maintain steel surface temperature more than 5 degrees F above the dew-point of the ambient air for the same period with relative humidity at a maximum of 60 percent at anytime during application. If coating is not applied during these surface temperatures and conditions, or if surface temperature exceeds 120 degrees F before cure, provide TOTAL REMOVAL AND RE-APPLY.

3.6.2 Application of SZC System, Joint Sealant and Stripe Coat

Apply SZC in accordance with SSPC PA 1 and as specified herein. Apply SZC to surfaces that meet all stated surface preparation requirements.

Prior to application SZC perform testing prescribed in paragraph PRE-APPLICATION TESTING FOR SURFACE CONTAMINATION, as necessary, to ensure minimal contamination. If contamination is found, revert to the specified testing rate. Such atmospheric events as a coastal storm blowing onshore can bring unusual chloride contamination. Concern for contamination should be continually prevalent, and spot testing should be accomplished to verify satisfactory conditions. Where visual examination or spot testing indicates contamination, perform sufficient testing to verify non-contamination, or to define extent of contamination for appropriate treatment.

Apply SZC in a consistent wet film in a continuous half lapped spray coat, overlapping 50 percent of the previous spray pass. In multiply coats applications apply two coats at 90 degree application patterns. Ensure that "cold joints" are no less than six inches from welds. Apply stripe coat by brush. For convenience, stripe coat material may be delivered by spray if followed immediately with brush-out and approved procedures include appropriate controls on thickness. Apply all other coats by spray application. Use appropriate controls to prevent airborne coating fog from drifting beyond 10 feet from the structure or containment perimeter. Cover or protect all surfaces that will not be coated. The cleanliness, temperature, recoat windows, and airborne paint containment requirements may necessitate the use of enclosures, portable shelters, or other appropriate controls.

Apply SZC at the following specified thickness:

Coat	Min. DFT (Mils)	Ideal DFT (Mils)	Max. DFT (Mils)
PolySpec LPE 5100	60	80 - 100	120
Chevron Phillips TZ 904	60	80 - 100	120
Premier Coating Systems PCS 1200 TA	60	80 - 100	120

3.6.2.1 Application of SZC Coating Material

Apply all field applications of SZC materials in accordance with manufacturer's printed instructions and literature for one coat application. Field Applications should be applied in one continuous half lapped spray coat, overlapping 50 percent of the previous spray pass to the "Ideal DFT" mils thickness. Test in accordance with SSPC PA 2, Appendix 1 and 3 for conformance.

Apply all shop applications of SZC materials in accordance with manufacturer's printed instructions and literature for two coat application. Shop Applications should be applied in continuous half lapped spray coats, overlapping 50 percent of the previous spray pass to approximately one half (40-50 mils) of the "Ideal DFT" mils thickness for each coat. Shop Application requires the second coat to be applied at 90 degree application to the first coat. Test all DFT in accordance with SSPC PA 2, Appendix 1 and 3 for conformance.

3.6.2.2 Application of Joint Sealant

Apply joint sealant to back-to-back steel joints that are more than 3/8 inches wide, deep pitted areas, gouges in the steel surface and penetrations. Some penetrations may require backfill. Consult manufacturer for recommendations of backfill material. Apply sealant within 24 hours of application of the SZC, and touch-up with SZC after appropriate cure of the sealant.

3.6.2.3 Application of Stripe Coat

Apply stripe coat of SZC to back-to-back steel joints that are seal welded. Apply stripe coat of SZC to top and bottom, or each side, of narrow joints. Apply by brush, working material into corners, crevices, angles, and welds, and onto outside corners and angles. Apply stripe coat within 24 hours of application of the SZC final coat.

3.6.2.4 Procedure for Holiday and Spot Repairs of Newly Applied Coating

Repair coating film defects at the earliest practicable time, preferably before application of the succeeding coat. Observe all requirements for soluble salts contamination, cleanliness between coats, and application conditions. Prepare defective area in accordance with SSPC SP 10/NACE No. 2, and feather coating as required to leave 6 inches of the SZC feathered and abraded. Protect adjacent areas from damage and overspray. Remove dust and solvent wipe the prepared area plus an additional 6 inches beyond the prepared area with clean denatured alcohol. Prepare repairs and apply SZC within 48 hours of the general application coat of SZC. Apply each repair coat to approximate thickness of surrounding SZC material.

3.7 PROJECT IDENTIFICATION

At the completion of the work, attach a prepared panel with the following information on the structure in 3/4 inch to 1 inch Helvetica style letters:

Date Coated:
Project Number:
Contractor:
Address:
SZC Material and Manufacturer
  Surface Prep: SSPC SP ____ Profile: ______
  Joint Sealant Manufacturer: __________________
  SZC Average Application Thickness: ____

3.8 FIELD QUALITY CONTROL

For marking of surfaces, use chalk for marking bare steel, and water based markers for marking coated surfaces, and remove marks prior to coating. Do not use any wax or grease based markers, or any other markers that leave a residue or stain.

3.8.1 Coating Inspector

The coating inspector must be considered a QC Specialist and must report to the QC Manager, as specified in Section 01 45 00 QUALITY CONTROL. The Coating Inspector must be present during all pre-preparation testing, surface preparation, coating application, initial cure of the coating system, during all coating repair work, and during completion activities as specified in Section 01 45 00 QUALITY CONTROL. The Coating Inspector must provide complete documentation of conditions and occurrences on the job site, and be aware of conditions and occurrences that are potentially detrimental to the coating system. The requirements for inspection listed in this Section are in addition to the QC inspection and reporting requirements specified in Section 01 45 00 QUALITY CONTROL.

3.8.2 Field Inspection

3.8.2.1 Inspection and Documentation Requirements

a. Perform field inspection in accordance with ASTM D3276 and the approved Coating Work Plan. Document Contractor's compliance with the approved Coating Work Plan.

b. Provide all tools and instruments required to perform the required testing, as well as any tools or instruments that the inspector considers necessary to perform the required inspections and tests.

Document each inspection and test, including required hold points and other required inspections and tests, as well as those inspections and tests deemed prudent from on-site evaluation to document a particular process or condition, as follows:

(1) Location or area;
(2) Purpose (required or special);
(3) Method;
(4) Criteria for evaluation;
(5) Results;
(6) Determination of compliance;
(7) List of required rework;
(8) Observations.

c. Collect and record Environmental Conditions as described in ASTM D3276 on a 24 hour basis, as follows:

(1) During surface preparation, every hour or when changes occur;
(2) During coating application and the first four days of initial cure, every hour or when changes occur;
(3) Note location, time, and temperature of the highest and lowest surface temperatures each day;
(4) Use a non-contact thermometer to locate temperature extremes, then verify with contact thermometers.

d. NOTE: Data collected on Environmental conditions in paragraph AUTOMATED MONITORING REQUIREMENTS may be used for overnight data, however, the data must be constantly verified as to location of sensors and validity of data with respect to the coating work being accomplished.

e. Document all equipment used in inspections and testing, including manufacturer, model number, serial number, last calibration date and future calibration date, and results of on-site calibration performed. Work documented using data from equipment found to be out of calibration must be considered as non-compliant since last calibration or calibration check, as required.

3.8.2.2 Inspection Report Forms

Develop project-specific report forms as required to report measurement and test results and observations being complete and compliant with contract requirements. This includes all direct requirements of the contract documents and indirect requirements of referenced documents. Show acceptance criteria with each requirement and indication of compliance of each inspected item. Annotation of non-compliance must be conspicuous so as to facilitate identification and transfer to the Rework Log. Report forms must include requirements and acceptance and rejection criteria, and must be legible and presented so that entered data can be quickly compared to the appropriate requirement.

3.8.2.3 Daily Inspection Reports

Submit one copy of daily inspection report completed each day when performing work under this Section, to the Contracting Officer. Note all non-compliance issues, and all issues that were reported for rework in accordance with QC procedures of Section 01 45 00 QUALITY CONTROL. Each report must be signed by the coating inspector and the QC Manager. Submit report within 24 hours of date recorded on the report.

3.8.2.4 Inspection Logbook

A continuous record of all activity related to this Section must employ the electronic reporting program TruQC or equivalent as outlined in Table III and be maintained on a daily basis. The computer / software package must be used to record all information provided in the Daily Inspection Reports, as well as other pertinent observations and information including photo documentation where appropriate. The designated Government Representative for the project is assigned the highest level Administrator privilages and only the Administrator must be able to modify reports.

In areas where photography is not allowed the computer must come with verification that the camera / photo capability has been removed. Alternatively, a continuous record of all activity related to this Section must be maintained in an Inspection Logbook on a daily basis. The logbook must be hard or spiral bound with consecutively numbered pages, and must be used to record all information provided in the Daily Inspection Reports, as well as other pertinent observations and information. The Coating Inspector's Logbook that is sold by NACE is satisfactory. Submit the original Inspection Logbook to the Contracting Officer upon completion of the project and prior to final payment.

3.8.2.5 Inspection Equipment

All equipment must be in good condition, operational within its design range, and calibrated as required by the specified standard for use of each device.

3.8.2.6 Black Light

Use a black light having a 365 nanometer intensity of 4,000 microwatts per square centimeter minimum at 15 inches. The Spectroline BIB-150P from Spectronics Corporation satisfies this requirement.

3.9 FINAL CLEANUP

Following completion of the work, remove debris, equipment, and materials from the site. Remove temporary connections to Government or Contractor furnished water and electrical services. Restore existing facilities in and around the work areas to their original condition.

TABLE I						
COATING QUALITY CONFORMANCE INSPECTION REQUIREMENTS						
Self Priming SZC Modified Epoxy, Low VOC, Barrier Coating						
Test	Componenent A		Component B		Mixed	
	Min.	Max.	Min.	Max.	Min.	Max.
Solids, by weight (ASTM D2369), Method E					98 per cent	
Weight ASTM D1475						
Kilograms / liter	1.14	1.26	0.96	1.43	0.96	1.43
Pounds / gallon	9.50	10.50	8.00	12.00	8.00	12.00
Dry Time (ASTM D1640), at 23 degrees C 73 degrees F						
Set to touch, hours	---	---	---	---	---	1.5
Dry-hard time, hours	---	---	---	---	---	2
Sag resistance (ASTM D4400)						
Micrometers	---	---	---	---	2540	---
Mils	---	---	---	---	100	---
Pot life, minutes 600 grams at 73 degrees F (via x2 viscosity)	---	---	---	---	20	---
Approximate FED-STD-595 White or Off White, no darker than #27778 Gray, no darker than color #26493 Green, no darker than color #24518	---	---	---	---	Conform	
Contrast ratio, Off White --- --- --- --- 0.95 --- (ASTM D2805) at 254 micrometers, 10 mils DFT	---	---	---	---	0.95	---
DFT Gloss, (ASTM D523) 60 degree specular	---	---	---	---	50	---

TABLE I						
COATING QUALITY CONFORMANCE INSPECTION REQUIREMENTS						
Self Priming SZC Modified Epoxy, Low VOC, Barrier Coating						
Test	Componenent A		Component B		Mixed	
	Min.	Max.	Min.	Max.	Min.	Max.
VOC * (ASTM D3960)						
Grams / liter	---	---	---	---	< 70	
Pounds / gallon	---	---	---	---	<.58	
Total Lead & Cadmium (ASTM D3335)	---	---	---	---	<.0006 percent	
Total Chromium (ASTM D3718)	---	---	---	---	<.0006 percent	
Fourier tansform infrared spectroscopy (FTIR)					Conform +/- 10 percent	
Match Manufacturer's Qualification FTIR test scans to Component "A" Liquid (ASTM D7588) Component "B" Liquid (ASTM D7588)						

Table II	
COATING QUALIFICATION INSPECTION REQUIREMENTS	
Self Priming SZC Modified Epoxy, Low VOC, Barrier Coating	
Physical Properties	Acceptance Criteria
Solids, by weight(ASTM D2369), Method E	>98 percent
Mix Ratio (by volume) (Components A and B)	1:1
Pigment content, percent wt (ASTM D2698)	
Component A, Resin	20.0 max.
Component B, Cure	25.0 min.
Total Components A and B	20.0 min.
Volatiles, percent wt (ASTM D2369)	
Component A, Resin	2.0 max.
Component B, Cure	5.0 max.
Mixed	0.4 max.
Mixed	5.0 max.
Non-volatile vehicle, percent wt	
Component A, Resin	53.0 min. 83.0 max.
Component B, Cure	70.0 min. 100.0 max.
Pot Life (600 grams at 73 degrees F), Minimum (via x2 viscosity)	20 minutes
Sag resistance, minimum (ASTM D4400)	
Micrometers	2540 min.
Mils	100 min.

Table II	
COATING QUALIFICATION INSPECTION REQUIREMENTS	
Self Priming SZC Modified Epoxy, Low VOC, Barrier Coating	
Physical Properties	Acceptance Criteria
Color of dry film Approximate FED-STD-595 White or Off White, no darker than color No. 27778; Gray, no darker than color No. 26493; Green, no darker than color No. 24518	Conform
Contrast ratio, Off White (ASTM D2805)at 254 micrometers, 10 mils	0.95 min.
DFT Gloss, (ASTM D523) at 127 micrometers, 5 mils DFT	50 min.
Flash Point, Components A & B, Degrees F, (Degrees C), by one of the following methods: (ASTM D3278), (ASTM D93) or (ASTM D56)	>200(93.3)
VOC * (ASTM D3960)	
Grams / liter	< 70 max.
Pounds / gallon	<.58 max.
Total Lead & Cadmium (ASTM D3335)	<.0006 percent
Total Chromium (ASTM D3718)	<.0006 percent
Weight (ASTM D1475)	
Component A, Kilograms / liter	1.14 min. 1.26 max.
Component B, Kilograms / liter	0.96 min. 1.43 max.
Mixed, Kilograms / liter	0.96 min. 1.43 max.
Component A, Pounds per gallon	9.50 min. 10.50 max.
Component B Pounds per gallon	8.00 min. 12.00 max.
Mixed, Pounds per gallon	8.00 min.
Dry Time, (ASTM D1640), at 23 degrees C, 73 degrees F	

Table II	
COATING QUALIFICATION INSPECTION REQUIREMENTS	
Self Priming SZC Modified Epoxy, Low VOC, Barrier Coating	
Physical Properties	Acceptance Criteria
Set to touch, hours	1.5 max.
Dry-hard time, hours	2 max.
Tensile Strength (psi) (ASTM D2370)	> 400
Elongation at break (ASTM D2370)	> 30
Hardness (Shore D), 14 Days Cure (ASTM D2240)	> 45
Adhesion, Steel (ASTM D4541), Test Method E, psi Cohesive Failure, psi (min.)	> 1,700 > 1,200
Flexibility, (ASTM D522), 0.125 inch Mandrel Bend	Pass
Compression Strength, psi (ASTM D575)	>9,000
Direct Impact Resistance, in/lbs (ASTM D2794)	> 100
Cured Spray Appearance, Free from Bubbles, Runs & other Defects	Conforms
Test No. 1 through No. 4	Conforms
Test No. 5 - FTIR - upon confirmation of product conformity to requirements, produce a set of three FTIR scans to be used to assess conformity of all subsequent batches of this material, as follows: (1) Component A Liquid, (ASTM D7588) (2) Component B Liquid, (ASTM D7588) (3) Mixed (Components A and B) Dry Film (0.01 - 0.03g coating in 0.5 g KBr)	

COATING QUALIFICATION INSPECTION REQUIREMENTS
TEST PANEL PREPARATION AND TEST

The Principal Testing Firm performing the testing must be responsible for application of protective coatings to test panels. The final report must include testing results for all samples, panels, or tests performed. The final report must be certified by the Testing Firm and kept by the manufacturer as proof of testing and conformance. Include all of the laboratory testing requirements.

Test Panel Requirements for Test (Applicable to Test Nos. 1 through 4)

All steel test panels, except Test No. 3 panels, must be ASTM A36/A36M, hot -rolled steel or equivalent with dimensions (in mm) as shown below. Certified mill test reports must be provided as prepared by the steel manufacturer or testing laboratory for all Grade 36 steel identifying actual physical and chemical analysis of the material. Test panels for Test No. 2 must be standard Taber panels, meeting the requirements of ASTM D4060.

Test Panel Dimensions (in mm)

Test	Width	Length	Thickness
1,2,3,4	100	150	6

Three test panels must be prepared for each complete system for each test. Test 4 requires three additional test panels to be prepared with the primer only. Control panels must be coated in bulk lots by a single applicator for use by all selected laboratories. The location and date of application must be reported. All control panels utilized during the testing evaluation of a system must be from the same lot. During transportation and storage, control panels must be protected such that coating damage will not occur. Beyond 30 days, the storage temperature and relative humidity for these panels must be 25 plus or minus 5 degrees C and 50 plus or minus 20 percent.

Suggested Acceptance Criteria-Two of three panels must pass for the complete system to pass. Acceptance criteria are included for interpreting data reported.

The panels must be cleaned in accordance with SSPC SP 5/NACE No. 1 using recyclable metallic abrasives in accordance with SSPC AB 3. The abrasives must have a maximum chloride content of 15 ppm determined in accordance with ASTM D512 and a maximum conductivity of 150 micromhos per cm determined in accordance with ASTM D4940. The abrasive mixture must be approximately 60 percent SAE shot number S230 and 40 percent SAE grit number G40. Both the shot and grit must have a Rockwell hardness of C45 plus or minus 3. The surface profile of the cleaned panels must be 50.8 to 76.2 micrometers (2 to 3 mils) when determined in accordance with SSPC PA 17. The profile must be clean, sharp and free of embedded friable material, with adequate roughness to insure effective adhesion of the applied primer.

Note: The SSPC SP 5/NACE No. 1 is required rather than SSPC SP 10/NACE No. 2 only for the convenience of the laboratory in order to guarantee that all panels are prepared identically and to assure comparative testing results. Steel surfaces prepared to a lesser degree may not yield the same performance.

COATING QUALIFICATION INSPECTION REQUIREMENTS
TEST PANEL PREPARATION AND TEST

Each coating must be applied within the dry film thickness range recommended by the manufacturer. All products must be applied using proper airless equipment except when this method is specifically not allowed by the paint manufacturer. All paints must be applied to panels mounted vertically at a distance 530 mm (21 in.) from the tip of the spray gun. The equipment must be capable of developing sufficient pressure to properly atomize the coating. Orifice size, application pressure, pump type and ratio, hose size and length, and any atypical application requirements must be recorded. If the pressure used varies by more than 10 percent from the suggested pressure listed in the manufacturer's application data information, the actual pressure used and a statement explaining the deviation must be provided in the final report.

For testing purposes the color of the Self Priming SZC Modified Epoxy, Low VOC, Barrier Coating must conform to FED-STD-595, no darker than Color Chip No. 27778 (Off White).

Each sample or panel must be marked and identified by an assigned system code number. The identification code number must be placed on the back of each panel with permanent yellow paint stick. It will also be typed and placed in front of the corresponding panel when photographs are taken. The number will have a minimum height of 10 mm and will identify the following information, which will be part of the final report:

1. Test number being performed. (i.e., Salt No. 1, Abrasion No. 2).
2. Replica test being performed (i.e., Salt Replica 3, Abrasion Replica 2).
3. Date of panel preparation.
4. Date that the test evaluation was performed.

Test panels coated with the Self Priming SZC Modified Epoxy, Low VOC, Barrier Coating only at the minimum recoat time frame stated in the product data sheet. Curing of the coated test panels, including control panels for the complete system, must be a minimum of 7 days and no more than 10 days. The curing climate must be at 25 plus or minus 2 degrees C and 65 plus or minus 5 percent relative humidity. The back of all test panels must be coated with 75 to 100 micrometers of a high-quality epoxy or urethane barrier coat.

After preparation of the test panels with the coating system to be evaluated the edges must be sealed and protected by applying vinyl tape around the entire outside edge. The vinyl tape must extend 5 mm onto the coated surface from the edge of the panel and must be applied after the coating has cured. The vinyl tape must meet the requirements of CID A-A-1689 and have an approximate vinyl thickness of 110 micrometers with an approximate neoprene adhesive thickness of 25 micrometers.

Test panels must be scribed in accordance with ASTM D1654 with a single "X" mark centered on the panel. The rectangular dimensions of the scribes must have a top width of 50 mm and a height of 100 mm. The scribing tool must be a straight-shank tungsten carbide tip, lathe cutting tool (ANSI B94.50, Style E). The scribe cut must expose the steel substrate as verified with a microscope.

COATING QUALIFICATION INSPECTION REQUIREMENTS
TEST PANEL PREPARATION AND TEST

Photographic Requirements (Applicable to Test Nos. 1 through 4).
Color photographs of each sample or panel must be taken as follows:

1. All photographs must include the code identification number for each sample or panel and the number of hours.
2. A photograph of the coated surface of each sample or panel must be taken after the application of the entire system to be evaluated.

Test No. 1:
1. Each time frame designated.
2. Once blistering or rusting is observed, the panel must be photographed and its condition documented at the end of each 1,000 hours for ASTM B117 Salt Fog Resistance Test.
3. Rust creepage evaluation: (1) after washing and prior to stripping of the scribe, and (2) after stripping of the scribe.

Test Nos. 2, 3, and 4. At the completion of each test. Measurement of Surface Profile and Dry Film Paint Thickness (Applicable to Test Nos. 1 through 4).

1. Surface Profile-Measure total surface profile in accordance with SSPC PA 17 using Rmax as the measure of profile height.
2. Dry Film Paint Thickness-The dry film paint thickness must be taken in accordance with ASTM D7091, with the following exception:

A.) Measure the dry film paint thickness on each test panel utilizing a Type II dry film thickness gage calibrated according to SSPC PA 2 as follows:
a.) Take two gage readings from the top third, the middle third, and the bottom third of the test panel. Readings should be taken at least 25 mm from any edge. To facilitate consistent measurements at fixed positions on the panel, the laboratory must use a template, providing six fixed locations on the panels. Discard any gage reading that cannot be repeated consistently. The average of the acceptable gage readings must be no less than the manufacturer's recommended minimum thickness. No single gage reading must be less than 80 percent of the manufacturer's recommended minimum. The average of the acceptable gage readings must be no more than the manufacturer's recommended maximum thickness. No single gage reading must be more than 120 percent of the manufacturer's recommended maximum. Recommended maximum dry film thickness must be detailed on the manufacturer's product bulletin of each product.

TESTS TO BE PERFORMED

Test No. 1 ASTM B117 Salt Fog Resistance Test

A salt fog resistance test must be performed in accordance with ASTM B117. The complete system must be exposed for durations of 4,000 and 5,000 hours. Evaluation-Full visual evaluations must be performed at the intermediate and final hours shown above. Rust creepage at the scribe and percent rusting at the scribed edges must be evaluated at intermediate hours and after scraping at 5,000 hours in accordance with ASTM D1654, Method 2, Scraping, (where applicable after cleaning). Blistering, rust creepage at the scribe, percent rusting at the scribed edges and a description of rusting in the scribemust be reported in table format. Test values must not exceed the Test Acceptance Criteria listed below, except percent rusting at the scribed edges, which will be reported for information only.

COATING QUALIFICATION INSPECTION REQUIREMENTS
TEST PANEL PREPARATION AND TEST

Blistering must be evaluated in accordance with ASTM D714. Blister size and frequency must be converted to a numerical value using Table A.

Table A Blister Value Conversion Table
(No blisters, equals a conversion number of 10.)

Blister Size	Few*	Blister Medium	Med Dense	Frequency Dense
No. 8	9	8	7	6
No. 6	8	7	6	5
No. 4	7	6	5	4
No. 2	6	5	4	3
No. 1	5	4	3	2

*Adjustment Values for "Few" Blister Frequency

Number of Blisters	Value
1	x.8
2	x.6
3	x.4
4	x.2
5 or more	x.0

If a specific number of blisters are reported under the frequency "Few" then add the appropriate decimal "Value" provided above.
Example: A report of two No. 6 blisters converts to a value of 8.6.

Rust Creepage at the Scribe
Rust creepage (a.k.a. cutback, undercut, loss of adhesion, deterioration, disbondment) must be measured perpendicular from the center of the scribe to the furthest point of cutback. Cutback must be measured in millimeters to the nearest 0.5 mm. For both intermediate and final evaluations, the maximum cutback must be measured at 5 mm intervals along the scribe on each side of the scribe. (For a 50 x 100 mm X-scribe, 23 measurements are required for each side of each leg of the X-scribe). Report the average and maximum cutback measurements. Defects at the scribe having the appearance of a "blister" will be defined to be rust creepage (cutback).

Percent Rusting at the Scribed Edges
The length of individual areas of rust creepage along both edges of the scribe measured in Rust Creepage at the Scribe (above) must be added together to achieve an aggregate length of rust creepage. This length of rusting must be divided by the total length of the scribe on both sides to yield a percent of rusting at the scribed edges.

Rusting in the Scribe
In addition to the measurement of Rust Creepage at the Scribe (above) and Percent Rusting at the Scribed Edges (above) a general description of rusting in the scribe itself will also be reported. This description will state whether the scribe is "clean, partially rusted, or completely rusted."

COATING QUALIFICATION INSPECTION REQUIREMENTS
TEST PANEL PREPARATION AND TEST

Acceptance Criteria
After the designated hours of exposure, the coating must exhibit no spontaneous delamination (evaluated subjectively). Percent rusting at the scribe must be reported as information only. Blistering, and both average and maximum rust creepage at the scribe, must not exceed the following acceptance levels:

Test Acceptance Criteria

	Blister Criteria		Rust Criteria		
Acceptance	Hours	Size/Freq.	Conversion Value	Hours	Creepage Max Avg.
Coating System	4000	No. 6 Medium	> 7	5000	< 5 mm

Panel Corrosion, outside scribe, max. 0.05 percent, ASTM D610

Test No. 2 ASTM D4060 Abrasion Resistance Test

A test for abrasion resistance must be performed in accordance with ASTM D4060 using a CS-17 wheel and 1 kg weight for 1,000 cycles. The test must be performed on panels coated with the full system to be tested (i.e., 40 mils, 60 mils, 100 mils, 125 mils). The hardness of the abrasive wheel must be checked in accordance with ASTM D2240 for each test performed.

Acceptance Criteria
The system must be tested to identify its "weight loss" in milligrams.
Acceptance: < 30 mg

Test No. 3 ASTM D4541 Adhesion Test

A test for adhesion must be performed in accordance with ASTM D4541, Test Method D, using apparatus under Appendix D. The adhesive used to perform this test must be a two-component epoxy, containing no solvents (e.g., 100 percent solids). The test must be performed on panels having the primer coat only and on panels having the complete system. A minimum of four tests must be performed on each panel.

Acceptance Criteria
1. System with Self Priming SZC Modified Epoxy, Low VOC, Barrier Coating must meet a minimum value of 11.72 Mpa (1,700 psi).

-OR-

2. System with Self Priming SZC Modified Epoxy, Low VOC, Barrier Coating must meet a minimum cohesive failure value of 8.27 Mpa (1,200 psi).

Test No. 4 ASTM D6944 Freeze Thaw Stability

The test must be performed on panels coated with the full system to be tested. Prepared panels must be exposed to a 30-day freeze/thaw/immersion cycle ASTM D6944, Test Method A. One 24-hour cycle must consist of 16 hours at approximately minus 30 degrees plus or minus 5 degrees C followed by four hours of thawing at 50 degrees plus or minus 5 degrees C and four hours tap water immersion at 25 degrees plus or minus 2 degrees C. This work is done with the panels remaining in the freezer mode on weekends and holidays. Upon completion of the test, adhesion tests must be performed as required in Test No. 3.

COATING QUALIFICATION INSPECTION REQUIREMENTS
TEST PANEL PREPARATION AND TEST

Acceptance Criteria
Tests must indicate that there has been no loss in the adhesion values, when compared with those obtained in Test No. 3, for the complete system, which exceeds the test variation allowed by ASTM D4541.

Test No. 5 ASTM D7588 Coating Identification Tests.

An analysis of vehicle solids by Fourier transform infrared (FT/IR) spectroscopy consisting of 16 scans minimum per sample must be performed as follows:

1. For the Self Priming SZC Modified Epoxy, Low VOC, Barrier Coating, infrared spectrum (2.5 to 15 micrometers) of each liquid vehicle component via the potassium bromide sandwich technique.

2. For the mixed and dried components in appropriate mixing ratios (dried film) via the potassium bromide single-pellet technique, or alternately by the IR card sampling technique, which is called the polymer-coated fiberglass screen or transparent film (PTFE) technique.

The Volatile Organic Compound (VOC) content must be determined in accordance with ASTM D3960. Multi-component coatings will be blended together in the specified mixing ratios prior to testing.

Any products may be qualified by providing independent testing results to the requirements in this table. Coating Systems that currently meet these requirements and do not require COATING QUALIFICATION INSPECTION testing until June 01, 2017 include the following products only:

Chevron Philips Chemical Co. (800)858-4327, Technical(832-813-4862
TZ-904 Performance Coating

ITW / PolySpec Thiokol (888)797-0033, (281)397-0033
LPE-5100 Flexible Epoxy Novolac Splash Zone

Premier Coating Systems, Inc (904)824-1799, (904)403-6113
PCS-No. 1200TA Reinforced Modified Epoxy Surface Tolerant Coating

TABLE III
Reporting Program Requirements QA/QC

Administrative Controls:

Administrators must be able to turn on and off unique access to specific jobs and contracts.

Administrators must be able to remotely enable/ disable access for users.

All enabled users must view the same active report in real time. There must be no opportunity for multiple versions of the same report to exist.

Administrators must be able to setup unique approval processes for each project and promote or remove unique people from this process at any time.

Administrators must be able to associate contract specific documents and specification limits quickly and easily.

Administrators must be able to associate PDS, SDS, blueprints, scope of work and contracts uniquely to each job.

Objectivity Controls:

Data Entry fields must be by multi-selectable choices, numeric keypads, pickers and skip logic to ensure repeatable data entry in a way that makes running analytics and metrics easy and objective.

The program / hardware package must be able to communicate with inspection devices that provide (batch) data export capability such as Elcometer and Defelsko gages.

Must automatically time, date and GPS stamp all reports without input or interference from the inspector.

Real Time Syncing:

Forms must be available for approved associates to view at all times.

Retrievable storage must be provided for all job related reports and documents for a minimum time of 5 years from completion of the job or project. Archiving of the documents after 5 years will be the responsibility of the Government.

Document Library:

All reports must be in searchable and annotatable PDF format.

The Administrator must be able to upload and annotate job specific reports in real time. Examples include but not limited to Safety Data Sheets, Product Data Sheets and Blueprints.

Annotations / modifications must be locked and associated with the document. Only the Administrator has rights to modify or delete annotations or allow modifications to the document library especially all related inspection reports.

TABLE III
Reporting Program Requirements QA/QC

Customization:

The program must be capable of being customized to specific jobs, contracts or specifications.

-- End of Section --

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DIVISION 10 - SPECIALTIES

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TRAFFIC SIGNAGE

02/15

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SECTION 10 14 53

TRAFFIC SIGNAGE
02/15

PART 1 GENERAL

1.1 REFERENCES

The publications listed below form a part of this specification to the extent referenced. The publications are referred to within the text by the basic designation only.

ASTM INTERNATIONAL (ASTM)

ASTM G155	(2013) Standard Practice for Operating Xenon Arc Light Apparatus for Exposure of Non-Metallic Materials

STATE OF CALIFORNIA DEPARTMENT OF TRANSPORTATION (CALTRANS)

CDT MUTCD	(2014) California Manual on Uniform Traffic Control Devices, Revision 1
CDT Sign Specs	(2014) California Sign Specifications
CDT Std Plans	(2015) State of California Department of Transportation Standard Plans
CTM 671	(2005) State of California Department of Transportation Division of Engineering Services Test Method For Evaluating Painted Metal Target Plate Material
CDT Std Specs	(2015) State of California Department of Transportation (CALTRANS) Standard Specifications

U.S. FEDERAL HIGHWAY ADMINISTRATION (FHWA)

FHWA SHS	(2004; Supplement 2012) Standard Highway Signs

1.2 GENERAL

All signs must be in accordance with the CDT MUTCD, CDT Sign Specs, and FHWA SHS.

1.3 SUBMITTALS

Government approval is required for submittals with a "G" designation; submittals not having a "G" designation are for information only. When used, a designation following the "G" designation identifies the office that will review the submittal for the Government. Submit the following in accordance with Section 01 33 00 SUBMITTAL PROCEDURES:

SD-03 Product Data

Traffic Sign Posts; G

Traffic Sign Panels; G

Retroreflective Sheeting; G

Flexible Posts; G

SD-04 Samples

Traffic Sign Panels

Flexible Posts

SD-07 Certificates

Traffic Sign Posts; G

Traffic Sign Panels; G

Retroreflective Sheeting; G

Flexible Posts; G

PART 2 PRODUCTS

2.1 TRAFFIC SIGN POSTS

2.1.1 Sign Panel Fastening and Mounting Hardware

Sign panel fastening and mounting hardware shall conform to the requirements as specified in CDT Std Specs Sections 82-3.02E and 75-1.02B.

2.1.2 Wood

Wood post shall conform to the requirements as specified in CDT Std Specs Sections 57-2.01B(2), 57-2.01B(3), and 82-3.02C.

2.2 TRAFFIC SIGN PANELS

Sign panel shall conform to the requirements as specified in CDT Std Specs Sections 82-2.02A, 82-2.02B, and 82-2.02E.

Reject any signs with blisters or other blemishes.

2.3 RETROREFLECTIVE SHEETING

Retroreflective sheeting shall conform to the requirements as specified in CDT Std Specs Sections 82-2.02C and 82-2.02D.

2.4 DELINEATOR

2.4.1 Flexible Posts

Flexible posts shall conform to the requirements as specified in CDT Std Specs Sections 81-2.02A, 81-2.02D, 81-2.02E, and 81-2.02F.

When tested under CTM 671, the enamel coating on a metal target plate must have satisfactory resistance to weathering, humidity, salt spray, and chemicals. The enamel coating must have:

1. Satisfactory adherence and impact resistance
2. Pencil lead hardness of at least HB
3. 60-degree specular gloss of at least 80 percent
4. Excitation purity of no more than 3 percent:
    4.1 As received
    4.2 After 1,000 hours in an artificial weathering device when tested under ASTM G155, Table X3.1, Cycle 1
5. Daylight luminous directional reflectance (Y value) of at least 7

PART 3 EXECUTION

3.1 SIGN POSTS

3.1.1 Wood

Post shall conform to requirements as specified in CDT Std Specs Sections 82-3.01D, 82-3.03A, 82-3.03B, and CDT Std Plans.

3.2 TRAFFIC SIGN PANELS

Sign panel shall conform to requirements as specified in CDT Std Specs Section 82-2.03A, and CDT Std Plans.

Upon request, submit test samples of sign panels and materials at various stages of production. The samples must be at least 12 by 12 inches and include the background material and legend.

At least 15 days before starting sign fabrication, submit at least 3 copies of your QC plan for sign panels. The QC plan must include:

1. Contact information for the person responsible for sign QC
2. Acceptance criteria for incoming raw materials at the fabrication plant
3. Type, method, and frequency of QC testing at the fabrication plant
4. Types and brand names of retroreflective sheeting
5. List of the retroreflective sheeting manufacturer's approved process colors, protective overlay film, and black nonreflective film, including the manufacturer's name and product name for each item
6. Manufacturer's installation and splicing instructions for the retroreflective sheeting
7. Manufacturer's instructions for cleaning each product
8. Method of packaging, transporting, and storing signs

Replace any damaged sign panels at no additional cost to the Government.

3.3 DELINEATORS

Delineators shall conform to requirements as specified in CDT Std Plans.

Drive the post in place where soil conditions allow if the driving method does not damage the post. Drill pilot holes if ground conditions are such that the post cannot be driven without being damaged.

Install the target plates after the post is set in place.

After setting the post, fill any space around it with rock-free earth. Thoroughly tamp and water the fill material such that it holds the post securely in position.

Unless the surplus material is hazardous, uniformly spread it along the adjacent roadway where designated by the Contracting Officer.

Before Contract Closeout, spot paint any exposed areas where the paint is damaged and clean any exposed areas that are soiled.

3.4 LOCATION AND POSITION OF SIGNS

Locate and erect all signs in accordance with the drawings, CDT Std Plans, and CDT MUTCD.

Each installed sign will be inspected by the Contracting Officer's representative prior to acceptance by the Government.

-- End of Section --

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DIVISION 13 - SPECIAL CONSTRUCTION

SECTION 13 48 00

SEISMIC PROTECTION FOR MISCELLANEOUS EQUIPMENT

08/08

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SECTION 13 48 00

SEISMIC PROTECTION FOR MISCELLANEOUS EQUIPMENT
08/08

PART 1 GENERAL

1.1 REFERENCES

The publications listed below form a part of this specification to the extent referenced. The publications are referred to within the text by the basic designation only.

ASME INTERNATIONAL (ASME)

ASME B18.2.1	(2012; Errata 2013) Square and Hex Bolts and Screws (Inch Series)
ASME B18.2.2	(2015) Nuts for General Applications: Machine Screw Nuts, Hex, Square, Hex Flange, and Coupling Nuts (Inch Series)

ASTM INTERNATIONAL (ASTM)

ASTM A153/A153M	(2016) Standard Specification for Zinc Coating (Hot-Dip) on Iron and Steel Hardware
ASTM A307	(2014; E 2017) Standard Specification for Carbon Steel Bolts, Studs, and Threaded Rod 60 000 PSI Tensile Strength
ASTM A563	(2015) Standard Specification for Carbon and Alloy Steel Nuts
ASTM E488/E488M	(2015) Standard Test Methods for Strength of Anchors in Concrete and Masonry Elements

U.S. DEPARTMENT OF DEFENSE (DOD)

UFC 3-310-04	(2013; with Change 1) Seismic Design of Buildings

1.2 SYSTEM DESCRIPTION

1.2.1 General Requirements

Apply the requirements for seismic protection measures, described in this section, to the mechanical equipment and systems outlined in Section 13 48 0 1 SEISMIC PROTECTION FOR MECHANICAL EQUIPMENT and the miscellaneous equipment and systems listed below, in accordance with UFC 3-310-04 and additional data furnished by the Contracting Officer. Provide seismic protection measures in addition to any other requirements called for in other sections of these specifications. The design for seismic protection shall be based on a Seismic Use Group III building occupancy and on site response coefficients for S_{MS} = 0.868g and S_{M1} = 0.540g. Accomplish resistance to lateral forces induced by earthquakes without consideration of friction resulting from gravity loads. The basic force formulas, for Ground Motions A and B in UFC 3-310-04, use the design spectral response acceleration parameters for the performance objective of the building, not for equipment in the building; therefore, corresponding adjustments to the formulas are required.

1.3 SUBMITTALS

Government approval is required for submittals with a "G" designation; submittals not having a "G" designation are for Contractor Quality Control approval or for information only. When used, a designation following the "G" designation identifies the office that will review the submittal for the Government. Submit the following in accordance with Section 01 33 00 SUBMITTAL PROCEDURES:

SD-02 Shop Drawings

Bracing; G
Resilient Vibration Isolation Devices; G
Equipment Requirements; G

SD-03 Product Data

Bracing; G
Equipment Requirements; G

SD-06 Test Reports

Anchor Bolts; G

PART 2 PRODUCTS

2.1 EQUIPMENT REQUIREMENTS

Submit detail drawings along with calculations, catalog cuts, templates, and erection and installation details, as appropriate, for the items listed below. Indicate thickness, type, grade, class of metal, and dimensions; and show construction details, reinforcement, anchorage, and installation with relation to the building construction. For equipment and systems in buildings that have a performance objective higher than life-safety, the drawings shall be stamped by the registered engineer who stamps the calculations. Calculations shall be stamped, by a registered engineer, and verify the capability of structural members to which bracing is attached for carrying the load from the brace.

2.1.1 Rigidly Mounted Equipment

Equipment to be furnished under this contract shall be constructed and assembled to withstand the seismic forces specified in UFC 3-310-04. For any rigid equipment which is rigidly attached on both sides of a building expansion joint, provide flexible joints for piping, electrical conduit, etc., that are capable of accommodating displacements equal to the full width of the joint in both orthogonal directions.

2.2 BOLTS AND NUTS

Squarehead and hexhead bolts, and heavy hexagon nuts, ASME B18.2.1, ASME B18.2.2, or ASTM A307 for bolts and ASTM A563 for nuts. Provide bolts and nuts galvanized in accordance with ASTM A153/A153M when used underground and/or exposed to weather.

PART 3 EXECUTION

3.1 BRACING

Provide bracing conforming to the arrangements shown. Secure trapeze-type hanger with not less than two 1/2 inch bolts.

3.2 BUILDING DRIFT

Sway braces for a piping run shall not be attached to two dissimilar structural elements of a building that may respond differentially during an earthquake unless a flexible joint is provided.

3.3 ANCHOR BOLTS

Submit copies of test results to verify the adequacy of the specific anchor and application, as specified.

3.3.1 Cast-In-Place

Use cast-in-place anchor bolts, conforming to ASTM A307, for floor or pad mounted equipment, except as specified below. Provide one nut on each bolt. Anchor bolts shall have an embedded straight length equal to at least 12 times nominal diameter of the bolt. Anchor bolts that exceed the normal depth of equipment foundation piers or pads shall either extend into concrete floor or the foundation or be increased in depth to accommodate bolt lengths.

3.3.2 Expansion or Chemically Bonded Anchors

Do not use expansion or chemically bonded anchors: 1)Unless test data in accordance with ASTM E488/E488M has been provided to verify the adequacy of the specific anchor and application. 2)To resist pull-out in overhead and wall installations if the adhesive is manufactured with temperature sensitive epoxies and the location is accessible to a building fire. Install expansion and chemically bonded anchors in accordance with the manufacturer's recommendations. Adjust the allowable forces for the spacing between anchor bolts and the distance between the anchor bolt and the nearest edge, as specified by the manufacturer.

3.3.2.1 General Testing

Test in place expansion and chemically bonded anchors not more than 24 hours after installation of the anchor, conducted by an independent testing agency; testing shall be performed on random anchor bolts as described below.

3.3.2.2 Torque Wrench Testing

Perform torque wrench testing on not less than 50 percent of the total installed expansion anchors and at least one anchor for every piece of equipment containing more than two anchors. The test torque shall equal the minimum required installation torque as required by the bolt manufacturer. Calibrate torque wrenches at the beginning of each day the torque tests are performed. Recalibrate torque wrenches for each bolt diameter whenever tests are run on bolts of various diameters. Apply torque between 20 and 100 percent of wrench capacity. Reach the test torque within one half turn of the nut, except for 3/8 inch sleeve anchors which shall reach their torque by one quarter turn of the nut. If any anchor fails the test, test similar anchors not previously tested until 20 consecutive anchors pass. Failed anchors shall be retightened and retested to the specified torque; if the anchor still fails the test it shall be replaced.

3.3.2.3 Pullout Testing

Test expansion and chemically bonded anchors by applying a pullout load using a hydraulic ram attached to the anchor bolt. At least 5 percent of the anchors, but not less than 3 per day shall be tested. Apply the load to the anchor without removing the nut; when that is not possible, the nut shall be removed and a threaded coupler shall be installed of the same tightness as the original nut. Check the test setup to verify that the anchor is not restrained from withdrawing by the baseplate, the test fixture, or any other fixtures. The support for the testing apparatus shall be at least 1.5 times the embedment length away from the bolt being tested. Load each tested anchor to 1 times the design tension value for the anchor. The anchor shall have no observable movement at the test load. If any anchor fails the test, similar anchors not previously tested shall be tested until 20 consecutive anchors pass. Failed anchors shall be retightened and retested to the specified load; if the anchor still fails the test it shall be replaced.

3.4 RESILIENT VIBRATION ISOLATION DEVICES

Where the need for these devices is determined, based on the magnitude of the design seismic forces, selection of anchor bolts for vibration isolation devices and/or snubbers for equipment base and foundations shall follow the same procedure as in paragraph ANCHOR BOLTS, except that an equipment weight equal to five times the actual equipment weight shall be used.

3.4.1 Resilient and Spring-Type Vibration Devices

Select vibration isolation devices so that the maximum movement of equipment from the static deflection point is 1/2 inch.

3.4.2 Multidirectional Seismic Snubbers

Install multidirectional seismic snubbers employing elastomeric pads on floor- or slab-mounted equipment. These snubbers shall provide 1/4 inch free vertical and horizontal movement from the static deflection point. Snubber medium shall consist of multiple pads of cotton duct and neoprene or other suitable materials arranged around a flanged steel trunnion so both horizontal and vertical forces are resisted by the snubber medium.

3.5 SWAY BRACES FOR PIPING

Provide transverse sway bracing for steel and copper pipe at intervals not to exceed those shown on the drawings. Transverse sway bracing for pipes of materials other than steel and copper shall be provided at intervals not to exceed the hanger spacing as specified in the drawings. Provide bracing consisting of at least one vertical angle 2 by 2 inch by 16 gauge and one diagonal angle of the same size.

3.5.1 Longitudinal Sway Bracing

Provide longitudinal sway bracing in accordance with Section 13 48 01 SEISMIC CONTROL FOR MECHANICAL EQUIPMENT.

3.5.2 Anchor Rods, Angles, and Bars

Anchor rods, angles, and bars shall be bolted to either pipe clamps or pipe flanges at one end and cast-in-place concrete or masonry insert or clip angles bolted to the steel structure on the other end. Rods shall be solid metal or pipe as specified below. Anchor rods, angles, and bars shall not exceed lengths given in the tabulation below.

3.5.3 Maximum Length for Anchor Braces

Type	Size (in)	Maximum Length* (ft-in)
Angles	1-1/2 x 1-1/2 x 1/4	4-10
	2 x 2 x 1/4	6-6
	2-1/2 x 1-1/2 x 1/4	8-0
	3 x 2-1/2 x 1/4	8-10
	3 x 3 x 1/4	9-10
Rods	3/4	3-1
	7/8	3-8
Flat Bars	1-1/2 x 1/4	1-2
	2 x 1/4	1-2
	2 x 3/8	1-9
Pipes (40s)	1	7-0
	1-1/4	9-0
	1-1/2	10-4
	2	13-1

3.5.4 Bolts

Bolts used for attachment of anchors to pipe and structure shall be not less than 1/2 inch diameter.

3.6 EQUIPMENT SWAY BRACING

3.6.1 Suspended Equipment and Light Fixtures

Provide equipment sway bracing for items supported from overhead floor or roof structural systems, including light fixtures. Braces shall consist of angles, rods, wire rope, bars, or pipes arranged as shown and secured at both ends with not less than 1/2 inch bolts. Provide sufficient braces for equipment to resist a horizontal force as specified in UFC 3-310-04 without exceeding safe working stress of bracing components. Provide, for approval, specific force calculations in accordance with UFC 3-310-04 for the equipment in the project. Submit details of equipment bracing for acceptance. In lieu of bracing with vertical supports, these items may be supported with hangers inclined at 45 degrees directed up and radially away from equipment and oriented symmetrically in 90-degree intervals on the horizontal plane, bisecting the angles of each corner of the equipment, provided that supporting members are properly sized to support operating weight of equipment when hangers are inclined at a 45-degree angle.

3.6.2 Floor or Pad Mounted Equipment

3.6.2.1 Shear Resistance

Bolt to the floor, floor mounted equipment. Requirements for the number and installation of bolts to resist shear forces shall be in accordance with paragraph ANCHOR BOLTS.

3.6.2.2 Overturning Resistance

Use the ratio of the overturning moment from seismic forces to the resisting moment due to gravity loads to determine if overturning forces need to be considered in the sizing of anchor bolts. Provide calculations to verify the adequacy of the anchor bolts for combined shear and overturning.

3.7 SPECIAL INSPECTION AND TESTING FOR SEISMIC-RESISTING SYSTEMS

Perform special inspections and testing for seismic-resisting systems and components.

-- End of Section --

SECTION TABLE OF CONTENTS

DIVISION 13 - SPECIAL CONSTRUCTION

SECTION 13 48 01

SEISMIC PROTECTION FOR MECHANICAL EQUIPMENT

10/07

-- End of Section Table of Contents --

SECTION 13 48 01

SEISMIC PROTECTION FOR MECHANICAL EQUIPMENT
10/07

PART 1 GENERAL

1.1 REFERENCES

The publications listed below form a part of this specification to the extent referenced. The publications are referred to within the text by the basic designation only.

AMERICAN INSTITUTE OF STEEL CONSTRUCTION (AISC)

AISC 325 (2017) Steel Construction Manual

U.S. DEPARTMENT OF DEFENSE (DOD)

UFC 3-310-04 (2013; with Change 1) Seismic Design of Buildings

1.2 SYSTEM DESCRIPTION

1.2.1 General Requirements

Apply the requirements for seismic protection measures described in this section to the mechanical equipment and systems listed below. Structural requirements shall be in accordance with Section 13 48 00 SEISMIC PROTECTION FOR MISCELLANEOUS EQUIPMENT.

1.2.2 Mechanical Equipment

Mechanical equipment to be seismically protected shall include the following items to the extent required on the drawings or in other sections of these specifications:

Pumps with Motors	Valves and Fittings for Piping
Water Piping	

1.2.3 Mechanical Systems

Install the following mechanical systems as required on the drawings and other sections of these specifications and seismically protect them in accordance with this specification:

a. Storm and Sanitary Sewer Systems.

b. All Process Piping.

1.2.4 Contractor Designed Bracing

Submit copies of the design calculations with the drawings. Calculations shall be approved, certified, stamped and signed by a registered Professional Engineer. Calculations shall verify the capability of structural members to which bracing is attached for carrying the load from the brace. Design the bracing in accordance with UFC 3-310-04 and additional data furnished by the Contracting Officer. Resistance to lateral forces induced by earthquakes shall be accomplished without consideration of friction resulting from gravity loads. UFC 3-310-04 uses parameters for the building, not for the equipment in the building; therefore, corresponding adjustments to the formulas shall be required. Loadings determined using UFC 3-310-04 are based on strength design; therefore, AISC 325 Specifications shall be used for the design.

1.2.5 Items Not Covered By This Section

1.2.5.1 Items Requiring No Seismic Restraints

Seismic restraints are not required for the following items:

a. All other piping less than 2-1/2inches inside diameter.

b. Piping suspended by individual hangers 12 inches or less in length from the top of pipe to the bottom of the supporting structural member where the hanger is attached, except as noted below.

All hangers shall meet the length requirements. If the length requirement is exceeded by one hanger in the run, the entire run shall be braced. Interior piping and ducts not listed above shall be seismically protected in accordance with the provisions of this specification.

1.3 SUBMITTALS

Government approval is required for submittals with a "G" designation; submittals not having a "G" designation are for Contractor Quality Control approval. When used, a designation following the "G" designation identifies the office that will review the submittal for the Government. Submit the following in accordance with Section 01 33 00 SUBMITTAL PROCEDURES:

SD-02 Shop Drawings

Coupling and BracingEquipment Requirements
Contractor Designed Bracing; G

SD-03 Product Data

Coupling and Bracing; G
Equipment Requirements; G
Contractor Designed Bracing; G

PART 2 PRODUCTS

2.1 EQUIPMENT REQUIREMENTS

Submit copies of the design calculations with the detail drawings. Calculations shall be stamped by a registered engineer and shall verify the capability of structural members to which bracing is attached for carrying the load from the brace.

2.1.1 Rigidly Mounted Equipment

Each item of rigid equipment shall be entirely located and rigidly attached on one side only of a building expansion joint. Piping, duct, electrical conduit, etc., which cross the expansion joint shall be provided with flexible joints that are capable of accommodating displacements equal to the full width of the joint in both orthogonal directions.

2.2 FLEXIBLE COUPLINGS

Flexible couplings shall have same pressure and temperature ratings as adjoining pipe.

2.3 FLEXIBLE MECHANICAL JOINTS

a. Mechanical couplings for steel or cast iron pipe shall be of the sleeve type and shall provide a tight flexible joint under all reasonable conditions, such as pipe movement caused by expansion, contraction, slight settling or shifting of the ground, minor variations in trench gradients, and traffic vibrations. Where permitted in other sections of these specifications, joints utilizing split-half couplings with grooved or shouldered pipe ends may be used.

b. Sleeve-type couplings shall be used for joining plain-end pipe sections. The coupling shall consist of one steel middle ring, two steel followers, two gaskets, and necessary steel bolts and nuts to compress the gaskets.

2.4 SWAY BRACING MATERIALS

Sway bracing materials (e.g. rods, plates, rope, angles, etc.) shall be as specified in Section 13 48 00 SEISMIC PROTECTION FOR MISCELLANEOUS EQUIPMENT.

PART 3 EXECUTION

3.1 COUPLING AND BRACING

a. Submit detail drawings, as specified here and throughout this specification, along with catalog cuts, templates, and erection and installation details, as appropriate, for the items listed. Submittals shall be complete in detail; shall indicate thickness, type, grade, class of metal, and dimensions; and shall show construction details, reinforcement, anchorage, and installation with relation to the building construction.

b. Coupling installation shall conform to the details shown on the drawings. Provisions of this paragraph apply to all piping within a 5 foot line around outside of building unless buried in the ground. Piping grouped for support on trapeze-type hangers shall be braced at the most frequent interval as determined by applying the requirements of this specification to each piping run on the common support.

c. Bracing components shall be sized as required for the total load carried by the common supports. Bracing rigidly attached to pipe flanges, or similar, shall not be used where it would interfere with thermal expansion of piping.

3.2 SPREADERS

Spreaders shall be provided between adjacent piping runs to prevent contact during seismic activity whenever pipe or insulated pipe surfaces are less than 4 inches apart. Spreaders shall be applied at same interval as sway braces at an equal distance between the sway braces. If rack type hangers are used where the pipes are restrained from contact by mounting to the rack, spreaders are not required for pipes mounted in the rack.

3.3 SWAY BRACES FOR PIPING

Sway braces shall be provided to prevent movement of the pipes under seismic loading. Braces shall be provided in both the longitudinal and transverse directions, relative to the axis of the pipe. The bracing shall not interfere with thermal expansion requirements for the pipes as described in other sections of these specifications.

3.3.1 Transverse Sway Bracing

Transverse sway bracing for steel and copper pipe shall be provided as specified in Section 13 48 00 SEISMIC PROTECTION FOR MISCELLANEOUS EQUIPMENT. All runs (length of pipe between end joints) shall have a minimum of two transverse braces. Transverse sway bracing for pipes of materials other than steel and copper shall be provided at intervals not to exceed the hanger spacing as specified in the drawings.

3.3.2 Longitudinal Sway Bracing

Longitudinal sway bracing shall be provided at 40 foot intervals unless otherwise indicated. All runs (length of pipe between end joints) shall have one longitudinal brace minimum. Sway braces shall be constructed in accordance with the drawings. Branch lines, walls, or floors shall not be used as sway braces.

3.3.3 Vertical Runs

Run is defined as length of pipe between end joints. Vertical runs of piping shall be braced at not more than 10 foot vertical intervals. Braces for vertical runs shall be above the center of gravity of the segment being braced. All sway braces shall be constructed in accordance with the drawings. Sway braces shall attach to the structural system and shall not be connected to branch lines, walls, or floors.

3.3.4 Clamps and Hangers

Clamps or hangers on uninsulated pipes shall be applied directly to pipe. Insulated piping shall have clamps or hangers applied over insulation.

-- End of Section --

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DIVISION 26 - ELECTRICAL

SECTION 26 00 00

BASIC ELECTRICAL MATERIALS AND METHODS

07/06

-- End of Section Table of Contents --

SECTION 26 00 00

BASIC ELECTRICAL MATERIALS AND METHODS
07/06

PART 1 GENERAL

1.1 REFERENCES

The publications listed below form a part of this specification to the extent referenced. The publications are referred to in the text by the basic designation only.

ASTM INTERNATIONAL (ASTM)

ASTM D709	(2017) Standard Specification for Laminated Thermosetting Materials

INSTITUTE OF ELECTRICAL AND ELECTRONICS ENGINEERS (IEEE)

IEEE 100	(2000; Archived) The Authoritative Dictionary of IEEE Standards Terms
IEEE C2	(2017; Errata 1-2 2017; INT 1 2017) National Electrical Safety Code
IEEE C57.12.28	(2014) Standard for Pad-Mounted Equipment - Enclosure Integrity
IEEE C57.12.29	(2014) Standard for Pad-Mounted Equipment - Enclosure Integrity for Coastal Environments

NATIONAL ELECTRICAL MANUFACTURERS ASSOCIATION (NEMA)

NEMA 250	(2014) Enclosures for Electrical Equipment (1000 Volts Maximum)

NATIONAL FIRE PROTECTION ASSOCIATION (NFPA)

NFPA 70	(2017; ERTA 1-2 2017; TIA 17-1; TIA 17-2; TIA 17-3; TIA 17-4; TIA 17-5; TIA 17-6; TIA 17-7; TIA 17-8; TIA 17-9; TIA 17-10; TIA 17-11; TIA 17-12; TIA 17-13; TIA 17-14; TIA 17-15; TIA 17-16; TIA 17-17) National Electrical Code

1.2 DEFINITIONS

a. Unless otherwise specified or indicated, electrical and electronics terms used in these specifications, and on the drawings, shall be as defined in IEEE 100.

b. The technical sections referred to herein are those specification sections that describe products, installation procedures, and equipment operations and that refer to this section for detailed description of submittal types.

c. The technical paragraphs referred to herein are those paragraphs in PART 2 - PRODUCTS and PART 3 - EXECUTION of the technical sections that describe products, systems, installation procedures, equipment, and test methods.

1.3 ELECTRICAL CHARACTERISTICS

Electrical characteristics for this project shall be 12 kV primary, three phase, three wire, 60 Hz, and 2,400 volts secondary, three phase, three wire. Final connections to the power distribution system at the existing Utility Transformer shall be made by the Utility.

1.4 ADDITIONAL SUBMITTALS INFORMATION

Submittals required in other sections that refer to this section must conform to the following additional requirements as applicable.

1.4.1 Shop Drawings (SD-02)

Include wiring diagrams and installation details of equipment indicating proposed location, layout and arrangement, control panels, accessories, piping, ductwork, and other items that must be shown to ensure a coordinated installation. Wiring diagrams shall identify circuit terminals and indicate the internal wiring for each item of equipment and the interconnection between each item of equipment. Drawings shall indicate adequate clearance for operation, maintenance, and replacement of operating equipment devices.

1.4.2 Product Data (SD-03)

Submittal shall include performance and characteristic curves.

1.5 QUALITY ASSURANCE

1.5.1 Regulatory Requirements

In each of the publications referred to herein, consider the advisory provisions to be mandatory, as though the word, "shall" had been substituted for "should" wherever it appears. Interpret references in these publications to the "authority having jurisdiction," or words of similar meaning, to mean the Contracting Officer. Equipment, materials, installation, and workmanship shall be in accordance with the mandatory and advisory provisions of NFPA 70 unless more stringent requirements are specified or indicated.

1.5.2 Standard Products

Provide materials and equipment that are products of manufacturers regularly engaged in the production of such products which are of equal material, design and workmanship. Products shall have been in satisfactory commercial or industrial use for 2 years prior to bid opening. The 2-year period shall include applications of equipment and materials under similar circumstances and of similar size. The product shall have been on sale on the commercial market through advertisements, manufacturers' catalogs, or brochures during the 2-year period. Where two or more items of the same class of equipment are required, these items shall be products of a single manufacturer; however, the component parts of the item need not be the products of the same manufacturer unless stated in the technical section.

1.5.2.1 Alternative Qualifications

Products having less than a 2-year field service record will be acceptable if a certified record of satisfactory field operation for not less than 6000 hours, exclusive of the manufacturers' factory or laboratory tests, is furnished.

1.5.2.2 Material and Equipment Manufacturing Date

Products manufactured more than 3 years prior to date of delivery to site shall not be used, unless specified otherwise.

1.6 WARRANTY

The equipment items shall be supported by service organizations which are reasonably convenient to the equipment installation in order to render satisfactory service to the equipment on a regular and emergency basis during the warranty period of the contract.

1.7 POSTED OPERATING INSTRUCTIONS

Provide for each system and principal item of equipment as specified in the technical sections for use by operation and maintenance personnel. The operating instructions shall include the following:

a. Wiring diagrams, control diagrams, and control sequence for each principal system and item of equipment.

b. Start up, proper adjustment, operating, lubrication, and shutdown procedures.

c. Safety precautions.

d. The procedure in the event of equipment failure.

e. Other items of instruction as recommended by the manufacturer of each system or item of equipment.

Print or engrave operating instructions and frame under glass or in approved laminated plastic. Post instructions where directed. For operating instructions exposed to the weather, provide weather-resistant materials or weatherproof enclosures. Operating instructions shall not fade when exposed to sunlight and shall be secured to prevent easy removal or peeling.

1.8 MANUFACTURER'S NAMEPLATE

Each item of equipment shall have a nameplate bearing the manufacturer's name, address, model number, and serial number securely affixed in a conspicuous place; the nameplate of the distributing agent will not be acceptable.

1.9 FIELD FABRICATED NAMEPLATES

ASTM D709. Provide laminated plastic nameplates for each equipment enclosure, relay, switch, and device; as specified in the technical sections or as indicated on the drawings. Each nameplate inscription shall identify the function and, when applicable, the position. Nameplates shall be melamine plastic, 0.125 inch thick, white with black center core. Surface shall be matte finish. Corners shall be square. Accurately align lettering and engrave into the core. Minimum size of nameplates shall be one by 2.5 inches. Lettering shall be a minimum of 0.25 inch high normal block style.

1.10 WARNING SIGNS

Provide warning signs for the enclosures of electrical equipment including substations, pad-mounted transformers, pad-mounted switches, generators, and switchgear having a nominal rating exceeding 600 volts.

a. When the enclosure integrity of such equipment is specified to be in accordance with IEEE C57.12.28 or IEEE C57.12.29, such as for pad-mounted transformers and pad-mounted SF6 switches, provide self-adhesive warning signs on the outside of the high voltage compartment door(s). Sign shall be a decal and shall have nominal dimensions of 7 by 10 inches with the legend "DANGER HIGH VOLTAGE" printed in two lines of nominal 2 inch high letters. The word "DANGER" shall be in white letters on a red background and the words "HIGH VOLTAGE" shall be in black letters on a white background. Decal shall be Panduit No. PPSO710D72 or approved equal.

1.11 ELECTRICAL REQUIREMENTS

Electrical installations shall conform to IEEE C2, NFPA 70, and requirements specified herein.

1.12 INSTRUCTION TO GOVERNMENT PERSONNEL

Where specified in the technical sections, furnish the services of competent instructors to give full instruction to designated Government personnel in the adjustment, operation, and maintenance of the specified systems and equipment, including pertinent safety requirements as required. Instructors shall be thoroughly familiar with all parts of the installation and shall be trained in operating theory as well as practical operation and maintenance work. Instruction shall be given during the first regular work week after the equipment or system has been accepted and turned over to the Government for regular operation. The number of man-days (8 hours per day) of instruction furnished shall be as specified in the individual section.

PART 2 PRODUCTS

2.1 FACTORY APPLIED FINISH

Electrical equipment shall have factory-applied painting systems which shall, as a minimum, meet the requirements of NEMA 250 corrosion-resistance test.

PART 3 EXECUTION

3.1 FIELD FABRICATED NAMEPLATE MOUNTING

Provide number, location, and letter designation of nameplates as indicated. Fasten nameplates to the device with a minimum of two sheet-metal screws or two rivets.

3.2 WARNING SIGN MOUNTING

Provide the number of signs required to be readable from each accessible side, but space the signs a maximum of 30 feet apart.

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DIVISION 26 - ELECTRICAL

SECTION 26 05 00

COMMON WORK RESULTS FOR ELECTRICAL

08/16

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SECTION 26 05 00

COMMON WORK RESULTS FOR ELECTRICAL
08/16

PART 1 GENERAL

1.1 REFERENCES

The publications listed below form a part of this specification to the extent referenced. The publications are referred to within the text by the basic designation only.

ASTM INTERNATIONAL (ASTM)

ASTM D709	(2017) Standard Specification for Laminated Thermosetting Materials

ELECTRONIC INDUSTRIES ALLIANCE (EIA)

EIA 480	(1981) Toggle Switches

INSTITUTE OF ELECTRICAL AND ELECTRONICS ENGINEERS (IEEE)

IEEE C57.12.28	(2014) Standard for Pad-Mounted Equipment - Enclosure Integrity
IEEE Stds Dictionary	(2009) IEEE Standards Dictionary: Glossary of Terms & Definitions

INTERNATIONAL CODE COUNCIL (ICC)

ICC/ANSI A117.1	(2009) Accessible and Usable Buildings and Facilities

NATIONAL ELECTRICAL MANUFACTURERS ASSOCIATION (NEMA)

ANSI Z535.1	(2017) Safety Colors
ANSI/NEMA OS 1	(2013) Sheet-Steel Outlet Boxes, Device Boxes, Covers, and Box Supports
NEMA 250	(2014) Enclosures for Electrical Equipment (1000 Volts Maximum)
NEMA PB 1	(2011) Panelboards
NEMA RN 1	(2005; R 2013) Polyvinyl-Chloride (PVC) Externally Coated Galvanized Rigid Steel Conduit and Intermediate Metal Conduit
NEMA TC 2	(2013) Standard for Electrical Polyvinyl Chloride (PVC) Conduit
NEMA TC 3	(2016) Polyvinyl Chloride (PVC) Fittings for Use With Rigid PVC Conduit and Tubing

NEMA VE 1	(2017) Metal Cable Tray Systems
NEMA WD 1	(1999; R 2015) Standard for General Color Requirements for Wiring Devices
NEMA WD 6	(2016) Wiring Devices Dimensions Specifications

NATIONAL FIRE PROTECTION ASSOCIATION (NFPA)

NFPA 70	(2017; ERTA 1-2 2017; TIA 17-1; TIA 17-2; TIA 17-3; TIA 17-4; TIA 17-5; TIA 17-6; TIA 17-7; TIA 17-8; TIA 17-9; TIA 17-10; TIA 17-11; TIA 17-12; TIA 17-13; TIA 17-14; TIA 17-15; TIA 17-16; TIA 17-17) National Electrical Code

UNDERWRITERS LABORATORIES (UL)

UL 1	(2005; Reprint Aug 2017) UL Standard for Safety Flexible Metal Conduit
UL 1242	(2006; Reprint Mar 2014) Standard for Electrical Intermediate Metal Conduit -- Steel
UL 489	(2016) UL Standard for Safety Molded-Case Circuit Breakers, Molded-Case Switches and Circuit-Breaker Enclosures
UL 506	(2017) UL Standard for Safety Specialty Transformers
UL 6	(2007; Reprint Nov 2014) Electrical Rigid Metal Conduit-Steel
UL 870	(2016) UL Standard for Safety Wireways, Auxiliary Gutters, and Associated Fittings

1.2 DEFINITIONS

a. Unless otherwise specified or indicated, electrical and electronics terms used in these specifications, and on the drawings, are as defined in IEEE Stds Dictionary.

b. The technical sections referred to herein are those specification sections that describe products, installation procedures, and equipment operations and that refer to this section for detailed description of submittal types.

1.3 SUBMITTALS

Government approval is required for submittals with a "G" designation; submittals not having a "G" designation are for Contractor Quality Control approval. When used, a designation following the "G" designation identifies the office that will review the submittal for the Government. Submit the following in accordance with Section 01 33 00 SUBMITTAL PROCEDURES:

SD-01 Preconstruction Submittals

Material, Equipment, and Fixture Lists

SD-03 Product Data

Conduits and Raceways; G

Wire and Cable; G

Splices and Connectors; G
Outlet Boxes, Pull Boxes and Junction Boxes; G

Circuit Breakers; G

Panelboards; G

SD-06 Test Reports

Continuity Test; G

Phase-Rotation Tests; G

Insulation Resistance Test; G

SD-08 Manufacturer's Instructions

Manufacturer's Instructions

PART 2 PRODUCTS

2.1 EQUIPMENT

Provide the standard cataloged materials and equipment of manufacturers regularly engaged in the manufacture of the products. For material, equipment, and fixture lists submittals, show manufacturer's style or catalog numbers, specification and drawing reference numbers, warranty information, and fabrication site.

2.1.1 Conduits and Raceways

2.1.1.1 Rigid Steel Conduit

Provide hot dipped galvanized rigid steel conduit complying with UL 6. Except where installed underground, or in corrosive areas, provide polyvinylchloride (PVC), or painted with bitumastic coated rigid steel conduit in accordance with NEMA RN 1.

Use threaded fittings for rigid steel conduit.

Use solid gaskets. Ensure conduit fittings with blank covers have gaskets, except in clean, dry areas or at the lowest point of a conduit run where drainage is required.

Provide covers with captive screws and are accessible after the work has been completed.

2.1.1.2 Flexible Metallic Conduit

Ensure flexible metallic conduit is galvanized steel and complies with UL 1.

Ensure fittings for flexible metallic conduit are specifically designed for such conduit.

Provide liquidtight flexible metallic conduit with a protective jacket of PVC extruded over a flexible interlocked galvanized steel core to protect wiring against moisture, oil, chemicals, and corrosive fumes.

Ensure fittings for liquidtight flexible metallic conduit are specifically designed for such conduit.

2.1.1.3 Intermediate Metal Conduit

Ensure intermediate metal conduit is galvanized steel and complies with UL 1242.

2.1.1.4 Rigid Nonmetallic Conduit

Ensure rigid nonmetallic conduit complies with NEMA TC 2 and NEMA TC 3 with a wall thickness not less than Schedule 40.

2.1.1.5 Wireways and Auxiliary Gutters

Ensure wireways and auxiliary gutters are a minimum 4 by 4-inch trade size conforming to UL 870.

2.1.1.6 Surface Raceways and Assemblies

Ensure surface metal raceways and multi-outlet assemblies conform to NFPA 70, and have receptacles conforming to NEMA WD 1, Type 5-20R.

2.1.2 Cable Trays

Provide ladder type cable trays conforming to NEMA VE 1.

2.1.3 Wire and Cable

Use copper 600-volt type XHHW for conductors installed in conduit. Ensure all conductors AWG No. 8 and larger, are stranded. All conductors smaller than AWG No. 8 are stranded.

Ensure flexible cable is Type SO and contains a grounding conductor with green insulation.

Ensure conductors installed in plenums are marked plenum rated.

2.1.4 Switches

2.1.4.1 Safety Switches

Ensure safety switches comply with NEMA 4, and are the heavy-duty type with enclosure, voltage, current rating, number of poles, and fusing as indicated on the drawings. Ensure switch construction is such that, when the switch handle in the "ON" position, the cover or door cannot be opened. Cover release device is coinproof and so constructed that an external tool is used to open the cover. Make provisions to lock the handle in the "OFF" position. Ensure the switch is not capable of being locked in the "ON" position.

Provide switches of the quick-make, quick-break type and terminal lugs for use with copper conductors.

Ensure safety color coding for identification of safety switches conforms to ANSI Z535.1.

2.1.4.2 Toggle Switches

Ensure toggle switches comply with EIA 480, control incandescent, mercury, and fluorescent lighting fixtures and are the heavy duty, general purpose, noninterchangeable flush-type.

Provide commercial grade toggle switches, single, double-pole, three four -way two-position devices rated 20 amperes at 277 volts, 60 hertz alternating current (ac) only.

Ensure all toggle switches are products of the same manufacturer.

2.1.5 Receptacles

Provide commercial grade, NEMA 5-20R receptacles, 20A, 125 VAC, 2-pole, 3-wire duplex conforming to NEMA WD 6.

2.1.6 Outlet Boxes, Pull Boxes and Junction Boxes

Ensure outlet boxes for use with conduit systems are in accordance with NEMA 4 and ANSI/NEMA OS 1 and are not less than 1-1/2 inches deep. Furnish all pull and junction boxes with screw-fastened covers.

2.1.7 Panelboards

Provide circuit breaker type lighting and appliance branch circuit panelboards in accordance with NEMA PB 1. Bolt circuit breakers to the bus. Plug-in circuit breakers are not acceptable. Provide copper buses of the rating indicated on the drawings, with main lugs or main circuit breaker. Provide all panelboards for use on grounded ac systems with a full-capacity isolated neutral bus and a separate grounding bus bonded to the panelboard enclosure. Ensure panelboard enclosures are NEMA 250, Type 1, in accordance with NEMA PB 1. Provide enclosure fronts with latchable hinged doors.

2.1.8 Circuit Breakers

Ensure circuit breaker interrupting rating is not less than those indicated and in no event less than 10,000 amperes root-mean-square (rms) symmetrical at 240 volts, respectively. Provide multipole circuit breakers of the common-trip type with a single handle. Molded case circuit breakers are bolt-on type conforming to UL 489.

2.1.9 Lamps and Lighting Fixtures

Manufacturers and catalog numbers shown on the drawings are indicative of the general type desired and are not intended to restrict the selection to fixtures of any particular manufacturer. Fixtures with the same salient features and equivalent light distribution and brightness characteristics, of equal finish and quality, are acceptable.

2.1.10 Manufacturer's Nameplate

Ensure each item of equipment has a nameplate bearing the manufacturer's name, address, model number, and serial number securely affixed in a conspicuous place; the nameplate of the distributing agent is not acceptable.

2.1.11 Warning Signs

Provide warning signs for the enclosures of electrical equipment including substations, pad-mounted transformers, pad-mounted switches, generators, and switchgear having a nominal rating exceeding 600 volts.

a. Enclosure integrity to conform with IEEE C57.12.28, such as for pad-mounted transformers. Provide self-adhesive warning signs on the outside of the high voltage compartment door(s). Provide decal signs with nominal dimensions of 7 by 10 inches. Print the legend "DANGER HIGH VOLTAGE" in two lines of nominal 2 inch high letters. Show the word "DANGER" in white letters on a red background and the words "HIGH VOLTAGE" in black letters on a white background. Use Panduit decal No. PPSO710D72 or approved equal.

b. When such equipment is guarded by a fence, mount signs on the fence. Provide metal signs having nominal dimensions of 14 by 10 inches with the legend "DANGER HIGH VOLTAGE KEEP OUT" printed in three lines of nominal 3-inch high white letters on a red and black field.

2.1.12 Dry-Type Distribution Transformers

Ensure that general purpose dry-type transformers with windings 600 volts or less are two-winding, 60 hertz, and self-cooled in accordance with UL 506. Ensure windings have a minimum of two 2-1/2-percent taps above and below nominal voltage.

PART 3 EXECUTION

3.1 PREPARATION

Submit manufacturer's instructions including special provisions required to install equipment components and system packages. Special provisions include impedances, hazards and safety precautions.

Clean and paint conduit, supports, fittings, cabinets, pull boxes, and racks as specified.

Protect metallic materials against corrosion. Provide equipment enclosures with the standard finish by the manufacturer when used for most indoor installations. For harsh indoor environments (any area subjected to chemical and abrasive action), and all outdoor installations, refer to Section 09 90 00 PAINTS AND COATINGS. Do not use aluminum when in contact with earth or concrete and, where connected to dissimilar metal, protect by using approved fittings and treatment. Except where other equivalent protective treatment is specifically approved in writing, provide hot-dip galvanized ferrous metals for items such as, anchors, bolts, braces, boxes, bodies, clamps, fittings, guards, nuts, pins, rods, shims, thimbles, washers, and miscellaneous items not made of corrosion-resistant steel.

3.2 INSTALLATION

3.2.1 Conduits, Raceways and Fittings

Ensure that conduit runs between outlet and outlet, between fitting and fitting, or between outlet and fitting does not contain more than the equivalent of three 90-degree bends, including those bends located immediately at the outlet or fitting.

Do not install crushed or deformed conduit. Avoid trapped conduit runs where possible. Take care to prevent the lodgment of foreign material in the conduit, boxes, fittings, and equipment during the course of construction. Clear any clogged conduit of obstructions or replace conduit.

Conduit and raceway runs concealed in or behind walls, above ceilings, or exposed on walls and ceilings 5 feet or more above finished floors and not subject to mechanical damage may be electrical metallic tubing (EMT).

3.2.1.1 Rigid Steel Conduit

Make field-made bends and offsets with approved Hickey bending tool or conduit bending machine. Use long radius conduit for elbows larger than 2-1/2 inches.

Provide a flush coupling for all conduit stubbed-up through concrete floors for connections to free-standing equipment with the exception of motor-control centers, cubicles, and other such items of equipment, when the floor slab is of sufficient thickness. Otherwise, provide a floor box set flush with the finished floor. For conduits installed for future use, terminate with a coupling and plug; set flush with the floor.

3.2.1.2 Flexible Metallic Conduit

Use flexible metallic conduit to connect recessed fixtures from outlet boxes in ceilings, transformers, and other approved assemblies.

Use bonding wires in flexible conduit as specified in NFPA 70, for all circuits. Flexible conduit is not considered a ground conductor.

Make electrical connections to vibration-isolated equipment with flexible metallic conduit.

Use liquidtight flexible metallic conduit in wet and oily locations and to complete the connection to motor-driven equipment.

3.2.1.3 Rigid Nonmetallic Conduit

Ensure rigid PVC conduit is direct buried.

Install a green insulated copper grounding conductor in conduit with conductors and solidly connect to ground at each end. Size grounding wires in accordance with NFPA 70.

3.2.1.4 Wireway and Auxiliary Gutter

Bolt together straight sections and fittings to provide a rigid, mechanical connection and electrical continuity. Close dead ends of wireways and auxiliary gutters. Plug all unused conduit openings.

Support wireways for overhead distribution and control circuits at maximum 10-foot intervals.

Ensure auxiliary gutters used to supplement wiring spaces for equipment not contained in a single enclosure contains no switches, overcurrent devices, appliances, or apparatus and is not more than 20 feet long.

3.2.1.5 Surface Raceways and Assemblies

Mount surface raceways plumb and level, with the base and cover secured. Minimum circuit run is three-wire, with one wire designated as ground.

3.2.1.6 Cable Trays

Support cable trays from ceiling hangers, equipment bays, or floor or wall supports. Cable trays may be mounted on equipment racks. Provide support when the free end extends beyond 3 feet. Maximum support spacing is 10 feet. Support trays 10-inches wide or less by one hanger. Support trays greater than 10 inches wide by two hangers. Bond cable trays at splices.

3.2.1.7 Splices and Connectors

Make all splices in AWG No. 8 and smaller with approved indentor crimp-type connectors and compression tools.

Make all splices in AWG No. 6 and larger with indentor crimp-type connectors and compression tools. Wrap joints with an insulating tape that has an insulation and temperature rating equivalent to that of the conductor.

3.2.2 Wiring

Color code feeder and branch circuit conductors as follows:

CONDUCTOR	COLOR AC
Phase A	Brown
Phase B	Orange
Phase C	Yellow
Neutral	Natural Gray
Equipment Grounds	Green

Use conductors up to and including AWG No. 2 that are manufactured with colored insulating materials. For conductors larger than AWG No. 2, have ends identified with color plastic tape in outlet, pull, or junction boxes.

Splice in accordance with the NFPA 70. Provide conductor identification within each enclosure where a tap, splice, or termination is made and at the equipment terminal of each conductor. Match terminal and conductor identification as indicated.

Where several feeders pass through a common pullbox, tag the feeders to clearly indicate the electrical characteristics, circuit number, and panel designation.

3.2.3 Safety Switches

Securely fasten switches to the supporting structure or wall, utilizing a minimum of four 1/4 inch bolts. Do not use sheet metal screws and small machine screws for mounting. Do not mount switches in an inaccessible location or where the passageway to the switch may become obstructed. Mounting height 4 feet above floor level, when possible.

3.2.4 Wiring Devices

3.2.4.1 Wall Switches and Receptacles

Install wall switches and receptacles so that when device plates are applied, the plates are aligned vertically to within 1/16 inch.

Bond ground terminal of each flush-mounted receptacle to the outlet box with an approved green bonding jumper when used with dry wall type construction.

3.2.4.2 Device Plates

Ensure device plates for switches are suitably engraved with a description of the loads when not within sight of the loads controlled.

Mark device plates and receptacle cover plates for receptacles other than 125-volt, single-phase, duplex, convenience outlets. Show the circuit number, voltage, frequency, phasing, and amperage available at the receptacle. Use self-adhesive labels having 1/4 inch embossed letters.

Similarly mark device plates for convenience outlets indicating the supply panel and circuit number.

3.2.5 Boxes and Fittings

Provide pullboxes where necessary in the conduit system to facilitate conductor installation. For conduit runs longer than 100 feet or with more than three right-angle bends, install a pullbox at a convenient intermediate location.

Securely mount boxes and enclosures to the building structure using supports that are independent of the conduit entering or leaving the boxes.

Select the mounting height of wall-mounted outlet and switch boxes, as measured between the bottom of the box and the finished floor, in accordance with ICC/ANSI A117.1 and as follows:

LOCATION	MOUNTING HEIGHT (inches)
Receptacles in offices	18
Receptacles in corridors	18
Receptacles in shops and laboratories	48
Receptacles in rest rooms	48

LOCATION	MOUNTING HEIGHT (inches)
Switches for light control	48

3.2.6 Lamps and Lighting Fixtures

Install new lamps of the proper type and wattage in each fixture. Securely fasten fixtures and supports to structural members and install parallel and perpendicular to major axes of structures.

3.2.7 Panelboards

Securely mount panelboards so that the top operating handle does not exceed 72-inches above the finished floor. Do not mount equipment within 36-inches of the front of the panel. Ensure directory card information is complete and legible.

3.2.8 Dry-Type Distribution Transformers

Connect dry-type transformers with flexible metallic conduit.

3.2.9 Field Fabricated Nameplates

Ensure nameplates conform to ASTM D709. Provide laminated plastic nameplates for each equipment enclosure, relay, switch, and device, as specified or as indicated on the drawings. Each nameplate inscription identifies the function and, when applicable, the position. Provide nameplates that are melamine plastic, 0.125-inch thick, black center core and a matte finish surface with square corners. Accurately align lettering and engrave into the core. Minimum size of nameplates is 1 by 2.5 inches. Lettering is a minimum of 0.25-inch high normal block style.

3.2.10 Identification Plates and Warnings

Provide identification plates for lighting and power panelboards, motor control centers, all line voltage heating and ventilating control panels, fire detector and sprinkler alarms, door bells, pilot lights, disconnect switches, manual starting switches, and magnetic starters. Attach identification plates to process control devices and pilot lights.

Install identification plates for all line voltage enclosed circuit breakers, identifying the equipment served, voltage, phase(s) and power source. For circuits 480 volts and above, install conspicuously located warning signs in accordance with OSHA requirements.

3.2.11 Posted Operating Instructions

Print or engrave operating instructions and frame under glass or in approved laminated plastic. Post instructions where directed. For operating instructions exposed to the weather, provide weather-resistant materials or weatherproof enclosures. Ensure operating instructions do not fade when exposed to sunlight. Secure instructions to prevent easy removal or peeling.

Ensure each system and principal item of equipment is as specified in the technical sections for use by operation and maintenance personnel. Include the following information with the operating instructions:

a. Wiring diagrams, control diagrams, and control sequence for each principal system and item of equipment.

b. Start up, proper adjustment, operating, lubrication, and shutdown procedures.

c. Safety precautions.

d. The procedure in the event of equipment failure.

e. Other items of instruction as recommended by the manufacturer.

3.3 FIELD QUALITY CONTROL

After completion of the installation and splicing, and prior to energizing the conductors, perform wire and cable continuity and insulation tests as herein specified before the conductors are energized.

Provide all necessary test equipment, labor, and personnel to perform the tests, as herein specified.

Isolate completely all wire and cable from all extraneous electrical connections at cable terminations and joints. Use substation and switchboard feeder breakers, disconnects in combination motor starters, circuit breakers in panel boards, and other disconnecting devices to isolate the circuits under test.

Perform insulation-resistance test on each field-installed conductor with respect to ground and adjacent conductors. Applied potential is 500 volts dc for 300 volt rated cable and 1000 volts dc for 600 volt rated cable. Take readings after 1 minute and until the reading is constant for 15 seconds. Minimum insulation-resistance values is not less than 25 Megohms for 300 volt rated cable and 100 Megohms for 600 volt rated cable. For circuits with conductor sizes AWG No. 8 and smaller insulation resistance testing is not required.

Perform continuity test to insure correct cable connection end-to-end (i.e correct phase conductor, grounded conductor, and grounding conductor wiring). Repair and verify any damages to existing or new electrical equipment resulting from mis-wiring. Receive approval for all repairs from the Contracting Officer prior to commencement of the repair.

Conduct phase-rotation tests on all three-phase circuits using a phase-rotation indicating instrument. Perform phase rotation of electrical connections to connected equipment in a clockwise direction, facing the source.

Submit test reports in accordance with referenced standards in this section.

Final acceptance requires the successful performance of wire and cable under test. Do not energize any conductor until the final test reports are reviewed and approved by the Contracting Officer.

-- End of Section --

SECTION TABLE OF CONTENTS

DIVISION 26 - ELECTRICAL

SECTION 26 05 13

MEDIUM-VOLTAGE CABLES

11/16

-- End of Section Table of Contents --

SECTION 26 05 13

MEDIUM-VOLTAGE CABLES
11/16

PART 1 GENERAL

Section 26 00 00 BASIC ELECTRICAL MATERIALS AND METHODS applies to work specified in this section.

1.1 REFERENCES

The publications listed below form a part of this specification to the extent referenced. The publications are referred to within the text by the basic designation only.

ASSOCIATION OF EDISON ILLUMINATING COMPANIES (AEIC)

AEIC C8	(2000) Extruded Dielectric Shielded Power Cables Rated 5 Through 46 kV
AEIC CS1	(2012) Impregnated-Paper-Insulated, Metallic Sheathed Cable, Solid Type

ASTM INTERNATIONAL (ASTM)

ASTM B3	(2013) Standard Specification for Soft or Annealed Copper Wire

INSTITUTE OF ELECTRICAL AND ELECTRONICS ENGINEERS (IEEE)

IEEE 400.2	(2013) Guide for Field Testing of Shielded Power Cable Systems Using Very Low Frequency (VLF)

NATIONAL ELECTRICAL MANUFACTURERS ASSOCIATION (NEMA)

ANSI/NEMA WC 71/ICEA S-96-659	(2014) Standard for Nonshielded Cables Rated 2001-5000 Volts for use in the Distribution of Electric Energy
NEMA WC 27500	(2015) Standard for Aerospace and Industrial Electrical Cable
NEMA WC 70	(2009) Power Cable Rated 2000 V or Less for the Distribution of Electrical Energy--S95-658
NEMA WC 74/ICEA S-93-639	(2012) 5-46 kV Shielded Power Cable for Use in the Transmission and Distribution of Electric Energy

NATIONAL FIRE PROTECTION ASSOCIATION (NFPA)

NFPA 70	(2017; ERTA 1-2 2017; TIA 17-1; TIA 17-2; TIA 17-3; TIA 17-4; TIA 17-5; TIA 17-6; TIA 17-7; TIA 17-8; TIA 17-9; TIA 17-10;

TIA 17-11; TIA 17-12; TIA 17-13; TIA 17-14; TIA 17-15; TIA 17-16; TIA 17-17)
National Electrical Code

1.2 DEFINITIONS

Medium-voltage power cables include all cables rated above 600 volts up to 35,000 volts.

1.3 SUBMITTALS

Government approval is required for submittals with a "G" designation; submittals not having a "G" designation are for Contractor Quality Control approval. When used, a designation following the "G" designation identifies the office that reviews the submittal for the Government. Submit the following in accordance with Section 01 33 00 SUBMITTAL PROCEDURES:

SD-03 Product Data

- Multiple-Conductor Shielded Cables; G
- Multiple-Conductor Nonshielded Cables; G
- Single-Conductor Shielded Cables; G
- Single-Conductor Nonshielded Cables; G
- Portable Cables; G
- Nonmetallic Jacket; G

SD-06 Test Reports

- Dielectric-Absorption Tests
- Medium-Voltage Tests
- Radiographic Tests; G

SD-07 Certificates

- Lead Sheath
- Minimum Bending Radius
- Medium-Voltage Tests
- Dielectric Absorption Tests
- Cable Splicers

SD-08 Manufacturer's Instructions

- Medium-Voltage Power Cables
- Pothead Terminations

1.4 QUALITY CONTROL

Provide a list of installed products to the Contracting Officer before performing the specified work. Show the qualifications of the cable splicers .

Ensure that cable splicers performing splicing have 5 years of experience in cable splicing and terminations. Ensure that once a termination or splice has been started by a worker, the same person completes that particular splice. Start and complete each termination and splice in one continuous work period.

1.5 DELIVERY, STORAGE, AND HANDLING

Ship cables on reels in a way that protects the cable from mechanical injury. Hermetically seal and attach each end of each length of cable to the reel.

Make the minimum reel drum diameter 14 times the overall diameter of the cable. Ensure that each cable length is installed with a pulling eye installed by the manufacturer, for installation in ducts, manholes, and utility tunnels.

PART 2 PRODUCTS

2.1 SYSTEM DESCRIPTION

2.1.1 Cable Voltage Ratings

Provide medium-voltage power cables including multiple- and single-conductor cables rated as follows, phase-to-phase, for grounded and ungrounded neutral systems:

5,000 volts, ungrounded neutral, on 2,400/4,160 -volt, three-phase, 60-hertz distribution systems.

2,400 volts, non-shielded, motor feeder conductors.

2.2 EQUIPMENT

Ensure that ethylene-propylene rubber and cross-linked polyethylene-insulated conductors are lead-free.

2.2.1 Multiple-Conductor Shielded Cables

2.2.1.1 Varnished Cambric and Lead

Provide multiple-conductor, varnished-cambric-insulated, lead-covered, shielded cable that conforms to NEMA WC 27500.

Provide cables that have a nonmetallic jacket over the lead sheath in accordance with paragraph NONMETALLIC JACKET.

2.2.1.2 Varnished Cambric with Interlocked Armor

Provide multiple-conductor, varnished-cambric-insulated, interlocked-armor-covered, shielded cable that conforms to NEMA WC 27500.

Apply close-fitting, interlocked-armor tape of galvanized steel over the jacket.

2.2.1.3 Synthetic Rubber with Interlocked Armor

Provide multiple-conductor, synthetic-rubber-insulated, interlocked-armor-covered, shielded cable that conforms to NEMA WC 70, ANSI/NEMA WC 71/ICEA S-96-659 and NEMA WC 74/ICEA S-93-639.

Apply close-fitting, interlocked-armor tape of galvanized steel over the jacket.

2.2.1.4 Butyl Rubber with Neoprene Jacket

Apply multiple-conductor, butyl-rubber-insulated, neoprene-jacketed, shielded cable that conforms to NEMA WC 70, ANSI/NEMA WC 71/ICEA S-96-659 and NEMA WC 74/ICEA S-93-639.

2.2.1.5 Cross-Linked Polyethylene with PVC Jacket

Provide multiple-conductor, cross-linked polyethylene-insulated, polyvinylchloride-jacketed, shielded cable that conforms to NEMA WC 70, ANSI/NEMA WC 71/ICEA S-96-659, NEMA WC 74/ICEA S-93-639 and AEIC C8. Provide taped shielding that consists of 5-mil thick copper shielding lap applied over 12-mil thick semiconducting tape. Wrap both helically with 10 -percent overlap, providing 100-percent coverage.

Shield cross-linked polyethylene (XLP) single- and multiple-conductor cables for grounded and ungrounded neutral voltage ratings of 2,000 volts or more.

2.2.1.6 Ethylene Propylene Rubber (EPR) with Jacketed Interlocked Armor

Provide multiple-conductor ethylene propylene rubber insulated interlocked armor covered shielded cables that conforms to NEMA WC 70, ANSI/NEMA WC 71/ICEA S-96-659, NEMA WC 74/ICEA S-93-639 and AEIC C8.

2.2.2 Multiple-Conductor, Nonshielded Cables

2.2.2.1 Synthetic Rubber with Neoprene Jacket

Provide multiple-conductor, synthetic-rubber-insulated, neoprene-jacketed, nonshielded cable that conforms to NEMA WC 70, ANSI/NEMA WC 71/ICEA S-96-659 and NEMA WC 74/ICEA S-93-639.

2.2.2.2 Butyl Rubber with Neoprene Jacket

Provide multiple-conductor, rubber-insulated, neoprene-jacketed, nonshielded cable that conforms to NEMA WC 70, ANSI/NEMA WC 71/ICEA S-96-659 and NEMA WC 74/ICEA S-93-639.

2.2.2.3 Cross-Linked Polyethylene with PVC Jacket

Provide multiple-conductor, polyethylene-insulated, polyvinylchloride-jacketed, nonshielded cable that conforms to NEMA WC 70, ANSI/NEMA WC 71/ICEA S-96-659, NEMA WC 74/ICEA S-93-639 and AEIC C8.

2.2.2.4 Ethylene-Propylene with PVC Jacket

Provide multiple-conductor, ethylene-propylene-insulated, PVC-jacketed, nonshielded cable that conforms to NEMA WC 70, ANSI/NEMA WC 71/ICEA S-96-659, NEMA WC 74/ICEA S-93-639 and AEIC C8.

2.2.3 Single-Conductor Shielded Cables

2.2.3.1 Butyl Rubber with Neoprene Jacket

Provide single-conductor, butyl-rubber-insulated, neoprene-jacketed, shielded cable that conforms to NEMA WC 70, ANSI/NEMA WC 71/ICEA S-96-659 and NEMA WC 74/ICEA S-93-639.

2.2.3.2 Cross-Linked Polyethylene with PVC Jacket

Provide single-conductor, polyethylene-insulated, PVC-jacketed, shielded cable that conforms to NEMA WC 70, ANSI/NEMA WC 71/ICEA S-96-659, NEMA WC 74/ICEA S-93-639 and AEIC C8.

2.2.3.3 Cross-Linked Polyethylene with Interlocked Armor

Provide single-conductor, polyethylene-insulated, PVC-jacketed, shielded cable with interlocked armor that conforms to NEMA WC 70, ANSI/NEMA WC 71/ICEA S-96-659, NEMA WC 74/ICEA S-93-639 and AEIC C8.

Apply a close-fitting, interlocked-armor tape of galvanized steel over the jacket.

2.2.3.4 Ethylene-Propylene-Rubber-Insulated with PVC Jacket

Provide single-conductor 15 kV rated cable assemblies that consist of the following: Class B stranded copper conductors, an extruded semiconducting shield over the conductors, 220 mils of ethylene propylene rubber insulation, an extruded or other approved semiconducting shield, a 5-mil minimum copper tape shield wrapped helically with a minimum 12.5 percent overlap and a PVC jacket.

Provide single-conductor, ethylene-propylene-insulated, PVC-jacketed, shielded cable that conforms to NEMA WC 70, ANSI/NEMA WC 71/ICEA S-96-659, NEMA WC 74/ICEA S-93-639 and AEIC C8.

2.2.4 Single-Conductor Nonshielded Cables

2.2.4.1 Butyl Rubber with Neoprene Jacket

Provide single-conductor, butyl-rubber-insulated, neoprene-jacketed, nonshielded cable that conforms to NEMA WC 70, ANSI/NEMA WC 71/ICEA S-96-659 and NEMA WC 74/ICEA S-93-639.

2.2.4.2 Cross-Linked Polyethylene

Provide single-conductor, cross-linked polyethylene-insulated, nonshielded cable that conforms to NEMA WC 70, ANSI/NEMA WC 71/ICEA S-96-659, NEMA WC 74/ICEA S-93-639 and AEIC C8.

2.2.4.3 Ethylene-Propylene-Rubber-Insulated with PVC Jacket

Provide single-conductor, ethylene-propylene-rubber-insulated, PVC-jacketed, nonshielded cable that conforms to NEMA WC 70, ANSI/NEMA WC 71/ICEA S-96-659, NEMA WC 74/ICEA S-93-639 and AEIC C8.

2.2.5 Portable Cables

Provide SHD multiple-conductor, butyl-rubber-insulated, neoprene-jacketed, shielded portable cable conforming to NEMA WC 70, ANSI/NEMA WC 71/ICEA S-96-659 and NEMA WC 74/ICEA S-93-639.

2.2.6 Cable Supports and Fittings

Not used.

2.3 COMPONENTS

2.3.1 Cable Identification

Provide cables that have a tape placed immediately under the lead sheath or outer jacket showing the name of the manufacturer, the year in which the cable was manufactured, and a unique number for identification purposes. Closely group information on the tape at 1-foot intervals to permit complete identification.

2.4 MATERIALS

2.4.1 Conductors

Ensure that conductors conform to the applicable requirements of NEMA WC 70, ANSI/NEMA WC 71/ICEA S-96-659, or NEMA WC 74/ICEA S-93-639. Ensure that conductors are solid copper conforming to ASTM B3 and that they are bare, or tin- or lead-alloy-coated, according to the type of insulation used.

2.5 TESTS, INSPECTIONS, AND VERIFICATIONS

Provide certificates showing that the cable manufacturer has made the following factory-conducted tests on each shipping length of cable. Before cable is delivered, provide certified copies of test data that shows conformance with the referenced standards and is approved.

PART 3 EXECUTION

3.1 INSTALLATION

Install medium-voltage cables in accordance with NFPA 70.

Install cable in underground duct banks, in conduit above and below grade, inside buildings, by open wire method, on insulator hooks; on racks, in wall and ceiling-mounted cable trays in utility tunnels and manholes, and by direct burial.

Secure cables with heavy-duty cable ties in existing or new trays mounted horizontally, where the cable rests on the tray bottom. Install cable ties at a minimum of 10 foot intervals.

Secure cables with metallic cable clamps, straps, hangers, or other approved supporting devices to tunnel walls, ceilings, and in new or existing cable trays mounted vertically, where the tray bottom is in a vertical plane.

When field cuts or other damage occurs to the PVC coating, apply a liquid PVC patch to maintain the integrity of the coating. After the installation is complete, perform an inspection to ensure that the coating has no voids, pinholes, or cuts.

Before installing new armored cable, ensure that cable trays are properly secured and supported. Add new permanent or temporary tray support devices as required to preclude cable tray failure during cable pulling or after cable is installed.

Cable or conductors of a primary distribution system will be rejected by the Contracting Officer when installed openly in cable trays or openly racked along interior walls; in the same raceway or conduit with ac or dc control circuits or ac power circuits operating at less than 600 volts; or in a manner allowing cable to support its own weight.

3.1.1 Moisture-Testing Before Pulling

Moisture-test cable that has paper insulation before pulling the cable into underground ducts. Ensure that radii of bends, potheads, fittings, cable risers, and other conditions are suitable for the cable and conform to the recommendations of the cable manufacturer.

3.1.2 Protection During Splicing Operations

Provide a blower to force fresh air into manholes or confined areas where free movement or circulation of air is obstructed. Have waterproof protective coverings available on the work site to protect against moisture while a splice is being made. Use pumps to keep manholes dry during splicing operations. Never make a splice or termination with the interior of a cable exposed to moisture. Moisture-test the conductor insulation paper before the splice is made. Use a manhole ring at least 6 inches above ground around the manhole entrance to keep surface water from entering the manhole. Before starting the splice, plug unused ducts and stop water seepage through ducts in use.

3.1.3 Duct Cleaning

Thoroughly clean ducts before installation of power cables. Pull a standard flexible mandrel through each duct to loosen particles of earth, sand, or foreign material in the line. Use a mandrel that is not less than 12 inches long with a diameter 1/2 inch less than the inside diameter of the duct. Then pull a brush with stiff bristles through each duct to remove the loosened particles. Use a brush with a diameter that is the same as or slightly larger than the diameter of the duct.

3.1.4 Pulling Cables in Ducts, Manholes and Utility Tunnels

Pull medium-voltage cables into ducts and utility tunnels with equipment designed for this purpose, including a power-driven winch, cable-feeding flexible tube guide, cable grips, and lubricants. Employ a sufficient number of trained personnel and equipment to ensure correct installation of the cable.

Set up the cable reel at the side of the manhole or tunnel hatch opening and above the duct or hatch level, allowing the cable to enter through the opening without reverse bending. Install a flexible tube guide through the opening in a manner that prevents the cable from rubbing against the edges of structural members.

Ensure that the pulling force for a cable grip on lead-sheathed cable does not exceed 1,500 pounds per square inch of sheath cross-sectional area.

Use a dynamometer in the pulling line to ensure that the pulling force is not exceeded. Ensure that the pulling force for a nonmetallic-sheathed cable does not exceed the smaller of 1,000 pounds or a value computed from the following equation:

TM = 0.008 X N X CM

Where: TM = maximum allowable pulling tension in pounds

N = number of conductors in the cable

CM = cross-sectional area of each conductor in circular mils

Unreel cable from the top of the reel. Carefully control payout. Attach cable to be pulled through a swivel to the main pulling wire by means of a pulling eye.

When pulling small cables and short straight lengths of heavier cables,use woven-wire cable grips to grip the cable end.

Attach pulling eyes to the cable conductors to prevent damage to the cable structure.

To prevent damage to the cable structure, use pulling eyes and cable grips together for nonmetallic sheathed cables.

Provide a minimum bending radius in accordance with the following:

CABLE TYPE	**MINIMUM BENDING RADIUS MULTIPLIER TIMES CABLE DIAMETER**
RUBBER- AND PLASTIC-INSULATED CABLE WITH OR WITHOUT INTERLOCKED ARMOR	
Nonshielded cables	8
Shielded cables with shielding wire	12
Shielded cables with shielding tape	8

Liberally coat cables with a suitable cable-pulling lubricant as the cable enters the tube guide or duct. Use grease and oil lubricants only on lead-sheathed cables. Cover nonmetallic sheathed cables with wire-pulling compounds that have no deleterious effects on the cable. Provide rollers, sheaves, or tube guides around which the cable is pulled that conform to the minimum bending radius of the cable.

Pull cables into ducts at a speed not to exceed 50 feet per minute and not in excess of maximum permissible pulling tension specified by the cable manufacturer. Ensure that cable pulling is done without using a vehicle. Stop pulling operations immediately if binding or obstruction is indicated and do not resume pulling operations until such difficulty is corrected. Provide sufficient slack for the cable to move freely when the cable expands or contracts.

Use cable racks to support cables when making cable splices in manholes or utility tunnels. Do not pull cable splices in ducts. Overlap cable ends at the ends of a section to provide sufficient undamaged cable for splicing. Make cables to be spliced in manholes or utility tunnels overlap the centerline of the proposed joint by not less than 2 feet.

Immediately seal cables cut in the field to keep out moisture. Seal nonleaded cables with rubber tape wrapped down to 3 inches from the cable end. Cover-wrap rubber tape with PVC tape. Seal lead-covered cables with wiping metal making a firm bond with the end of the sheath or with a disk of lead fitted over the end and wiped to the sheath.

3.1.5 Splices and Terminations

Make splices in manholes or tunnels except where cable terminations are specifically indicated. Expedite splicing and terminating of cables in order to minimize exposure and cable deterioration.

Terminate cables in potheads. Use dry terminations with medium-voltage pennants, preformed, and hand-wrapped stress cones for terminating cables. Install potheads with a means for making external connections to the cable conductors of single-conductor cables; protecting the cable insulation against moisture, oil, or other contaminant; physically protecting and supporting cables; and maintaining the insulation of the cable.

Field-fabricate pothead terminations from termination kits supplied by and in accordance with the pothead manufacturer's recommendations for the type, size, and electrical characteristics of the cable.

Ensure that installation includes built-up or prefabricated heat or cold shrink stress-relief cones at the terminals of all shielded cables and at the terminals of single-conductor lead-covered cables rated 15 kV and above, ungrounded.

Field-fabricate cable splices from splicing kits supplied by and in accordance with the cable manufacturer's recommendations for the type, size, and electrical characteristics of the cable specified. Locate cable splices in manholes midway between the cable racks on the walls of the manholes and supported with cable arms at approximately the same elevation as the enclosing duct.

If cable splices in the tunnel are not installed in cable trays, install the cable splices on cable racks or by other approved methods that minimize physical stress on the splice connections. Support splices at approximately the same elevation as the installed cable except where space limitations or existing cable length limitations make this method impractical or impossible.

Support all universal demountable splices in a manner that minimizes physical stress on the splice connections. Support each cable end termination using a pair of saddle supports under the cable end termination or cable with a minimum 12 inches and a maximum 30 inches separation between the supports. Secure the cable end termination and cable to the supports in a manner that prevents movement of termination or cable at the support. Install saddle supports on a galvanized steel framing channel that is anchored to the wall, securely fastened to the cable tray, or installed by other approved methods.

3.1.6 Multiple-Conductor Potheads

Install multiple-conductor capnut potheads that are hermetically sealed, and suitable for the type, size, and electrical characteristics of the cable. Install potheads consisting of bells or bodies with bell caps, bushing, cable connectors, lugs, and entrance fittings.

Provide pothead bells or bodies that are cast iron with mounting brackets as required, pipe plugs for fillings and vent holes, machined-flanged surfaces for bell caps, and cable entrance fittings. Provide pothead bell caps for cables up to 250 kc mils that are cast iron; and for cables of larger size and higher current ratings that are cast aluminum. Provide bell caps that have matching machined-flanged surfaces for sealing with gasket and cap-screw connections.

Install bushings that are glazed wet-process electrical porcelain insulators, factory-assembled, and hermetically sealed to the bell cap.

Provide cable connectors that are high-conductivity copper, accurately machined, and threaded for internal and external electrical connections. Ensure that cross-sectional and contact areas are adequate to carry the full-load current rating of the conductors. Provide solder cable connectors with a gasket seal between the connector and bushing.

Provide cast-bronze wiping-sleeve cable-entrance fittings for lead-covered cable, and cast-aluminum positive-sealed stuffing boxes for nonlead-covered cables. Provide cast-iron conduit couplings and armor base fittings.

Three-conductor potheads with a neutral stud and lug are allowed in lieu of four-conductor potheads in four-wire grounded neutral systems.

Use completely filled potheads, leaving no gaps or voids, with an insulating compound suitable for the type of cable, insulation, voltage rating, and ambient operating temperatures in accordance with the pothead manufacturer's recommendations. Ground pothead parts that do not carry current.

3.1.7 Single-Conductor Potheads

Use single-conductor potheads with a hermetically sealed capnut. Ensure that potheads are suitable for the type, size, and electrical characteristics of the cable specified. Provide potheads that consist of cast bodies, bushings, cable connectors, lugs, and entrance fittings.

Provide pothead bodies that are metal castings with mounting brackets, when required, pipe plugs for filling and vent holes, and a machined-flanged surface for cable-entrance fittings. Use cast-iron bodies for cables up to 250 kc mils, and cast aluminum for cables of larger size and higher current ratings.

Ensure that bushings are glazed wet-process electrical porcelain insulators, factory-assembled, and hermetically sealed to the pothead body.

Install high-conductivity copper cable connectors accurately machined and threaded for internal and external electrical connections. Ensure adequate cross-sectional and contact areas to carry the full-load current rating of the conductors. Provide solder type cable connectors with gasket seal between the connector and bushing.

Completely fill potheads, leaving no gaps or voids, with an insulating compound suitable for the type of cable, insulation, voltage rating, and ambient operating temperatures in accordance with the pothead manufacturer's recommendations. Ground pothead parts that do not carry current.

3.2 FIELD QUALITY CONTROL

Subject each installation to dielectric-absorption tests and medium-voltage tests after the installation of medium-voltage power cables has been completed, including splices, joints, and terminations, and before the cable is energized.

Provide test equipment, labor, and technical personnel to perform the electrical acceptance tests.

Make arrangements to have tests witnessed and approved by the Contracting Officer.

Completely isolate each power-cable installation from extraneous electrical connections at cable terminations and joints. Observe safety precautions.

First give each power cable a full dielectric absorption test with a 5000-volt insulation-resistance test set. Apply the test for enough time to fully charge the cable. Record readings every 15 seconds during the first 3 minutes of the test and at 1-minute intervals thereafter. Continue the test until three equal readings, 1 minute apart, are obtained. Ensure that the minimum reading is 200 megohms at an ambient temperature of 68 degrees F. Correct the readings that were not taken at 68 degrees F ambient temperature.

Upon successful completion of the dielectric absorption tests, subject the cable to a direct-current high-potential test for 5 minutes applying test voltages in accordance with AEIC CS1 and IEEE 400.2 for paper-impregnated, lead-covered cable; AEIC C8 and IEEE 400.2 for cross-linked, polyethylene-insulated cable; and AEIC C8 and IEEE 400.2 for ethylene propylene rubber-insulated cable.

Record leakage current readings every 30 seconds during the first 2 minutes and every minute thereafter for the remainder of the test. When the leakage current continues to increase after the first minute, immediately terminate the test and take steps to find and correct the fault. When a second test becomes necessary, repeat this test procedure.

Upon satisfactory completion of the high-potential test, give the cable a second dielectric-absorption test as before.

Provide results of the second dielectric-absorption test that agree with the first test and that indicate no evidence that the cable has been permanently injured by the high-potential test.

Record test data identifying the cable and location, megohm readings versus time, leakage current readings versus time, and cable temperature versus time.

Final acceptance depends upon the satisfactory performance of the cable under test. Do not energize cable until recorded test data has been approved by the Contracting Officer. Provide final test reports of the dielectric absorption tests and medium-voltage tests to the Contracting Officer. Provide reports with a cover letter/sheet clearly marked with the system name, date, and the words "Final Test Report - Forward to the Systems Engineer/Condition Monitoring Office/Predictive Testing Group for inclusion in the Maintenance Database."

Perform radiographic tests on all potheads at the discretion of the

Contracting Officer to determine if voids exist in the pothead. Rework unacceptable terminations at no additional expense to the Government.

3.3 CLOSEOUT ACTIVITIES

Provide manufacturer's instructions showing the recommended sequence and method of installation for medium-voltage power cables and pothead terminations.

-- End of Section --

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INSULATED WIRE AND CABLE
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PART 1 GENERAL

1.1 REFERENCES

The publications listed below form a part of this specification to the extent referenced. The publications are referred to within the text by the basic designation only.

INSTITUTE OF ELECTRICAL AND ELECTRONICS ENGINEERS (IEEE)

IEEE 1202	(2006; R 2012; CORR 1 2012) Flame-Propagation Testing of Wire and Cable

INSULATED CABLE ENGINEERS ASSOCIATION (ICEA)

ICEA S-58-679	(2014) Control, Instrumentation and Thermocouple Extension Conductor Identification
ICEA T-30-520	(1986) Conducting Vertical Cable Tray Flame Tests with Theoretical Heat Input Rate of 70,000 B.T.U./Hour

NATIONAL ELECTRICAL MANUFACTURERS ASSOCIATION (NEMA)

ANSI/NEMA WC 71/ICEA S-96-659	(2014) Standard for Nonshielded Cables Rated 2001-5000 Volts for use in the Distribution of Electric Energy
NEMA WC 26	(2008) Binational Wire and Cable Packaging Standard
NEMA WC 57	(2014) Standard for Control, Thermocouple Extension, and Instrumentation Cables
NEMA WC 70	(2009) Power Cable Rated 2000 V or Less for the Distribution of Electrical Energy--S95-658
NEMA WC 74/ICEA S-93-639	(2012) 5-46 kV Shielded Power Cable for Use in the Transmission and Distribution of Electric Energy

NATIONAL FIRE PROTECTION ASSOCIATION (NFPA)

NFPA 70	(2017; ERTA 1-2 2017; TIA 17-1; TIA 17-2; TIA 17-3; TIA 17-4; TIA 17-5; TIA 17-6; TIA 17-7; TIA 17-8; TIA 17-9; TIA 17-10; TIA 17-11; TIA 17-12; TIA 17-13; TIA 17-14; TIA 17-15; TIA 17-16; TIA 17-17) National Electrical Code

UNDERWRITERS LABORATORIES (UL)

UL 1685	(2015) UL Standard for Safety Vertical-Tray Fire-Propagation and Smoke-Release Test for Electrical and Optical-Fiber Cables
UL 2556	(2015) UL Standard for Safety Wire and Cable Test Methods
UL 44	(2018) Thermoset-Insulated Wires and Cables

1.2 SUBMITTALS

Government approval is required for submittals with a "G" designation; submittals not having a "G" designation are for Contractor Quality Control approval. When used, a designation following the "G" designation identifies the office that will review the submittal for the Government. Submit the following in accordance with Section 01 33 00 SUBMITTAL PROCEDURES:

SD-03 Product Data

Wire and Cable; G

Conductors; G

Cable Manufacturing Data

SD-06 Test Reports

Test Report(s), Inspection Report(s), and Verification Report(s); G

1.3 DELIVERY, STORAGE, AND HANDLING

Furnish cables on reels or coils. Each cable and the outside of each reel or coil, must be plainly marked or tagged to indicate the cable length, voltage rating, conductor size, and manufacturer's lot number and reel number. Each coil or reel of cable must contain only one continuous cable without splices. Cables for exclusively dc applications, as specified in paragraph "High-Voltage Test Source," must be identified as such. Shielded cables rated 2,001 volts and above must be reeled and marked in accordance with NEMA WC 26, as applicable. Reels must remain the property of the Contractor.

1.4 PROJECT/SITE CONDITIONS

Non-corrosive, unclassified.

PART 2 PRODUCTS

2.1 MATERIALS

2.1.1 Wire Table

Furnish wire and cable in accordance with the requirements of the wire table below.

2.1.2 Rated Circuit Voltages

All power wire and cable must have minimum rated circuit voltages in accordance with NEMA WC 70, ANSI/NEMA WC 71/ICEA S-96-659, or NEMA WC 74/ICEA S-93-639 as applicable. Power wire and cable for circuit voltages rated 0-600 volts must be rated not less than 600 volts. Control wire and cable must have minimum rated circuit voltages in accordance with NEMA WC 57, but must be rated 600 volts if routed in raceway with other conductors that are rated 600 volts.

2.1.3 Conductors

2.1.3.1 Material for Conductors

Conductors must conform to all the applicable requirements of NEMA WC 57, NEMA WC 70, ANSI/NEMA WC 71/ICEA S-96-659, or NEMA WC 74/ICEA S-93-639 as applicable. Copper conductors must be annealed copper material and they may be bare, or tin- or lead-alloy-coated, if required by the type of insulation used.

2.1.3.2 Size

Minimum wire size must be No. 12 AWG for power and lighting circuits; No. 10 AWG for current transformer secondary circuits; No. 14 AWG for potential transformer, relaying, and control circuits; No. 16 AWG for annunciator circuits; and No. 19 AWG for alarm circuits. Minimum wire sizes for rated circuit voltages of 2,001 volts and above must not be less than those listed for the applicable voltage in ANSI/NEMA WC 71/ICEA S-96-659 or NEMA WC 74/ICEA S-93-639, as applicable.

2.1.3.3 Stranding

Conductor stranding classes cited herein must be as defined for control conductors in NEMA WC 57 or as defined for 0-2,000 volts power conductors in NEMA WC 70, as applicable. Lighting conductors No. 10 AWG and smaller must be solid or have Class B stranding. Any conductors used between stationary and moving devices, such as hinged doors or panels, must have Class H or K stranding. All other conductors must have Class B or C stranding, except that conductors as shown, or in the schedule, as No. 12 AWG may be 19 strands of No. 25 AWG, and conductors shown as No. 10 AWG may be 19 strands of No. 22 AWG. Conductor stranding classes for circuit voltages 2,001 volts and above must be as defined in ANSI/NEMA WC 71/ICEA S-96-659 and NEMA WC 74/ICEA S-93-639, as applicable.

2.1.3.4 Conductor Shielding

Use conductor shielding conforming to NEMA WC 57 for control wire and cable as applicable. Use conductor shielding conforming to ANSI/NEMA WC 71/ICEA S-96-659 or NEMA WC 74/ICEA S-93-639, as applicable, on power cables having a rated circuit voltage above 2,000 volts.

2.1.3.5 Separator Tape

Where conductor shielding, strand filling, or other special conductor treatment is not required, a separator tape between conductor and insulation is permitted.

2.1.4 Insulation

2.1.4.1 Insulation Material

Unless specified otherwise or required by NFPA 70, wires in conduit, other than service entrance, must be 600-volt, Type XHHW conforming to UL 44. Insulation for control wire and cable must meet the requirements of NEMA WC 57. Insulation requirements for wire and cable rated less than 2,000 volts must meet the requirements of NEMA WC 70. Insulation requirements for wire and cable rated 2,001-5,000 volts must meet the requirements of ANSI/NEMA WC 71/ICEA S-96-659. Insulation requirements for wire and cable rated 5,001 volts and greater must meet the requirements of NEMA WC 74/ICEA S-93-639.

For shielded cables of rated circuit voltages above 2,000 volts, the following provisions must also apply:

a. XLPE, if used, must be tree-retardant.

b. Insulation must be chemically bonded to conductor shielding.

c. The insulation material and its manufacturing, handling, extrusion and vulcanizing processes must all be subject to strict procedures to prevent the inclusion of voids, contamination, or other irregularities on or in the insulation. Insulation material must be inspected for voids and contaminants.

d. Cables with repaired insulation defects discovered during factory testing, or with splices or insulation joints, are prohibited.

2.1.4.2 Insulation Thickness

The insulation thickness for each conductor must be based on its rated circuit voltage.

2.1.4.2.1 Power Cables, 2,000 Volts and Below

The insulation thickness for single-conductor and multiple-conductor power cables rated 2,000 volts and below must be as required by NEMA WC 70, as applicable. Some thicknesses of NEMA WC 70 will be permitted only for single-conductor cross-linked thermosetting polyethylene insulated cables without a jacket. NEMA WC 70 ethylene-propylene rubber-insulated conductors must have a jacket.

2.1.4.2.2 Power Cables, Rated 2,001 Volts and Above

Thickness of insulation for power cables rated 2,001 volts and above must be in accordance with the following

a. Non-shielded cables, 2,001 to 5,000 volts, must comply with ANSI/NEMA WC 71/ICEA S-96-659, as applicable.

b. Shielded cables rated 5,000 volts to 46,000 volts must comply with NEMA WC 74/ICEA S-93-639, as applicable.

2.1.4.2.3 Single-Conductor and Multiple-Conductor Control Cables

The insulation thickness of control conductor sizes 22 AWG to 10 AWG used for control and related purposes must be as required by NEMA WC 57, as applicable. Control conductors larger than 10 AWG must be as required by NEMA WC 70.

2.1.4.3 Insulation Shielding

Unless otherwise specified, provide insulation shielding for conductors having rated circuit voltages of 2,001 volts and above. The voltage limits above which insulation shielding is required, and the material requirements, are given in ANSI/NEMA WC 71/ICEA S-96-659 or NEMA WC 74/ICEA S-93-639, as applicable. The material, if thermosetting, must meet the wafer boil test requirements as described in ANSI/NEMA WC 71/ICEA S-96-659 or NEMA WC 74/ICEA S-93-639, as applicable. The method of shielding must be in accordance with the current practice of the industry; however, the application process must include strict precautions to prevent voids or contamination between the insulation and the nonmetallic component. Voids, protrusions, and indentations of the shield must not exceed the maximum allowances specified in ANSI/NEMA WC 71/ICEA S-96-659 or NEMA WC 74/ICEA S-93-639, as applicable. The cable must be capable of operating without damage or excessive temperature when the shield is grounded at both ends of each conductor. All components of the shielding system must remain tightly applied to the components they enclose after handling and installation in accordance with the manufacturer's recommendations. Shielding systems which require heat to remove are prohibited unless specifically approved.

2.1.5 Jackets

All cables must have jackets meeting the requirements of NEMA WC 57, NEMA WC 70, ANSI/NEMA WC 71/ICEA S-96-659, and NEMA WC 74/ICEA S-93-639, as applicable, and as specified herein. Individual conductors of multiple-conductor cables must be required to have jackets only if they are necessary for the conductor to meet other specifications herein. Jackets of single-conductor cables and of individual conductors of multiple-conductor cables, except for shielded cables, must be in direct contact and adhere or be vulcanized to the conductor insulation. Multiple-conductor cables and shielded single-conductor cables must be provided with a common overall jacket, which must be tightly and concentrically formed around the core. Repaired jacket defects found and corrected during manufacturing are permitted if the cable, including jacket, afterward fully meets these specifications and the requirements of the applicable standards.

2.1.5.1 Jacket Material

The jacket must be one of the materials listed below. Variations from the materials required below will be permitted only if approved for each specific use, upon submittal of sufficient data to prove that they exceed all specified requirements for the particular application.

2.1.5.1.1 General Use

Heavy-duty black neoprene	NEMA WC 70, ANSI/NEMA WC 71/ICEA S-96-659, or NEMA WC 74/ICEA S-93-639
Heavy-duty chlorosulfonated polyethylene	NEMA WC 57, NEMA WC 70, ANSI/NEMA WC 71/ICEA S-96-659, or NEMA WC 74/ICEA S-93-639
Heavy-duty cross-linked (thermoset) chlorinated polyethylene	NEMA WC 70, ANSI/NEMA WC 71/ICEA S-96-659, or NEMA WC 74/ICEA S-93-639

2.1.5.1.2 Accessible Use Only, 2,000 Volts or Less

Cables installed where they are entirely accessible, such as cable trays and raceways with removable covers, or where they pass through less than 10 feet of exposed conduit only, must have jackets of one of the materials in item "a. General Use" or one of the following:

2.1.5.2 Jacket Thickness

The minimum thickness of the jackets must be not less than 80 percent of the respective nominal thicknesses specified below.

2.1.5.2.1 Multiple-Conductor Cables

Thickness of the jackets of the individual conductors of multiple-conductor cables must be as required by NEMA WC 57, NEMA WC 70, ANSI/NEMA WC 71/ICEA S-96-659, or NEMA WC 74/ICEA S-93-639 as applicable and must be in addition to the conductor insulation thickness required by the applicable respective NEMA publication for the insulation used. Thickness of the outer jackets and associated coverings of the assembled multiple-conductor cables must be as required by NEMA WC 57, NEMA WC 70, ANSI/NEMA WC 71/ICEA S-96-659, or NEMA WC 74/ICEA S-93-639 as applicable.

2.1.5.2.2 Single-Conductor Cables

Single-conductor cables must have a jacket thickness as specified in NEMA WC 57, NEMA WC 70, ANSI/NEMA WC 71/ICEA S-96-659, or NEMA WC 74/ICEA S-93-639 as applicable.

2.1.6 Metal-Clad Cable

2.1.6.1 General

The metallic covering or sheath must be interlocked metal tape, conforming to the applicable requirements of NEMA WC 57, NEMA WC 70, ANSI/NEMA WC 71/ICEA S-96-659, or NEMA WC 74/ICEA S-93-639. The type of metal for the metallic covering must be galvanized steel. If the covering is of ferrous metal, it must be galvanized. Grounding conductor(s) conforming to NEMA WC 57, NEMA WC 70, ANSI/NEMA WC 71/ICEA S-96-659, or NEMA WC 74/ICEA S-93-639 as applicable must be furnished for each multiple-conductor metal-clad cable. Assembly and cabling must be as specified in paragraph "Cabling." The metallic covering must be applied over an inner jacket or filler tape. The cable must be assembled so that the metallic covering will be tightly bound over a firm core.

2.1.6.2 Jackets

Metal-clad cables may have a jacket under the armor, and must have a jacket over the armor. Jackets must comply with the requirements of NEMA WC 57, NEMA WC 70, ANSI/NEMA WC 71/ICEA S-96-659, or NEMA WC 74/ICEA S-93-639 as applicable. The outer jacket for the metal-clad cable may be of polyvinyl chloride (PVC) only if specifically approved.

2.1.7 Multiple-Conductor Cables

Grounding conductor(s) conforming to NEMA WC 57, NEMA WC 70, ANSI/NEMA WC 71/ICEA S-96-659, or NEMA WC 74/ICEA S-93-639 as applicable must be furnished for each multiple-conductor cable. Assembly and cabling must be as specified in paragraph CABLING.

2.2 CABLE IDENTIFICATION

2.2.1 Color-Coding

Insulation of individual conductors of multiple-conductor cables must be color-coded in accordance with ICEA S-58-679, except that colored braids will not be permitted. Only one color-code method must be used for each cable construction type. Control cable color-coding must be in accordance with ICEA S-58-679. Power cable color-coding must be black for Phase A, red for Phase B, blue for Phase C, white for grounded neutral, and green for an insulated grounding conductor, if included. Other individual conductors must be color-coded as indicated, but such color-coding may be accomplished by applying colored plastic tapes or colored sleeves at terminations.

2.2.2 Shielded Cables Rated 2,001 Volts and Above

Marking must be in accordance with ANSI/NEMA WC 71/ICEA S-96-659 or NEMA WC 74/ICEA S-93-639, as applicable.

2.2.3 Cabling

Individual conductors of multiple-conductor cables must be assembled with flame-and moisture-resistant fillers, binders, and a lay conforming to NEMA WC 57, NEMA WC 70, ANSI/NEMA WC 71/ICEA S-96-659, or NEMA WC 74/ICEA S-93-639. Flat twin cables are prohibited. Fillers must be used in the interstices of multiple-conductor round cables with a common covering where necessary to give the completed cable a substantially circular cross section. Fillers must be non-hygroscopic material, compatible with the cable insulation, jacket, and other components of the cable. The rubber-filled or other approved type of binding tape must consist of a material that is compatible with the other components of the cable and must be lapped at least 10 percent of its width.

2.2.4 Dimensional Tolerance

The outside diameters of single-conductor cables and of multiple-conductor cables must not vary more than 5 percent and 10 percent, respectively, from the manufacturer's published catalog data.

PART 3 EXECUTION

3.1 INSTALLATION INSTRUCTIONS

Submit cable manufacturing data. The following information must be provided by the cable manufacturer for each size, conductor quantity, and type of cable furnished:

a. Minimum bending radius, in inches - For multiple-conductor cables, this information must be provided for both the individual conductors and the multiple-conductor cable.

b. Pulling tension and sidewall pressure limits, in pounds.

c. Instructions for stripping semiconducting insulation shields, if furnished, with minimum effort without damaging the insulation.

d. Upon request, compatibility of cable materials and construction with specific materials and hardware manufactured by others must be stated. Also, if requested, recommendations must be provided for various cable operations, including installing, splicing, terminating, etc.

3.2 TEST REPORT(S), INSPECTION REPORT(S), AND VERIFICATION REPORT(S)

3.2.1 Cable Data

Do not begin any wire and cable fabrication until materials are submitted and approved by the Contracting Officer. Submit cable data for approval including, but not limited to, dimensioned sketches showing cable construction and sufficient additional data to show that wire and cable meet the requirements of this Section.

3.2.2 Inspection and Tests

Inspection and tests of wire and cable furnished under these specifications must be made by and at the plant of the manufacturer, and the manufacturer must provide certification and certification reports of completed inspections and completed tests. The Government may require or perform further tests before or after installation. Testing in general must comply with NEMA WC 57, NEMA WC 70, ANSI/NEMA WC 71/ICEA S-96-659, or NEMA WC 74/ICEA S-93-639 as applicable. Specific tests required for particular materials, components, and completed cables must be as specified in the sections of the above standards applicable to those materials, components, and cable types. Tests must also be performed in accordance with the additional requirements specified below. Submit two certified copies of test reports.

3.2.2.1 High-Voltage Test Source

Where the applicable standards allow a choice, high-voltage tests for cables to be used exclusively on dc circuits must be made with dc test voltages. Cables to be used exclusively on ac circuits must be tested with ac test voltages. If both ac and dc will be present, on either the same or separate conductors of the cable, ac test voltages must be used.

3.2.2.2 Shielded Cables Rated 2,001 Volts or Greater

The following test(s) must be performed in addition to those specified above:

a. If high-voltage testing is done with an AC test voltage as specified in paragraph "High-Voltage Test Source," an additional test must be made using a DC test voltage rated at 75 percent of the specified full DC test voltage, for 5 consecutive minutes.

b. If voltage tests after installation are required for 5-65kV shielded power cables then testing must be done in accordance with NEMA WC 74/ICEA S-93-639, Appendix F.

3.2.2.3 Flame Tests

All multiple-conductor and single-conductor cable assemblies must pass either the vertical cable tray flame tests required by ICEA T-30-520 (stated in, but not required by NEMA WC 70), the vertical tray flame propagation test requirements of UL 1685 and IEEE 1202, the wire and cable burning characteristics test of the UL 2556 VW-1 Test, or (for control cables only) the flame test as required by NEMA WC 57. If such tests, however, have previously been made on identical cables, these tests need not be repeated. Instead, certified reports of the original qualifying tests must be submitted. In this case the reports furnished under paragraph "Reports," must include information, identify critical information, and verify that all of each cable's materials, construction, and dimensions are the same as those in the qualifying tests.

3.2.2.4 Independent Tests

The Government may make visual inspections, continuity or resistance checks, insulation resistance readings, power factor tests, or dc high potential tests at field test values. A cable's failure to pass these tests and inspections, or failure to produce readings consistent with acceptable values for the application, will be grounds for rejection of the cable.

3.2.2.5 Reports

Furnish results of tests. No wire or cable must be shipped until authorized. Lot number and reel or coil number of wire and cable tested must be indicated on the test reports.

-- End of Section --

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DIVISION 26 - ELECTRICAL

SECTION 26 05 26

GROUNDING AND BONDING

05/18

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SECTION 26 05 26

GROUNDING AND BONDING
05/18

PART 1 GENERAL

1.1 SUMMARY

Section Includes

1. Material and installation requirements for grounding and bonding system(s).

1.1.1 Related Specification Sections

Related Specification Sections include but are not necessarily limited to:

1. Division 00 - Procurement and Contracting Requirements.
2. Division 01 - General Requirements.
3. Section 26 05 00 - Electrical - Common Work Results.
4. Section 26 05 19 - Wire and Cable.
5. Section 26 05 33 - Raceways and Boxes.

1.2 REFERENCES

The publications listed below form a part of this specification to the extent referenced. The publications are referred to within the text by the basic designation only.

ASTM INTERNATIONAL (ASTM)

ASTM B8	(2011; R 2017) Standard Specification for Concentric-Lay-Stranded Copper Conductors, Hard, Medium-Hard, or Soft

INSTITUTE OF ELECTRICAL AND ELECTRONICS ENGINEERS (IEEE)

IEEE 837	(2014) Standard for Qualifying Permanent Connections Used in Substation Grounding

NATIONAL FIRE PROTECTION ASSOCIATION (NFPA)

NFPA 70	(2017; ERTA 1-2 2017; TIA 17-1; TIA 17-2; TIA 17-3; TIA 17-4; TIA 17-5; TIA 17-6; TIA 17-7; TIA 17-8; TIA 17-9; TIA 17-10; TIA 17-11; TIA 17-12; TIA 17-13; TIA 17-14; TIA 17-15; TIA 17-16; TIA 17-17) National Electrical Code

UNDERWRITERS LABORATORIES (UL)

UL 467	(2013; Reprint Jun 2017) UL Standard for Safety Grounding and Bonding Equipment

1.3 SUBMITTALS

Government approval is required for submittals with a "G" designation; submittals not having a "G" designation are for information only. Submit the following in accordance with Section 01 33 00 SUBMITTAL PROCEDURES:

SD-02 Shop Drawings

Shop Drawings

SD-03 Product Data

Product Technical Data

1.3.1 Shop Drawings

See Specification Section 01 33 00 for requirements for the mechanics and administration of the submittal process.

1.3.2 Product Technical Data

Provide submittal data for all products specified in PART 2 of this Specification Section except:

1) Grounding clamps, terminals and connectors.
2) Exothermic welding system.

See Specification Section 26 05 00 for additional requirements.

PART 2 PRODUCTS

2.1 MANUFACTURERS

Subject to compliance with the Contract Documents, the following manufacturers are acceptable:

Ground rods and bars and grounding clamps, connectors and terminals:

a. ERICO by Pentair.
b. Harger Lightning & Grounding.
c. Heary Bros. Lightning Protection Co. Inc.
d. Burndy by Hubbell.
e. Robbins Lightning, Inc.
f. Blackburn by Thomas & Betts.
g. Thompson Lightning Protection, Inc.

Exothermic weld connections:
a. ERICO by Pentair - Cadweld.
b. Harger Lightning & Grounding - Ultraweld.
c. Burndy by Hubbell - Thermoweld.
d. FurseWELD by Thomas & Betts.

2.2 COMPONENTS

2.2.1 Wire and Cable

1. Bare conductors: Soft drawn stranded copper meeting ASTM B8.

2. Insulated conductors: Color coded green, per Specification Section 26 05 19.

2.2.2 Conduit

As specified in Specification Section 26 05 33.

2.2.3 Ground Bars

1. Solid copper:
   a. 1/4 IN thick.
   b. 2 or 4 IN wide.
c. 24 IN long minimum in main service entrance electrical rooms, 12 IN long elsewhere.
2. Predrilled grounding lug mounting holes.
3. Stainless steel or galvanized steel mounting brackets.
4. Insulated standoffs.

2.2.4 Ground Rods

1. 3/4 IN x 10 FT.
2. Copper-clad:
   a. 10 MIL minimum uniform coating of electrolytic copper molecularly bonded to a rigid steel core.
   b. Corrosion resistant bond between the copper and steel.
   c. Hard drawn for a scar-resistant surface.

2.2.5 Grounding Clamps, Connectors and Terminals

1. Mechanical type:
   a. Standards: UL 467.
   b. High copper alloy content.
2. Compression type for interior locations:
   a. Standards: UL 467.
   b. High copper alloy content.
   c. Non-reversible.
   d. Terminals for connection to bus bars shall have two bolt holes.
3. Compression type suitable for direct burial in earth or concrete:
   a. Standards: UL 467, IEEE 837.
   b. High copper alloy content.
   c. Non-reversible.
   d. Factory filled with oxide inhibiting compound.

2.2.6 Exothermic Weld Connections

1. Copper oxide reduction by aluminum process.
2. Molds properly sized for each application.

PART 3 EXECUTION

3.1 INSTALLATION

3.1.1 General

1. Install products in accordance with manufacturer's instructions.
2. Size grounding conductors and bonding jumpers in accordance with NFPA 70, Article 250, except where larger sizes are indicated on the Drawings.

3. Remove paint, rust, or other non-conducting material from contact surfaces before making ground connections. After connection, apply manufacturers approved touch-up paint to protect metallic surface from corrosion.
4. Where ground conductors pass through floor slabs or building walls provide nonmetallic sleeves and install sleeve per Specification Section 01 73 20.
   a. Seal the sleeve interior to stop water penetration.
5. Do not splice grounding electrode conductors except at ground rods.
6. Install ground rods and grounding electrode conductors in undisturbed, firm soil.
   a. Provide excavation required for installation of ground rods and conductors.
   b. Use driving studs or other suitable means to prevent damage to threaded ends of sectional rods.
   c. Unless otherwise specified, connect conductors to ground rods with compression type connectors or exothermic weld.
   d. Provide sufficient slack in conductor to prevent conductor breakage during backfill or due to ground movement.
   e. Backfill excavation completely, thoroughly tamping to provide good contact between backfill materials and ground rods and conductors.
7. Do not use exothermic welding if it will damage the structure the grounding conductor is being welded to.

3.1.2 Grounding Electrode System

1. Provide a grounding electrode system in accordance with NFPA 70, Article 250 and as indicated on the Drawings.
   a. All grounding electrode conductors terminate on a main ground bar located adjacent to the service entrance equipment.
2. Grounding electrode conductor terminations:
   a. Ground bars mounted on wall: Use a two-hole compression type conductor terminal and bolt it to the ground bar with two bolts.
   b. Ground bars in electrical equipment: Use compression type conductor terminal and bolt it to the ground bar or manufacture's provided mechanical type termination device.
   c. Piping systems: Use mechanical type connections.
   d. Building steel, below grade and encased in concrete: Use compression type connector or exothermic weld.
   e. Building steel, above grade: Use a two-hole compression type conductor terminal and bolt to the steel with two bolts or exothermic weld.
   f. Ground rod: Compression type or exothermic weld, unless otherwise specified.
   g. At all above grade terminations, the conductors shall be labeled per Specification Section 10 14 00.
3. Ground ring grounding system:
   a. Ground ring consists of ground rods and a conductor looped around the structure.
   b. Placed at a minimum of 10 FT from the structure foundation and 2 FT-6 IN below grade.
   c. Provide a minimum of four ground rods placed at the corners of the structure and additional rods so that the maximum distance between ground rods does not exceed 50 FT.
   d. Building/Structure grounding:
      1) Bond building/structure metal support columns to the ground ring at all corners of the structure.
   e. Grounding conductor: Bare conductor, size as indicated on the Drawings.

4. Triad grounding system:
   a. Triad consists of three ground rods arranged in a triangle separated by 20 FT and a conductor interconnecting each ground rod.
   b. Place first ground rod a minimum of 10 FT from the structure foundation and 2 FT 6 IN below grade.
   c. Grounding conductor: Bare conductor, size as indicated on the Drawings.

3.1.3 Supplemental Grounding Electrode

1. Provide the following grounding in addition to the equipment ground conductor supplied with the feeder conductors whether or not shown on the Drawings.
   a. See Grounding Electrode System paragraph for conductor termination requirements.
2. Metal light poles:
   a. Connect metal pole and pole base reinforcing steel to a ground rod.
   b. Grounding conductor: Bare #6 AWG minimum.
3. Equipment support rack and pedestals mounted outdoors:
   a. Connect metallic structure to a ground rod.
b. Grounding conductor: #6 AWG minimum.

3.1.4 Transformer Separately Derived Grounding System

1. Install the System Bonding Jumper at the transformer. At the first disconnect, ensure the neutral is isolated from ground.
2. Structures with a single electrical room/area:
   a. Connect grounding electrode conductor to the Grounding Electrode System main ground bar.
3. Structures with multiple electrical rooms/areas:
   a. Provide a ground bar mounted in each electrical room/area.
   b. Interconnect all ground bars in a daisy chain or radial fashion to the main ground bar as indicated on the Drawings.
   c. Connect grounding electrode conductor to the electrical room/area ground bar.
4. See Grounding Electrode System paragraph for conductor termination requirements.

3.1.5 Raceway Bonding/Grounding

1. Install all metallic raceway so that it is electrically continuous.
2. Provide an equipment grounding conductor in all raceways with insulation identical to the phase conductors, unless otherwise indicated on the Drawings.
3. NFPA 70 required grounding bushings shall be of the insulating type.
4. Provide double locknuts at all panels.
5. Bond all conduits, at entrance and exit of equipment, to the equipment ground bus or lug.
6. Provide bonding jumpers if conduits are installed in concentric knockouts.
7. Make all metallic raceway fittings and grounding clamps tight to ensure equipment grounding system will operate continuously at ground potential to provide low impedance current path for proper operation of overcurrent devices during possible ground fault conditions.

3.1.6 Equipment Grounding

1. Ground all utilization equipment with an equipment grounding conductor.

3.1.7 Manhole and Handhole Grounding

1. Provide a ground rod and ground bar, when indicated or as needed, in each manhole and handhole with exposed metal parts.
   a. Expose a minimum of 4 IN of the rod above the floor for field connections to the rod.
2. Connect all exposed metal parts (e.g., conduits and cable racks) to the ground rod.

3.2 FIELD QUALITY CONTROL

Leave grounding system uncovered until observed by Owner.

-- End of Section --

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DIVISION 26 - ELECTRICAL

SECTION 26 05 33

RACEWAYS AND BOXES

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SECTION 26 05 33

RACEWAYS AND BOXES
05/18

PART 1 GENERAL

1.1 SUMMARY

Section Includes:
1. Material and installation requirements for:
    a. Conduits.
    b. Conduit fittings.
    c. Conduit supports.
    d. Wireways.
    e. Outlet boxes.
    f. Pull and junction boxes.

1.1.1 Related Specification Sections

Related Specification Sections include but are not necessarily limited to:
1. Division 00 - Procurement and Contracting Requirements.
2. Division 01 - General Requirements.
3. Section 26 05 00 - Electrical - Basic Requirements.
4. Section 26 05 43 - Electrical - Exterior Underground.
5. Section 26 27 26 - Wiring Devices.

1.2 REFERENCES

The publications listed below form a part of this specification to the extent referenced. The publications are referred to within the text by the basic designation only.

ASTM INTERNATIONAL (ASTM)

ASTM A123/A123M	(2017) Standard Specification for Zinc (Hot-Dip Galvanized) Coatings on Iron and Steel Products
ASTM A153/A153M	(2016) Standard Specification for Zinc Coating (Hot-Dip) on Iron and Steel Hardware
ASTM D2564	(2012) Standard Specification for Solvent Cements for Poly(Vinyl Chloride) (PVC) Plastic Piping Systems

NATIONAL ELECTRICAL MANUFACTURERS ASSOCIATION (NEMA)

ANSI C80.1	(2005) American National Standard for Electrical Rigid Steel Conduit (ERSC)
NEMA 250	(2014) Enclosures for Electrical Equipment (1000 Volts Maximum)
NEMA RN 1	(2005; R 2013) Polyvinyl-Chloride (PVC) Externally Coated Galvanized Rigid Steel

	Conduit and Intermediate Metal Conduit
NEMA TC 2	(2013) Standard for Electrical Polyvinyl Chloride (PVC) Conduit
NEMA TC 3	(2016) Polyvinyl Chloride (PVC) Fittings for Use With Rigid PVC Conduit and Tubing

NATIONAL FIRE PROTECTION ASSOCIATION (NFPA)

NFPA 70	(2017; ERTA 1-2 2017; TIA 17-1; TIA 17-2; TIA 17-3; TIA 17-4; TIA 17-5; TIA 17-6; TIA 17-7; TIA 17-8; TIA 17-9; TIA 17-10; TIA 17-11; TIA 17-12; TIA 17-13; TIA 17-14; TIA 17-15; TIA 17-16; TIA 17-17) National Electrical Code

UNDERWRITERS LABORATORIES (UL)

UL 1	(2005; Reprint Aug 2017) UL Standard for Safety Flexible Metal Conduit
UL 1203	(2013; Reprint Feb 2018) UL Standard for Safety Explosion-Proof and Dust-Ignition-Proof Electrical Equipment for Use in Hazardous (Classified) Locations
UL 360	(2013; Reprint Jan 2015) Liquid-Tight Flexible Steel Conduit
UL 467	(2013; Reprint Jun 2017) UL Standard for Safety Grounding and Bonding Equipment
UL 50	(2015) UL Standard for Safety Enclosures for Electrical Equipment, Non-Environmental Considerations
UL 514A	(2013; Reprint Aug 2017) UL Standard for Safety Metallic Outlet Boxes
UL 514B	(2012; Reprint Nov 2014) Conduit, Tubing and Cable Fittings
UL 6	(2007; Reprint Nov 2014) Electrical Rigid Metal Conduit-Steel
UL 651	(2011; Reprint Jun 2016) UL Standard for Safety Schedule 40 and 80 Rigid PVC Conduit and Fittings
UL 870	(2016) UL Standard for Safety Wireways, Auxiliary Gutters, and Associated Fittings

1.3 SUBMITTALS

Government approval is required for submittals with a "G" designation; submittals not having a "G" designation are for information only. Submit the following in accordance with Section 01 33 00 SUBMITTAL PROCEDURES:

SD-02 Shop Drawings

Shop Drawings

SD-03 Product Data

Product Technical Data

Provide submittal data for all products specified in PART 2 of this Specification Section except:
1) Conduit fittings.
2) Support systems.

See Specification Section 26 05 00 for additional requirements.

Fabrication and/or layout drawings

Identify dimensional size of pull and junction boxes to be used.

1.3.1 Shop Drawings

See Specification Section 01 33 00 for requirements for the mechanics and administration of the submittal process.

1.3.2 Product Technical Data

Provide submittal data for all products specified in PART 2 of this Specification Section except:

1) Conduit fittings.
2) Support systems.

See Specification Section 26 05 00 for additional requirements.

Fabrication and/or layout drawings

Identify dimensional size of pull and junction boxes to be used.

1.4 DELIVERY, STORAGE, AND HANDLING

See Specification Section 26 05 00.

PART 2 PRODUCTS

2.1 MANUFACTURERS

S ubject to compliance with the Contract Documents, the following manufacturers are acceptable:

1. Rigid metal conduits and electrical metallic tubing:
   a. Allied Tube and Conduit.
   b. Western Tube and Conduit Corporation.
   c. Wheatland Tube.
   d. Patriot Aluminum Products, LLC.
2. PVC coated rigid metal conduits:
   a. Ocal by Thomas & Betts.
   b. Robroy Industries.
3. Rigid nonmetallic conduit:
   a. Prime Conduit.

   b. Cantex, Inc.
   c. Osburn Associates, Inc.
   d. Champion Fiberglass, Inc.
   e. United Fiberglass of America, Inc.
4. Flexible conduit:
   a. AFC Cable Systems.
   b. Anamet, Inc.
   c. Electri-Flex Company.
   d. International Metal Hose Company.
   e. Southwire Company, LLC.
5. Wireway:
   a. Hoffman Engineering.
   b. Wiegmann by Hubbell.
   c. Square D by Schneider Electric.
6. Conduit fittings and accessories:
   a. Appleton by Emerson Electric Co.
   b. Carlon by Thomas & Betts.
   c. Cantex, Inc.
   d. Crouse-Hinds by Eaton.
   e. Killark by Hubbell.
   f. Osburn Associates, Inc.
   g. O-Z/Gedney by Emerson Electric Co.
   h. Raco by Hubbell.
   i. Steel City by Thomas & Betts.
   j. Thomas & Betts.
7. Support systems:
   a. Unistrut by Atkore International, Inc.
   b. B-Line by Eaton.
   c. Kindorf by Thomas & Betts.
   d. Minerallac Company.
   e. CADDY by Pentair.
   f. Superstrut by Thomas & Betts.
8. Outlet, pull and junction boxes:
   a. Appleton by Emerson Electric Co.
   b. Crouse-Hinds by Eaton
   c. Killark by Hubbell.
   d. O-Z/Gedney by Emerson Electric Co.
   e. Steel City by Thomas & Betts.
   f. Raco by Hubbell
   g. Bell by Hubbell.
   h. Hoffman Engineering.
   i. Wiegmann by Hubbell.
   j. B-Line by Eaton.
   k. Adalet.
   l. RITTAL North America LLC.
   m. Stahlin by Robroy Enclosures.

Submit request for substitution to the Contracting Officer.

2.2 RIGID METAL CONDUITS

2.2.1 Rigid Galvanized Steel Conduit (RGS):

1. Mild steel with continuous welded seam.
2. Metallic zinc applied by hot-dip galvanizing or electro-galvanizing.
3. Threads galvanized after cutting.
4. Internal coating: Baked lacquer, varnish or enamel for a smooth surface.
5. Standards: NFPA 70 Type RMC, NEMA/ANSI C80.1, UL 6.

2.2.2 PVC-Coated Rigid Steel Conduit (PVC-RGS)

1. Nominal 40 MIL Polyvinyl Chloride Exterior Coating:
   a. Coating: Bonded to hot-dipped galvanized rigid steel conduit conforming to NEMA/ANSI C80.1.
   b. The bond between the PVC coating and the conduit surface: Greater than the tensile strength of the coating.
2. Nominal 2 mil, minimum, urethane interior coating.
3. Urethane coating on threads.
4. Conduit: Epoxy prime coated prior to application of PVC and urethane coatings.
5. Female Ends:
   a. Have a plastic sleeve extending a minimum of 1 pipe diameter or 2 IN, whichever is less beyond the opening.
   b. The inside diameter of the sleeve shall be the same as the outside diameter of the conduit to be used with it.
6. Standards: NFPA 70 Type RMC, NEMA/ANSI C80.1, UL 6, NEMA RN 1.

2.3 RIGID NONMETALLIC CONDUIT

2.3.1 Schedules 40 (PVC-40) and 80 (PVC-80)

1. Polyvinyl-chloride (PVC) plastic compound which includes inert modifiers to improve weatherability and heat distribution.
2. Rated for direct sunlight exposure.
3. Fire retardant and low smoke emission.
4. Shall be suitable for use with 90 DEGC wire and shall be marked "maximum 90 DEGC".
5. Standards: NFPA 70 Type PVC, NEMA TC 2, UL 651.

2.4 FLEXIBLE CONDUIT

2.4.1 Flexible Galvanized Steel Conduit (FLEX)

1. Formed of continuous, spiral wound, hot-dip galvanized steel strip with successive convolutions securely interlocked.
2. Standard: NFPA 70 Type FMC, UL 1.

2.4.2 PVC-Coated Flexible Galvanized Steel (liquid-tight) Conduit (FLEX-LT)

1. Core formed of continuous, spiral wound, hot-dip galvanized steel strip with successive convolutions securely interlocked.
2. Extruded PVC outer jacket positively locked to the steel core.
3. Liquid and vaportight.
4. Standard: NFPA 70 Type LFMC, UL 360.

2.5 WIREWAY

2.5.1 General

1. Suitable for lay-in conductors.
2. Designed for continuous grounding.
3. Covers:
   a. Hinged or removable in accessible areas.

   b. Non-removable when passing through partitions.
4. Finish: Rust inhibiting primer and manufacturer's standard paint inside and out except for stainless steel type.
5. Standards: UL 870, NEMA 250.

2.5.2 General Purpose (NEMA 1 rated) Wireway

1. 14 or 16 gage steel without knockouts.
2. Cover: Solid, non-gasketed and held in place by captive screws.

2.5.3 Raintight (NEMA 3R) Wiring Trough

1. 14 or 16 GA galvanized steel without knockouts.
2. Cover: Non-gasketed and held in place by captive screws.

2.5.4 Watertight (NEMA 4X rated) Wireway

1. 14 GA Type 304 or 316 stainless steel bodies and covers without knockouts and 10 GA stainless steel flanges.
2. Cover: Fully gasketed and held in place with captive clamp type latches.
3. Flanges: Fully gasketed and bolted.

2.5.5 Dusttight (NEMA 12 rated) Wireway

1. 14 GA steel bodies and covers without knockouts and 10 GA steel flanges.
2. Cover: Fully gasketed and held in place with captive clamp type latches.
3. Flanges: Fully gasketed and bolted.

2.6 CONDUIT FITTINGS AND ACCESSORIES

2.6.1 Fittings for Use with RGS

1. General:
   a. In hazardous locations listed for use in Class I, Groups C and D locations.
2. Locknuts:
   a. Threaded steel or malleable iron.
   b. Gasketed or non-gasketed.
   c. Grounding or non-grounding type.
3. Bushings:
   a. Threaded, insulated metallic.
   b. Grounding or non-grounding type.
4. Hubs: Threaded, insulated and gasketed metallic for raintight connection.
5. Couplings:
   a. Threaded straight type: Same material and finish as the conduit with which they are used on.
   b. Threadless type: Gland compression or self-threading type, concrete tight.
6. Unions: Threaded galvanized steel or zinc plated malleable iron.
7. Conduit bodies (ells and tees):
   a. Body: Zinc plated cast iron or cast copper free aluminum with threaded hubs.
   b. Standard and mogul size.
   c. Cover:
      1) Clip-on type with stainless steel screws.
      2) Gasketed or non-gasketed galvanized steel, zinc plated cast iron

or cast copper free aluminum.

8. Conduit bodies (round):
    a. Body: Zinc plated cast iron or cast copper free aluminum with threaded hubs.
    b. Cover: Threaded screw on type, gasketed, galvanized steel, zinc plated cast iron or cast copper free aluminum.
9. Sealing fittings:
    a. Body: Zinc plated cast iron or cast copper free aluminum with threaded hubs.
    b. Standard and mogul size.
    c. With or without drain and breather.
    d. Fiber and sealing compound: UL listed for use with the sealing fitting.
10. Hazardous location flexible coupling (HAZ-FLEX):
    a. Liquid tight and arc resistant.
    b. Electrically conductive so no bonding jumper is required.
    c. Dry and wet areas:
        1) Bronze braided covering over flexible brass core.
        2) Bronze end fittings.
        3) Zinc-plated steel or malleable iron unions and nipples.
    d. Corrosive areas:
        1) Stainless steel braided covering over flexible stainless steel core.
        2) Stainless steel end fittings.
        3) Aluminum unions and nipples.
11. Service entrance head:
    a. Malleable iron, galvanized steel or copper free aluminum.
    b. Insulated knockout cover for use with a variety of sizes and number of conductors.
12. Expansion couplings:
    a. 2 IN nominal straight-line conduit movement in either direction.
    b. Galvanized steel with insulated bushing.
    c. Gasketed for wet locations.
    d. Internally or externally grounded.
13. Expansion/deflection couplings:
    a. 3/4 IN nominal straight-line conduit movement in either direction.
    b. 30-degree nominal deflection from the normal in all directions.
    c. Metallic hubs, neoprene outer jacket and stainless steel jacket clamps.
    d. Internally or externally grounded.
    e. Watertight, raintight and concrete tight.
14. Standards: UL 467, UL 514B, UL 1203.

2.6.2 Fittings for Use with PVC-RGS

The same material and construction as those fittings listed under paragraph "Fittings for Use with RGS" and coated as defined under paragraph "PVC Coated Rigid Steel Conduit (PVC-RGS)."

2.6.3 Fittings for Use with FLEX

1. Connector:
    a. Zinc plated malleable iron.
    b. Squeeze or clamp-type.
2. Standard: UL 514B

2.6.4 Fittings for Use with FLEX-LT

1. Connector:

   a. Straight or angle type.
   b. Metal construction, insulated and gasketed.
   c. Composed of locknut, grounding ferrule and gland compression nut.
   d. Liquid tight.
2. Standards: UL 467, UL 514B.

2.6.5 Fittings for Use with Rigid Nonmetallic PVC Conduit

1. Coupling, adapters and conduit bodies:
   a. Same material, thickness, and construction as the conduits with which they are used.
   b. Homogeneous plastic free from visible cracks, holes or foreign inclusions.
   c. Bore smooth and free of blisters, nicks or other imperfections which could damage the conductor.
2. Solvent cement for welding fittings shall be supplied by the same manufacturer as the conduit and fittings.
3. Standards: ASTM D2564, NEMA TC 3, UL 651, UL 514B

2.6.6 Fittings for Use with Rigid Nonmetallic Fiberglass Conduit

1. Coupling and adapters shall be of the same material, thickness, and construction as the conduit.
2. Epoxy adhesive for joining conduits and fittings shall be supplied by the same manufacturer as the conduit and fittings and shall provide a concrete and water tight connection.
3. Standard: NFPA 70 Type RTRC, NEMA TC14.AG, NEMA TC14.BG, NEMA TC.XW, UL 2420, UL 2415, UL 2515A.

2.6.7 Weather and Corrosion Protection Tape

1. PVC based tape, 10 mils thick.
2. Protection against moisture, acids, alkalis, salts and sewage and suitable for direct bury.
3. Used with appropriate pipe primer.

2.7 ALL RACEWAY AND FITTINGS

2.7.1 Mark Products

1. Identify the nominal trade size on the product.
2. Stamp with the name or trademark of the manufacturer.

2.8 OUTLET BOXES

2.8.1 Metallic Outlet Boxes

1. Hot-dip galvanized steel.
2. Conduit knockouts and grounding pigtail.
3. Styles:
   a. 2 IN x 3 IN rectangle.
   b. 4 IN square.
   c. 4 IN octagon.
   d. Masonry/tile.
4. Accessories:
   a. Flat blank cover plates.
   b. Barriers.
   c. Extension, plaster or tile rings.
   d. Box supporting brackets in stud walls.

    e. Adjustable bar hangers.
5. Standards: NEMA/ANSI OS 1, UL 514A

2.8.2 Cast Outlet Boxes

1. Zinc plated cast iron or die-cast copper free aluminum with manufacturer's standard finish.
2. Threaded hubs and grounding screw.
3. Styles:
    a. "FS" or "FD".
    b. "Bell".
    c. Single or multiple gang and tandem.
    d. "EDS" or "EFS" for hazardous locations.
4. Accessories: 40 MIL PVC exterior coating and 2 MIL urethane interior coating.
5. Standards: UL 514A, UL 1203.

2.9 PULL AND JUNCTION BOXES

2.9.1 NEMA 1 Rated

1. Body and cover: 14 GA minimum, galvanized steel or 14 GA minimum, steel finished with rust inhibiting primer and manufacturers standard paint inside and out.
2. With or without concentric knockouts on four sides.
3. Flat cover fastened with screws.

2.9.2 NEMA 4 Rated

1. Body and cover: 14 GA steel finished with rust inhibiting primer and manufacturers standard paint inside and out.
2. Seams continuously welded and ground smooth.
3. No knockouts.
4. External mounting flanges.
5. Hinged or non-hinged cover held closed with stainless steel screws and clamps.
6. Cover with oil resistant gasket

2.9.3 NEMA 4X Rated (metallic)

1. Body and cover: 14 GA Type 304 or 316 stainless steel.
2. Seams continuously welded and ground smooth.
3. No knockouts.
4. External mounting flanges.
5. Hinged door and stainless steel screws and clamps.
6. Door with oil-resistant gasket.

2.9.4 NEMA 4X Rated (Nonmetallic)

1. Body and cover: Ultraviolet light protected fiberglass-reinforced polyester boxes.
2. No knockouts.
3. External mounting flanges.
4. Hinged door with quick release latches and padlocking hasp.
5. Door with oil resistant gasket.

2.9.5 NEMA 7 and NEMA 9 Rated

1. Cast gray iron alloy or copper-free aluminum with manufacturer's

standard finish.

2. Drilled and tapped openings or tapered threaded hub.
3. Cover bolted-down with stainless steel bolts or threaded cover with neoprene gasket.
4. External mounting flanges.
5. Grounding lug.
6. Accessories: 40 MIL PVC exterior coating and 2 MIL urethane interior coating.

2.9.6 NEMA 12 Rated

1. Body and cover:
   a. 14 GA steel finished with rust inhibiting primer and manufacturers standard paint inside and out.
   b. Type 5052 H-32 aluminum, unpainted.
2. Seams continuously welded and ground smooth.
3. No knockouts.
4. External mounting flanges.
5. Non-hinged cover held closed with captivated cover screws threaded into sealed wells or hinged cover held closed with stainless steel screws and clamps.
6. Flat door with oil resistant gasket.

2.9.7 Miscellaneous Accessories

1. Rigid handles for covers larger than 9 SQFT or heavier than 25 LBS.
2. Split covers when heavier than 25 LBS.
3. Weldnuts for mounting optional panels and terminal kits.
4. Terminal blocks: Screw-post barrier-type, rated 600 volt and 20 ampere minimum.

2.9.8 Standards

NEMA 250, UL 50

2.10 SUPPORT SYSTEMS

2.10.1 Multi-conduit Surface or Trapeze Type Support and Pull or Junction Box Supports

1. Material requirements.
   a. Galvanized steel: ASTM A123/A123M or ASTM A153/A153M.
   b. Stainless steel: AISI Type 316.
   c. PVC coat galvanized steel: ASTM A123/A123M or ASTM A153/A153M and 20 MIL PVC coating.

2.10.2 Single Conduit and Outlet Box Support Fasteners

1. Material requirements:
   a. Zinc plated steel.
   b. Stainless steel.
   c. Malleable iron.
   d. PVC coat malleable iron or steel: 20 MIL PVC coating.
   e. Steel protected with zinc phosphate and oil finish.

2.11 OPENINGS AND PENETRATIONS IN WALLS AND FLOORS

Sleeves, smoke and fire stop fitting through walls and floors:

See Specification Section 01 73 20.

PART 3 EXECUTION

3.1 RACEWAY INSTALLATION - GENERAL

Shall be in accordance with the requirements of:

1. NFPA 70.
2. Manufacturer instructions.

3.1.1 Size of Raceways

1. Raceway sizes are shown on the Drawings, if not shown on the Drawings, then size in accordance with NFPA 70.
2. Unless specifically indicated otherwise, the minimum raceway size shall be:
   a. Conduit: 3/4 IN.
   b. Wireway: 2-1/2 IN x 2-1/2 IN.

3.1.2 Field Bending and Cutting of Conduits

1. Utilize tools and equipment recommended by the manufacturer of the conduit, designed for the purpose and the conduit material to make all field bends and cuts.
2. Do not reduce the internal diameter of the conduit when making conduit bends.
3. Prepare tools and equipment to prevent damage to the PVC coating.
4. Degrease threads after threading and apply a zinc rich paint.
5. Debur interior and exterior after cutting.

3.1.3 Male Threads

Male threads of conduit systems shall be coated with an electrically conductive anti-seize compound.

3.1.4 Protective Coating Integrity of Conduits, Fittings, Outlet, Pull and Junction Boxes

The protective coating integrity of conduits, fittings, outlet, pull and junction boxes and accessories shall be maintained.

1. Repair galvanized components utilizing a zinc rich paint.
2. Repair painted components utilizing touch up paint provided by or approved by the manufacturer.
3. Repair PVC coated components utilizing a patching compound, of the same material as the coating, provided by the manufacturer of the conduit; or a self-adhesive, highly conformable, cross-linked silicone composition strip, followed by a protective coating of vinyl tape.
   a. Total nominal thickness: 40 MIL.
4. Repair surfaces which will be inaccessible after installation prior to installation.

3.1.5 Moisture and Debris

Remove moisture and debris from conduit before wire is pulled into place.

1. Pull mandrel with diameter nominally 1/4 IN smaller than the interior of the conduit, to remove obstructions.

2. Swab conduit by pulling a clean, tight-fitting rag through the conduit.
3. Tightly plug ends of conduit with tapered wood plugs or plastic inserts until wire is pulled.

3.1.6 Rope

Only nylon or polyethylene rope shall be used to pull wire and cable in conduit systems.

3.1.7 Temperature and Condensation

Where portions of a raceway are subject to different temperatures and where condensation is known to be a problem, as in cold storage areas of buildings or where passing from the interior to the exterior of a building, the raceway shall be sealed to prevent circulation of warm air to colder section of the raceway.

3.1.8 Fill Openings

Fill openings in walls, floors, and ceilings and finish flush with surface.

See Specification Section 01 73 20.

3.2 RACEWAY ROUTING

Raceways shall be routed in the field unless otherwise indicated.

1. Conduit and fittings shall be installed, as required, for a complete system that has a neat appearance and is in compliance with all applicable codes.
2. Run in straight lines parallel to or at right angles to building lines.
3. Do not route conduits:
   a. Through areas of high ambient temperature or radiant heat.
   b. In suspended concrete slabs.
   c. In concrete members including slabs, slabs on grade, beams, walls, and columns unless specifically located and detailed on structural Drawings.
4. Locate sleeves or conduits penetrating floors, walls, and beams so as not to significantly impair the strength of the construction. Do not place conduit penetrations in columns.
5. Conduit shall not interfere with, or prevent access to, piping, valves, ductwork, or other equipment for operation, maintenance and repair.
6. Provide pull boxes or conduit bodies as needed so that there is a maximum of 360 DEG of bends in the conduit run or in long straight runs to limit pulling tensions.

All conduits within a structure shall be installed exposed except as follows:

1. As indicated on the Drawings.
2. Concealed above gypsum wall board or acoustical tile suspended ceilings.
3. Conduits in architecturally finished areas shall be concealed.
4. Embedded in floor slabs or buried under floor serving equipment in non-architecturally finished areas that are not located on or near a wall or column and the ceiling height is greater than 12 FT.
5. Embedded in floor slabs or buried under floor slabs where shown on the Contract Drawings or with the Engineer's permission.

Maintain minimum spacing between parallel conduit and piping runs in accordance with the following when the runs are greater than 30 FT:

1. Between instrumentation and telecommunication: 1 IN.
2. Between instrumentation and 125 V, 48 V and 24 VDC, 2 IN.
3. Between instrumentation and 600 V and less AC power or control: 6 IN.
4. Between instrumentation and greater than 600 VAC power: 12 IN.
5. Between telecommunication and 125 V, 48 V and 24 VDC, 2 IN.
6. Between telecommunication and 600 V and less AC power or control: 6 IN.
7. Between telecommunication and greater than 600 VAC power: 12 IN.
8. Between 125 V, 48 V and 24 VDC and 600 V and less AC power or control: 2 IN.
9. Between 125 V, 48 V and 24 VDC and greater than 600 VAC power: 2 IN.
10. Between 600 V and less AC and greater than 600 VAC: 2 IN.
11. Between process, gas, air and water pipes: 6 IN.

Conduits shall be installed to eliminate moisture pockets.

1. Where water cannot drain to openings, provide drain fittings in the low spots of the conduit run.

Conduit shall not be routed on the exterior of structures except as specifically indicated on the Drawings.

Where sufficient room exists within the housing of roof-mounted equipment, the conduit shall be stubbed up inside the housing.

Provide all required openings in walls, floors, and ceilings for conduit penetration.

1. See Specification Section 01 73 20.

3.3 RACEWAY APPLICATIONS

3.3.1 Permitted Raceway Types Per Wire or Cable Types

1. Power wire or cables: All raceway types.
2. Control wire or cables: All raceway types.
3. Instrumentation cables: Metallic raceway except nonmetallic may be used underground.
4. Motor leads from a VFD: RGS, RAC or shielded VFD cables in all other raceways.
5. Telecommunication cables: All raceway types.

3.3.2 Permitted Raceway Types Per Area Designations

1. Dry areas:
   a. RGS.
2. Wet areas:
   a. RGS.
3. Corrosive areas:
   a. PVC-RGS.
4. Highly corrosive areas:
   a. PVC-RGS.
   b. PVC-80.
5. NFPA 70 hazardous areas:
   a. RGS.

3.3.3 Permitted Raceway Types Per Routing Locations

1. In stud framed walls:

a. EMT.
2. In concrete block or brick walls:
   a. PVC-40.
3. Above acoustical tile ceilings:
   a. EMT.
   b. NEMA 1 rated wireway.
4. Embedded in poured concrete walls and floors:
   a. PVC-40.
   b. PVC-RGS when emerging from concrete into areas designated as wet, corrosive or highly corrosive.
5. Beneath floor slab-on-grade:
   a. PVC-40.
6. Through floor penetrations, see Specification Section 01 73 20:
   a. PVC-RGS in areas designated as wet, corrosive or highly corrosive.
7. Direct buried conduits and ductbanks:
   a. PVC-80.
   b. 90 DEG elbows for transitions to above grade:
      1) PVC-RGS.
   d. Long sweeping bends greater than 15 DEG:
      1) PVC-RGS.
8. Concrete encased ductbanks:
   a. PVC-40.
   b. PVC-EB.
   c. 90 degree elbows for transitions to above grade:
      1) PVC-RGS.
   d. Long sweeping bends greater than 15 DEG:
      1) RGS for sizes 2 IN and larger.

3.3.4 FLEX conduits

FLEX conduits shall be installed for connections to light fixtures, HVAC equipment and other similar devices above the ceilings.

1. The maximum length shall not exceed:
   a. 6 FT to light fixtures.
   b. 3 FT to all other equipment.

3.3.5 FLEX-LT conduits

FLEX-LT conduits shall be install as the final conduit connection to light fixtures, dry type transformers, motors, electrically operated valves, instrumentation primary elements, and other electrical equipment that is liable to vibrate.

1. The maximum length shall not exceed:
   a. 6 FT to light fixtures.
   b. 3 FT to motors.
   c. 2 FT to all other equipment.

3.3.6 HAZ-FLEX coupling

F. HAZ-FLEX coupling shall be installed as the final conduit to motors, electrically operated valves, instrumentation primary elements and electrical equipment that is liable to vibrate.

1. The maximum length shall not exceed:
   a. 3 FT to motors.
   b. 2 FT to all other equipment.

3.3.7 NEMA 1 Rated Wireway

1. Surface mounted in electrical rooms.
2. Surface mounted above removable ceilings tiles of an architecturally finished area.

3.3.8 NEMA 3R Wiring Trough

1. Surface mounted in exterior locations.

3.3.9 NEMA 4X Rated Wireway

1. Surface mounted in areas designated as wet and or corrosive.

3.3.10 NEMA 12 Rated Wireway

1. Surface mounted in areas designated as dry in architecturally and non-architecturally finished areas.

3.4 CONDUIT FITTINGS AND ACCESSORIES

3.4.1 Conduit Seals

1. Installed in conduit systems located in hazardous areas as required by the NFPA 70.
2. Filler plug and drain shall be accessible.
3. Pour the conduit seals in a two-step process.
   a. Pour the seal and leave cover off.
   b. After seal is dry, inspect for proper sealing, install cover and mark (for example, paint or permanent marker) as complete.

3.4.2 Rigid nonmetallic conduit and fittings

Rigid nonmetallic conduit and fittings shall be joined utilizing solvent cement.

1. Immediately after installation of conduit and fitting, the fitting or conduit shall be rotated 1/4 turn to provide uniform contact.

3.4.3 Expansion Fittings Installation

Install Expansion Fittings:

1. Where conduits are exposed to the sun and conduit run is greater than 200 FT.
2. Elsewhere as identified on the Drawings.

3.4.4 Expansion/Deflection Fittings Installation

Install Expansion/Deflection Fittings:

1. Where conduits enter a structure.
   a. Except electrical manholes and handholes.
   b. Except where the ductbank is tied to the structure with rebar.
2. Where conduits span structural expansions joints.
3. Elsewhere as identified on the Drawings.

3.4.5 Threaded connections

Threaded connections shall be made wrench-tight.

3.4.6 Conduit joints

Conduit joints shall be watertight:

1. Where subjected to possible submersion.
2. In areas classified as wet.
3. Underground.

3.4.7 Terminate Conduits

1. In metallic outlet boxes:
    a. RGS:
        1) Conduit hub and locknut.
        2) Insulated bushing and two locknuts.
        3) Use grounding type locknut or bushing when required by NFPA 70.
2. In NEMA 1 rated enclosures:
    a. RGS:
        1) Conduit hub and locknut.
        2) Insulated bushing and two locknuts.
        3) Use grounding type locknut or bushing when required by NFPA 70.
3. In NEMA 12 rated enclosures:
    a. Watertight, insulated and gasketed hub and locknut.
    b. Use grounding type locknut or bushing when required by NFPA 70.
4. In NEMA 4 and NEMA 4X rated enclosures:
    a. Watertight, insulated and gasketed hub and locknut.
5. In NEMA 7 and NEMA 9 rated enclosures:
    a. Into an integral threaded hub.
6. When stubbed up through the floor into floor mount equipment:
    a. With an insulated grounding bushing on metallic conduits.
    b. With end bells on nonmetallic conduits.

3.4.8 Threadless Couplings

Threadless couplings shall only be used to join new conduit to existing conduit when the existing conduit end is not threaded and it is not practical or possible to cut threads on the existing conduit with a pipe threader.

3.5 CONDUIT SUPPORT

3.5.1 Permitted multi-conduit surface or trapeze type support system

Permitted multi-conduit surface or trapeze type support system per area designations and conduit types:

1. Dry or wet and/or hazardous areas:
    a. Galvanized system consisting of: Galvanized steel channels and fittings, nuts and hardware and conduit clamps.
2. Corrosive areas:
    a. PVC coated steel system consisting of: PVC coated galvanized steel channels and fittings and conduit clamps with stainless steel nuts and hardware.
3. Highly corrosive areas:
    a. PVC coated steel system consisting of: PVC coated galvanized steel channels and fittings and conduit clamps with stainless

steel nuts and hardware.

4. Conduit type shall be compatible with the support system material.
   a. Galvanized steel system may be used with RGS.
   b. Stainless steel system may be used with RGS and PVC-RGS.
   c. PVC coated galvanized steel system may be used with PVC-RGS and PVC-40 and PVC-80.

3.5.2 Permitted single conduit support fasteners

Permitted single conduit support fasteners per area designations and conduit types.

1. Architecturally finished areas:
   a. Material: Zinc plated steel, or steel protected with zinc phosphate and oil finish.
   b. Types of fasteners: Spring type hangers and clips, straps, hangers with bolts, clamps with bolts and bolt on beam clamps.
   c. Provide anti-rattle conduit supports when conduits are routed through metal studs.
2. Dry or wet and/or hazardous areas:
   a. Material: Zinc plated steel, stainless steel and malleable iron.
   b. Types of fasteners: Straps, hangers with bolts, clamps with bolts and bolt on beam clamps.
3. Corrosive areas:
   a. Material: Stainless steel and PVC coat malleable iron or steel.
   b. Types of fasteners: Straps, hangers with bolts, clamps with bolts and bolt on beam clamps.
4. Highly corrosive areas:
   a. Material: PVC coat malleable iron or steel.
   b. Types of fasteners: Straps, hangers with bolts, clamps with bolts and bolt on beam clamps.
5. Conduit type shall be compatible with the support fastener material.
   a. Zinc plated steel, steel protected with zinc phosphate and oil finish and malleable iron fasteners may be used with RGS.
   b. Stainless steel system may be used with RGS and PVC-RGS.
   c. PVC coated fasteners may be used with PVC-RGS and PVC-40 and PVC-80.
   d. Nonmetallic fasteners may be used with PVC-40, PVC-80 and fiberglass.

3.5.3 Conduit Support General Requirements

Conduit Support General Requirements:

1. Maximum spacing between conduit supports per NFPA 70.
2. Support conduit from the building structure.
3. Do not support conduit from process, gas, air or water piping; or from other conduits.
4. Provide hangers and brackets to limit the maximum uniform load on a single support to 25 LBS or to the maximum uniform load recommended by the manufacturer if the support is rated less than 25 LBS.
   a. Do not exceed maximum concentrated load recommended by the manufacturer on any support.
   b. Conduit hangers:
      1) Continuous threaded rods combined with struts or conduit clamps: Do not use perforated strap hangers and iron bailing wire.
   c. Do not use suspended ceiling support systems to support raceways.
   d. Hangers in metal roof decks:
      1) Utilize fender washers.

2) Not extend above top of ribs.
3) Not interfere with vapor barrier, insulation, or roofing.

5. Conduit support system fasteners:
   a. Use sleeve-type expansion anchors as fasteners in masonry wall construction.
   b. Do not use concrete nails and powder-driven fasteners.

3.6 OUTLET, PULL AND JUNCTION BOX INSTALLATION

3.6.1 General

1. Install products in accordance with manufacturer's instructions.
2. See Specification Section 26 05 00 and the Drawings for area classifications.
3. Fill unused punched-out, tapped, or threaded hub openings with insert plugs.
4. Size boxes to accommodate quantity of conductors enclosed and quantity of conduits connected to the box.

3.6.2 Outlet Boxes

1. Permitted uses of metallic outlet boxes:
   a. Housing of wiring devices:
      1) Recessed in all stud framed walls and ceilings.
      2) Recessed in poured concrete, concrete block and brick walls of architecturally finished areas and exterior building walls.
   b. Pull or junction box:
      1) Above gypsum wall board or acoustical tile ceilings.
      2) Above 10 FT in an architecturally finished area where there is no ceiling.
2. Permitted uses of cast outlet boxes:
   a. Housing of wiring devices surface mounted in non-architecturally finished dry, wet, corrosive, highly corrosive and hazardous areas.
   b. Pull and junction box surface mounted in non-architecturally finished dry, wet, corrosive and highly corrosive areas.
   3. Mount device outlet boxes where indicated on the Drawings and at heights as scheduled in Specification Section 26 05 00.
4. Set device outlet boxes plumb and vertical to the floor.
5. Outlet boxes recessed in walls:
   a. Install with appropriate stud wall support brackets or adjustable bar hangers so that they are flush with the face of the wall.
   b. Locate in ungrouted cell of concrete block with bottom edge of box flush with bottom edge of block and flush with the face of the block.
6. Place barriers between switches in boxes with 277 V switches on opposite phases.
7. Back-to-back are not permitted.
8. When an outlet box is connected to a PVC coated conduit, the box shall also be PVC coated.

3.6.3 Pull and Junction Boxes

1. Install pull or junction boxes in conduit runs where indicated or required to facilitate pulling of wires or making connections.
   a. Make covers of boxes accessible.
2. Permitted uses of NEMA 1 enclosure:
   a. Pull or junction box surface mounted above removable ceiling tiles of an architecturally finished area.
3. Permitted uses of NEMA 4 enclosure:

   a. Pull or junction box surface mounted in areas designated as wet.
4. Permitted uses of NEMA 4X metallic enclosure:
   a. Pull or junction box surface mounted in areas designated as wet and/or corrosive.
5. Permitted uses of NEMA 7 enclosure:
   a. Pull or junction box surface mounted in areas designated as Class I hazardous.
      1) Provide PVC coating in corrosive and highly corrosive areas when PVC coated conduit is used.
6. Permitted uses of NEMA 12 enclosure:
   a. Pull or junction box surface mounted in areas designated as dry.

-- End of Section --

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LOW VOLTAGE OVERCURRENT PROTECTIVE DEVICES

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SECTION 26 05 71

LOW VOLTAGE OVERCURRENT PROTECTIVE DEVICES
02/17

PART 1 GENERAL

Section 26 00 00 BASIC ELECTRICAL MATERIALS AND METHODS applies to work specified in this section.

1.1 REFERENCES

The publications listed below form a part of this specification to the extent referenced. The publications are referred to within the text by the basic designation only.

AMERICAN NATIONAL STANDARDS INSTITUTE (ANSI)

ANSI C12.1	(2008) Electric Meters Code for Electricity Metering

ASTM INTERNATIONAL (ASTM)

ASTM D877/D877M	(2013) Standard Test Method for Dielectric Breakdown Voltage of Insulating Liquids Using Disk Electrodes

ELECTRONIC INDUSTRIES ALLIANCE (EIA)

EIA 443	(1979) NARM Standard for Solid State Relays Service

INSTITUTE OF ELECTRICAL AND ELECTRONICS ENGINEERS (IEEE)

IEEE C37.17	(2012) Standard for Trip Devices for AC and General-Purpose DC Low-Voltage Power Circuit Breakers
IEEE C37.90	(2005; R 2011) Standard for Relays and Relay Systems Associated With Electric Power Apparatus
IEEE C57.13	(2016) Requirements for Instrument Transformers
IEEE C63.2	(2009) Standard for Electromagnetic Noise and Field Strength Instrumentation, 10 Hz to 40 GHz - Specifications
IEEE C63.4	(2014) American National Standard for Methods of Measurement of Radio-Noise Emissions from Low-Voltage Electrical and Electronic Equipment in the Range of 9 kHz to 40 GHz

IPC - ASSOCIATION CONNECTING ELECTRONICS INDUSTRIES (IPC)

IPC D330	(1992) Design Guide Manual

NATIONAL ELECTRICAL MANUFACTURERS ASSOCIATION (NEMA)

ANSI C78.23	(1995; R 2003) American National Standard for Incandescent Lamps - Miscellaneous Types
NEMA 250	(2014) Enclosures for Electrical Equipment (1000 Volts Maximum)
NEMA AB 3	(2013) Molded Case Circuit Breakers and Their Application
NEMA FU 1	(2012) Low Voltage Cartridge Fuses
NEMA ICS 1	(2000; R 2015) Standard for Industrial Control and Systems: General Requirements
NEMA ICS 2	(2000; R 2005; Errata 2008) Industrial Control and Systems Controllers, Contactors, and Overload Relays Rated 600 V
NEMA ICS 6	(1993; R 2016) Industrial Control and Systems: Enclosures

NATIONAL FIRE PROTECTION ASSOCIATION (NFPA)

NFPA 70	(2017; ERTA 1-2 2017; TIA 17-1; TIA 17-2; TIA 17-3; TIA 17-4; TIA 17-5; TIA 17-6; TIA 17-7; TIA 17-8; TIA 17-9; TIA 17-10; TIA 17-11; TIA 17-12; TIA 17-13; TIA 17-14; TIA 17-15; TIA 17-16; TIA 17-17) National Electrical Code

UNDERWRITERS LABORATORIES (UL)

UL 489	(2016) UL Standard for Safety Molded-Case Circuit Breakers, Molded-Case Switches and Circuit-Breaker Enclosures
UL 508	(1999; Reprint Oct 2013) Industrial Control Equipment

1.2 SUBMITTALS

Government approval is required for submittals with a "G" designation; submittals not having a "G" designation are for information only. When used, a designation following the "G" designation identifies the office that reviews the submittal for the Government. Submit the following in accordance with Section 01 33 00 SUBMITTAL PROCEDURES:

SD-02 Shop Drawings

Connection Diagrams; G

Fabrication Drawings; G

Control Devices; G

Protective Devices; G

SD-03 Product Data

Fuses; G

Motor Controllers; G

Circuit Breakers; G

Control Devices; G

Indicating Instruments; G

Indicating Lights; G

SD-06 Test Reports

Dielectric Tests; G

Final Test Reports; G

SD-08 Manufacturer's Instructions

Control Devices; G

Protective Devices; G

SD-10 Operation and Maintenance Data

Circuit Breakers; G

PART 2 PRODUCTS

2.1 SYSTEM DESCRIPTION

Submit connection diagrams showing the relations and connections of control devices and protective devices by showing the general physical layout of all controls, the interconnection of one system (or portion of system) with another, and internal tubing, wiring, and other devices.

Submit fabrication drawings for control devices and protective devices consisting of fabrication and assembly details performed in the factory.

2.2 EQUIPMENT

2.2.1 Motor Controllers

Conform to NEMA ICS 1, NEMA ICS 2, and UL 508 for motor controllers. Ensure controllers have thermal overload protection in each phase.

2.2.1.1 Manual Motor Controllers

Not used.

2.2.1.2 Magnetic Motor Controllers

Not used.

2.2.1.3 Combination Motor Controllers

Not used.

2.2.2 Circuit Breakers

Provide circuit breakers that conform to UL 489 and NEMA AB 3.

2.2.2.1 Molded-Case Circuit Breakers

Provide molded-case, manually operated, trip-free circuit breakers, with inverse-time thermal-overload protection and instantaneous magnetic short-circuit protection as required. Completely enclose circuit breakers in a molded case, with a factory-sealed, calibrated sensing element to prevent tampering.

Locate thermal-magnetic tripping elements in each pole of the circuit breaker, and provide inverse-time-delay thermal-overload protection and instantaneous magnetic short-circuit protection. Provide an instantaneous magnetic tripping element that is adjustable and accessible from the front of the breaker on frame sizes larger than 100 A.

Size the breaker as required for the continuous-current rating of the circuit. Provide the breaker class as required.

Provide sufficient interrupting capacity of the panel and lighting branch circuit breakers to successfully interrupt the maximum short-circuit current imposed on the circuit at the breaker terminals. Provide circuit breaker interrupting capacities with a minimum of 10,000 A and that conform to NEMA AB 3.

Provide the common-trip-type multipole circuit breakers having a single operating handle and a two-position on/off indication. Provide circuit breakers with temperature compensation for operation in an ambient temperature of 104 degrees F. Provide circuit breakers that have root mean square (rms) symmetrical interrupting ratings sufficient to protect the circuit being supplied. Interrupting ratings may have selective-type tripping (time delay, magnetic, thermal, or ground fault).

Provide a phenolic-composition breaker body capable of having such accessories as handle-extension, handle-locking, and padlocking devices attached where required.

For meter circuit disconnects, provide circuit breakers of the motor-circuit-protector type that meet the applicable requirements of NFPA 70.

For service disconnection, provide enclosed circuit-breakers with external handles for manual operation. Provide sheet-metal enclosures with hinged covers suitable for surface mounting.

2.2.2.2 Enclosed Molded-Case Circuit Breakers

For enclosed circuit breakers, provide thermal-magnetic, molded-case circuit breakers in surface-mounted, nonventilated enclosures conforming to

NEMA 250 and UL 489.

Provide enclosed circuit breakers in nonhazardous locations as follows:

a. Contain circuit breakers installed inside clean, dry locations in NEMA Type 1, general purpose, sheet-steel enclosures.

b. Contain circuit breakers installed in unprotected outdoor locations, in NEMA Type 3R, weather-resistant sheet-steel enclosures that are splashproof, weatherproof, sleetproof, and moisture-resistant.

c. Contain circuit breakers installed in wet locations, in NEMA Type 4, watertight corrosion-resistant, sheet-steel enclosures constructed to prevent entrance of water.

2.2.3 Fuses

Provide a complete set of fuses for all switches and switchgear. Ensure that fuses have a voltage rating of not less than the circuit voltage.

Make no change in continuous-current rating, interrupting rating, or clearing or melting time of fuses unless written permission is first obtained from the Contracting Officer.

Provide nonrenewable-cartridge-type fuses for ratings 30 A, 125 V or less. Provide renewable-cartridge-type fuses for ratings above 30 A 600 V or less with time-delay dual elements, except where otherwise indicated. Ensure that fuses conform to NEMA FU 1.

Install special fuses such as extra-high interrupting-capacity fuses, fuses for welding machines, and capacitor fuses where required. Do not use plug fuses.

Label fuses showing UL class, interrupting rating, and time-delay characteristics, when applicable.

Provide porcelain fuse holders when field-mounted in a cabinet or box. Do not use fuse holders made of such materials as ebony asbestos, Bakelite, or pressed fiber for field installation.

2.2.4 Control Devices

2.2.4.1 Magnetic Contactors

Provide magnetic contactors in accordance with NEMA ICS 1 and NEMA ICS 2 as required for the control of low-voltage, 60-Hz, tungsten-lamp loads, fluorescent-lamp loads, resistance-heating loads, and the primary windings of low-voltage transformers.

Provide core-and-coil assembly that operates satisfactorily with coil voltage between 85 percent and 110 percent of its voltage rating.

Provide contactors that are designed with a normally open holding-circuit auxiliary contact for control circuits, with a rating in accordance with NEMA ICS 1 and NEMA ICS 2.

Furnish solderless pressure wire terminal connectors, or make available for line and load connections to contactors in accordance with NEMA ICS 1 and NEMA ICS 2.

Provide magnetic contactors with a rating in accordance with NEMA ICS 1 and NEMA ICS 2.

2.2.4.2 Control-Circuit Transformers

Provide control-circuit transformers within the enclosure of magnetic contactors and motor controllers when the line voltage exceeds 120 V. Provide an encapsulated dry-type, single-phase, 60-Hz transformer, with a 120 V (or 24 V) isolated secondary winding.

Do not provide a transformer with a rated primary voltage less than the rated voltage of the controller, or a rated secondary current less than the continuous-duty current of the control circuit.

Provide voltage regulation of the transformer such that, with rated primary voltage and frequency, the secondary voltage is not less than 95 percent nor more than 105 percent of rated secondary voltage.

Provide a source of supply for control-circuit transformers at the load side of the main disconnecting device. Protect the secondary winding of the transformer and control-circuit wiring against overloads and short circuits, with fuses selected in accordance with NEMA ICS 6. Ground the secondary winding of the control-circuit transformer in accordance with NEMA ICS 6.

2.2.4.3 Magnetic Control Relays

Provide magnetic control relays for energizing and de-energizing the coils of magnetic contactors or other magnetically operated devices, in response to variations in the conditions of electric control devices in accordance with NEMA ICS 1, and NEMA ICS 2.

Ensure that the core-and-coil assembly operates satisfactorily with coil voltages between 85 percent and 110 percent of their voltage rating.

Provide relays that are designed to accommodate normally open and normally closed contacts.

Provide 120 V, 60-Hz, Class AIB magnetic control relays with a continuous--contact rating of 10 A, and with current-making and -breaking ability in accordance with NEMA ICS 1 and NEMA ICS 2, two normally open and two normally closed.

2.2.4.4 Pushbuttons and Switches

a. Pushbuttons

For low-voltage ac full-voltage magnetic pushbutton controllers, provide heavy-duty, oiltight NEMA 250, Type 12, momentary-contact devices rated 600 V, with pilot light, and with the number of buttons and the marking of identification plates as shown. Furnish pushbutton color code in accordance with NEMA ICS 6.

Provide pushbuttons that are designed with normally open, circuit-closing contacts; normally closed circuit-opening contacts; and two-circuit normally open and normally closed circuit-closing and -opening contacts. Ensure that pushbutton-contact ratings are in accordance with NEMA ICS 1 and NEMA ICS 2, with contact designation A600.

Identify pushbuttons in remote-control stations with identification plates affixed to the front cover in a prominent location. Identify the system being controlled on the identification plate.

b. Selector Switches

Provide heavy-duty, oiltight, maintained-contact selector switches for low-voltage control circuits, with the number of positions and the marking of identification plates in accordance with NEMA ICS 1 and NEMA ICS 2.

Identify selector switches in remote-control stations with engraved identification plates affixed to the front cover in a prominent location. Identify the system being controlled on the identification plate.

c. Ammeter Selector Switches

Not used.

d. Voltmeter Selector Switches

Not used.

e. Miscellaneous Switches

Provide float, limit, door, pressure, proximity, and other types of switches in accordance with IPC D330 and of the types and classes indicated.

2.2.5 Finish

Protect metallic materials against corrosion. Provide equipment with the standard finish by the manufacturer when used for most indoor installations. For harsh indoor environments (any area subjected to chemical or abrasive action) and all outdoor installations, refer to Section 09 90 00 PAINTS AND COATINGS.

2.3 COMPONENTS

2.3.1 Instrument Transformers

Comply with the interference requirements listed below, measured in accordance with IEEE C63.2, and IEEE C63.4 for Instrument transformers.

Insulation Class kV	Basic Insulation Level kV	Nominal System Voltage kV	Preferred Test Voltage for Potential Transformers kV	Test Voltage for Current Transformers kV	Radio Influence Voltage Level, Microvolts Dry Type Filled	Oil
0.6	10	----	----	0.76	250	250
1.2	30	0.208 0.416 0.832 1.04	0.132 0.264 0.528 0.66	0.76	250	250
2.5	45	2.40	1.52	1.6 7	250	250
5.0	60	4.16 4.80	2.64 3.04	3.34	250	250
8.7	75	7.20 8.32	4.57 5.28	5.77	250	250
15L or 15H	95 - 110	12.00 12.47 14.40	7.62 7.92 9.14	9.41	1000	250
25	150	23.00	14.60	15.70	2500	650
34.5	200	34.50	21.90	23.0	----	650
46	250	46.00	29.20	29.30	----	1250
69	350	69.00	43.80	44.00	----	1250
92	450	92.00	58.40	58.40	----	2500
115	550	115.00	73.40	73.40	----	2500
138	650	138.00	88.00	88.00	----	2500

2.3.1.1 Current Transformers

Ensure that current transformers conform to IEEE C57.13 for installation in metal-clad switchgear. Use a standard 3-A secondary transformer.

Provide wound-type transformers.

Provide transformers that have single secondary winding.

Provide transformers that are complete with a secondary short-circuiting device.

For window-type current transformers, provide indoor, dry-type construction, with secondary current ratings as indicated with the specified burden, frequency, and accuracy.

2.3.1.2 Potential Transformers

For potential transformers, conform to IEEE C57.13 for installation in metal-clad switchgear. Use standard 120-volt secondary transformers.

Provide transformers that have single secondary winding.

Provide burden, frequency, and accuracy as required.

For disconnecting potential transformers with integral fuse mountings and current-limiting fuses, provide indoor, dry-type two-winding construction with primary and secondary voltage ratings as required.

2.3.2 Enclosures

2.3.2.1 Equipment Enclosures

Provide enclosures for equipment in accordance with NEMA 250.

Contain equipment that is installed inside clean, dry locations in a NEMA Type 1, general-purpose sheet-steel enclosure.

Contain equipment that is installed in wet locations in a NEMA Type 4, watertight, corrosion-resistant, sheet-steel enclosure. Construct the enclosure to prevent entrance of water when tested in accordance with NEMA ICS 6 for Type 4 enclosures.

Contain equipment that is installed in industrial locations in a NEMA Type 12, industrial-use, sheet-steel enclosure. Construct the enclosure to prevent the entrance of dust, lint, fibers, and flyings and the seepage of oil and coolant.

2.3.3 Time Switches

Not used.

2.3.4 Protective Relays

2.3.4.1 Overcurrent Relays

Provide a trip unit that employs a combination of discrete components and integrated circuits to ensure the time-current protection functions as required in a modern, selectively coordinated distribution system.

Conform relays to IEEE C37.90 for overcurrent relays.

For protection against phase and ground faults, provide single-phase nondirectional, removable, induction-type overcurrent relays with built-in testing facilities designed for operation on the dc or ac control circuit indicated.

Provide ground-fault overcurrent relays with short-time inverse-time characteristics with adjustable current tap range as required.

Provide phase-fault overcurrent relays with varied inverse-time characteristics with adjustable current tap range as required. Provide attachments that indicate instantaneous trip with adjustable current range as required.

Provide solid-state, static-type trips for low-voltage power circuit breakers in accordance with EIA 443 and IEEE C37.17.

Provide complete system-selective coordination by using a combination of the following time-current curve-shaping adjustments: ampere setting; long-time delay; short-time pickup; short-time delay; instantaneous pickup; and ground fault.

Provide switchable or easily defeatable instantaneous and ground fault trips.

Make all adjustments using nonremovable, discrete-step, highly reliable switching plugs for precise settings. Provide a sealable, transparent cover over the adjustments to prevent tampering.

Furnish trip devices with three visual indicators to denote the automatic tripping mode of the breaker, including overload, short circuit, and ground fault.

Wire the trip unit to the appropriate terminals so that an optional, remote, automatic trip accessory can be used to provide the same indication.

Make available for use a series of optional, automatic trip relays for use with the trip unit to provide remote alarm and lockout circuits.

Provide all trip units with test jacks for in-service functional testing of the long-time instantaneous and ground-fault circuits using a small handheld test kit.

2.3.4.2 Directional Overcurrent Relays

Not used.

2.3.4.3 Reclosing Relays

Not used.

2.3.4.4 Undervoltage Relays

Not used.

2.3.5 Indicating Instruments

2.3.5.1 Ammeters

Not used.

2.3.5.2 Voltmeters

Not used.

2.3.5.3 Watt-Hour Meters/Wattmeters

Not used.

2.3.5.4 Graphic Demand Meters

Not used.

2.3.6 Indicating Lights

2.3.6.1 General-Purpose Type

For indicating lights, provide oiltight instrument devices with threaded base and collar for flush mounting; translucent convex lens; candelabra screw-base lampholder; and 120 V, 6 W, Type S-6 incandescent lamp in accordance with ANSI C78.23. Provide indicating lights that are color-coded in accordance with NEMA ICS 6.

Provide indicating lights in remote-control stations when pushbuttons and selector switches are out of sight of the controller.

2.3.6.2 Switchboard Indicating Lights

For switchboard indicating lights, provide the manufacturer's standard transformer-type units 120 V input using low-voltage lamps and convex lenses of the colors indicated. Provide indicating lights that are capable of being relamped from the switchboard front. Do not use indicating lights that use resistors in series with the lamps, except in dc control circuits. Provide lights that have a press-to-test feature.

PART 3 EXECUTION

3.1 INSTALLATION

Clearly list fuse information on equipment drawings.

Install control devices and protective devices that are not factory-installed in equipment, in accordance with the manufacturer's recommendations. Field-adjust the devices. Perform operation tests on the control and protective devices. Conform requirements for installation of control and protective devices to NFPA 70, NEMA ICS 1, and NEMA ICS 2.

3.2 FIELD QUALITY CONTROL

3.2.1 Tests

Demonstrate the operation and controls of protective devices of non-factory-installed equipment.

Verify tap settings of instrumentation, potential, and current transformers.

Perform dielectric tests on insulating oil in oil circuit breakers before the breakers are energized. Test oil in accordance with ASTM D877/D877M, and provide breakdown voltage that is not less than 25,000 V. Provide manufacturer certification that the oil contains no PCB's, and affix a label to that effect on each breaker tank and on each oil drum containing the insulating oil.

Field-adjust reduced-voltage starting devices to obtain optimum operating conditions. Provide test meters and instrument transformers that conform to ANSI C12.1 and IEEE C57.13.

Do not energize control and protective devices until the results of the recorded test data have been approved by the Contracting Officer. Provide final test reports with a cover letter/sheet clearly marked with the system name, date, and the words final test reports to the Contracting Officer for approval.

-- End of Section --

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SECTION 26 08 01

ELECTRICAL POWER SYSTEM STUDY
01/19

PART 1 GENERAL

1.1 SUMMARY

Contractor shall be responsible to obtain information on existing electrical equipment and existing electrical power system studies if available. Field work will be required to verify actual installation from point of Pacific Gas And Electric (PG&E) connection to first piece of new electrical equipment connected to the existing electrical system.

Contractor shall be responsible for the activities required to perform all analyses including, but not limited to: data collection, system modeling, and model verification, using industry approved modeling software (ETAP, SKM).

Analysis shall include Protective device coordination study, Short Circuit study, Fault and Device Duty evaluation, Load Flow study, Transient Motor Starting (TMS) Study and Arc Flash Hazard Assessment. Project deliverables shall include a detailed report of the findings and recommendations.

Contractor will adjust all relays and adjustable trip circuit breakers to settings determined by the Power system study.

Contractor shall provide and attach new Arc Flash labels to new and existing electrical equipment as required by National Fire Protection Agency (NFPA) NFPA 70E.

1.2 REFERENCES

The publications listed below form a part of this specification to the extent referenced. The publications are referred to within the text by the basic designation only.

INSTITUTE OF ELECTRICAL AND ELECTRONICS ENGINEERS (IEEE)

IEEE 1584	(2018) Guide for Performing Arc Flash Hazard Calculations
IEEE C2	(2017; Errata 1-2 2017; INT 1 2017) National Electrical Safety Code

NATIONAL FIRE PROTECTION ASSOCIATION (NFPA)

NFPA 70E	(2018; TIA 18-1; TIA 81-2) Standard for Electrical Safety in the Workplace

1.3 SUBMITTALS

Government approval is required for submittals with a "G" designation; submittals not having a "G" designation are for information only. When used, a designation following the "G" designation identifies the office that will review the submittal for the Government. Submit the following in accordance with Section 01 33 00 SUBMITTAL PROCEDURES:

SD-01 Preconstruction Submittals

Initial Studies and Reports; G

SD-06 Test Reports

Electrical power system study; G

SD-07 Certificates

Certification; G

Credentials

SD-11 Closeout Submittals

Final Studies and Reports; G

1.3.1 Electrical Power System Study

Completed electrical power system studies shall be bound and submitted to Engineer.

Contractor is responsible for completing an electrical power system study. Contractor shall provide a table containing the settings of all relays and adjustable trip circuit breakers rated over 100A.

Contractor shall perform an electrical power system study to determine the final settings of the relays, fused and adjustable trip circuit breakers over 100A per the final "As-Built" installation. The study shall be included in the switchgear O&M manual. This submittal will contain the following:

1. Complete input data report, including computer generated protected device settings report.
2. Load Flow Study
3. Load Flow, Short Circuit and Arc Flash analyzer reports in MS Excel format.
4. Short Circuit and Arc Flash result analyzer reports shall indicate worst case scenario conditions and associated results.
5. Coordination Study Report including computer generated Time-current Characteristic Curves (TCC).
6. Arc Flash Hazard Assessment Report and Personal Protective Equipment Label.
7. Electronic copy of computer software (project) model including update to existing model if available.

1.3.2 Initial Studies and Reports

Include the following in the initial short circuit current report:

a. List of all devices included in the studies.
b. A description of all operating scenarios.
c. Form and format of arc flash labels.

1.3.3 Final Studies and Reports

Format and Quantity:

a. Provide 6 bound copies of all final reports.
b. Provide 3 complete sets of electronic files on CD or DVD media, including the electrical system model(s), configuration files, custom libraries, and any other files used to perform the studies and produce the reports. Also provide an electronic version of the bound reports in PDF format.

Include the sections below in the final report:

a. Copies of correspondence and data obtained from the Electric Utility Company.
b. Letter certifying the inspection and verification of existing equipment.
c. One-line diagrams:
    1) The following information shall be included at a minimum:
        a) Motor horsepower.
        b) Transformer data:
            (1) KVA
            (2) Configuration
        c) Cable Data:
            (1) Insulation.
            (2) Size.
            (3) Length.
    2) One-line diagrams shall be fully legible at 11-inch by 17-inch size.
d. Include in the load flow study:
    1) Descriptions, purpose, basis, assumptions, recommendations, and scope of the study.
    2) Modeling of utility and generator equivalent impedance calculated from short circuit duty.
    3) Modeling of motor and non-motor loads.
    4) Reporting of bus voltage, voltage angle, and voltage drop at each bus, and branch voltage drop, branch loss, and total system losses.
e. Include in the transient motor starting study:
    1) Descriptions, purpose, basis, assumptions, recommendations, and scope of the study.
    2) Simulation of all pump motor scenarios dynamically modeled throughout starting, stopping or reacting to load changes. Simulations to be run from utility and generator power.
    3) Voltage dip impact on motor starting and motor accelerating times.
    4) Evaluation of interaction between multiple motors during starting conditions, motor starting heating problems, application of reduced voltage starters.
    5) Optimal timing of staggered motor starting and re acceleration schemes.
    6) Time related output data including bus voltage, motor speed, motor slip, motor torque, load torque, accelerating torque, stator voltage, stator current, input power, VARs, power factor, and rotor current.
f. Include in the short-circuit fault analysis study:
    1) Descriptions, purpose, basis, assumptions, recommendations, and scope of the study.
    2) Normal system connections and those, which result in maximum fault conditions.
    3) Tabulation of circuit breaker, fuse, and other protective device ratings compared to maximum calculated short circuit duties.
    4) Fault current calculations for the cases run including a definition of terms and guide for interpretation of computer software printouts.
g. Protective device coordination study shall include:
    1) Descriptions, purpose, basis, assumptions, recommendations, and

scope of the study.
2) List all requirements used in the selection and setting criteria for any protective devices.
3) Manufacturer's time-current curves for circuit breakers, fuses, motor circuit protectors, and other protective devices for all new equipment.
4) Time-current curves (TCCs) graphically indicating the coordination proposed for the system on log-log graphs. At least 3 of the copies shall be in color.
5) Tabulation of relay, fuse, circuit breaker, and other protective devices in graphical form with a one-line diagram to display area coordination.
6) Where coordination could not be achieved, an explanation shall be included in the report to support the statement along with recommendations to improve coordination. Recommended equipment modifications or settings shall be in a tabulated form.

h. Include in the arc-flash study:
1) Descriptions, purpose, basis, assumptions, recommendations, and scope of the study.
2) Normal system connections and those, which result in maximum arc-flash conditions.
3) Arc-flash raw data, calculations, and assumptions.
4) Arc-flash label data:
a) Identifying the content of each label.
b) Identifying the location of each label.

1.3.4 Certification

Submit written certification, sealed, and signed by the professional engineer conducting the study, equipment supplier, and electrical subcontractor stating that the data used in the study is correct.

1.3.4.1 Credentials

Submit the credentials of the individual(s) performing the study and the individual in responsible charge of the study.

1.3.5 Engineer Review

The Engineer will review all studies and reports. After review, the Engineer will make recommendations and/or require changes to be made to the short-circuit analysis, protective device coordination or arc-flash studies. These changes shall be provided as part of the scope of work.

1.4 SYSTEM DESCRIPTION

1.4.1 General Study Requirements

1.4.1.1 Scope

The load flow, transient motor starting, short-circuit fault analysis, protective device coordination and arc-flash hazard studies shall include all equipment in the power distribution system including but not limited to:

1) Utility equipment.
2) Switchboards.
3) Generators.
4) Transformers:
a) Including all dry-type transformers.

5) Motor Control Centers.
6) Autotransformer Starters.
7) Disconnect Switches.
8) Motors.
9) Panelboards: Including all 240 and 208 volt systems
10) Vendor Control Panels.
11) HVAC Equipment.

1.4.1.2 Study Scenarios

1) The studies shall include all possible electrical system configurations, for example:
   a) Operation on normal (utility) source.
   b) Operation on generator source.

1.4.1.3 Required Data

Obtain, for all equipment, the required data for preparation of the study, including, but not limited to:

a. Transformer kilovolt-ampere and impedances.
b. Generator impedances.
c. Generator decrement curves.
d. Bus withstand ratings.
e. Cable and bus data.
f. Protective device taps, time dials, instantaneous pickups, and time delay settings.

1.4.1.4 Electric Utility Information

Obtain the Electric Utility information on the minimum and maximum available fault current, minimum and maximum utility impedances, utility protective device settings including manufacturer and model number, interrupting ratings, X/R ratios, and model information one level above the point of connection:

a. Utility tolerances and voltage variations.

1.4.1.5 Site Visit and Field Data

The individual performing the studies shall visit the site and collect all necessary field data in order to perform and complete comprehensive electrical system studies.

Coordinate with client to obtain prior system coordination and arc flash studies.

1.4.1.6 Equipment Layouts And Configurations

Obtain equipment layouts and configurations from the manufacturer's final submittal requirements and Contract Drawings as required.

1.4.1.7 Bus and Conductor Data

Use impedances of the actual installed or specified conductors, unless otherwise indicated.

Use cable and bus impedances calculated at 25 degrees Celsius, unless otherwise indicated.

Use 600-volt cable reactance based on typical dimensions of actual installed or specified conductors, unless otherwise indicated for low voltage conductors.

Use 2.4kv and 5kv cable reactance based on typical dimension of actual installed or specified conductors, unless otherwise indicated for medium voltage conductors.

Use bus withstand values for all equipment having buses.

Use medium voltage cable reactance's based on typical dimensions of shielded and non-shielded cables with 133 percent insulation levels, unless otherwise indicated.

1.4.1.8 Motors

Each motor shall be individually modeled:

1) Grouping of motors for fault contribution current is not acceptable.

Use the equipment, bus, and device designations as indicated on the Drawings for all studies.

1.4.2 Short-circuit Fault Analysis Study Additional Requirements

The short-circuit fault analysis shall be performed and submitted in 2 phases:

Initial short-circuit fault analysis:
1) Based on the Contract Documents and Electric Utility information.
2) The initial short-circuit fault analysis report shall indicate the estimated available short-circuit current at the line side terminals of each piece of equipment covered by the scope of the study.
3) Provide a list of assumptions used in the initial study.

Final short-circuit analysis:
1) The final short-circuit fault analysis shall modify the initial analysis as follows:
    a) Utilize the actual equipment provided on the project.
    b) Utilize conductor lengths based on installation.

Calculate 3-phase bolted fault, line-to-line fault, and line-to-ground fault short circuit current values at each piece of equipment in the distribution system.

Evaluate bus bracing, short circuit ratings, fuse interrupting capacity and circuit breaker adjusted interrupting capacities against the fault currents, and calculate X/R values:
a. Identify and document all devices and equipment as either inadequate or acceptable.

Calculate line-to-ground momentary short circuit values at all buses having ground fault devices.

Provide calculation methods, assumptions, one-line diagrams, and source impedance data, including Utility X/R ratios, typical values, recommendations, and areas of concern.

1.4.3 Protective Device Coordination Study Additional Requirements

Protective device coordination study additional requirements:

Furnish protective device settings for all functions indicated on the Drawings, including, but not limited to:
a. Current.
b. Voltage:
   1) Provide settings for all voltage relays based upon actual Utility and generator tolerances and specifications.
c. Frequency:
   1) Provide settings for all frequency relays based upon actual Utility and generator tolerances and specifications.
d. Machine protection functions:
   1) Provide settings for all motor and generator protective relays based on the manufacturer's recommended protection requirements.

Provide log-log form time-current curves (TCCs) graphically indicating the coordination proposed for the system:
a. Include with each TCC a complete title and one-line diagram with legend identifying the specific portion of the system covered by the particular TCC:
   1) Typical time-current curves for identical portions of the system, such as motor circuits, are acceptable as allowed by the ENGINEER.
b. Include a detailed description of each protective device identifying its type, function, manufacturer, and time-current characteristics:
   1) These details can be included on the TCC.
c. Include a detailed description of each protective device tap, time dial, pickup, instantaneous, and time delay settings:
   1) These details can be included in the TCC.

TCCs shall include all equipment in the power distribution system where required to demonstrate coordination. Include Utility relay and fuse characteristics, medium voltage equipment protective relay and fuse characteristics, low-voltage equipment circuit breaker trip device characteristics, transformer characteristics, motor and generator characteristics, and characteristics of other system load protective devices:

a. Include all devices down to the largest branch circuit and largest feeder circuit breaker in each motor control center, main breaker in branch panelboards and fused disconnect switches.
b. Provide ground fault TCCs with all adjustable settings for ground fault protective devices.
c. Include manufacturing tolerances and damage bands in plotted fuse and circuit breaker characteristics.
d. On the TCCs show transformer full load currents, transformer magnetizing inrush, ANSI transformer withstand parameters and transformer damage curves.
e. Cable damage curves.
f. Terminate device characteristic curves at a point reflecting the maximum symmetrical or asymmetrical fault current to which the device is exposed based on the short-circuit fault analysis study.
g. Coordinate time interval medium-voltage relay characteristics with upstream and downstream device to avoid nuisance tripping.

Suggest modifications or additions to equipment rating or settings in a tabulated form.

1.4.4 Arc-Flash Hazard Study Additional Requirements

Include the calculated arc-flash boundary and incident energy (calories/square centimeter) at each piece of equipment in the distribution system:

a. Perform Arc-flash calculations for both the line side and load side of switchgear, switchboard, motor control center, and panelboard main breakers.
b. Perform arc-flash calculations for all short-circuit scenarios with all motors on for 3 to 5 cycles and with all motors off.
c. Protective device clearing time shall be limited to 2 seconds, maximum.

Provide executive summary of the study results.

Provide a detailed written discussion and explanation of the tabulated outputs.

Provide alternative device settings to allow the Engineer to select the desired functionality of the system:

a. Minimize the arc-flash energy by selective trip and time settings for equipment maintenance purposes.
b. Identify the arc-flash energy based upon the criteria of maintaining coordination and selectivity of the protective devices.

Perform the arc flash study calculations using both IEEE 1584 and NFPA 70E. Provide both studies in the final report. Provide summary based upon worst case results between IEEE 1584 and NFPA 70E.

1.4.5 Electrical System Study Meetings

The individual conducting the load flow, transient motor starting, short circuit analysis, protective device coordination, and the arc-flash hazard studies shall meet with the Engineer 3 times.

The purpose of the 3 meetings is as follows:

Initial meeting:
1) Meet with the Engineer to discuss the scope of the studies.
2) Discuss the Engineer's operational requirements for both normal operation and maintenance.

Preliminary results meeting:
1) This meeting will be held after the studies have been completed, reviewed, and accepted by the Engineer.
2) The purpose of this meeting is to inform the Engineer of the results of the study and impacts on normal operation and maintenance including:
    a) Load flow results and its potential impact on operations.
    b) Transient Motor Starting results and recommended solutions for optimal timing.
    c) Protective device coordination problems and recommended solutions.
    d) Explanation of the arc-flash study results and its potential impact on operations.
    e) Recommendations for reduction of arc-flash category levels including reduction of protective device settings or changes in operational practices.

Final meeting:

1) Discuss changes to the reports based on the previous meeting.
2) Discuss with the Engineer how changes to the electrical system may change the arc-flash hazard category.
3) Deliver the final electrical system studies report.

The meetings will be at the Engineer's facility:

a. Provide a minimum of 3 weeks notice to the Engineer in advance of the projected meeting date.
b. Submit a draft of the meeting agenda when each meeting is requested.

Meeting materials:

a. Prepare and provide the following materials:
    1) Meeting agenda. Include at a minimum the scope of the meeting, estimated time length for the meeting and meeting goals.
    2) Six copies of the project one-line diagrams for the initial meeting.
    3) Six copies of the studies of the submitted study.

1.4.6 Right to Modify

By virtue of the fact that this is a professional study, the Engineer reserves the right to modify the requirements of the study to comply with its operational requirements. The protective device coordination study and the arc-flash study shall be modified based on the results of the meetings with the Engineer.

1.5 QUALITY ASSURANCE

Refer to Section 26 00 00.

Qualifications of the entity responsible for electrical system studies:

1. The studies shall be performed, stamped, and signed by a Professional Engineer registered in the state where the project is located.
2. A minimum of 5 years' experience in power system analysis is required for the individual in responsible charge of the studies.
3. The short-circuit analysis, protective device coordination, and arc-flash hazard studies shall be performed with the aid of a digital computer program:
    a. Point-to-point calculations are not acceptable.

The study shall be performed by an independent firm.

1.6 SEQUENCING

Site visit to gather data on the existing facility systems for all studies:

1. Make multiple trips as required to obtain all data for the short-circuit, protection device coordination and arc flash study.

Submit the initial short-circuit analysis study before submittal of any electrical equipment.

Submit the final short-circuit analysis and protective device coordination studies.

Initial arc-flash meeting.

Submit the arc-flash hazard study.

Second arc-flash meeting for preliminary results.

Final arc-flash meeting and final reports.

PART 2 PRODUCTS

2.1 MANUFACTURERS

Electrical system study software:
1. Powertools by SKM Systems Analysis, or approved equal.

2.2 COMPONENTS

2.2.1 Arc-Flash Hazard Labels

Dimensions:
a. Minimum 5 inches by 3.5 inches.

Materials:

a. Polyester with polyvinyl polymer over-laminate.
b. Self-adhesive.
c. Resistant to:
    1) UV.
    2) Chemicals and common cleaning solvent resistant.
    3) Scuffing.
    4) Wide temperature changes.

Contents:
a. Short-circuit bus identification.
b. Calculated incident energy (calories/square centimeter) range.
c. Arc-flash protection boundary.
d. Shock Hazard Boundary:
    1) The Contactor may provide separate labels for indication of the shock hazard boundary.

Color Scheme:
a. For locations above 40 calories/square centimeter:
    1) White label with red "DANGER" strip across the top.
    2) Black lettering.
b. For locations below 40 calories/square centimeter:
    1) White label with orange "WARNING" strip across the top.
    2) Black lettering.

2.3 SITE VISIT

Review safety procedures, and facility conditions prior to site visit.

Request available short circuit current and X/R ratio from Pacific Gas and Electric (PG&E) at PG&E point of connection. Indicate available short circuit at all substations and switchboards between the PG&E point of connection and the last piece of equipment which shall require Arc Flash label. Record the settings of all relays and adjustable trip circuit breakers 100A or above between PG&E feed point and the last piece of equipment requiring Arc Flash label. Incorporate the recorded information in all electrical system studies.

If the above data is not available state the reason that the information could not be located and the method used to determine the assumed settings.

PART 3 EXECUTION

3.1 ELECTRICAL POWER SYSTEM STUDIES

A one line diagram shall be provided with all equipment and material that is part of the electrical system studies. The device numbers and names shall match those shown on the existing 'As-Built' Drawings or Contract Drawings for new equipment. The following data shall be collected for the study.

1. Product Data for overcurrent protective devices involved in overcurrent protective device coordination studies. Use equipment designation tags that are consistent with electrical distribution system diagrams, overcurrent protective device submittals, input and output data, and recommended device settings.

2. Electrical Distribution System Diagram: In hard-copy and electronic-copy formats, showing the following:

   a. Circuit-breaker and fuse-current ratings and types.
   b. Generator kilovolt amperes, size, voltage, and source impedance
   c. Cables: Indicate conduit material, sizes of conductors, conductor material, insulation, and length.
   d. Motor horsepower and code letter designation according to NEMA MG 1.

3. Data sheets to supplement electrical distribution system diagram, cross-referenced with tag numbers on diagram, showing the following:

   a. Special load considerations such as cranes, including starting inrush currents, regeneration and frequent starting and stopping
   b. Transformer characteristics, including primary protective device, magnetic inrush current, and overload capability
   c. Motor full-load current, locked rotor current, service factor, starting time, type of start, and thermal-damage curve.
   d. Ratings, types, and settings of utility company's overcurrent protective device
   e. Manufacturer, frame size, interrupting rating in amperes rms symmetrical, ampere or current sensor rating, long-time adjustment range, short-time adjustment range, and instantaneous adjustment range for circuit breakers
   f. Manufacturer and type, ampere-tap adjustment range, time-delay adjustment range, instantaneous attachment adjustment range, and current transformer ratio for overcurrent relays
   g. Panelboards, switchboards, motor-control center ampacity, and interrupting rating in amperes rms symmetrical

3.2 SHORT CIRCUIT STUDY

Short circuit study will be performed to ensure that all electrical equipment and protective devices can withstand the maximum available short circuit current.

1. Calculate the maximum available short circuit current in amperes rms symmetrical at circuit-breaker positions of the electrical power distribution system. The calculation shall be for a current

immediately after initiation and for a three-phase bolted short circuit. Calculate momentary and interrupting duties on the basis of maximum available fault current at each of the following:

a. Switchgear, switchboard, busways, bus duct, motor control centers, unit substations, transformers, panelboards, automatic transfer switches and other significant locations throughout the system.

2. Study electrical distribution system from normal and alternate power sources throughout electrical distribution system for Project. Include studies of system-switching configurations and alternate operations that could result in maximum fault conditions

3. Protective Device Time-Current Coordination Analysis
   a. The time-current coordination analysis shall be performed with the aid of computer software program, SKM or approved equal, and will include the determination of settings, ratings, or types for the overcurrent protective devices supplied.
   b. A sufficient number of computer generated Time-current Characteristic Curves (TCC) log-log plots shall be provided to indicate the degree of system protection and coordination by displaying the time-current characteristics of connected overcurrent devices and other pertinent system parameters.
   c. Computer printouts shall accompany the log-log plots and will contain descriptions for each of the devices shown, settings of the adjustable devices, the short-circuit current availability at the device location and device identification numbers to aid in locating the devices on the log-log plots and the system one-line diagram.
   d. When equipment is directly connected to Pacific Gas and Electric (PG&E), Contractor shall work with PG&E and ensure that all relay settings or adjustable trip breaker coordinate with PG&E.
   e. The study shall include a separate, table containing the suggested device setting of all relays and adjustable overcurrent protective devices; indicate the equipment where the device is located, and the device number corresponding to the device on the system one-line diagram.
   f. A computer generated system one-line diagram shall be provided which clearly identifies individual equipment buses, bus numbers, device identification numbers and the maximum available short-circuit current at each bus. These identifications must be in accordance with Contract Documents and identical to what is shown in Contract Documents.
   g. A discussion section which evaluates the degree of system protection and service continuity with overcurrent devices, along with recommendations as required for addressing system protection or device coordination deficiencies.

4. Significant deficiencies in protection and/or coordination shall be called to the attention of the Engineer and recommendations made for improvements as soon as they are identified.

3.3 LOAD FLOW STUDY

Load flow study shall be performed to evaluate the system's capability to adequately supply the connected load and prevent overloading of equipment.

Compare equipment (transformers, cables, breakers, fuses) operating values against manufacturer's specified maximum capability ratings whenever available.

Provide a computer generated Alert View list/report which lists all equipment that is overloaded

Voltage drop calculations shall be performed on all circuits to determine the worst case voltage drop. Feeder voltage drop shall be limited to 3% and combined feeder and branch circuit shall be less than 5%. The voltage drop results shall be shown individually on the single line diagram

Provide a computer generated load flow analysis report that provides a summarized comparison of power flow results between the different scenarios being evaluated.

3.4 ARC FLASH HAZZARD ANAYSIS

All requirements shall be from the latest edition of the referenced code or standard. Arc Flash warning labels shall be provided on all electrical equipment as required by the NEC, IEEE 1584, IEEE C2 and NFPA 70E. In case of any conflict the more stringent requirement shall be used.

1. The Arc Flash Hazard Analysis shall be performed with the aid of a digital computer in order to calculate Arc Flash Incident Energy (AFIE) levels and arc flash protection boundary distances.
2. The Arc Flash Hazard Analysis shall be performed in conjunction with a short-circuit analysis and a time-current coordination analysis.
3. Results of the Arc Flash Hazard Analysis shall be submitted in tabular form, and shall include device or bus name, bolted fault and arcing fault current levels, flash protection boundary distances, personal-protective equipment classes and AFIE levels.
4. The Arc Flash Hazard Analysis shall be performed by a registered professional electrical engineer.
5. The Arc Flash Hazard Analysis shall be performed in compliance with IEEE Standard 1584, the IEEE Guide for Performing Arc Flash Calculations.
6. The Arc Flash Hazard Analysis shall include recommendations for reducing AFIE levels and enhancing worker safety.
7. The Arc Flash Hazard Analysis shall report incident energy values based on the existing incident energy values at all buses within the scope of the study in addition to incident energy values based on the recommended overcurrent device setting changes.

Calculations shall be performed to determine the following and all calculations must be submitted for each piece of equipment. The minimum information required in an Arc Flash hazard protection analysis are:

1. HAZARD RISK CATEGORY (HRC): A general classification of hazard involved in performing specified tasks. Typically ranges from 0 to 4. The NFPA provides a recommended list of PPE for each HRC in table 130.7 of NFPA 70E.
2. INCIDENT ENERGY (cal/cm2) at 18 inches: This is the energy per unit area for a potential arc flash 18 inches from the source of the arc.
3. ARC FLASH BOUNDARY: This is the distance from the arc flash source for which a person is likely to receive a second degree burn. Second degree burns typically occur at an energy level of 1.2 cal/cm2
4. SHOCK HAZARD PROTECTION INFORMATION: The minimum information required in a Shock Hazard protection analysis are:
    a. Limited Approach Boundary: This boundary may only be crossed by a qualified person, or an unqualified person wearing appropriate PPE

and accompanied by a qualified person.

b. Restricted Approach Boundary: This boundary may only be crosses by authorized management using adequate shock prevention equipment and techniques.
c. Prohibited Approach Boundary: This boundary may only be crossed by a qualified person that has the same level of protection required for direct contact with live parts.
d. A Copy of the calculations and label shall be submitted for Arc Flash Labels
e. A discussion section which evaluates the degree of system protection and service continuity with overcurrent devices, along with recommendations to lower available Arc Fault currents.

3.5 FINAL REQUIREMENTS

The Final Study performed by the Contractor shall be generated based on the final electrical equipment submittals and final pulled conductor lengths.

Based on the findings of the final report the Contractor shall have a third party Contractor set the relays and circuit breakers prior to final acceptance and functional testing

The Final Report will be reviewed by, signed and stamped by a registered professional Electrical Engineer.

-- End of Section --

EXAMPLE OF LABEL TO BE USED

(3.5 INCH X 5 INCH THERMAL TRANSFER TYPE LABEL OF HIGH ADHESION POLYESTER)

<u>Example of information provided in the final analysis</u>.

	BUS NAME		
	100 T-920A	**101 PNL PCA**	**102 TD-304**
Protective Device Name	004 Dual	101 PCA Main	101 PCA - 10
KV	0.48	0.48	0.48
Bus Bolted Fault (kA)	14.81	14031	7.51
Protective Device Bolted Fault (kA)	13.65	13.15	7.51
Arcing Fault (kA)	8.45	8.19	5.14
Time / Delay Trip (sec)	1.451	0.04	0.0017
Breaker Opening Time (sec)	0	0	0
GND	Yes	Yes	Yes
Equipment Type	Panel	Panel	Panel
GAP (mm)	25	25	25
Arc Flash Boundary (in)	145	18	7
Working Distance (in)	18	18	18
Incident Energy (cal/cm²)	36.8	1.17	0.27
Hazard / Risk Category Number	4	0	0

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SECTION 26 08 13

ACCEPTANCE TESTING

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SECTION 26 08 13

ACCEPTANCE TESTING
11/18

PART 1 GENERAL

1.1 SUMMARY

Section includes basic requirements for acceptance testing.

1.1.1 Related Specification Sections

1. Division 00 - Procurement and Contracting Requirements.
2. Division 01 - General Requirements.
3. Section 01 61 03 - Equipment - Basic Requirements.

1.2 REFERENCES

The publications listed below form a part of this specification to the extent referenced. The publications are referred to within the text by the basic designation only.

INTERNATIONAL ELECTRICAL TESTING ASSOCIATION (NETA)

NETA ATS	(2017; Errata 2017) Standard for Acceptance Testing Specifications for Electrical Power Equipment and Systems

1.3 QUALITY ASSURANCE

1.3.1 Qualifications

1. Testing firm qualifications: See Specification Section 01 61 03.
2. Field personnel:
    a. See Specification Section 01 61 03.
    b. As an alternative, supervising technician may be certified by the equipment manufacturer.
3. Analysis personnel:
    a. See Specification Section 01 61 03 As an alternative, supervising technician may be certified by the equipment manufacturer.

1.3.2 Phasing Diagram

Coordinate with Utility Company for phase rotations and Phase A, B and C markings. Create a phasing diagram showing the coordinated phase rotations with generators and motors through the transformers.

1.4 SUBMITTALS

Submit the following in accordance with Section 01 33 00 SUBMITTAL PROCEDURES:

SD-01 Preconstruction Submittals

Coordinated phasing diagram

Photocopies of all continuity tests

SD-11 Closeout Submittals

Report

1.4.1 Informational Submittals

Prior to energizing equipment submit:

a. Coordinated phasing diagram.
b. Photocopies of all continuity tests.

Within two weeks after successful completion of Demonstration Period (Commissioning Period) submit:

a. Single report containing information including:
    1) Summary of Project.
    2) Information from pre-energization testing.
    3) See testing and monitoring reporting requirements in Specification Section 01 61 03.

PART 2 PRODUCTS

2.1 FACTORY QUALITY CONTROL

Provide Electrical equipment with all factory tests required by the applicable industry standards or NRTL.

Factory testing will not be accepted in lieu of field acceptance testing requirements specified in this Specification Section and Specification Section 01 61 03.

PART 3 EXECUTION

3.1 FIELD QUALITY CONTROL

3.1.1 General

1. See Specification Section 01 61 03.
2. Complete electrical testing in three phases:
    a. Pre-energization testing phase.
    b. Equipment energized with no load.
    c. Equipment energized under load.
3. Perform testing in accordance with this Specification Section and NETA ATS.
4. Provide field setting and programming of all adjustable protective devices and meters to settings as determined by the approved coordination study.

3.1.2 Equipment Monitoring and Testing Plan

See Specification Section 01 61 03.

3.1.3 Instruments Used in Equipment and Connections Quality Control Testing

See Specification Section 01 61 03.

3.1.4 Testing and Monitoring Program Documentation

See Specification Section 01 61 03.

3.1.5 Electrical Equipment and Connections Testing Program

1. See Specification Section 01 61 03.
2. See individual Division 26 Specification Sections for equipment specific testing requirements.
3. Test all electrical equipment.
   a. Perform all required NETA testing.
   b. Perform all required NETA testing plus the optional testing identified with each specific type of equipment in Article 3.2 of this Specification Section.
4. See Schedule at the end of PART 3 for equipment to be tested and specific test requirements.

3.2 SPECIFIC EQUIPMENT TESTING REQUIREMENTS

3.2.1 Switchgear and Switchboards

1. Perform inspections and tests per NETA ATS 7.1.
2. Components: Test all components per applicable paragraphs of this Specification Section and NETA ATS.

3.2.2 Cable - Low Voltage

1. Perform inspections and tests per NETA ATS 7.3.2

3.2.3 Cable - Medium Voltage

1. Perform inspections and tests per NETA ATS 7.3.3.
2. Non-destructive partial discharge test:
   a. After energization, perform a partial discharge test for baseline data for future partial discharge maintenance testing.
   b. Perform the work while the medium voltage circuits and equipment are energized.
      1) The cables shall not be disconnected or de-energized and the testing shall not expose the cables to voltages that exceed normal operating voltage.
   c. Use a frequency domain detection process incorporating a spectrum analyzer with radio frequency current transformer (RF CT) sensors.
      1) The detection system, including spectrum analyzer, RF CT's and interconnecting cable, shall have a partial discharge detection range that at least covers the frequency range of 10 kHz to 300 MHz.
      2) Testing shall be performed in a manner that complies with the requirements of IEEE 400 and IEEE 400.3.

3.2.4 Medium Voltage Source Transfer System

1. Perform applicable inspections and test per:
   a. NETA ATS for Air Interrupter Switches.
   b. Manufacturer's instructions.

3.2.5 Medium Voltage Circuit Breakers

1. Perform inspections and tests per NETA ATS 7.6.2.
2. Components: Test all components per applicable paragraphs of this

Specification Section and NETA ATS.

3. Perform the following optional tests per NETA ATS:
   a. Control wiring insulation resistance.
   b. Minimum trip and close voltage.
   c. Overpotential.
4. Perform the following additional tests:
   a. High-potential vacuum integrity test per manufacturer's recommendations.

3.2.6 Low Voltage Power Circuit Breakers

1. Perform inspections and tests per NETA ATS 7.6.1.2.
   a. Tests shall include primary current injection testing of all breakers at final settings.
   b. Where short-time or instantaneous settings on large frame breakers are beyond the current capability of field testing, primary injection tests at reduced currents shall be permitted if combined with secondary injection calibration test of trip unit at final settings.
2. Components: Test all components per applicable paragraphs of this Specification Section and NETA ATS.
3. Perform the following additional tests:
   a. Shunt trip devices minimum tripping voltage.
4. Record as-left settings.

3.2.7 Low Voltage Molded Case Circuit Breakers

1. Perform inspections and tests per NETA ATS 7.6.1.1.
2. Components:
   a. Test all components per applicable paragraphs of this Specification Section and NETA ATS.
   b. Thermal magnetic breakers: Visual and mechanical inspection per NETA ATS only.

c. Solid state trip type: Visual and mechanical inspection and electrical tests per NETA ATS.

3. Record as-left settings.

3.2.8 Instrument Transformers

1. Perform inspections and tests per NETA ATS 7.10.
2. Components: Test all components per applicable paragraphs of this Specification Section and NETA ATS.
3. Perform the following optional tests per NETA ATS:
   a. Dielectric withstand test on potential transformers.

3.2.9 Grounding

1. Perform inspections and tests per NETA ATS 7.13.
2. Components: Test all components per applicable paragraphs of this Specification Section and NETA ATS.

3.2.10 Motors

1. Perform inspections and tests per NETA ATS 7.15.
2. See Specification Section 01 61 03.

3.2.11 Motor Controllers

1. Perform inspections and tests per NETA ATS 7.16.

2. Components: Test all components per applicable paragraphs of this Specification Section and NETA ATS.

3.2.12 Control System Functional Test

1. Perform test upon completion of equipment acceptance tests.
2. The test is to prove the correct interaction of all sensing, processing and action devices.
3. Develop a test plan and parameters for the purpose of evaluating the performance of the system.
4. Perform the following tests:
   a. Verify the correct operation of all interlock safety devices for fail-safe functions in addition to design function.
   b. Verify the correct operation of all sensing devices, alarms and indicating devices.

-- End of Section --

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SECTION 26 13 16

MEDIUM VOLTAGE METAL ENCLOSED LOAD INTERRUPTER SWITCHGEAR

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SECTION 26 13 16

MEDIUM VOLTAGE METAL ENCLOSED LOAD INTERRUPTER SWITCHGEAR
11/18

PART 1 GENERAL

1.1 SUMMARY

This section includes Generator Quick Connection switchgear.

1.1.1 Related Specification Sections

Related Specification Sections include but are not necessarily limited to:

1. Division 00 - Procurement and Contracting Requirements.
2. Division 01 - General Requirements.
3. Section 26 05 00 - Common Work Results for Electrical.

1.2 REFERENCES

The publications listed below form a part of this specification to the extent referenced. The publications are referred to within the text by the basic designation only.

INSTITUTE OF ELECTRICAL AND ELECTRONICS ENGINEERS (IEEE)

IEEE C37.20.3	(2013) Standard for Metal-Enclosed Interrupter Switchgear
IEEE C62.11	(2012) Standard for Metal-Oxide Surge Arresters for Alternating Current Power Circuits (>1kV)

UNDERWRITERS LABORATORIES (UL)

UL 44	(2018) Thermoset-Insulated Wires and Cables

NATIONAL ELECTRICAL MANUFACTURERS ASSOCIATION (NEMA)

NEMA 250	(2014) Enclosures for Electrical Equipment (1000 Volts Maximum)

AMERICAN NATIONAL STANDARDS INSTITUTE (ANSI)

1.3 SUBMITTALS

Submit the following in accordance with Section 01 33 00 SUBMITTAL PROCEDURES:

SD-02 Shop Drawings

General arrangement plan view showing door swings, cable entrance locations, shipping splits, etc.

Cross sections, elevations and details

Complete single-line diagram

Auxiliary and control system wiring diagrams (e.g., heaters)

SD-03 Product Data

Provide submittal data for all products specified in PART 2 of this Specification Section.

Nameplate data for all equipment

Mounting details and loading information for concrete foundation design.

Installation instructions and procedures

SD-06 Test Reports

Certified reports of all factory production tests; G

SD-09 Manufacturer's Field Reports

Service equipment marking and documentation

Record of test results, inspections and procedures witnessed or performed by factory service representative

SD-10 Operation and Maintenance Data

Operation and Maintenance Manual; G

SD-11 Closeout Submittals

Requirements for the mechanics, administration, and the content of Operation and Maintenance Manual submittals

1.3.1 Shop Drawings

Shop drawings of the following shall be submitted:

General arrangement plan view showing door swings, cable entrance locations, shipping splits, etc.

Cross sections, elevations and details

Complete single-line diagram

Auxiliary and control system wiring diagrams (e.g., heaters)

1.3.2 Product Data

Provide submittal data for all products specified in PART 2 of this Specification Section.

Nameplate data for all equipment

Mounting details and loading information for concrete foundation design.

Installation instructions and procedures

See Specification Section 26 05 00 for additional requirements.

1.3.3 Test Reports

Certified reports of all factory production tests shall be submitted.

1.4 DELIVERY, STORAGE, AND HANDLING

See Specification Section 26 05 00

PART 2 PRODUCTS

2.1 MANUFACTURERS

Subject to compliance with the Contract Documents, the following manufacturers are acceptable:

1. APT.
2. ABB.
3. General Electric.
4. Square D by Schneider Electric.
5. Siemens Corporation.
6. Eaton.

Submit request for substitution to Contracting Officer.

2.2 LOAD INTERRUPTER SWITCHGEAR

2.2.1 Ratings

1. Voltage: As indicated on the Drawings.
2. Amperage: As indicated on the Drawings.
3. Number of phases: Three.
4. Number of wires: Three.
5. Frequency: 60 Hz.
6. Grounding system: Solid.
7. Short circuit:
    a. Fault closing and momentary: 40 kA
    b. Short time (2 second): 25 kA.
    c. RMS Symmetrical: 20 kA.
8. Basic impulse level: 60 kV.

2.2.2 Construction

1. Standards: IEEE C37.20.3.
2. Completely metal enclosed vertical sections housing load interrupter switches with or without fuses.
3. Front access only.
4. Removable rear coverfor cable installation and maintenance.
5. Hinged, full-length front doors latching padlockable handles.
6. ertical sections with switches:
    a. High impact viewing window to view switch blades through the closed door.
    b. Door interlocked with switch.
    c. Grounded, meshed metal barrier in front of switch.
    d. Provisions to padlock switch in open or closed position.
    e. OPEN-CLOSED switch position indicators.
    f. Grounding point to allow grounding cables to be installed with the

switch in the open position and the switch door closed and locked.
g. Fuse storage provisions when section contains fuses.
7. Enclosure:
   a. NEMA 3R non-walk-in, for exterior locations.
      1) Sloped roof.
      2) Screened opening to prevent entrance of rodents.
      3) Thermostatically controlled space heaters powered by an integral control power transformer located on load side of utility metering.
8. External nameplate with switchgear ratings, manufacturer name and date of manufacture.
9. Interior and exterior steel surfaces cleaned and painted with rust inhibiting primer and manufacturer's standard paint.
   a. Finish color: Light gray.

2.2.3 Buses

1. Material: Tin-plated aluminum or silver-plated copper.
2. Bus supports, stand-off insulators and sleeves: Porcelain, glass polyester or epoxy.
3. Ground bus: Sized to carry the rated 2-second short circuit current.
4. Provisions for future extension.

2.2.4 Load Interrupter Switches

1. Configuration as indicated on the Drawings.
2. Three-pole gang operated.
3. Two-position (open/closed).
4. Manual quick-make, quick-break utilizing a heavy-duty coil spring to provide openings and closing energy.
5. Switch mechanism shaft is driven by a metal-to-metal linkage from the operating handle.
6. The opening and close of the switch shall be independent of the speed at which the handle is moved.
7. Circuit interruption shall take place within an arc compressor or chute.
8. Insulating barriers between each phase and/or enclosure per manufacturer standards.
9. Provide a kirk-key type mechanism on breaker to keep from closing breaker if the main breaker is closed.

2.2.5 Fuses

1. Current limiting.
2. E-rated.
3. Size as indicated on the Drawings.

2.2.6 Surge Arresters

1. Standards: IEEE C62.11.
2. MCOV rating: As indicated on the Drawings.
3. Metal oxide type, station class.

2.2.7 Auxiliary Equipment Control Power Transformer

1. Indoor, dry type.
2. Number of phases: Single-phase.
3. Rated primary voltage: 2,400.
4. Rated secondary voltage: 120/240 V.

2.2.8 Heavy-duty (Utility) Terminal Blocks

1. General:
   a. Ratings: 600 V, 30 amps.
   b. Molded one-piece thermoplastic body.
   c. Washer head terminal screws to accommodate up to a #10 AWG wire.
2. Current transformer shorting terminal blocks:
   a. Short circuiting strip for shorting screws and screw "parking stations."
   b. GE Type EB-27 or approved equal.
3. Non-shorting terminal blocks:
   a. GE Type EB-25 or approved equal.

2.2.9 Control Wire

1. Conductor shall be copper with 600 V rated insulation.
2. Conductors shall be stranded.
3. Minimum #12 AWG.
4. Surface mark with manufacturer's name or trademark, conductor size, insulation type and UL label.
5. Conform to UL 44 for type SIS or MTW insulation.

2.2.10 Wire Terminators

1. Ratings: 600 V.
2. Tin plated high strength copper alloy.
3. Solderless, non-insulated, ring type.

2.2.11 Generator Connection Receptacles

Provide 600A air insulated deadbreak bushing wells and caps. Coordinate with owner for specific type of receptacles required for owner's existing generator conductors. Receptacles shall be rated for 2.4kv, 60hz.

2.3 SOURCE QUALITY CONTROL

Switchgear factory tests in accordance with IEEE and ANSI standards.

2.4 MAINTENANCE MATERIALS

A. One set of fuses for each size utilized in switchgear with fuse handling tools
B. One set of three grounding jumpers with storage bag.
C. Touch-up paint.

PART 3 EXECUTION

3.1 INSTALLATION

Install in accordance with manufacturer's instructions.

Arrange as shown on the Drawings.

3.1.1 Outdoor Locations

1. NEMA 3R non-walk-in enclosure.
2. Install on concrete pad, align all sides of the switchgear 3 IN from top edge of pad chamfer and securely bolt to pad.

3.1.2 Service Equipment Marking and Documentation

1. Provide service rated equipment with available fault current and arc-flash hazard warning labels as required by NFPA 70 and other applicable codes.
2. Provide documentation of the calculations made for compliance with the marking requirements.
3. Provide labels in accordance with Section 10 14 53.
4. Record of test results, inspections and procedures witnessed or performed by factory service representative shall be submitted.

3.1.3 Miscellaneous

Paint any scratched surfaces with touch-up paint.

3.2 FIELD QUALITY CONTROL

A qualified factory-trained manufacturer's representative shall certify in writing that the equipment has been installed, adjusted and tested in accordance with the manufacturer's recommendations.

3.2.1 Acceptance Tests

See Specification Section 26 08 13.

3.3 TRAINING

A qualified factory-trained manufacturer's representative shall provide the Owner with 4 HRS of on-site training in the operation and maintenance of the switchgear and its components. An operation and maintenance manual shall be developed and submitted. Requirements for the mechanics, administration, and the content of Operation and Maintenance Manual submittals shall also be submitted.

-- End of Section --

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DIVISION 26 - ELECTRICAL

SECTION 26 29 01

ELECTRIC MOTORS, 3-PHASE VERTICAL INDUCTION TYPE

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SECTION 26 29 01

ELECTRIC MOTORS, 3-PHASE VERTICAL INDUCTION TYPE
11/08

PART 1 GENERAL

1.1 REFERENCES

The publications listed below form a part of this specification to the extent referenced. The publications are referred to within the text by the basic designation only.

AMERICAN BEARING MANUFACTURERS ASSOCIATION (ABMA)

ABMA 11	(2014) Load Ratings and Fatigue Life for Roller Bearings
ABMA 9	(2015) Load Ratings and Fatigue Life for Ball Bearings

ASTM INTERNATIONAL (ASTM)

ASTM A123/A123M	(2017) Standard Specification for Zinc (Hot-Dip Galvanized) Coatings on Iron and Steel Products
ASTM A153/A153M	(2016) Standard Specification for Zinc Coating (Hot-Dip) on Iron and Steel Hardware
ASTM B344	(2014) Standard Specification for Drawn or Rolled Nickel-Chromium and Nickel-Chromium-Iron Alloys for Electrical Heating Elements

NATIONAL ELECTRICAL MANUFACTURERS ASSOCIATION (NEMA)

NEMA MG 1	(2016; SUPP 2016) Motors and Generators

1.2 SUMMARY

The work under this section includes providing all labor, equipment, and material and performing all operations required to design, manufacture, assemble, test, and package and deliver the vertical induction motors for driving pumps specified under Section 35 45 01 VERTICAL PUMPS, AXIAL-FLOW AND MIXED-FLOW IMPELLER TYPE.

a. These motors shall be supplied complete with all accessories, spare parts, tools, and manufacturer's data and instructions as specified herein.

b. Submit 6 copies of complete instructions for the proper installation, inspection, and maintenance of the machines provided for this particular service. Instruction manuals shall be submitted to the Contracting Officer not later than the date the equipment is shipped from the manufacturer's plant. The instructions shall include a cross-sectional drawing indicating the major component parts of the motor and the procedure for disassembly.

c. Submit 6 copies of a complete list of renewal parts with prices for each different rating of motor. This list shall accompany the instruction manual.

1.3 SUBMITTALS

Government approval is required for submittals with a "G" designation; submittals not having a "G" designation are for Contractor Quality Control approval. When used, a designation following the "G" designation identifies the office that will review the submittal for the Government. Submit the following in accordance with Section 01 33 00 SUBMITTAL PROCEDURES:

SD-02 Shop Drawings

Motors; G

SD-03 Product Data

Insulated Windings; G
Duty Cycle; G
Motors; G
Government Study
Spare Parts

SD-06 Test Reports

Starting Capabilities
Factory Tests

SD-07 Certificates

Power Factor and Efficiency
Factory Tests

SD-10 Operation and Maintenance Data

Instructions; G

1.4 QUALITY ASSURANCE

1.4.1 Corrosion Prevention and Finish Painting

The equipment provided under these specifications will be subjected to severe moisture conditions and shall be designed to render it resistant to corrosion from such exposure. The general requirements to be followed to mitigate corrosion are specified below. Any additional special treatment or requirement considered necessary for any individual items is specified under the respective item. However, other corrosion-resisting treatments that are the equivalent of those specified herein may, with the approval of the Contracting Officer, be used.

1.4.1.1 Fastenings and Fittings

Where practicable, all screws, bolts, nuts, pins, studs, springs, washers, and other similar fittings shall be of corrosion-resisting material or shall be treated in an approved manner to render them resistant to corrosion.

1.4.1.2 Corrosion-Resisting Materials

Corrosion-resisting steel, copper, brass, bronze, copper-nickel, and nickel-copper alloys are acceptable corrosion-resisting materials.

1.4.1.3 Corrosion-Resisting Treatments

Hot-dip galvanizing shall be in accordance with ASTM A123/A123M or ASTM A153/A153M as applicable. Other corrosion-resisting treatments may be used if approved by the Contracting Officer.

1.4.1.4 Frames

Motor frames, end bells, covers, conduit boxes, and any other parts, if of steel, and if they will be coated during the process of insulating the windings, shall be cleaned of rust, grease, millscale, and dirt, and then treated and rinsed in accordance with manufacturer's standard process. If any of the above-listed parts are not coated during the process of insulating the windings then, in addition to the above, they shall be given one coat of primer and then two coats of manufacturer's standard moisture-resistant coating, processed as required.

1.4.1.5 Cores

The assembled motor core shall be thoroughly cleaned and then immediately primed by applying a minimum of two coats of a moisture-resisting and oil-resisting insulating compound. Air gap surfaces shall be given a minimum of one coat.

1.4.1.6 Shafts

Exposed surfaces of motor shafts shall be cleaned of rust, grease, and dirt and, except for bearing surfaces, given one coat of a zinc molybdate or equivalent primer and two coats of a moisture-proof coating, each cured as required. Shafts of a corrosion-resisting steel may be used in lieu of the above treatment.

1.4.1.7 Finish Painting

Finish painting of all equipment shall be in accordance with the standard practice or recommendation of the manufacturer, as approved by the Contracting Officer.

1.4.2 Government Study

Submit 6 copies of the specified data. Supply to the Government, for completion of its Motor Torque and Accelerating Time Studies (MTATS), the following data:

a. Complete equivalent circuit data referred to the stator with friction, windage, and stray load losses.

b. Current, power factor, and torque versus speed (0-100 percent, inclusive, in 1 percent increments up to 95 percent and in 0.1 percent increments above 95 percent) and load (0-125 percent, inclusive, in 25 percent increments) as a function of line voltage (from 80 percent to 110 percent, inclusive, in 5 percent increments), for rated and 90 percent of rated voltage at starter. Only tabulated data will be required.

c. Load inertia, Wk2 of motor rotating parts, pound-foots.

PART 2 PRODUCTS

2.1 NAMEPLATES

Nameplate data shall include rated voltage, rated full-load amperes, rated horsepower, service factor, number of phases, RPM at rated load, frequency, code letter, locked-rotor amperes, duty rating, insulation system designation, and maximum ambient design temperature.

2.2 MOTORS

The motors to be supplied under these specifications shall be of the vertical shaft type as required by the pump manufacturer, normal or low starting torque, low starting current, squirrel-cage induction type, designed for full voltage starting, of drip-proof construction, and shall conform to the applicable requirements of NEMA MG 1, except as hereinafter specified.

a. Submit 6 copies of equipment foundation dimensions; outline drawings with weights, nameplate data, and details showing method of mounting and anchoring the motor. Contracting Officer's approval shall be obtained in writing prior to the commencement of manufacture of motors.

b. Six copies of complete descriptive specification of each type and size motor provided, with necessary cuts, photographs, and drawings to clearly indicate the construction of the motor, the materials and treatments used to prevent corrosion of parts, bearing construction, and type of insulation used on all windings.

c. Submittal shall include all information required for selection of protective and control equipment and for operational setting, such as, but not limited to, normal and maximum operation temperature for windings and bearings, overload trip setting for motor at pump maximum head condition and starting times for starting at rated and 90 percent starter voltage.

2.2.1 Rating

Each motor shall be wound for 3-phase, 60-Hz, alternating current, and for the respective operating voltage listed below:

PLANT	PUMP	SERVICE	MOTOR OPERATING VOLTAGE
3	PMP101	water	2,400
3	PMP102	water	2,400
3	PMP103	water	2,400

PLANT	PUMP	SERVICE	MOTOR OPERATING VOLTAGE
3	PMP104	water	2,400

The motor shall be designed for operation in a 105 degrees Fambient temperature and all temperature rises shall be above this ambient temperature. The rated horsepower of the motor shall be not less than 110 percent of the determined maximum load requirement of the pump. Motors shall have a service factor of 1.0 or shall be applied using a service factor of 1.0 if standard service factor is greater than 1.0. The temperature rise above the ambient temperature for continuous rated full-load conditions and for the class of insulation used shall not exceed the values given in NEMA MG 1, paragraph 12.42 or paragraph 20.8.

2.2.2 Operating Characteristics

2.2.2.1 Torques

Starting torque shall be sufficient to start the pump to which the motor will be connected under the maximum conditions specified, but in no case shall the starting torque be less than 60 percent of full-load torque. Breakdown torque shall be not less than 200 percent of full-load torque.

2.2.2.2 Locked-Rotor Current

The locked-rotor current shall not exceed 600 percent of normal full-load running current.

2.2.2.3 Starting Capabilities

Large motors, on the basis of the load torque characteristics and the load inertia Wk2 listed in NEMA MG 1, paragraphs 20.41 and 20.42, shall as a minimum be capable of making the starts required in NEMA MG 1, paragraph 20.43. Smaller motors shall conform to the requirements in NEMA MG 1, paragraph 12.50. Submit 6 copies of certified test reports, when available, of tests previously performed on motors of each type and size specified or calculated data to substantiate the motor's capability to conform to the specified requirements.

2.2.2.4 Duty Cycle

Submit an analysis to verify that the motor, when operated in accordance with the duty cycle specified, will not undergo injurious temperature rise. If the duty cycle cannot be met with a standard NEMA design motor, the motor manufacturer shall provide a description of proposed modifications to provide such compliance. Each motor, when operating at rated voltage and frequency and on the basis of the connected pump load inertia Wk2 and the speed-torque characteristics of the load during starting conditions as furnished by the pump manufacturer, shall be capable of performing on a continuous basis the standard motor duty cycle without injurious temperature rise. A starting information nameplate setting forth the starting capabilities shall be provided on each motor. This nameplate shall also include the minimum time at standstill and the minimum running time prior to an additional start.

2.2.2.5 Balance

The balance for each motor when measured in accordance with NEMA MG 1, paragraph 12.06 or paragraph 20.53, shall not exceed the values specified. Each motor's characteristics shall be such that the provisions of Section 35 45 01 VERTICAL PUMPS, AXIAL-FLOW AND MIXED-FLOW IMPELLER-TYPE are met.

2.2.2.6 Noise

All motors shall operate at a noise level less than 85 decibels A-weighted mean sound pressure level (dBA). The specified noise limit applies for a reference distance of one meter for free-field conditions.

2.2.2.7 Power Factor and Efficiency

The power factor and efficiency at full load, 3/4 full load, and 1/2 full load shall be not less than 0.79, 0.75, and 0.64, respectively. Motors will be rejected if factory tests specified in paragraph FACTORY TESTS do not demonstrate that these values will be met or exceeded. Submit certification of guaranteed value of power factor and efficiency for full load, 3/4 full load, and 1/2 full load.

2.2.3 Frames and Brackets

Frames and end brackets shall be of cast iron, cast steel, or welded steel. The mounting ring, unless otherwise approved, shall be built integral with the frame or lower end bracket and arranged for direct mounting on the pump, or station floor, or as required by the installation conditions. Treatment against corrosion shall be as specified in paragraph GENERAL REQUIREMENTS.

2.2.3.1 Stator Frame

The stator frame shall be rigid and sufficiently strong to support the weight of the upper bearing bracket load, the weight of the stator core and windings, and to sustain the operating torques without perceptible distortion. The stator frame, if not direct mounted on the pump, shall be supported on a motor base or drive pedestal which in turn will be supported on sole plates or other suitable structure installed in the concrete foundation constructed as part of the pumping station structure. The motor base or drive pedestal shall be provided with bolts and dowels for fastening to the sole plates or supporting structure for preserving the alignment.

2.2.3.2 Supporting Bracket

The upper bracket supporting the thrust bearing and upper guide bearings shall have sufficient strength and rigidity to support the weight of the entire rotating element of the motor, together with the pump impeller and shaft, and the hydraulic thrust of the pump impeller.

2.2.3.3 Overspeed Alternate

Each motor shall be designed to withstand indefinitely, without injury, the maximum overspeed to which the motor will be subjected when the pump to which it is connected is acting as a hydraulic turbine under the maximum head with the pump discharge pipe open.

2.2.3.4 Antireverse Device Alternate

A self-actuated backstop device or antireversing ratchet, to prevent reverse rotation of the pump due to loss of power or failure of the electric prime mover, shall be installed as an integral part of the motor. The design of the device shall be submitted to and approved by the Contracting Officer. It shall have sufficient capacity to prevent reverse rotation with a back-flow through the pump. If the device requires a lubrication system, an oil reservoir independent of the one used for the thrust bearing and complete with visible oil level gauge and 120-volt a.c. rated high and low level contacts shall be provided. All electrical leads shall be terminated in the accessory terminal box specified in paragraph MOTOR TERMINALS AND BOXES. The lubricant for the antireverse device shall contain a corrosion inhibitor whose type and grade shall be shown on a special nameplate attached to the frame adjacent to the lubricating filling device.

2.2.3.5 Eyebolts

Eyebolts, lugs, or other approved means shall be provided for assembling, dismantling, and removing the motor, if required, from above using an overhead crane. All lifting devices required for use in conjunction with the crane shall be provided with the motor.

2.2.4 Cores

The cores for the stators and rotors shall be built up of separately punched thin laminations of low-hysteresis loss, nonaging, annealed, electrical silicon steel, assembled under heavy pressure, and clamped in such a manner as to insure that the assembled core is tight at the top of the teeth of the laminated core. Laminations shall be properly insulated from each other. Only laminations free from burrs shall be used, and care shall be taken to remove all burrs or projecting laminations from the slots of the assembled cores. Cores shall be keyed, dovetailed, or otherwise secured to the shaft or frame in an approved manner. Treatment against corrosion shall be as specified in paragraph GENERAL REQUIREMENTS.

2.2.5 Insulated Windings

All motors shall have a nonhygroscopic, sealed, fungus-resisting insulation of a type designed and constructed to withstand severe moisture conditions, and insofar as practicable, to operate after long periods of idleness without previous drying out. All windings and connections shall be of the sealed type as defined in NEMA MG 1 paragraph 1.27.2. Submit a detailed description of and specification for the manufacturing process, the materials and the insulating varnish or compound used in insulating the windings shall be submitted to the Contracting Officer for approval before manufacture of the motors is commenced. If, in the opinion of the Contracting Officer, the insulation proposed is not of the quality specified and if the methods of manufacture are not considered to be in accordance with best modern practice, the motors will not be accepted. Submit 6 copies of motor design curves and 6 copies of motor speed-torque curves, as specified. Insulated windings, unless otherwise approved, shall be completely assembled in the motor core before impregnating with the insulating compound. The compound shall consist of 100 percent solid resin.

a. Impregnation of the windings with the insulating compound shall be by vacuum impregnation method followed by baking. The procedure shall be repeated as often as necessary to fill in and seal over the interstices of the winding, but in no case shall the number of dips and bakes be less than two dips and bakes when the vacuum method of impregnation is used. The completed stator shall be of a type that is capable of passing the submerged or sprayed water test, as applicable, required by

NEMA MG 1 paragraph 20.49.

b. Random wound coils may be used on motors supplied in NEMA frame size 445 TP and smaller. The components of the insulation system and the conductor insulation of the coils shall be Class F insulation with a 110 percent continuous overload factor as defined in NEMA MG 1 paragraph 1.66. After winding, the completely wound stator shall be encapsulated with an insulating resin as defined in NEMA MG 1 paragraph 1.27.1.

c. Form wound coils shall be used on motors supplied in NEMA frames larger than 445 TP. The components of the insulation system and the coil insulation of the rectangular conductors shall conform to Class F insulation with a 110 percent continuous overload factor as defined in NEMA MG 1, paragraph 1.66. The completed stator windings and connections shall be of the sealed type as defined in NEMA MG 1 paragraph 1.27.2.

d. Insulation to ground shall be processed on the coil. Slot tubes or cells are not acceptable. The insulation shall be of adequate thickness and breakdown strength throughout the length of the coil. Mica shall be used in the slot portion and shall be of adequate thickness to withstand the dielectric tests specified in paragraph FACTORY TESTS. Form wound coils shall be of such uniformity that the stator windings on motors of equal ratings shall be alike, in shape and size, and be interchangeable.

e. Submit motor design (characteristic) curves or tabulated data (test or calculated), indicating the speed, power factor, efficiency, current, and kilowatt input, all plotted or tabulated against torque or percent load as abscissa. The base value shall be given whether ANSI or IEEE standard system is used. The maximum allowable reverse rotation speed for the motor shall also be provided.

f. Submit pump andmotor speed-torque curves for the pump starting operation. The motor speed-torque curves shall be plotted for the following values of voltage at the motor terminals: The output of the closed transition auto-transformer-type reduced voltage starter supplied at rated and 90 percent of rated motor voltage. The pump torque curve shall be plotted for starting and accelerating against maximum head. Computations shall be furnished to demonstrate that the motor furnished will carry the pump load under all the foregoing conditions.

g. Coils of all windings shall be fully braced so that vibration is virtually eliminated during repeated starts as required by the duty cycle specified as well as during normal operation. If a tied system is used it shall be such that no tie depends upon the integrity of any other tie within the system.

2.2.6 Thermal Protection

For motors rated 500 hp or greater, resistance temperature detectors (two per phase) shall be provided in accordance with NEMA MG 1, paragraph 20.63. Detectors shall have a copper resistance element having a resistance of 10 ohms at 76 degrees F. Leads shall be terminated on the terminal blocks specified in paragraph MOTOR TERMINALS AND BOXES. For motors rated less than 500 hp, positive-temperature-coefficient thermistors (one per phase) shall be embedded in the windings. The thermistors with all necessary additional equipment, as required, shall open a normally closed contact when the critical temperature is reached. All outgoing wiring shall terminate on the terminal blocks specified in paragraph MOTOR TERMINALS AND BOXES.

2.2.7 Winding Heaters

Heaters shall be wrapped around the winding end turns. They shall be designated for operation on 120 volts, 1-phase, 60 Hz, alternating current and of sufficient capacity or wattage that, when energized, they will hold the temperature of the motor windings approximately 10 degrees C above the ambient temperature. They shall be designed for continuous operation and to withstand at least 10 percent overvoltage continuously. The rate of heat dissipation shall be uniform throughout the effective length of the heater. Heaters installed around the winding end turns shall consist of the required turns of heating cable wrapped around the end turns and secured in place before the winding is impregnated.

2.2.7.1 Heating Element

Heating element shall conform to the requirements of ASTM B344 for an 80 percent nickel and 20 percent chromium alloy.

2.2.7.2 Sheath

Sheath shall be of a corrosion-resisting, nonoxidizing metal and shall have a wall thickness not less than 0.025 inch.

2.2.7.3 Insulation

Insulation shall be a granular mineral refractory material, highly resistant to heat, and shall have a minimum specific resistance of 1,000 megohms per inch cubed at 1,000 degrees F. Insulation for the heating cable (winding wraparound type) type heaters shall be suitable for a conductor temperature of 356 degrees F.

2.2.7.4 Terminals

Terminals of the heater, including the leads, shall be watertight and shall be provided with leads suitable for making connections to the drip-proof terminal box provided in paragraph MOTOR TERMINALS AND BOXES.

2.2.8 Shafts

Shafts shall be made of high grade steel, finished all over, and of ample size to drive the pumps under maximum load conditions. Shafts shall be of solid types as required by the pump manufacturer. See paragraph GENERAL REQUIREMENTS for treatment against corrosion.

2.2.9 Bearings

2.2.9.1 Loading

Bearings shall be capable of withstanding all stresses incidental to the normal operation of the unit.

2.2.9.2 Thrust Bearings

Thrust bearings shall be of the antifriction type of either the ball or roller type. Tandem or series bearing assemblies shall not be used. Antifriction bearings shall conform to the requirements of ABMA 9 an d ABMA 11.

2.2.9.3 Guide Bearings

Guide bearings shall be of the sleeve or antifriction type of either the ball or roller type or a combination of sleeve and antifriction bearings.

2.2.9.4 Lubrication

Bearings shall be either oil or grease lubricated and the lubricant used shall contain a corrosion inhibitor. Type and grade of lubricant used shall be shown on a special nameplate which shall be attached to the frame of the motor adjacent to the bearing lubricant filling device. In addition to the quantity of lubricant required to fill the system initially, spare lubricant shall be provided in sufficient quantity to purge and refill the system.

2.2.9.5 Housings

Bearing housings shall be of a design and method of assembly that will permit ready removal of the bearings, prevent escape of lubricant and entrance of foreign matter, and protected by the lubricant when the motor is idle. Except for prelubricated antifriction bearings of an approved type, suitable means shall be provided to apply and drain the lubricant. Oil-lubricated bearing housings shall be provided with oil-level indicator gauges that will be readily visible.

2.2.9.6 Cooling

All bearings shall be self-cooling unless otherwise specifically approved by the Contracting Officer. If the use of cooling is approved, the means employed shall, unless otherwise approved by the Contracting Officer, require no auxiliary pumping equipment; and suitable means shall be provided to indicate the bearing temperature, actuate an alarm when the bearing temperature is above normal, and actuate a device to shut down the motor when the maximum safe operating temperature of the bearing is reached. Cooling coils shall be of copper tubing and designed for the operating pressure used to circulate the cooling water.

2.2.9.7 Rating

Antifriction bearings shall be rated on the basis of a minimum life factor of 8,800 hours, based on the life expectancy of 90 percent of the group, unless otherwise approved by the Contracting Officer.

2.2.9.8 Shaft Currents

Bearings shall be insulated or otherwise protected against the damaging effects of shaft currents.

2.3 SURGE PROTECTION

2.3.1 Surge Capacitors

A three-pole capacitor unit, equipped with built-in discharge resistors and using a non-polychlorinated biphenyl (PCB) insulating medium, shall be provided in the main terminal box. Each pole shall be rated 0.5 microfarad and 2,400 volts line-to-line. Removable bus links shall be provided for motor testing. These links shall be treated to resist corrosion, shall be designed to maintain a positive contact, and shall have low contact resistance.

2.3.2 Surge Arresters

Surge arresters of the station type with porcelain tops shall be provided in the main terminal box. The arresters shall be of the metal-oxide type rated 4,500 volts maximum continuous operating voltage (MCOV) line-to-ground. Removable bus links shall be provided for motor testing. These links shall be treated to resist corrosion, shall be designed to maintain a positive contact, and shall have low contact resistance.

2.3.3 Space Heater

If recommended by the surge protection manufacturer, a space heater of adequate capacity and rated 120 volts shall be provided. Space heaters shall have a maximum watt density of 20 watts per square inch.

2.4 MOTOR TERMINALS AND BOXES

2.4.1 Stator Terminal Box

Drip-proof cast iron or steel conduit terminal boxes, treated as specified for frames in paragraph GENERAL REQUIREMENTS, shall be supplied for housing the stator lead connections surge capacitors and surge arresters and shall have adequate space to facilitate the installation and maintenance of cables and equipment. Boxes shall have a bolted cover providing unrestricted access, be mounted on the motor frame, and shall have an auxiliary floor supporting structure, when required, supplied by the motor manufacturer. Conduit entrance shall be from the bottom. The boxes shall be designed to permit removal of motor supply leads when the motor is removed. A "HIGH VOLTAGE - 2,400 VOLTS" warning sign shall be provided on the cover of the box.

2.4.2 Stator Terminals

Insulated terminal leads shall receive a treatment equal to that of the motor winding. Leads shall be brought out of the stator frame and shall be provided with terminal lugs for connection to the motor supply wiring.

2.4.3 Grounding

A ground bus and means for external connection to the station grounding system shall be provided in the stator terminal box when surge protection is provided.

2.4.4 Accessory Leads and Boxes

Terminal leads for motor winding space heaters, surge protection equipment space heater and any other auxiliary equipment shall be brought into conveniently located terminal boxes provided with terminal blocks for extension by others. The terminal boxes shall be drip-proof and treated as specified for frames in paragraph GENERAL REQUIREMENTS. All auxiliary wiring shall be stranded copper conductors with 600-volt flame-retardant insulation, except temperature detector leads may be in accordance with the manufacturer's standard practice. All wiring and terminals shall be properly identified.

2.5 WRENCHES, TOOLS, AND SPECIAL EQUIPMENT

Provide all nonstandard and special equipment required for dismantling, reassembly, and general maintenance of the motor units. Provide one complete set of lifting attachments such as detachable eyebolts or special slings for handling various parts with a hoist.

2.6 FACTORY TESTS

One motor of each rating type, selected at random by the Contracting Officer, shall be given a complete test. The remainder of the motors shall be given a check test.

a. Submit 6 copies of test reports recording all data obtained during the tests specified to the Contracting Officer for each motor used. Test reports shall include performance curves indicating the results of subparagraph COMPLETE TEST below.

b. Submit 6 certified copies of the results of a "Complete Test" for duplicate equipment. It will be accepted in lieu of the "Complete Test" as specified in subparagraph COMPLETE TEST below for equipment of the respective rating and type.

c. No substitute will be accepted for the "Check Test." The base value shall be given whether ANSI or IEEE standard system is used. All complete tests shall be witnessed by the Contracting Officer unless waived in writing.

2.6.1 Complete Test

A complete test of a motor shall include the following:

2.6.1.1 Excitation Test

Including a plot of volts as abscissa versus amperes and watts as ordinates.

2.6.1.2 Impedance Test

Including a plot of volts as abscissa versus amperes and watts as ordinates.

2.6.1.3 Performance Test

Including a plot of torque or percent load as abscissa versus efficiency, power factor, amperes, watts, and RPM or percent slip as ordinates.

2.6.1.4 Speed-Torque Test

Prony brake or other equivalent method. Including a plot of torque in foot-pounds as abscissa versus speed in RPM as ordinate.

2.6.1.5 Temperature Test

Made on completion of paragraph c above. (If screens are provided over openings, test will be made with screens removed and by thermometer).

2.6.1.6 Insulation Resistance-Temperature Test

Shall be taken following heat run, readings being taken at approximately 10 degrees C intervals. Temperature shall be determined by the resistance method. Test result values shall be plotted on semilogarithmic graphs, the insulation resistance values as logarithmic ordinates and the temperature values as uniform abscissas. For comparison purposes, a curve indicating the safe operating value of insulation resistance shall be plotted on the same sheet with the insulation resistance-temperature test curve.

2.6.1.7 Vibration Measurement

In accordance with NEMA MG 1 paragraph 20.54.

2.6.1.8 Conformance Tests

In accordance with NEMA MG 1 paragraph 20.47.

2.6.2 Check Test

A check test of a motor shall include the following:

2.6.2.1 Routine Test

Test in accordance with NEMA MG 1 paragraph 12.51 or NEMA MG 1 paragraph 20.47.

2.6.2.2 Cold Resistance Measurement

2.6.2.3 Insulation Resistance and Winding Temperature

Insulation resistance and winding temperature at time the insulation resistance was measured.

2.6.2.4 Conformance Test

In accordance with NEMA MG 1 paragraph 20.47.

2.6.2.5 Vibration

Vibration measurement in accordance with NEMA MG 1 paragraph 12.07 or NEMA MG 1 paragraph 20.54.

2.6.3 Form Wound Coil Test

All form wound coils, either before or after they are placed in the slots, shall be tested for short circuits between turns of the individual coils by applying a high frequency voltage of not less than 75 percent of the voltage for which the machine is insulated, or by applying a surge test voltage of equivalent value to the terminals of each coil. Equivalent surge voltage shall be a wave whose peak value is equal to 1.06 times the voltage for which the motor is insulated.

2.6.4 Winding Space Heater Test

Each winding space heater unit shall be tested at the factory for successful operation and dielectric strength.

PART 3 EXECUTION

NOT USED

... -- End of Section --

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SECTION 26 42 17

CATHODIC PROTECTION SYSTEM (IMPRESSED CURRENT)
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PART 1 GENERAL

1.1 REFERENCES

The publications listed below form a part of this specification to the extent referenced. The publications are referred to within the text by the basic designation only.

ASTM INTERNATIONAL (ASTM)

ASTM D1248	(2012) Standard Specification for Polyethylene Plastics Extrusion Materials for Wire and Cable

INSTITUTE OF ELECTRICAL AND ELECTRONICS ENGINEERS (IEEE)

IEEE 81	(2012) Guide for Measuring Earth Resistivity, Ground Impedance, and Earth Surface Potentials of a Ground System

NACE INTERNATIONAL (NACE)

NACE RP0193	(2001) External Cathodic Protection of On-Grade Carbon Steel Storage Tank Bottoms
NACE SP0169	(2015) Control of External Corrosion on Underground or Submerged Metallic Piping Systems
NACE SP0188	(1999; R 2006) Discontinuity (Holiday) Testing of New Protective Coatings on Conductive Substrates

NATIONAL ELECTRICAL MANUFACTURERS ASSOCIATION (NEMA)

ANSI C80.1	(2005) American National Standard for Electrical Rigid Steel Conduit (ERSC)
NEMA TC 2	(2013) Standard for Electrical Polyvinyl Chloride (PVC) Conduit

NATIONAL FIRE PROTECTION ASSOCIATION (NFPA)

NFPA 70	(2017; ERTA 1-2 2017; TIA 17-1; TIA 17-2; TIA 17-3; TIA 17-4; TIA 17-5; TIA 17-6; TIA 17-7; TIA 17-8; TIA 17-9; TIA 17-10; TIA 17-11; TIA 17-12; TIA 17-13; TIA 17-14; TIA 17-15; TIA 17-16; TIA 17-17) National Electrical Code

UNDERWRITERS LABORATORIES (UL)

UL 467	(2013; Reprint Jun 2017) UL Standard for Safety Grounding and Bonding Equipment
UL 506	(2017) UL Standard for Safety Specialty Transformers
UL 510	(2017) UL Standard for Safety Polyvinyl Chloride, Polyethylene and Rubber Insulating Tape
UL 514A	(2013; Reprint Aug 2017) UL Standard for Safety Metallic Outlet Boxes
UL 6	(2007; Reprint Nov 2014) Electrical Rigid Metal Conduit-Steel

1.2 SYSTEM DESCRIPTION

Submit proof that the materials and equipment furnished under this section conform to the specified requirements contained in the referenced standards or publications. The label or listing by the specified agency will be acceptable evidence of such compliance. Where a pipe is referenced within this specification, the same application shall be made to the pumps as shown on the Drawings.

1.2.1 General Requirements

a. Provide a complete, operating impressed current cathodic protection system in accordance with NFPA 70, the applicable federal, state and local regulations, and the requirements of this contract.

b. The system includes planning, inspecting the installation, adjusting and testing cathodic protection and test system using rectifiers and impressed current anodes, supplemented with sacrificial anodes as needed, for utilities and equipment shown. The cathodic protection system shall also include cables, connectors, splices, corrosion protection test stations, ace power panels, and any other equipment required for a complete operating system providing the specified protection. The cathodic protection system includes (a) calculations for rectifier, anodes, and any recommendations for supplementing or changing the minimum design criteria to provide the specified potentials and (b) equipment, wiring, and wiring devices necessary to produce a continuous flow of direct current from anodes in the soil electrolyte to the pipe surfaces.

c. Submit 6 copies of Detail Drawings consisting of a complete list of equipment and material including manufacturer's descriptive and technical literature, catalog cuts, results of system design calculations including soil resistivity, installation instructions and certified test data stating the maximum recommended anode current output density and the rate of gaseous production, if any, at that current density. Detail drawings shall contain complete wiring and schematic diagrams and any other details required to demonstrate that the system has been coordinated and will function properly as a unit. The installation shall meet the specified protection criteria for a 25 year life.

d. Submit 6 copies of operating manual outlining the step-by-step procedures required for system startup, operation, adjustment of current flow, and shutdown. The manuals shall include the manufacturer's name, model number, service manual, parts list, and brief description of all equipment and their basic operating features.

e Submit 6 copies of maintenance manual listing routine maintenance procedures, recommendation for maintenance testing, possible breakdowns and repairs, and troubleshooting guides. The manuals shall include single line diagrams for the system as installed; instructions in making pipe- to-reference cell potential measurements and frequency of monitoring; instructions for dielectric connections, interference and sacrificial anode bonds; instructions shall include precautions to ensure safe conditions during repair of pipe system.

1.2.2 Contractor's Modifications

The specified system is based on an impressed current system supplemented with anodes. The Contractor may modify the cathodic protection system after review of the project, site verification and analysis if the proposed modifications include the impressed current anodes and rectifiers and will provide better overall system performance.

a. Submit 6 copies of detail drawings showing proposed changes in location, scope or performance indicating any variations from, additions to, or clarifications of contract drawings. The drawings shall show proposed changes in anode arrangement, anode size and number, anode materials and layout details, conduit size, wire size, mounting details, wiring diagram, method for electrically isolating each pipe, and any other pertinent information to the proper installation and performance of the system.

b. The modifications shall be fully described, shall be approved by the Contracting Officer and shall meet the following criteria. The proposed system shall achieve a minimum pipe-to-soil "Instant Off" potential of minus 850 millivolts with reference to a saturated copper-copper sulfate reference cell on the underground metallic components of the piping.

c. Take resistivity measurements of the soil in the vicinity of the pipes and ground bed sites; based upon the measurements taken, adjust current and voltage of the rectifier as required to produce a minimum of minus 850 millivolts "Instant Off" potential between the structure being tested and the reference cell. This potential shall be obtained over 95 percent of the metallic area without the "Instant Off" potential exceeding 1200 millivolts.

d. Submit final report regarding supplemental anode installation. The report shall include pipe-to-soil measurements throughout the affected area, indicating that the additions corrected the conditions which made the additional anodes necessary, and current measurements for the additional anodes. The following special materials and information are required: Calculations on current and voltage for 30 V rectifier plus rectifier and meter specifications; taping materials and conductors; zinc grounding cell, installation and testing procedures, and equipment; coating material; system design calculations for rectifier, anode number, life, and parameters to achieve protective potential; backfill shield material and installation details showing waterproofing; bonding and waterproofing details; insulated resistance wire; exothermic weld equipment and material.

1.3 SUBMITTALS

Government approval is required for submittals with a "G" designation; submittals not having a "G" designation are for Contractor Quality Control approval. When used, a designation following the "G" designation identifies the office that will review the submittal for the Government. Submit the following in accordance with Section 01 33 00 SUBMITTAL PROCEDURES:

SD-02 Shop Drawings

Detail Drawings; G
Contractor's Modifications; G

SD-03 Product Data

Miscellaneous Materials; G
Spare Parts

SD-06 Test Reports

Tests and Measurements
Contractor's Modifications; G

SD-07 Certificates

Tests and Measurements
Cathodic Protection System
Services of "Corrosion Expert"; G

SD-10 Operation and Maintenance Data

Cathodic Protection System; G
Training Course; G

1.4 QUALITY ASSURANCE

1.4.1 Services of "Corrosion Expert"

Obtain the services of a "corrosion expert" to supervise, inspect, and test the installation and performance of the cathodic protection system. "Corrosion expert" refers to a person, who, by reason of thorough knowledge of the physical sciences and the principles of engineering and mathematics, acquired by professional education and related practical experience, is qualified to engage in the practice of corrosion control of buried metallic piping systems.

a. Such a person shall be accredited or certified by the National Association of Corrosion Engineers (NACE) as a NACE Accredited Corrosion Specialist or a NACE certified Cathodic Protection (CP) Specialist or be a registered professional engineer who has certification or licensing that includes education and experience in corrosion control of buried or submerged metallic piping systems, if such certification or licensing includes 5 years experience in corrosion control on underground metallic surfaces of the type under this contract.

b. Submit the "corrosion expert's" name and qualifications certified in writing to the Contracting Officer prior to the start of construction, including the name of the firm, the number of years of experience, and a list of not less than five of the firm's installations three or more years old that have been tested and found satisfactory.

c. The "corrosion expert" shall make at least 3 visits to the project site. The first of these visits shall include obtaining soil resistivity data, acknowledging the type of pipeline coatings to be used and reporting to the Contractor the type of cathodic protection required. Once the submittals are approved and the materials delivered, the "corrosion expert" shall revisit the site to ensure the Contractor understands installation practices and laying out the components. The third visit shall involve testing the installed cathodic protection systems and training applicable personnel on proper maintenance techniques. The "corrosion expert" shall supervise installation and testing of all cathodic protection.

1.4.2 Isolators

Isolators are required to isolate the indicated pipes from any other structure. Isolators shall be provided with lightning protection and a test station as shown.

1.4.3 Anodes and Bond Wires

Install anodes in sufficient number and of the required type, size and spacing to obtain a uniform current distribution of 2.5 milliamperes per square foot minimum to underground metal surfaces. For each cathodic protection system, the metallic components and structures to be protected shall be made electrically continuous. This shall be accomplished by installing bond wires between the various structures. Bonding of existing buried structures may also be required to preclude detrimental stray current effects and safety hazards. Provisions shall be included to return stray current to its source without damaging structures intercepting the stray current. The electrical isolation of underground facilities in accordance with acceptable industry practice shall be included under this section.

1.4.4 Nonmetallic Pipe Systems

When nonmetallic pipe is approved, direct buried or submerged metallic components of the pipe system shall have cathodic protection. Metallic components are connectors, tees, valves, short pipes, elbows, tie rods, or other metallic equipment. The use of nonmetallic pipe does not change other requirements of the specifications such as submittals, testing, or design calculations for each metallic component. Deviations due to the use of nonmetallic pipe shall be approved by the Contracting Officer.

1.4.4.1 Coatings

Coatings for metallic components shall be as required for metallic fittings. Protective covering (coating and taping) shall be completed and tested on each metallic component and shall be as required for underground metallic pipe. Mechanical joints and fittings of either the electrically conductive or insulating type shall be coated with an underground type dielectric coating system. Where external electrical continuity bonds are installed across mechanical joints, bare or exposed metal, welds, bare wire and exposed coupling parts shall be coated with a coating system.

a. Couplings and fittings which have a low profile exterior designed to permit tape coating shall be primed and wrapped with an underground type pipe tape system or two-part epoxy system.

1.4.4.2 Tracer Wire

When a nonmetallic pipe line is used to extend or add to an existing metallic line, an insulated No. 8 AWG copper wire shall be connected to a terminal in a test station located at each point of transition from metallic pipe to nonmetallic pipe. At each of these test stations, the tracer wire terminal shall be strapped or bonded to the terminal for the negative connection wire to the existing metallic line. The tracer wire shall be run the length of the new nonmetallic line. This wire shall be used as a locator tracer wire and to maintain continuity to any future extension of the pipe line.

1.5 DELIVERY, STORAGE, AND HANDLING

Storage for anodes will be designated by the Contracting Officer. If anodes are not stored in a building, protect them from inclement weather. Packaged anodes damaged as result of improper handling or weather exposure shall be resacked and the required backfill added.

1.6 EXTRA MATERIALS

Submit spare parts data for each different item of material and equipment specified, after approval of detail drawings and not later than 2 months prior to the date of beneficial occupancy. Include in the data a complete list of parts, special tools, and supplies, with current unit prices and source of supply. Furnish one spare anode of each type.

PART 2 PRODUCTS

2.1 IMPRESSED CURRENT ANODES

2.1.1 Mixed Metal Oxide Anodes

Mixed metal oxide anodes shall be of the size indicated and shall conform to the following requirements.

2.1.1.1 Conductive Material

The electrically conductive coating shall contain a mixture consisting primarily of iridium, tantalum, and titanium oxides. The average composition is generally a 50/50 atomic percent mixture of iridium and titanium oxides, with a small amount of tantalum. The resistivity, as tested by the manufacturer, shall be no more than 0.002 ohm-centimeter, and the bond strength shall be greater than 7.25 ksi to guarantee the current capacity life and the quality of the conductive ceramic coating. The adhesion or bond strength shall be determined by epoxy bonding a 0.1 inch diameter stud to the ceramic coating and measuring the load to failure (about 10.15 ksi) of either the epoxy or the interface between the coating and the substrate. The anode must be inert and the electrically conductive ceramic coating dimensionally stable. The ceramic coated anode shall be capable of sustaining a current density of 100 ampere per 10.764 square feet in an oxygen generating electrolyte at 150 degrees F for 20 years, to ensure the current capacity life. An accelerated current capacity life test shall be performed by the manufacturer on every lot of anode wire used to construct the anode as described. The mixed metal oxide coating shall be applied to the wire anode by a firm that is regularly engaged in and has a minimum 5 years experience in manufacturing and applying mixed metal oxide coatings to titanium anode substrates. The mixed metal oxide must be sintered to the titanium surface as to remain tightly bound to the surface when bent 180 degrees onto itself.

2.1.1.2 Anode Life Test

The anode wire material shall sustain current densities of 100 ampere per 10.764 square feet in an oxygen generating electrolyte for 20 years. The manufacturer shall certify that a representative sample taken from the same lot used to construct the anode, has been tested and meets the following criteria. The test cell sustains a current density of 10,000 ampere per 10.764 square feet in a 15 weight percent sulfuric acid electrolyte at 150 degrees F without an increase in anode to cathode potential of more than 1 volt. The cell containing the anode shall be powered with a constant current power supply for the 30 day test period. The representative sample shall be 5 inch in length taken from the lot of wire that is to be used for the anode.

2.1.1.3 Canister Contained Mixed Metal Oxide Anodes

Canister contained mixed metal oxide anodes shall be packed at the factory in light weight, light gauge steel uni-body TIG welded canisters with calcinated petroleum coke breeze. The canisters shall be capped with TIG welded steel and caps providing a totally encapsulated construction. The connecting cable shall pass through a hole in an end cap designed to be tight fitting with a heavy duty strain relief allowing for handling of the canister by the cable. The anode shall be centered in the canister by centralizers to maintain rod position.

2.1.1.4 Anode Connecting Cables

Anodes shall have connecting cables installed at the factory. The connection between the anode rod or ribbon and the lead wire shall be made with a solid crimp couple with solder. The connection shall be sealed in cast epoxy.

2.1.1.5 Canister Connection Cables

Canister connecting cables shall consist of an ultra low resistance solder connection which is a minimum of three times stronger than the cable. For ceramic coated canister anodes, the cable connection shall consist of two molded dielectric layers (pressure seals), a flexible backfill resin encapsulant stabilizer, a schedule 40 PVC pipe Type 1 seal, and Type 1 PVC pipe end plugs. The seals and end plugs shall resist chlorine gas and acid.

2.2 RECTIFIERS AND ASSOCIATED EQUIPMENT

2.2.1 Rectifier Unit

Rectifier unit shall consist of a transformer, rectifying elements, transformer tap adjuster, terminal block, one dc output voltmeter, one dc output ammeter, one combination volt-ammeter, one toggle switch for each meter, fuse holders with fuses for each dc circuit, variable resistors, an ac power-supply circuit breaker, lightning arresters for both input and output, all wired and assembled in a weatherproof cabinet. The overall efficiency of the rectifier shall be not less than 65 percent when operated at nameplate rating and shall be capable of supplying continuous full rated output at an ambient temperature of 112 degrees F in full sunlight with expected life in excess of 10 years.

2.2.1.1 Transformer

Transformer shall conform to UL 506.

2.2.1.2 Rectifiers

Rectifying elements shall be silicon diodes connected to provide full-wave rectification. Silicon diodes shall be protected by selenium surge cells or varistors against over-voltage surges and by current-limiting devices against over-current surges.

2.2.1.3 Meters

Meters shall be accurate to within plus or minus 2 percent of full scale at 80 degrees F, and shall possess temperature stability above and below 80 degrees F and shall possess temperature stability above and below 80 degrees F of at least 1 percent per 10 degrees F. Separate meters shall be 2-1/2 inch nominal size or larger.

2.2.1.4 Circuit Breaker

A flush-mounted, fully magnetic, properly rated non-terminal type circuit breaker shall be installed in the primary circuit of the rectifier supply transformer.

2.2.1.5 Fuses

Cartridge-type fuses with suitable fuse holders shall be provided in each leg of the dc circuit.

2.2.2 Cabinet Construction

Cabinet shall be constructed as shown on the Drawings. The enclosure shall have oil-resistant gasket. The door shall be hinged and have a hasp that will permit the use of a padlock. The cabinet shall be fitted with screened openings of the proper size to provide for adequate cooling. Holes, conduit knockouts, or threaded hubs of sufficient size and number shall be conveniently located.

2.2.2.1 Wiring Diagram

A complete wiring diagram of the power unit showing both the ac supply and the dc connections to anodes shall be on the inside of the cabinet door. All components shall be shown and labeled.

2.2.2.2 Grounding Provisions

Grounding provisions shall comply with NFPA 70 and UL 467 including a ground terminal in the cabinet. The grounding conductor from the terminal to the earth grounding system shall be solid or stranded copper not smaller than No. 6 AWG. The earth grounding system shall consist of one or more ground rods. Ground rods shall be of copper-clad steel conforming to UL 467 not less than 3/4 inch in diameter by 8 feet in length. Rods shall be driven full length into the earth. Sectional type rods may be used.

2.2.2.3 Resistance to Ground

The resistance to ground shall be measured using the fall-of-potential method described in IEEE 81. The maximum resistance of driven ground shall not exceed 25 ohms under normally dry conditions. If this resistance cannot be obtained with a single rod, additional rods not less than 6 feet on centers, or if sectional type rods are used, additional sections may be coupled and driven with the first rod. In high-ground-resistance, UL listed chemically charged ground rods may be used. If the resultant resistance exceeds 25 ohms measured not less than 48 hours after rainfall, the Contracting Officer shall be notified immediately. Connections below grade shall be fusion welded. Connections above grade shall be fusion welded or shall use UL 467 approved connectors.

2.2.3 Wiring

Wiring shall be installed in accordance with NFPA 70 and as shown on the Drawings.

2.3 MISCELLANEOUS MATERIALS

Within 30 days after receipt of notice to proceed, submit an itemized list of equipment and materials including item number, quantity, and manufacturer of each item. The list shall be accompanied by a description of procedures for each type of testing and adjustment, including testing of coating for thickness and holidays. Installation of materials and equipment shall not commence until this submittal is approved.

2.3.1 Electrical Wire

2.3.1.1 Anode Connecting Wire

Anode connecting wire shall be as shown on the Drawings.

2.3.1.2 Anode Header Cable

Cable for anode header and distribution shall be ss shown on the Drawings.

2.3.1.3 Test Wires

Test wires shall as shown on the Drawings.

2.3.1.4 Resistance Wire

Resistance wire shall be as shown on the Drawings.

2.3.2 Conduit

Nonmetallic conduit shall conform to NEMA TC 2.

2.3.3 Test Boxes and Junction Boxes

Boxes shall be outdoor type conforming to UL 514A.

2.3.4 Vent Pipes

All deep wells shall be vented in anode zones. Openings in the vent shall not be larger than 0.006 inch.

2.3.5 Polyethylene Insulation

Polyethylene insulation shall comply with the requirements of ASTM D1248 and of the following types, classes, and grades:

2.3.5.1 High Molecular Weight Polyethylene

High molecular weight polyethylene shall be Type I, Class C, Grade E5.

2.3.5.2 High Density Polyethylene

High density polyethylene shall be Type III, Class C, Grade E3.

2.3.6 Test Stations

Provide test stations complete with an insulated terminal block having the indicated number of terminals; provided with a lockable cover and have a cast-in legend, "C.P. Test" and complete with an insulated terminal block having the required number of terminals. (One terminal required for each conductor). Provide sufficient test stations to monitor underground isolation points. Test-bond stations (potential measurement and stray current control) shall be provided to monitor pipe to soil potential of proposed underground pipes or existing underground metallic structures which may conduct stray current from the new cathodic protection system. The location of the test-bond stations shall ensure that the pipe to soil potential of metallic pipe not designated to be protected is not made less negative by the energization of the cathodic protection system. Test station terminal connections and the terminal conductor shall be permanently tagged to identify each termination of the conductors (e.g. identify the conductors connected to the protected structures). Conductors shall be permanently identified in the station by means of plastic or metal tags, or plastic sleeves to indicate termination. Each conductor shall be color coded in accordance with the drawings. The station test facility, including permanent Cu-Cu S04 reference cells and test returns shall be installed as indicated. Pavement inserts shall be nonmetallic and shall allow Cu-Cu S04 reference electrode to contact the electrolyte beneath the pavement surface. Abbreviations shall not be used. Welding of electrical connections shall be as follows: Exothermic welds shall be "CADweld", "Thermo-weld", or approved equal. Use and selection of these materials and welding equipment shall be in accordance with the manufacturer's recommendations.

2.3.7 Calibrated Shunts

Install shunts calibrated in current per potential (e.g. mA/V) between the lead or header wire connected to the anode and the current collector lead connected to the structure. The calibration of the shunt shall be clearly marked and installed to be visible.

2.3.8 Sealing and Dielectric Compound

Sealing and dielectric compound shall be a black, rubber based compound that is soft, permanently pliable, tacky, moldable, and unbacked. Apply compound as recommended by the manufacturer, but not less than 1/8 inch thick.

2.3.9 Protective Covering

Except as otherwise specified, protective covering for underground metallic components including pipe and fittings shall be applied mechanically in a factory or field plant specially equipped for the purpose. Valves and fittings that cannot be coated and wrapped mechanically shall have the protective covering applied by hand, preferably at the plant applying the covering to the pipe. Joints shall be coated and wrapped by hand. Hand coating and wrapping shall produce a covering equal in thickness to the covering applied mechanically. Piping and components installed in valve boxes or manholes shall also receive the specified protective coating.

2.3.9.1 Field Joints

Coat field joints with material compatible with the pipeline coating compound. Apply the joint coating material to an equal thickness as the pipeline coating. Unbonded coatings shall not be used on buried metallic piping. This prohibition includes unbonded polymer wraps or tubes.

2.3.9.2 Inspection of Pipe Coatings

Once the pipeline or vessel is set in the trench, conduct an inspection of the coating including electrical holiday detection as described in paragraph TESTS AND MEASUREMENTS.

2.3.10 Preformed Sheaths

Preformed sheaths for encapsulating electrical wire splices to be buried underground shall fit the insulated wires entering the spliced joint.

2.3.11 Epoxy Potting Compound

Epoxy potting compound for encapsulating electrical wire splices to be buried underground shall be a two package system made for the purpose.

2.3.12 Backfill Shields

Backfill shields shall consist of approved pipeline wrapping or fiberglass reinforced, coal-tar impregnated tape, or plastic weld caps, specifically made for the purpose.

2.3.13 Electrical Tape

Pressure-sensitive vinyl plastic electrical tape shall conform to UL 510.

2.3.14 Cable Marker Tape

Traceable marker tape shall be manufactured for the purpose and clearly labeled "Cathodic Protection Cable Buried Below".

2.3.15 Electrically Isolating Pipe Joints

Electrically isolating pipe joints for above or below ground use shall be as shown on the Drawings.

2.3.15.1 Threaded Fittings

Threaded type electrically isolating pipe joints shall have molded plastic screw threads and be used above ground only. Machined plastic screw threads shall not be used.

2.3.15.2 Electrically Isolating Pipe Joints

Electrically isolating pipe joints shall be of a type that is in regular factory production.

2.3.16 Electrically Conductive Couplings

Electrically conductive couplings shall be of a type that has a published maximum electrical resistance rating given in the manufacturer's literature. Cradles and seals shall be of a type that is in regular factory production made for the purpose of electrically isolating the carrier pipe from the casing and preventing the incursion of water into the annular space.

2.3.17 Joint and Continuity Bonds

Provide bonds across joints or any electrically discontinuous connections in the piping, and other pipes and structures with other than welded or threaded joints included in this cathodic protection system. Unless otherwise specified, bonds between structures and across joints in pipe with other than welded or threaded joints shall be with No. 4 AWG stranded copper cable with polyethylene insulation. Bonds between structures shall contain sufficient slack for any anticipated movement between structures. Bonds across pipe joints shall contain a minimum of 4 inch of slack to allow for pipe movement and soil stress. Bonds shall be attached by exothermic welding. Exothermic weld areas shall be insulated with coating compound and approved by the Contracting Officer. Continuity bonds shall be installed as necessary to reduce stray current interference. Additional joint bonding shall be done where determined during construction or testing or as directed. Joint bonding shall include excavation and backfilling. There shall be a minimum of 2 continuity bonds between each structure and other than welded or threaded joints. Electrical continuity shall be tested across joints with other than welded or threaded joints and across metallic portions of sewage lift stations and water booster stations.

2.3.17.1 Resistance Bonds

Resistance bonds shall be adjusted for minimum interference while achieving the criteria of protection. Alternate methods may be used when approved.

2.3.17.2 Stray Current Measurements

Perform stray current measurements as indicated. Alternate methods may be used when approved. The stray current test report shall indicate location of test, type of pipes tested, method of testing.

2.3.18 Electrical Isolation of Structures

Isolating fittings, including isolating flanges and couplings, shall be installed above ground or in a concrete hand hole. As a minimum, isolating flanges or unions shall be provided at the following locations:

a. Connection of new piping to existing pipes.

2.4 ANODES

2.4.1 Packaged Anodes

Provide anodes in packaged form with the anode surrounded by specially prepared quick-wetting backfill and contained in a cloth or paper sack. Anodes shall be centered in the backfill material. The backfill material shall have the following composition, unless otherwise indicated.

Material	Percent by Weight
Gypsum	75
Bentonite	20
Sodium Sulfate	5

2.4.2 Lead Wires

Anode lead wires shall consist of No. 10 solid copper wire, with TW insulation. Lead wires shall be not less than 10 feet in length, without splices.

2.4.3 Connection Wires

Wires shall consist of No. 10 solid copper wire with RHW-USE or polyethylene insulation.

2.4.4 Insulation

Type RHW-USE insulation shall comply with NFPA 70. Polyethylene insulation shall comply with ASTM D1248; high molecular weight polyethylene shall be Type I, Class C, Grade E5; high density polyethylene shall be Type III, Class C, Grade E3.

2.4.5 Conduit Steel

Conduit steel shall conform to UL 6 and ANSI C80.1.

2.4.6 Tape

Pressure-sensitive vinyl plastic electrical tape shall conform to UL 510.

2.4.7 Backfill Shields

Provide shields consisting of approved wrapping of reinforced fiberglass coal-tar impregnated tape, or plastic weld caps specifically made for the purpose and installed in accordance with the manufacturer's recommendations. When joint bonds are required, due to the use of mechanical joints, the entire joint shall be protected with kraft paper joint cover. The joint cover shall be filled with poured hot coal-tar enamel.

2.4.8 Electrical Connections

Electrical connections shall be done as follows:

a. Exothermic welds shall be "Cadweld" or Burndy "Thermo-Weld" or approved equal. Use of these materials shall be in accordance with the manufacturer's recommendations.

b. Electrical shielded arc welds on steel pipe shall be approved via shop drawing action.

c. Other methods of welding shall be specifically approved for use by the pipe manufacturer.

2.4.9 Anode Installation

Anode configuration and size shall be as indicated on the Drawings.

2.5 LEAD WIRE CONNECTIONS

Lead wire to structure connections shall be by exothermic welding process. Weld charges made specifically for use on cast iron shall be used on cast iron pipe. A backfill shield filled with a pipeline mastic sealant or material compatible with the coating shall be placed over the weld connection and shall cover the exposed metal adequately.

PART 3 EXECUTION

3.1 CRITERIA OF PROTECTION

Acceptance criteria for determining the adequacy of protection on a buried pipe shall be in accordance with NACE SP0169, and NACE RP0193, and as specified below.

3.1.1 Iron and Steel

Use the following method a. for testing cathodic protection voltages. If more than one method is required, use method b.

a. A negative voltage of at least minus 850 millivolts as measured between the pipe and a saturated copper-copper sulphate reference electrode contacting the (electrolyte) earth directly over the pipe. Determination of this voltage shall be made with the cathodic protection system in operation. Voltage drops shall be considered for valid interpretation of this voltage measurement. A minimum of minus 850 millivolts "instant off" potential between the pipe being tested and the reference cell shall be achieved over 95 percent of the area of the structure. Obtain adequate number of measurements over the entire structure, pipe, tank, or other metallic component to verify and record achievement of minus 850 millivolts "instant off". This potential shall be obtained over 95 percent of the total metallic area without the "instant off" potential exceeding 1200 millivolts.

b. A minimum polarization voltage shift of 100 millivolts as measured between the pipe and a saturated copper-copper sulphate reference electrode contacting the earth directly over the pipe. This polarization voltage shift shall be determined byinterrupting the protective current and measuring the polarization decay. When the protective current is interrupted, an immediate voltage shift will occur. The voltage reading, after the immediate shift, shall be used as the base reading from which to measure polarization decay. Measurements achieving 100 millivolts shall be made over 95 percent of the metallic surface.

3.2 GROUND BED INSTALLATION

3.2.1 Shallow Ground Beds

Shallow ground beds shall contain size and quantity of anodes designed to meet performance criteria of the cathodic protection system at an initial operating current output density not exceeding 40 percent of maximum recommended current output density.

3.2.1.1 Vertically Buried Bare Anodes

Vertically buried bare anodes shall be installed in vertical holes in the ground having a depth, spacing, and location shown. The holes in the ground shall be sufficiently large to provide an annular space around the anode not less than 4 inch. The anodes shall be centered in the hole and backfilled with calcined petroleum coke breeze or metallurgical coke breeze. Backfill shall be compacted.

3.2.1.2 Vertically Buried Canister-Contained Anodes

Vertically buried canister-contained anodes shall be installed in vertical holes in the ground having depth, spacing, and locations shown. The holes in the ground shall be sufficiently larger in diameter than the canisters to facilitate easy lowering into the hole and backfilling. The space between the canister and the wall of the hole shall be completely backfilled with a wet slurry of earth free of stones.

3.2.1.3 Cable Protection

Positive cable to the ground bed and negative cable to the pipe to be protected shall be buried a minimum depth of 30 inch except where above ground construction utilizing conduit is used.

3.2.1.4 Multiple Anode Systems

Multiple anode systems shall consist of groups of anodes connected in parallel to a header cable, buried in the ground at depths, spacing, and locations shown. The anodes shall be buried vertically.

3.2.1.5 Distributed Anode Systems

Distributed anode systems shall consist of a line or row of anodes connected in parallel to a header cable and buried in the ground parallel to the pipeline. The anodes shall be at the pipeline at depths, spacing, and locations shown. The anodes shall be buried vertically.

3.2.2 Deep Anode Ground Beds

Deep anode ground beds shall consist of an installation of anodes supported one above the other and supported in place by a method that does not suspend the anodes from the connecting cable.

3.2.2.1 Anode Centering

Anodes shall be centered in the well by means of centering devices.

3.2.2.2 Casing

The casing shall be to a depth and elevation as shown on the Drawings.

3.2.2.3 Casing Insulation

The portion of casing above the top anode shall be coated with an electrically insulating underground type coating.

3.2.2.4 Anode Requirements

Anode sizes, spacing, number of anodes, depth of well, and other details shall be as shown.

3.2.2.5 Anode Lead Wire

Each anode shall have a separate, continuous wire extending from the anode to the junction box at the well head.

3.2.2.6 Anode Cables

Anode cables shall terminate in a nearby junction box, equipped with individual anode current shunts. Where full length casing is used, two wire connections from casing shall terminate in the junction box.

3.2.2.7 Anode and Cable Installation

If the method of installation utilizes backfill support for anodes and cable, provide slack in the cable near each anode and increase the cable insulation in thickness from 7/64 to 5/32 inch utilizing an approved composite of plastic and elastomeric materials.

3.2.2.8 Backfill

Backfill the well with calcined petroleum coke breeze or metallurgical coke breeze surrounding the anodes by a method that does not leave voids or bridging. The recommended method is to pump the backfill from the bottom upward. The well shall be over-filled with coke breeze allowing for settlement so that the settled level after a number of days is as high as the level shown. The number of days allowed for settling of the coke breeze will be determined by the Contracting Officer. If the top level of coke breeze is below the level shown after settlement, put additional coke breeze in the well. The backfill used shall not require tamping. The top portion of the well shall be sealed for 25 feet to prevent surface water run-off. All vents shall be vented above the high water mark and at a safe height.

3.2.2.9 Cable Marker Tape

Locate traceable marker tape in the same trench above cathodic protection cables including structure leads, anode leads, anode header cables, test station leads, bonding cables, and rectifier electrical power cables.

3.2.2.10 Pavement Inserts

Install pavement inserts at a minimum of 100 foot intervals for pipelines. The pavement inserts shall be installed directly over the structure being protected and tested.

3.3 MISCELLANEOUS INSTALLATION

3.3.1 Rectifier Installation

Mounting shall be as shown.

3.3.2 Wire Connections

3.3.2.1 Wire Splicing

Connecting wire splicing shall be made with copper compression connectors or exothermic welds, following instructions of the manufacturer. Split-bolt type connectors shall not be used.

3.3.2.2 Steel Surfaces

Connections to ferrous pipe shall be made by exothermic weld methods as manufactured by an approved manufacturer for the type of pipe. Electric arc welded connections and other types of welded connections to ferrous pipe and structures shall be approved before use.

3.3.3 Pipe Joints

3.3.3.1 Electrical Continuity

Underground pipe shall be electrically continuous except at places where electrically isolating joints are specified. Pipe joined by means other than welding shall meet the following electrical continuity requirements:

a. Mechanical joints that are not factory designed to provide electrical continuity shall be bonded by installing a metallic bond across the joint. The bonding connections shall be made by the exothermic welding process.

b. Mechanical joints designed to provide electrical continuity may be used.

3.3.3.2 Electrical Isolation of Structures

Perform electrical isolation of structures as follows:

3.3.3.2.1 Isolating Fittings

Install isolating flanges and couplings aboveground, or within manholes, wherever possible, but an isolating device that electrically separates a pipeline shall not be installed in a confined area where a combustible atmosphere may collect unless precautions are taken to prevent arcing such as by means of externally located surge arresters, grounding cells, or other means. Isolating flanges and couplings in lines entering buildings shall be located at least 12 inch above grade or floor level.

3.3.4 Dissimilar Metals

Buried piping of dissimilar metals including new and old steel piping, excepting valves, shall be electrically separated by means of electrically insulating joints at every place of connection. The insulating joint, including the pipes, shall be coated with an underground type dielectric coating for a minimum distance of 10 diameters on each side of the joint.

3.3.5 Ferrous Valves

Dissimilar ferrous valves in a buried ferrous pipeline, including the pipe, shall be coated with an underground type dielectric coating for a minimum distance of 10 diameters on each side of the valve.

3.3.6 Brass or Bronze Valves

Brass or bronze valves shall not be used in a buried ferrous pipeline.

3.3.7 Metal Pipe Junction

If the dissimilar metal pipe junction, including valves, is not buried and is exposed to atmosphere only, the connection or valve, including the pipe, shall be coated with an underground type dielectric coating for a minimum distance of 3 diameters on each side of the junction.

3.3.8 Casing

Where a pipeline is installed in a casing under a roadway or railway, the pipeline shall be electrically isolated from the casing, and the annular space sealed against incursion of water.

3.3.9 Test Stations

Test stations shall be of the type and location shown. Buried electrically isolating joints shall be provided with test wire connections brought to a test station. Changes in designated location shall have prior approval. Unless otherwise shown, other test stations shall be located as follows:

a. At 1,000 foot intervals or less.

b. Where the pipe or conduit crosses any other metal pipe.

c. At both ends of casings under roadways and railways.

d. Where both ends of an insulating joint are not accessible above ground for testing purposes.

3.4 TRAINING COURSE

Conduct a training course for the operating staff as designated by the Contracting Officer. The training period shall consist of a total of 16 hours of normal working time and shall start after the system is functionally completed but prior to final acceptance tests. Submit the proposed Training Course Curriculum (including topics and dates of discussion) indicating that all of the items contained in the operating and maintenance instructions, as well as demonstrations of routine maintenance operations, including testing procedures included in the maintenance instructions, are to be covered. The field instructions shall cover all of the items contained in the operating and maintenance instructions, as well as demonstrations of routine maintenance operations, including testing procedures included in the maintenance instructions. At least 14 days prior to date of proposed conduction of the training course, submit the training course curriculum for approval, along with the proposed training date. Training shall consist of demonstration of test equipment, providing forms for test data and the tolerances which indicate that the system works satisfactorily.

3.5 TESTS AND MEASUREMENTS

Submit test reports in booklet form tabulating field tests and measurements performed, upon completion and testing of the installed system and including close interval potential survey, casing and interference tests, final system test verifying protection, insulated joint and bond tests, and holiday coating test. Submit a certified test report showing that the connecting method has passed a 120-day laboratory test without failure at the place of connection, wherein the anode is subjected to maximum recommended current output while immersed in a 3 percent sodium chloride solution. Each test report shall indicate the final position of controls.

3.5.1 Baseline Potentials

Each test and measurement will be witnessed by the Contracting Officer. Notify the Contracting Officer a minimum of 5 working days prior to each test. After backfill of the pipe and anodes is completed, but before the anodes are connected to the pipe, the static potential-to-soil of the pipe shall be measured. The locations of these measurements shall be identical to the locations specified for pipe- to-reference electrode potential measurements.

3.5.2 Isolation Testing

Before the anode system is connected to the pipe, an isolation test shall be made at each isolating joint or fitting. This test shall demonstrate that no metallic contact, or short circuit exists between the two isolated sections of the pipe. Any isolating fittings installed and found to be defective shall be reported to the Contracting Officer.

3.5.2.1 Insulation Checker

Use a Model 601 insulation checker, as manufactured by "Gas Electronics" or an approved equal, for isolating joint (flange) electrical testing in accordance with manufacturer's operating instructions. An isolating joint that is good will read full scale on the meter; if an isolating joint is shorted, the meter pointer will be deflected at near zero on the meter scale. Location of the fault shall be determined from the instructions and the joint shall be repaired. If an isolating joint is located inside a vault, the pipe shall be sleeved with insulator when entering and leaving the vault.

3.5.2.2 Cathodic Protection Meter

Use a Model B3A2 cathodic protection meter, as manufactured by "M. C. Miller" or an approved equal using the continuity check circuit for isolating joint (flange) electrical testing. Perform this test in addition to the Model 601 insulation checker. Continuity is checked across the isolated joint after the test lead wire is shorted together and the meter adjusted to scale. A full scale deflection indicates the system is shorted at some location. The Model 601 verifies that the particular insulation under test is good and the Model B3A2 verifies that the system is isolated. If the system is shorted, further testing shall be performed to isolate the location of the short.

3.5.3 Anode Output

After the rectifier is energized, the current output of the individual anode leads shall be measured by using an approved method. This may be done with a shunt and MV meter, a low-resistance ammeter, or a clamp-on milliammeter. The total current shall be measured and compared to the sum of all anode currents and to the rectifier output current. If an individual anode output current meets or exceeds the recommended output for that anode, the system shall be turned down or balancing resistors installed. Calculation of the wattage of the resistors shall be sufficient to handle the maximum load which will be encountered on the anode lead. All measurements obtained, the date, time, and locations of all measurements shall be recorded.

3.5.4 Electrode Potential Measurements

Upon completion of the installation and with the entire cathodic protection system in operation, electrode potential measurements shall be made using a copper-copper sulphate reference electrode and a potentiometer-voltmeter, or a direct current voltmeter having an internal resistance (sensitivity) of not less than 10 megohms per volt and a full scale of 10 volts. The locations of these measurements shall be identical to the locations used for baseline potentials. The values obtained and the date, time, and locations of measurements shall be recorded. No less than 8 measurements shall be made over any length of line or component. Additional measurements shall be made at each distribution service riser, with the reference electrode placed directly over the service line.

3.5.5 Location of Measurements

3.5.5.1 Coated Piping or Conduit

For coated piping or conduit, take measurements from the reference electrode located in contact with the earth, directly over the pipe. Connection to the pipe shall be made at service risers, valves, test leads, or by other means suitable for test purposes. Pipe to soil potential measurements shall be made at intervals not exceeding 2.5 feet. The Contractor may use a continuous pipe to soil potential profile in lieu of 2.5 ft interval pipe to soil potential measurements. Additional measurements shall be made at each distribution service riser, with the reference electrode placed directly over the service line adjacent to the riser. Potentials shall be plotted versus distance to an approved scale. Locations where potentials do not meet or exceed the criteria shall be identified and reported to the Contracting Officer.

3.5.6 Casing Tests

Before final acceptance of the installation, the electrical separation of carrier pipe from casings shall be tested and any short circuits corrected.

3.5.7 Interference Testing

Before final acceptance of the installation, interference tests shall be made with respect to any foreign pipes in cooperation with the owner of the foreign pipes. A full report of the tests giving all details shall be made.

3.5.8 Holiday Test

Repair any damage to the protective covering, during transit and handling, before installation. After field coating and wrapping has been applied, inspect the entire pipe by an electric holiday detector with impressed current in accordance with NACE SP0188 using a full ring, spring type coil electrode. The holiday detector shall be equipped with a bell, buzzer, or other type of audible signal which sounds when a holiday is detected. Holidays in the protective covering shall be repaired upon detection. Occasional checks of holiday detector potential will be made by the Contracting Officer to determine suitability of the detector. Furnish labor, materials, and equipment necessary for conducting the inspection. Inspect the coating system for holes, voids, cracks, and other damage during installation.

3.5.9 Recording Measurements

Record all pipe- to-soil potential measurements including initial potentials where required. Locate, correct and report to Contracting Officer any short circuits to foreign pipes encountered during checkout of the installed cathodic protection system. Pipe- to-soil potential measurements are required on as many pipes as necessary to determine the extent of protection or to locate short-circuits.

-- End of Section --

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EARTHWORK

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SECTION 31 00 00

EARTHWORK

PART 1 GENERAL

The work covered by this section consists of furnishing all plant, labor, equipment, and materials and of performing all operations in connection with earthwork, in accordance with these Specifications and applicable Plans. Excavation and reconstruction/modification of the existing levee embankment will be required in order to construct adjacent levees, seepage berms, and toe berms. Excavation and fill for Plant 3 outfall structure, discharge pipelines, and utilities are to be performed. Levee and berm fill will consist of project borrow source materials and excavated materials, if meeting project criteria.

1.1 REFERENCES

The publications listed below form a part of this specification to the extent referenced. The publications are referred to within the text by the basic designation only.

ACI INTERNATIONAL

ACI 229R	(2005) Controlled Low Strength Materials

ASTM INTERNATIONAL (ASTM)

ASTM C127	(2015) Standard Test Method for Density, Relative Density (Specific Gravity), and Absorption of Coarse Aggregate
ASTM C131/C131M	(2014) Standard Test Method for Resistance to Degradation of Small-Size Coarse Aggregate by Abrasion and Impact in the Los Angeles Machine
ASTM C136/C136M	(2014) Standard Test Method for Sieve Analysis of Fine and Coarse Aggregates
ASTM D1140	(2000; R 2006) Amount of Material in Soils Finer than the No. 200 (75-micrometer) Sieve
ASTM C33/C33M	(2018) Standard Specification for Concrete Aggregates
ASTM C50/C50M	(2013) Sampling, Sample Preparation, Packaging, and Marking of Lime and Limestone Products
ASTM C977	(2010) Quicklime and Hydrated Lime for Soil Stabilization
ASTM D1556/D1556M	(2015; E 2016) Standard Test Method for

	Density and Unit Weight of Soil in Place by Sand-Cone Method
ASTM D1557	(2012; E 2015) Standard Test Methods for Laboratory Compaction Characteristics of Soil Using Modified Effort (56,000 ft-lbf/ft3) (2700 kN-m/m3)
ASTM D2166/D2166M	(2016) Standard Test Method for Unconfined Compressive Strength of Cohesive Soil
ASTM D2216	(2010) Laboratory Determination of Water (Moisture) Content of Soil and Rock by Mass
ASTM D2487	(2017) Standard Practice for Classification of Soils for Engineering Purposes (Unified Soil Classification System)
ASTM D3551	(2008) Laboratory Preparation of Soil-Lime Mixtures Using a Mechanical Mixer
ASTM D3740	(2012a) Minimum Requirements for Agencies Engaged in the Testing and/or Inspection of Soil and Rock as Used in Engineering Design and Construction
ASTM D3744/D3744M	(2011a) Standard Test Method for Aggregate Durability Index
ASTM D4318	(2017; E 2018) Standard Test Methods for Liquid Limit, Plastic Limit, and Plasticity Index of Soils
ASTM D4643	(2017) Standard Test Method for Determination of Water Content of Soil and Rock by Microwave Oven Heating
ASTM D5080	(2008) Standard Test Method for Rapid Determination of Percent Compaction
ASTM D6913	(2017) Particle-Size Distribution of Soils using Sieve Analysis
ASTM D6938	(2017a) Standard Test Method for In-Place Density and Water Content of Soil and Soil-Aggregate by Nuclear Methods (Shallow Depth)
ASTM D698	(2012; E 2014; E 2015) Laboratory Compaction Characteristics of Soil Using Standard Effort (12,400 ft-lbf/cu. ft. (600 kN-m/cu. m.))

U.S. ARMY CORPS OF ENGINEERS (USACE)

EM 385-1-1	(2014) Safety and Health Requirements Manual

ER 1110-1-261 (1999) Quality Assurance of Laboratory Testing Procedures

1.2 DEFINITIONS

1.2.1 Suitable Materials

Suitable materials shall consist of soils classified in accordance with ASTM D2487 as CL, CL-ML, CH, MH, ML, SC, SM, GP, GW, GM, GC, GC-GM, GP-GM, GW-GM, GP-GC, GW-GC, SP, SW, SP-SM, SW-SM, SP-SC, SW-SC, and SC-SM meeting the additional requirements of paragraph 2.2, TYPES OF FILL MATERIALS. Suitable materials shall be free from debris and organic material as defined herein. Materials shall not be classified as unsuitable based solely on moisture content.

1.2.2 Unsuitable Materials

Unsuitable materials include all other materials that are not defined as suitable materials in paragraph 1.2.1 Suitable Materials. Materials shall not be classified as unsuitable based solely on moisture content. Material containing roots greater than 1/2-inch in diameter, debris, rubble, trash or other deleterious items shall be classified as unsuitable materials. Unsuitable materials shall be disposed of in accordance with Section 02 41 00 DEMOLITION.

Soils containing visible concentrations of organics or classified as organic clay or organic silt (OH or OL) are unsuitable, except for strippings.

1.2.3 Fill Material

The terms "embankment" or "fill" or "backfill" as used in these specifications are defined as the earth fill portions of the levee embankment structure, other fills related to the levee, or other fills within the limits of the project.

1.2.3.1 Soil Type 1 Fill

Earthen fill to be used for construction of seepage berms, toe berms, patrol roads, and patrol road ramps. Soil Type 1 fill shall consist of suitable materials meeting the additional requirements of paragraph 2.2 TYPES OF FILL MATERIALS.

1.2.3.2 Soil Type 2 Fill

Earthen fill to be placed on the levee embankment and landside adjacent levee. Soil Type 2 Fill shall consist of suitable materials meeting the additional requirements of paragraph 2.2 TYPES OF FILL MATERIALS.

1.2.3.3 Soil Type 3 Fill

Earthen fill to be placed on the levee embankment and landside adjacent levee. Soil Type 3 Fill shall consist of suitable materials meeting the additional requirements of paragraph 2.2 TYPES OF FILL MATERIALS.

1.2.3.4 Soil Type 4 Fill

Earthen fill to be placed on the levee embankment and landside adjacent levee. Soil Type 4 Fill shall consist of suitable materials meeting the additional requirements of paragraph 2.2 TYPES OF FILL MATERIALS.

1.2.3.5 Lime-Stabilized Soil

The upper 24 inches of the levee crown of the landside adjacent levee embankment composed of materials meeting Soil Type 4 Fill requirements shall be lime-stabilized to achieve Soil Type 2 Fill material characteristics.

1.2.3.6 Controlled Low Strength Material

Controlled Low Strength Material (CLSM) to be used to backfill around relief well outlet pipes, backfill of utilities, and structures such as manholes, as shown on DRAWINGS. CLSM shall be as defined in ACI 229R and shall meet the requirements specified in Section 03 52 01 CONTROLLED LOW STRENGTH MATERIAL.

1.2.3.7 Filter Material and Drain Rock

Suitable material for use as filter layers and drain rock under the drained seepage berm and meeting the additional requirements of paragraph 2.2 TYPES OF FILL MATERIALS.

1.2.4 Granular Structural Backfill

Earthen fill to be placed within 4-feet of completed or partially completed structures and meeting the additional requirements of paragraph 2.2 TYPES OF FILL MATERIALS.

1.2.5 Utility Trench Backfill

Earthen fill to be placed between utilities and within 5 feet of utilities measured horizontally of new utilities where shown on the drawings, and abandoned utility excavations. Utility Trench Backfill shall consist of suitable materials meeting the additional requirements of paragraph 2.2 TYPES OF FILL MATERIALS.

1.2.6 Degree of Compaction

Degree of compaction shall be expressed as a percentage of the maximum density obtained by the test procedures presented in ASTM D698 and ASTM D1557 where specified, abbreviated herein as percent of laboratory maximum density.

1.3 QUALIFICATIONS

Refer to the proposal forms for additional qualification requirements for Contractor's Project Manager, Site Superintendent, and Field Quality Control Representative.

1.3.1 Earthwork Contractor

The earthwork contractor performing levee construction and reconstruction shall have experience in projects of similar size and scope completed in the last 5 years. The project experience must have been performed by the entity proposing to perform the work as defined below. An individual's experience from former companies shall qualify as contractor experience provided that the individual is the Contractor's designated Project Manager or Site Superintendent. Qualifying experience in levee construction and reconstruction shall consist of the following:

Satisfactorily performed the work and completed the construction of at least three earthen levee or earth fill dam projects. The projects must have included a minimum earthen levee or earth fill dam embankment or berm quantity of 25,000 cubic yards.

The Qualifications Earthwork Contractor shall be submitted prior to construction.

1.3.2 Field Quality Control Representative

The earthwork contractor shall maintain a field Quality Control representative (FQCR) of an independent testing laboratory (Section 01 45 00 QUALITY CONTROL) at the site on a full-time basis to perform inspection and testing in accordance with paragraph 3.15 FIELD QUALITY CONTROL. The individual shall have served in the FQCR role on at least three earthen levee or earth fill dam projects completed in the last 10 years and have experience in all aspects of earthwork construction.

The Qualifications Field Quality Control Representative shall be submitted prior to construction.

1.3.3 Civil or Geotechnical Engineer

The civil or geotechnical engineer shall have experience in performing levee construction and reconstruction projects of similar size and scope completed in the last 5 years. Qualifying experience in levee construction and reconstruction shall consist of the following:

Satisfactorily performed the work and completed the construction of at least three earthen levee or earth fill dam projects. The projects must have included a minimum earthen levee or earth fill dam embankment or berm quantity of 25,000 cubic yards.

The Qualifications Civil or Geotechnical Engineer shall be submitted prior to construction.

1.4 SUBMITTALS

Government approval is required for submittals with a "G" designation; submittals not having a "G" designation are for information only. When used, a designation following the "G" designation identifies the office that will review the submittal for the Government. The designation "DO" represents the District Office Engineering Division and the designation "RO" represents the Resident Office. Submit the following in accordance with Section 01 33 00 SUBMITTAL PROCEDURES:

SD-01 Preconstruction Submittals

Excavation Plan for Relief Well Construction; G, DO

Excavation Plan for Pump Station 3; G, DO

Excavation Plan for Outfall Structure; G, DO

Excavation Plan for Pipe Removal; G, DO

Qualifications Earthwork Contractor: G, DO

Qualifications Field Quality Control Representative; G, DO

Qualifications Civil or Geotechnical Engineer; G, DO

Preconstruction Video And Photograph Survey; G, RO

Survey Data; G, RO

Equipment Data; G, RO

Materials Distribution And Stockpile Plan; G, DO

Shoring And Sheeting Plan; G, DO

Plan Of Operations; G, DO

Flood Stage Contingency Plan; G, DO

SD-03 Product Data

Embankment And Backfill Materials; G, DO

Filter Material; G, DO

Drain Rock; G, DO

SD-05 Design Data

Lime Stabilization Mix Design; G, DO

SD-07 Certificates

Lime; G, DO

SD-09 Manufacturer's Field Reports

Quality Control Testing; G, DO

Test Data Summaries; G, DO

Construction Verification Survey Report; G, RO

1.5 GENERAL CONDITIONS

1.5.1 Lines and Grades

Submit Preconstruction Video and Photograph Survey of the levee crown roadway gravel, paving, and levee slope area showing adequate detail per paragraph 1.19 of Section 01 00 00 GENERAL REQUIREMENTS.

Unless otherwise noted on the Plans, the embankment shall be restored to pre-construction lines and grades as determined by surveys noted in paragraph 1.18 of Section 01 00 00 GENERAL REQUIREMENTS. Submit copies of survey data in the form of cross sections of the levee prior to construction. Submit written certification that the data is accurate and surveying was performed by a licensed surveyor authorized to practice land surveying in the State of California. Submit all data within 24 hours of performing field surveys per paragraph 1.18 of Section 01 00 00 GENERAL

REQUIREMENTS.

Where variations are noted on the Plans, the embankments and backfills shall be constructed to the lines, grades, and cross sections indicated on the Plans, unless otherwise directed by the Contracting Officer. The Contracting Officer reserves the right to increase or decrease the foundation widths and embankment slopes or to make such other changes in the embankment or backfill sections as may be deemed necessary to produce a safe structure. Changes in quantities resulting from such revisions will not constitute justification for change in contract unit prices, except as provided for in the General Specifications.

1.5.2 Conduct of the Work

Twenty days prior to commencement of haul road construction or placing embankment and backfill, whichever is earlier, submit for review a Plan of Operations for accomplishing all embankment and backfill construction and for the location and construction of haul roads. The plan shall be reviewed and approved by the Contracting Officer prior to the start of Work. This plan shall include, but not be limited to, the Contractor's proposed sequence of construction for embankment and backfill items, and methods and types of equipment to be utilized for all embankment and backfill operations, including transporting, placing, and compaction. This plan shall also include the names and addresses of the commercial testing labs which will perform the soil testing and inspection and describe how all required soils testing will be performed and reported. The requirements for independent testing laboratories shall meet requirements of Section 01 45 00 QUALITY CONTROL.

Maintain and protect the embankment, backfill, and any identified existing structures, utilities, and trees in a satisfactory condition at all times until final completion and acceptance of all work under the Contract. Submit a list of equipment data used for hauling, fill placement, compaction, and sprinkling equipment and include weights, size, and contact pressures as part of the Plan of Operations. If the hauling equipment causes horizontal shear planes or slickensides, rutting, quaking, heaving, cracking, or excessive deformation of the embankment or backfill, limit the type, load, or travel speed of the hauling equipment on the embankment or backfill. The Contractor may be required to remove, at his own expense, any embankment material placed outside of prescribed slope lines. Any approved embankment or backfill material which is lost in transit or rendered unsuitable after being placed in the embankment or backfill and before final acceptance of the work shall be replaced by the Contractor in a satisfactory manner and no additional payment will be made. Excavate and remove from the embankment or backfill any material which is unsatisfactory and shall also dispose of such material and refill the excavated area as directed, all at no cost to the Government.

1.5.3 Fill Materials

Submit a Materials Distribution and Stockpile Plan that describes where material will be obtained, placed, stockpiled and blended for usage or for disposal. This information shall be submitted within 10 days after the notice to proceed. Describe how materials excavated from the borrow area shall be identified to allow field personnel to determine the appropriate end use of the material.

Materials for embankment construction shall be suitable materials obtained from either the designated borrow areas or project excavations. Blend and reuse project excavations to the maximum extent possible. Materials shall be blended at the borrow site or approved staging/stockpile area. Materials shall be tested for suitability prior to placement. Material not meeting the specified requirements shall be hauled off site and disposed of in a legal manner.

1.5.4 Haul Roads, Working Surfaces, and Temporary Ramps

Haul roads, working surfaces, and temporary ramps shall be located and constructed within the construction limits shown on the Plans. Prior to the commencement of construction submit for review a site plan detailing the location of all haul roads and temporary ramps within the construction limits.

Haul roads, working surfaces, and temporary ramps shall be constructed to maintain the intended traffic and be maintained in good condition throughout the contract period. Haul roads and ramps which cross any creek or drainage channel shall be constructed and maintained by the Contractor so as to not flood either upstream areas by restricting stream flows or flood downstream areas by the release of any stored water in the event that the crossing fails for any cause. Haul roads, working surfaces, and ramps constructed during the contract duration shall be removed after work is completed and the impacted area restored to its preconstruction conditions. All costs associated with these haul roads and ramps shall be considered as a subsidiary obligation of the Contractor.

1.5.5 Excavations

Submit the following written Excavation Plans a minimum of 20 days prior to the beginning of any excavation work: Excavation Plan for Relief Well Construction, Excavation Plan for Pump Station 3, Excavation Plan for Outfall Structure, and Excavation Plan for Pipe Removal. This plan shall be reviewed and approved by the Contracting Officer prior to starting any excavation work. If necessary, the plan shall be modified as required to meet field conditions, and the modifications shall be reviewed prior to use. As a minimum, the plan shall include the following:

a. Proposed methods for preventing interference with, or damage to, existing underground and overhead utility line, trees designated to remain, and other existing improvements or natural features designated to remain within or adjacent to the construction right-of-way.

b. The proposed methods for controlling surface and groundwater in the excavations.

c. Stockpiling and blending plan for embankment material showing locations, stockpile heights, slopes, limits, and drainage around the stockpile areas.

d. A complete listing of equipment used for excavation and transport of the excavated material.

e. The Contractor's proposed sequence of work for excavating with plan and cross sectional views showing starting and final work locations and clearing, grubbing and stripping limits.

f. The Contractor's proposed road pattern and plan for implementing dust control measures.

1.5.6 Slides and Foundation Failures

Repair any sliding that occurs in any part of the embankment, channel slopes and backfills prescribed in this section prior to final acceptance of the work. When the slide is caused through the fault of the Contractor, the repair shall be made at no cost to the Government. The Contracting Officer shall be the sole judge of whether a slide or foundation failure is caused through a fault of the Contractor. Submit a plan detailing how the repair will be completed. The plan shall be reviewed and approved by the Contracting Officer prior to the start of repair work. When the slide is not the fault of the Contractor, an extension of the unit prices for excavation and embankment shall be made to cover the cost of the repairs.

1.5.7 Drainage Requirements

Do not block or restrict the flow in a natural drain, existing culvert, ditch or channel at any time without obtaining prior written approval. This approval shall not relieve the Contractor from responsibility for any damage caused by his operation. Monitor the channel flow and provide sufficient free discharge areas so that conditions are not worsened upstream or downstream by possible floods during construction. Surface water shall be directed away from excavations and construction sites so as to prevent erosion and undermining of foundations. Diversion ditches, dikes, and grading shall be provided and maintained as necessary during construction. Excavated slopes and backfill surfaces shall be protected to prevent erosion and sloughing. Excavation shall be performed so that the site and the area immediately surrounding the site and affecting operations at the site shall be continually and effectively drained. If private property is to be used for drainage, submit written evidence that the right has been obtained from the property owner for drainage on his property. After construction, natural drains, existing culverts, ditches and channels affected by construction shall be restored to their preconstruction condition.

1.5.8 Utilities

Movement of construction machinery and equipment over or near utilities (including underground and overhead utilities) during construction shall be at the Contractor's risk and shall adhere to the requirements of EM 385-1-1 and any other applicable utility agency requirements. Utility lines damaged during construction shall be immediately reported to the Contracting Officer and repaired at the Contractor's expense. Utilities that are designated as removal shall be removed and backfilled, as per contract Drawings.

1.5.9 Protection of Existing Man-Made Facilities and Natural Features

Embankment excavation shall be conducted in such a manner as to avoid damage to trees to be left standing and trees outside the excavation areas, existing buildings, man-made facilities and natural features, with due regard to the safety of employees and others.

1.5.10 Civil or Geotechnical Engineer

The Contractor is required to hire a Professional Civil or Geotechnical Engineer to provide inspection of excavations and soil/groundwater conditions throughout construction. The Civil or Geotechnical Engineer shall be responsible for performing pre-construction and periodic site visits throughout construction to assess site conditions. The Civil or Geotechnical Engineer shall update the excavation, sheeting and dewatering plans as construction progresses to reflect changing conditions and shall submit an updated plan if necessary. A written report shall be submitted, at least monthly, informing the Contactor and Contracting Officer of the status of the plan and an accounting of the Contractor's adherence to the plan addressing any present or potential problems. The Civil or Geotechnical Engineer shall be available to meet with the Contracting Officer at any time throughout the contract duration.

1.6 CRITERIA FOR BIDDING

Base bids on the following criteria:

a. Surface elevations are as indicated.

b. Pipes or other artificial obstructions, except those indicated, will not be encountered.

c. Blasting will not be permitted. Remove material in an approved manner.

PART 2 PRODUCTS

2.1 MATERIALS

2.1.1 Fill Materials

Prior to delivery of any borrow material to the site, submit soil test results for embankment and backfill materials in accordance with Section 31 23 00 BORROW SITE EXCAVATION in NATOMAS BASIN RIVERSIDE CANAL PHASE 2 RELOCATION PROJECT contract documents for review and approval by the Contracting Officer.

Project fills shall be constructed of suitable earth materials as defined in Paragraph 1.2 DEFINITIONS and as required below in paragraph 2.2 TYPES OF FILL MATERIALS and obtained from project excavations or the borrow site(s) in accordance with Section 31 23 00 BORROW SITE EXCAVATION in NATOMAS BASIN RIVERSIDE CANAL PHASE 2 RELOCATION PROJECT contract documents. Blend and reuse project excavations to the maximum extent possible. Materials shall be screened of oversize material and blended as needed to obtain a blended material suitable for construction meeting the fill requirements outlined in these Specifications. Materials shall be screened, blended and tested for suitability at the borrow site, at staging/stockpile areas, or at other designated areas approved by the Contracting Officer. The test results and suitability of fill material shall be reviewed and approved by the Contracting Officer prior to placement. Soil classification tests shall be completed for all blended material in accordance with ASTM D2487.

If a disagreement between the Contractor and Contracting Officer occurs over the suitability of fill materials, perform laboratory testing as directed by the Contracting Officer to demonstrate compliance with the specifications at no additional cost to the Government. This testing shall comply with paragraph 3.15 FIELD QUALITY CONTROL. The failure of the Contractor to perform this testing shall not relieve the Contractor from the obligation to provide suitable materials.

2.2 TYPES OF FILL MATERIALS

2.2.1 Soil Types 1, 2, 3, and 4 Fill and Utility Trench Backfill Material

Soil Types 1, 2, 3, and 4 Fill and Utility Trench Backfill materials shall be obtained from project excavations and from the borrow site(s) per Section 31 23 00 BORROW EXCAVATIONS in NATOMAS BASIN RIVERSIDE CANAL PHASE 2 RELOCATION PROJECT contract documents. Soil Types 1, 2, 3, and 4 Fill and Utility Trench Backfill materials shall meet the following criteria. The fill placement areas are also identified in the following Table 1. The suitability of the materials shall be determined in accordance with paragraph 3.15 FIELD QUALITY CONTROL.

TABLE 1
FILL MATERIAL REQUIREMENTS

Fill Material Type	Applicable Areas	Soil Class	Gradations (Percent Passing)		Atterberg Limits	
			Sieve Size - 2 inch ASTM D6913	Sieve Size - #200 ASTM D1140	Liquid Limit (ASTM D4318 - Wet Prep. Method)	Plasticity Index (ASTM D4318 - Wet Prep. Method)
Type 1 Fill	Seepage berm; Roadways; Ramps (outside levee prism); Pumping Plant No. 3 Positive Closure Vault *1	SP-SM, SM, SC, ML, CL, CH, GC, GM	100	$\geq$10	Running 10-test Average < 55 No single test >60	Running 10-test Average 10<PI<40 No single test <8
Type 2 Fill	Fills with 2H:1V side slope; Utility backfill; Pumping Plant No. 3 Siphon Breaker Vaults*1	CL, SC, ML, SM	100	$\geq$30	Running 10-test Average < 40 No single test >45	Running 10-test Average 10<PI<30 No single test <8

TABLE 1
FILL MATERIAL REQUIREMENTS

Fill Material Type	Applicable Areas	Soil Class	Gradations (Percent Passing)		Atterberg Limits	
Type 3 Fill	Fills with 3H:1V side slope; Roadways; Ramps (within levee prism)	SC, SM, ML, CL, CH	100	$\geq$30	Running 10-test Average < 55 No single test >60	Running 10-test Average 10<PI<40 No single test <8
Type 4 Fill	Fills with 4H:1V side slope	SC, SM, ML, CL, CH	100	$\geq$30	Running 10-test Average < 60 No single test >65	Running 10-test Average 10<PI<45 No single test <8
Utility Trench Backfill	Fill between utilities and within 5 feet of new existing utilities	CL, SC, ML, SM	100	$\geq$20	< 35	8 <PI < 25

Notes:
1. For Pumping Plant No. 3 positive closure vault and siphon breaker vaults, the soil types indicated in Table 1 are to be used unless otherwise shown on the Drawings.
2. See Section 3.8 for testing frequency to determine suitability

2.2.2 Lime-Stabilized Soil

2.2.2.1 Lime

Submit copies of certified test data. Lime shall be a standard brand of quicklime or hydrated lime conforming to ASTM C977 and the following physical and chemical requirements. Sample lime in accordance with ASTM C50/C50M.

a. Conform to the following gradation requirements: 97 percent passes a No. 30 sieve, and a minimum of 75 percent passes a No. 200 sieve.
b. Combined calcium oxide and magnesium oxide not less than 90 percent.
c. Lime does not exceed 5 percent carbon dioxide or 2 percent free moisture (taken at the point of manufacturing).

2.2.2.2 Soil for Lime-Stabilization

Soil for lime-stabilization will consist of Soil Type 4 Fill. See 2.2.1 for soil requirements.

2.2.3 Filter Material and Drain Rock

Filter material and drain rock shall be used under the drained seepage berm, as shown on the project plans. Prior to delivery of any filter material and drain rock to the site, submit test results for filter material and drain rock for review by the Contracting Officer. Filter material shall consist of washed concrete aggregate or sand meeting the requirements for fine aggregate in ASTM C33/C33M and these specifications. Filter material shall meet the following gradation requirements:

TABLE 2
FILTER MATERIAL REQUIREMENTS

GRADATION		**TEST PROCEDURE**
Sieve Size	**Percent Passing**	
3/8-inch	100	ASTM C136
No. 4	95 to 100	
No. 8	80 to 100	
No. 16	50 to 85	
No. 30	25 to 60	
No. 50	5 to 30	
No. 100	0 to 10	
No. 200	0 to 5	

Drain rock shall consist of hard, durable, clean sand, gravel, or crushed stone meeting the quality requirements of Caltrans Class 2 Permeable Material except as stated herein. Drain rock must have a specific gravity of at least 2.6 and absorption less than 2.0 percent per ASTM C127, and a percentage of wear (loss) of not more than 35 percent after 500 revolutions in accordance with ASTM C131/C131M. Drain rock shall meet the following gradation requirements after placement and compaction:

TABLE 3
DRAIN ROCK REQUIREMENTS

GRADATION		**TEST PROCEDURE**
Sieve Size	**Percent Passing**	
1-inch	100	ASTM C136
3/4-inch	90 to 100	
3/8-inch	40 to 100	
No. 4	25 to 40	
No. 8	18 to 33	
No. 30	5 to 15	
No. 50	0 to 7	
No. 200	0 to 3	

Filter material and drain rock shall be evenly graded between the specified limits and shall be free of adherent coatings, foreign materials, corrosive agents, soils, organic matter, and soft, friable, thin or elongated particles. Filter material or drain rock not meeting the requirements of these specifications shall be removed and replaced with materials meeting the specified requirements at no additional cost to the Government.

2.2.4 Granular Structural Backfill

Structural backfill consists of earthen fill placed within 5 feet in all directions measured horizontally of completed or existing structures, including the outfall structure at Pumping Plant 3. Structural backfill shall extend to a minimum depth of 1 feet below the foundation of any structure and shall slope upward at a slope of 1.5H:1V and daylight to the existing grade, as shown on the project Drawings. Prior to delivery of any structural backfill material to the site, submit test results for structural backfill material for review by the Contracting Officer. Structural backfill material shall consist of sand, sand with gravel, sand with silt, sand with clay, sand with silt and gravel meeting the requirements in these specifications. Structural backfill placed within the levee embankment, adjacent levee, or utility excavations shall meet the below requirements.

a. Liquid Limit $\leq$25 and Plasticity Index $\leq$6

b. Structural fill material shall meet the following gradation requirements after placement and compaction:

TABLE 4
GRANULAR STRUCTURAL BACKFILL REQUIREMENTS

GRADATION		**TEST PROCEDURE**
Sieve Size	**Percent Passing**	
2-inch	100	ASTM D6913
1-inch	95 to 100	
No. 4	25 to 75	
No. 40	5 to 50	
No. 200	0 to 10	

Structural backfill shall be compacted in accordance with paragraph 3.11 COMPACTION.

2.2.5 Temporary Trench for the Deadman

Fill used for backfilling the temporary trench created for the deadman construction is to consist of material meeting requirements for suitable fill in accordance with paragraph 1.2.1 SUITABLE MATERIALS.

2.2.6 Topsoil

Seepage berm surfaces excluding side slopes shall be dressed with topsoil obtained from the stripping operations. Materials containing roots greater than 1/2-inch in diameter, debris, rubble, trash or other deleterious items shall be classified as unsuitable materials. Unsuitable materials shall be disposed of in accordance with Section 02 41 00 DEMOLITION.

2.3 LIME STABILIZATION MIX DESIGN

The Contractor shall construct a lime-stabilized crown in the landside adjacent levee. To accomplish this, the Contractor shall provide a mix design and job-mix formula for mixed material for subgrade soils prepared by an approved laboratory. pH test shall be performed and determined that the initial percent of lime content is 5 percent hydrated lime by weight (based on oven-dry weight of the soil). Using the initial design lime content conduct moisture-density relations of the composite aggregate mixture in accordance with ASTM D1557 on specimens prepared in accordance with ASTM D3551. Mix design shall include certified test reports showing results of 28-day unconfined compression test and the freezing and thawing tests. Prepare triplicate samples of the soil lime mixture for unconfined compression at the initial design lime content, 2 percent above, and 2 percent below initial design lime content. Mold a minimum of three cylinders of each lime-soil mixture in accordance with ASTM D2166/D2166M. Test specimen molds shall be approximately 2 inches in diameter by 4 inches in height, except molds shall be approximately 4 inches in diameter by 8 inches in height if more than 35 percent of the material is retained on the No. 4 sieve. Cure and test specimens in accordance with ASTM D2166 with the following exceptions: (1) cure specimens in sealed containers in a moist room at 100 percent relative humidity and 73 degrees F for 7 days.

Before or during construction, if the source of any lime materials is changed, or if there is any significant variation in subgrade materials, conduct additional tests and adjust amount of lime as required to obtain the specified results. Compare results of the unconfined compressive strength and durability test. The lowest lime content which meets the unconfined compressive strength of 250 psi is the design lime content.

Post-treatment material characteristics must meet the requirements for Type 2 Fill of Liquid Limit $\leq$40, Plasticity Index greater than or equal to 10 and less than or equal to 30, and Fines Content $\geq$ 30. Post lime-stabilized material shall conform to the requirements for Type 2 Fill under Paragraph 2.2.1 SOIL TYPES 1, 2, 3, AND 4 FILL AND UTILITY TRENCH BACKFILL MATERIAL. The testing frequency of the post-treatment materials shall be performed in accordance with Section 3.8.2.

2.4 BURIED WARNING AND IDENTIFICATION TAPE

Polyethylene plastic and metallic core or metallic-faced, acid- and alkali-resistant, polyethylene plastic warning tape manufactured specifically for warning and identification of buried utility lines. Provide tape on rolls, 3 inch minimum width, color coded as specified below for the intended utility with warning and identification imprinted in bold black letters continuously over the entire tape length. Warning and identification to read, "CAUTION, BURIED (intended service) LINE BELOW" or similar wording. Color and printing shall be permanent, unaffected by moisture or soil.

TABLE 5
BURIED WARNING AND IDENTIFICATON TAPE

Warning Tape Color	
Red:	Electric
Purple:	Non Potable Water

2.4.1 Warning Tape for Metallic Piping

Acid and alkali-resistant polyethylene plastic tape conforming to the width, color, and printing requirements specified above. Minimum thickness of tape shall be 0.003 inch. Tape shall have a minimum strength of 1500 psi lengthwise, and 1250 psi crosswise, with a maximum 350 percent elongation.

2.4.2 Detectable Warning Tape for Non-Metallic Piping

Polyethylene plastic tape conforming to the width, color, and printing requirements specified above. Minimum thickness of the tape shall be 0.004 inch. Tape shall have a minimum strength of 1500 psi lengthwise and 1250 psi crosswise. Tape shall be manufactured with integral wires, foil backing, or other means of enabling detection by a metal detector when tape is buried up to 3 feet deep. Encase metallic element of the tape in a protective jacket or provide with other means of corrosion protection.

2.5 DETECTION WIRE FOR NON-METALLIC PIPING

Detection wire shall be insulated single strand, solid copper with a minimum of 12 AWG.

PART 3 EXECUTION

3.1 TOLERANCES

All embankments (prior to placement of aggregate surfacing) and backfills shall be constructed to the grades, lines, and cross-sections shown on the Plans and as determined by Contractor's Government-reviewed pre-construction surveys. The levee and adjacent side slopes shall have a tolerance of 0 to plus 0.4 feet for final dressing (measured perpendicular to the slope and prior to respread of strippings on levee slopes). The levee and adjacent levee crowns shall have a tolerance of 0 to plus 0.1 feet above and 0 feet below. These tolerances will be allowed provided that any excess material is so distributed that the crown and slopes of the levee and adjacent levee drain and that there are no abrupt humps or depressions in any surfaces.

A tolerance of 0.2 feet above or below the prescribed grade will be allowed for finished surfaces outside the levee embankment provided that the surface drains away from the levee and adjacent levee in the direction indicated on the Plans with no abrupt humps or depressions.

3.2 LOCATION OF UNDERGROUND UTILITIES

Location of the existing utilities indicated is approximate. The contractor shall physically verify the location and elevation of the existing utilities indicated prior to starting construction.

3.3 DELIVERY, STORAGE, AND HANDLING

Delivery, storage, and handling is to be performed in a manner to prevent contamination or segregation of materials.

3.4 GROUND SURFACE PREPARATION

3.4.1 Subgrade Preparation

After clearing, grubbing and stripping (as described in Section 31 11 00 CLEARING, GRUBBING, AND STRIPPING) of the embankment and foundation area to the extent indicated on the Plans or otherwise required, the sides of stump holes, test pits, and other similar cavities or depressions shall be broken down so as to flatten out the slopes to no steeper than 1H:1V, and the sides of the cut or hole shall be scarified to provide bond between the foundation material and the fill. Unless otherwise directed, each depression shall be filled with the same material type that is to be placed immediately above the foundation. The fill shall be benched or keyed, placed in layers, moisture conditioned, and compacted in accordance with the applicable provisions of these Specifications for the specific material type. Materials which cannot be compacted by roller equipment because of inadequate clearances shall be compacted with hand operated compactors in accordance with Paragraph 3.11 COMPACTION for the specific material type.

Prior to placement of compacted fill in any section of the embankment, the foundation of such section shall be observed by the Contracting Officer's representative and approved by the Contracting Officer before the surface is loosened thoroughly by scarifying, plowing, disking or harrowing to a minimum depth of 6 inches, and moisture conditioned to the amount specified in Paragraph 3.10 MOISTURE CONTROL for the appropriate type of material.

After removal of roots or other debris turned up in the process of loosening, the entire surface of the foundation area shall be compacted to the minimum specified percentage of the maximum dry density. Immediately prior to placement of compacted fill on or against the surfaces of any partially filled section, all soft or loose material, all material containing cracks or gullies, and all material that does not conform with the specified embankment materials shall be removed. The remaining surface of the partially filled section shall be loosened by scarifying, plowing, disking or harrowing to a minimum depth of 6 inches, and the moisture content shall be adjusted as specified in Paragraph 3.10 MOISTURE CONTROL for the appropriate type of material. The surface of the partially filled section upon which fill is to be placed, shall then be compacted as herein specified for the appropriate type of fill. No separate payment will be made for loosening and rolling the foundation area or the surfaces of partially filled sections, but the entire cost thereof shall be included in the applicable contract price.

All surfaces shall be firm and unyielding. No rutting or pumping shall be allowed on subgrade to receive fill. If the Contracting Officer determines the subgrade to be unsuitable, the material will be rejected and shall be reworked to meet the requirements of these specifications at no additional cost to the Government.

3.4.2 Benching

Benching into the existing levee embankment or existing side slopes is required in order to place and compact the material in horizontal layers. The vertical face cut into the existing surface resulting from the benching shall be a minimum of 6-inches in height but shall not exceed 12-inches in height. The horizontal cut into the side slope shall be proportional to the excavated slope indicated on the Drawings (e.g. 1V:2H excavated slope would result in a bench cut of 12-inches horizontal cut for a 6-inch loose lift). Plow, step, bench, or break up sloped surfaces steeper than 1V:4H so that the fill material will bond with the existing material. When slopes surfaces are equal to or milder than 1V:4H, benching is not needed.

3.4.3 Subgrade Preparation for Lime Stabilization

The subgrade of the lime stabilization area will be prepared in accordance with levee fill placement (Section 3.6.2). Clean the area of debris, roots, trash, organic and other deleterious materials. The area will be inspected for adequate compaction and shall be capable of withstanding, without displacement, the compaction specified for the soil-lime mixture. Debris and removed unsatisfactory in-place material shall be disposed of as specified.

3.5 SHORING AND SHEETING

In addition to EM 385-1-1 and other requirements set forth in this contract, submit a Shoring and Sheeting Plan that includes drawings and calculations, certified by a registered civil engineer authorized to practice in the State of California, and describes the methods for temporary shoring and temporary sheeting of excavations. Temporary sheet piling is to be in accordance with Section 31 41 16 METAL SHEET PILING. Drawings shall include material sizes and types, arrangement of members, and the sequence and method of installation and removal. Calculations shall include data and references used and include provisions in the shoring and sheeting plan that will accomplish the following:

a. Prevent undermining of embankments, roads, or structures.

b. Prevent slippage or movement in banks or slopes adjacent to the excavation.

c. Prevent slippage or movement in banks or slopes during utility replacement.

d. Allow for the abandonment of temporary shoring and sheeting materials in place in critical areas as the work is completed.

3.6 DEWATERING

See Specification Section 31 23 19 DEWATERING for dewatering requirements.

3.7 TOP SOIL

3.7.1 Topsoil Harvest

Topsoil shall be harvested when in the air dry condition to a depth of 12 inches below the surface of the existing topsoil grade. At the discretion of the Contracting Officer or representative, contractor may disc mow stubble or light residue of herbaceous biomass into the topsoil layer before stripping. Contractor shall mow moderate to dense areas of existing herbaceous ground cover, and haul offsite before topsoil excavation commences. Coarse wood, concrete, or metal shall not be included in the harvested topsoil.

3.7.2 Topsoil Handling and Storage

Where possible, harvested topsoil shall be hauled directly to the stockpile location. Stockpiled soil shall be stored in the air-dried condition and driven on as few times as possible. Stockpiles shall not be used as borrow material haul routes or for equipment storage during levee construction. Moisture addition to the surface shall be minimized and limited to that required for dust control or vehicle traction, and shall be applied by sprinkling and not driving on dampened soil.

3.7.3 Topsoil Stockpiles

Stockpiles shall be stored dry and not compacted through the earthmoving process more than is necessary for dust control and traction during placement. The only water application shall be to control dust and allow for traction of scrapers. Coarse disking of the surface can also control dust. Weeds growing on the stockpile shall be controlled with a non-residual herbicide such as Glyphosate or equivalent. Herbicides and methods of application shall be reviewed and approved by the Contracting Officer before weed work commences.

3.8 EXCAVATION

Excavation shall consist of the degrade of the existing levee crown, excavation of the landside and waterside slopes, excavation of roadways, excavation as necessary to key and bench fills, and removal of objectionable and unsuitable materials, and excavation for utility modifications. Excavations shall only be performed at the locations designated in the Plans and in the approved Excavation Plan. Excavation for borrow materials shall be performed in accordance with Section 31 23 00 BORROW SITE EXCAVATION in NATOMAS BASIN RIVERSIDE CANAL PHASE 2 RELOCATION

PROJECT contract documents.

3.8.1 Levee Crown Degrade or Foundation Degrade

Levee crown degrade shall consist of the removal of the existing levee crown to the lines and grades shown on the Plans to construct a working surface for utility abandonment. Crown surfacing and roadway removal and salvage shall be performed in accordance with the Plans and these Specifications.

Suitable Soil Types, as described in 2.2 TYPES OF FILL MATERIALS excavated from the existing levee during degrading operations may be temporarily stockpiled within the allowable working limits shown on the Plans. If adequate space is not available, excavated material shall be hauled to staging areas shown on the Plans for stockpiling and processing.

Materials obtained from project excavations that do not meet the requirements for suitable soil types, as described in 2.2 TYPES OF FILL MATERIALS, but can be blended to meet the requirements for fill materials, shall not be wasted. This material shall be blended in approved staging/stockpile areas in sufficient quantity to meet the requirements for suitable soil type materials and shall be used as shown on the Plans. Materials that cannot be blended to meet fill material requirements as outlined under paragraph 2.2 TYPES OF FILL MATERIALS, and also do not meet suitable soil type materials requirements shall become the property of the Contractor and shall be disposed of off-site in a accordance with applicable federal, state, and local regulations.

The Contractor may modify the working surface elevations indicated on the plans based on the capabilities of the contractor's construction equipment. Submit a plan for any such modification to the working surface elevations to the Contracting Officer for review. The Contractor's plan shall include the Contractor's proposed working surface elevations, the station limits where the change is proposed, the additional levee degrade excavation quantity associated with the change, and the additional fill material needed. All costs associated with any such modification to the working surface elevations, including costs associated with adjustments to the utility abandonment, levee degrade, levee embankment fill, etc., shall be the responsibility of the Contractor.

In the event the water surface elevation is forecasted by the State-Federal Flood Forecast Center to increase significantly for any reason, the Government reserves the right to require the Contractor to stop excavation and to begin continuous operations to complete all partially completed section(s) of the levee embankment. At least 15 days prior to any levee excavation, submit a Flood Stage Contingency Plan outlining the contingency operations in the event that river elevations above the flood stage (as defined by the Government) are forecasted. The contingency plan shall include the proposed measures to protect the landside areas which have a reduced level of protection due to construction activities. The plan shall include river stage monitoring, river stage at which the plan will be activated, material and equipment to be used in performance of the contingency plan, and the existing location, type and quantity of the stockpiled emergency material. The plan shall also include the length of levee to be degraded at any one time, where stockpiled materials will be stored, and the method for monitoring river elevations. Keep any levee degrade material on the project site for the duration of the construction period, protected from inclement weather, for use as emergency backfill as necessary.

3.8.2 Over-Excavation

Over-excavation within the limits of the foundations of levees and structures shall be backfilled to grade with the same material type that is to be placed immediately above the excavation, keyed into adjacent ground, placed in lifts not exceeding six inches and compacted in accordance with this Specification.

3.8.3 Slopes and Surcharges

Temporary excavation slopes shall not be steeper than 2 horizontal to 1 vertical, unless shown otherwise on the plans. This may be accomplished by benching the temporary slope so that the average slope is not steeper than the specified amount.

No temporary, permanent, or construction slope shall be surcharged with excavated or stockpiled material or with heavy construction equipment. The toe of stockpiled material or routing of construction equipment shall be maintained a minimum distance back from the top of the finished excavation equal to the depth of the excavation. Any slide or other adverse conditions caused by failure of the Contractor to maintain these conditions shall be considered the responsibility of the Contractor and remedial measures shall be at the Contractor's expense.

3.8.4 Utilities

Excavations for utility modifications and removal shall be as specified on the Plans and in these Specifications. Excavate to the dimensions indicated or to safe limits if dimensions are not provided. Rock, where encountered, shall be removed below the bottom of the pipe or structure.

3.9 PLACEMENT AND SPREADING

3.9.1 General

No fill shall be placed on any part of the embankment foundation or levee degrade surface until such areas have been inspected and approved by the Contracting Officer.

3.9.1.1 Gradation and Distribution

The gradation and distribution of materials shall be such that the levee embankment will be free from lenses, pockets, streaks, and layers of material differing substantially in texture or gradation from surrounding material of the same type. If lenses, pockets, or layers of materials differing substantially in texture or gradation from surrounding material occur in the spread material, the layer shall be removed, blended, and tested for suitability prior to replacement. Screening and blending of materials shall occur in approved staging/stockpile areas, and shall be performed under the observation of the Contracting Officer's Representative. During the placement and spreading process, maintain at all times a force of workers and appropriate equipment adequate to remove oversized particles, oversized roots, debris, rubble, trash, deleterious items, concentrations of organic material, oversized stones, and all oversized rock fragments from all fill materials. The maximum allowed particle size for the appropriate fill material type shall be as indicated in Paragraph 2.2 TYPES OF FILL MATERIALS.

3.9.1.2 Foundations and Partial Embankment Fills

The foundations and all partial embankments receiving fill shall be kept thoroughly drained. Placement operations will be such as to avoid mixing of materials from adjacent sections as much as practicable.

3.9.1.3 Equipment Traffic

Equipment traffic on any embankment zone shall be routed to minimize rutting of placed fill and to distribute the compactive effort as much as practicable. Ruts formed in the surface of any layer of spread material shall be filled before that material is compacted. If the compacted surface of any layer of material is too smooth to bond properly with the succeeding layer, the surface shall be loosened by scarifying or other reviewed methods before material for the succeeding layer is placed.

3.9.2 Placement of Embankment and Structural Backfill

No embankment or backfill shall be placed on or against concrete less than 7 days after placement or 70 percent of the design strength is achieved, without prior approval by the Contracting Officer. Crawler-type tractors, vibratory equipment and other similar compaction equipment shall not be used within 5 feet of any completed or partially completed structure. Compaction within 5 feet of completed or partially completed structures shall be accomplished by the use of mechanical hand tampers, vibrating plates, or other approved methods and equipment. Ensure that compaction operations do not damage any existing utilities. Any damage caused by the Contractor's operation shall be repaired at the Contractor's expense.

3.9.3 Backfill and Fill Material Placement Over Pipes and at Walls

Backfilling shall not begin until construction below finish grade has been approved, underground utilities systems have been inspected, tested and approved, forms removed, and the excavation cleaned of trash and debris. Backfill shall be brought to the indicated finish grade. Where pipe is coated or wrapped for protection against corrosion, the backfill material up to an elevation 2 feet above sewer lines and 1 foot above other utility lines shall be free from stones larger than 1 inch in any dimension. Heavy equipment for spreading and compacting backfill shall not be operated closer to foundation or retaining walls than a distance equal to the height of backfill above the top of footing; the area remaining shall be compacted in layers not more than 4 inches in compacted thickness with power-driven hand tampers suitable for the material being compacted. Backfill shall be placed carefully around pipes or tanks to avoid damage to coatings, wrappings, or tanks. Backfill shall not be placed against foundation walls prior to 7 days after completion of the walls. As far as practicable, backfill shall be brought up evenly on each side of the wall and sloped to drain away from the wall.

3.9.4 Fill Materials

Suitable Soil Types, as described in 2.2 TYPES OF FILL MATERIALS, shall be placed and spread in layers not more than specified loose lift thickness in Section 3.6.2, except within 5 feet of structure, the uncompacted layer thickness shall be reduced to 4 inches unless otherwise indicated on the plans. Where fill narrows to less than an equipment width, levee embankments shall be overbuilt to equipment width and trimmed to the design slopes shown on the plans.

3.9.5 Filter Material and Drain Rock

Filter material and drain rock shall be placed to the lines and grades shown on the Plans. These materials shall be compacted in 8-inch loose lifts by two complete coverages of a 10-ton vibratory smooth drum roller as specified in paragraph 3.11.1.2 VIBRATORY SMOOTH DRUM ROLLER. Adjacent to structures, or in areas inaccessible to large construction equipment, these materials shall be compacted by two complete coverages with a vibratory plate compactor meeting the requirements specified in paragraph 3.11.1.4 HAND OPERATED COMPACTORS. When a vibratory plate compactor is used, loose lift thickness shall be limited to 4-inches.

3.9.6 Topsoil

Seepage berms excluding the side slopes shall be dressed with four inches of topsoil (measured perpendicular to the berm surface)obtained from stripping operations. Topsoil shall be uniformly blended in staging/stockpile areas then placed in uniform thickness.

Topsoil shall have sufficient moisture before spreading to ensure proper placement. Unnecessary vehicle operation or hauling on the seepage berm following topsoil placement shall not be allowed.

3.9.7 Topsoil Erosion Control Seeding

The reapplied topsoil shall be hydroseeded with the specified erosion control Type 2 Seed Mix, shredded fiber mulch and a suitable tackifier. After hydroseeding, straw shall be blown over surface as specified. Erosion channels and soil slips that develop during the rain season shall be repaired and returned to the original finish grade with topsoil in place. During the rain season, erosion channels shall be repaired by diversion or dispersion to prevent erosion from concentrated runoff.

3.10 MOISTURE CONTROL

3.10.1 General

The materials in each layer of the fill shall contain the specified amount of moisture, within the limits specified below. Material that is not within the specified moisture content limits outlined below after compaction shall be reworked to obtain the specified moisture content, regardless of density.

3.10.1.1 Insufficient Moisture for Suitable Bond

If the top or contact surfaces of partially filled sections do not meet the specified moisture range, loosen the dried materials by scarifying or disking to a minimum depth of six inches, dampen the loosened material and compact this layer in accordance with the applicable requirements of Paragraph 3.11 COMPACTION.

3.10.1.2 Excessive Moisture for Suitable Bond

If the top or contact surfaces of partially filled sections do not meet the specified moisture range, the wet material shall be scarified and permitted to dry, assisted by disking or harrowing, if necessary, to a minimum depth of six inches. The material shall be dried to an acceptable moisture range, and shall be compacted in accordance with the applicable requirements of Paragraph 3.11 COMPACTION.

3.10.1.3 Drying Wet Material

Material that is too wet shall be substantially dried in the staging/stockpile area or borrow area prior to bringing to the levee embankment or placing in fills. Drying shall be assisted by disking or harrowing, if necessary, until the moisture content is reduced to an amount that will require minimal processing once the material is placed.

3.10.1.4 Increasing Moisture in Dry Material

The moisture content of material that is too dry shall be adjusted in the staging/stockpile area or the borrow area prior to bringing to the levee embankment. Add water to the fill material by harrowing, or other approved methods, work the moisture into the material until a uniform distribution of moisture is obtained that will require minimal processing once the material is placed. Water applied on a layer of fill shall be accurately controlled in amount so that free water will not appear on the surface during or subsequent to rolling. Should too much water be added to any part of the embankment, the rolling on that section of the embankment shall be delayed until the moisture content of the materials is reduced to an amount within the specified limits.

3.10.2 Moisture Content Requirements

The moisture content of Suitable Soil Types, as described in 2.2 TYPES OF FILL MATERIALS, after compaction shall be within the limits of 3 percentage points above optimum to 1 percentage point below optimum moisture content as determined by the test method specified in 3.8.2 Compaction of Fill. These moisture requirements shall also apply for subgrade to receive Suitable Soil Types, as described in 2.2 TYPES OF FILL MATERIALS; ramps and roadways; structural backfill; and utility trench backfill.

Filter material to be moisture conditioned at the quarry and stockpile prior to handling and hauling. Ensure filter material is moist during hauling, placing, and spreading. Add water to the filter material as it is being compacted and the moisture content must be uniform throughout the lift. Procedures for adding water during compaction must be approved by the Contracting Officer.

No moisture control is required for the drain rock except to control dust.

3.11 COMPACTION

3.11.1 Compaction Equipment

Compaction equipment shall conform to the following requirements and shall be used as prescribed in subsequent paragraphs.

3.11.1.1 Tamping Rollers

The use of self-propelled non-vibratory tamping rollers conforming with the following specification will be permitted, and their design and operation is subject to approval, at any time during the prosecution of the work. The Contracting Officer may direct such modifications to the tamping feet or variations in roller drum weight where applicable, as may be found necessary to secure optimum compaction of the earth fill materials. If use of self-propelled tamping rollers causes shearing of the fill, laminations in the fill, or results in inadequate compaction, the Contracting Officer will direct that such rollers be replaced or other adjustments to moisture contents, lift thickness, or number of passes be made.

a. Multi-Drum Units: Four-drum equipment separated by cab and differential and arranged in tandem must have its static weight equally distributed to all compaction drums and must have the tandem drums positioned such that the prints of the tamping feet produced by the tandem drums are staggered. The surface on which the tamping feet are mounted must have a minimum outside diameter of 4 feet and at least one tamping foot for each 100 square inches of drum surface. The distance between the centers of any two adjacent tamping feet must be not less than 9 inches. The length of each tamping foot from the outside mounting surface of the drum must be not more than 10 inches and must be maintained at not less than 7 inches. The bearing surface of each tamping foot must be flat or slightly pointed and have a surface area not less than 14 square inches nor more than 36 square inches. Cupped recesses within the bearing surface of each tamping foot will be permitted but must not exceed 0.5 inches in depth. During rolling operations, the spaces between the tamping feet must be maintained clear of materials which would impair the effectiveness of the tamping roller. The weight of all roller drums during compaction of fill materials must be maintained uniform and with the weight per foot of drum length not less than 3,500 pounds. Compactor's must be operated at speeds less than 2.0 miles per hour and must not be used to spread material in lifts.

b. Single Drum Units: Self propelled single drum units must have a minimum static weight at the drum of 20,000 lbs. The minimum drum diameter must be 5 feet and the minimum drum length must be 6 feet. There must be at least one tamping foot or pad for approximately each 100 square inches of the drum surface area. The distance between the center of any two adjacent feet or pads must not be less than 9 inches. The length of each foot/pad from the outside mounting surface of the drum must not be less than 4 inches at any time. The bearing surface of each tamping foot/pad must be flat or slightly pointed and have a surface area between 18 and 36 square inches. During rolling the spaces between the tamping feet/pads must be maintained clear of all material including caked on soil that impairs the effectiveness of the roller. For self-propelled rollers in which steering is accomplished through the use of rubber-tired wheels, the tire pressure must not exceed 40 psi. The use of the compactor must be discontinued if the tires leave ruts that prevent uniform compaction by the tamping roller and the substitution of appropriate towed tamping rollers may be directed. When a self-propelled roller is provided with a dozer blade, coverages made with the blade in operation must not be counted as passes for compaction. Self-propelled rollers must be operated at a speed not to exceed 2.0 mph and must not be used to spread material in lift.

3.11.1.2 Vibratory Smooth Drum Rollers

Vibratory smooth drum rollers for compacting filter material, drain rock, pervious sand and gravel fills, or filter and transition drainage layers, shall be equipped with a smooth steel compaction drum and shall be operated at a frequency of vibration during compaction operations between 1100 and 1900 vibrations per minute (vpm). Use a 10-ton vibratory smooth drum roller. The 10-ton vibratory smooth drum roller shall have a minimum static weight of 20,000 pounds, a minimum static weight at the drum of 12,000 lbs, a minimum dynamic force of 40,000 pounds when operating at 1100 to 1900 vpm, and an applied force between 5,000 and 9,000 pounds per foot of compaction drum length. The level of amplitude and vibration frequency during compaction will be maintained uniform throughout the fill zone within which it is operating. Rollers shall be operated at speeds not to exceed 1.5 mph. The equipment manufacturer shall furnish sufficient data, plans, and computation for verification of the above specifications, and the character and efficiency of this equipment shall be subject to review.

3.11.1.3 Rubber-Tired Rollers

Rubber-tired rollers shall have a minimum of four wheels equipped with pneumatic tires. The tires shall be of such size and ply as to be capable of being operated at tire pressures between 80 and 100 psi at an 25,000 pound wheel load. The roller wheels shall be located abreast and so designed that each wheel will carry approximately equal load in traversing uneven ground. The spacing of the wheels shall be such that the distance between the nearest edges of adjacent tires will not be greater than 50 percent of the rated tire width of a single tire at the operating pressure for an 25,000 pound wheel load. The roller shall be provided with a body suitable for ballast loading such that the load per wheel may be varied, as directed by the Contracting Officer, from 18,000 to 25,000 pounds. The roller shall be towed at a speed not to exceed 5 miles per hour. The character and efficiency of this equipment shall be subject to review and approval by the Contracting Officer.

3.11.1.4 Hand Operated Compactors

Compaction of material in areas where it is impracticable to use a roller or tractor compaction shall be performed by the use of approved hand operated power compactors.

a. Power Tampers: Power tampers shall be hand operated equipment capable of compacting material in confined areas. The compactors shall be either an internal combustion or pneumatic activated tamper. Tampers shall have sufficient weight and striking power to produce the specified compaction. The character and efficiency of this equipment shall be subject to the review and approval by the Contracting Officer.

b. Vibratory Plate Compactor: Vibratory compactors operated by hand in confined areas shall utilize the oscillating cam principle and shall have a minimum static weight of 500 lbs and deliver an impact of not less than 2000 lbf at a rate of approximately 2000 impulses per minute. The character and efficiency of this equipment shall be subject to the review and approval by the Contracting Officer.

3.11.1.5 Crawler-Type Tractors

Crawler-type tractors used for spreading or compaction shall weigh not less than 20,000 pounds, shall exert a unit tread pressure of not less than 6 psi, and shall be operated at a speed not to exceed 3.5 miles per hour.

3.11.1.6 Miscellaneous Equipment

Scarifiers, disks, spring-tooth or spike-tooth harrows, spreaders, and other equipment shall be suitable for use in embankment construction. Equipment used for processing fill material shall be capable of penetrating the full loose lift thickness of the specific material type.

3.11.2 Compaction of Fill

After a layer of material has been placed and spread, it shall be harrowed to break up the fill materials to eliminate all clods and to obtain uniform moisture distribution. Harrowing shall be performed with a heavy disk plow, or other approved harrow, a minimum of four passes, to the full depth of the layer. If four passes of the harrow does not accomplish the breaking up of the materials, additional passes of the harrow shall be required or the material shall be evaluated for removal.

Fill compaction near structures shall comply with the following minimum requirement. Maximum dry density is to be in accordance with ASTM D1557:

TABLE 6
FILL COMPACTION REQUIREMENTS NEAR STRUCTURES AND PIPES

LOCATION	PERCENT OF THE MAXIMUM DENSITY	MAXIMUM LOOSE LIFT THICKNESS (INCHES)
Fill applications within a minimum distance of 5 feet from new and existing structures, and new and existing pipelines.	97 percent	4*1

Note:
1. A hand operated compactor is required within 5 feet distance of structures and pipelines.

Fill compaction shall comply with the following minimum requirements (maximum dry density in accordance with ASTM D698):

TABLE 7
FILL COMPACTION REQUIREMENTS

LOCATION	PERCENT OF THE MAXIMUM DENSITY	MAXIMUM LOOSE LIFT THICKNESS (INCHES)
Subgrade*1 to Receive Soil Types 1, 2, 3, and 4 fill materials (including degraded levee working surface)	95 percent	-
Levee Embankment, Ramps and Roadways, Adjacent Levees	97 percent	6
Utility Trench Backfill	97 percent	4
Granular Structural Backfill	97 percent	4
12 Inches Beneath Aggregate Base or Aggregate Surfacing	97 percent	6

TABLE 7
FILL COMPACTION REQUIREMENTS

LOCATION	PERCENT OF THE MAXIMUM DENSITY	MAXIMUM LOOSE LIFT THICKNESS (INCHES)
Soil Type 1 Fill, Non-Structural Fill, Seepage Berms, and Toe Berms within the Project	94 percent	8
Upper 12 inches of roadway and ramp subgrade	100 percent	4
Backfill in temporary trench for the deadman	97 percent	4

Note:
1. In cultural resource areas at STA 686+00 to STA 694+00, subgrade preparation may not be performed.

In areas which are not accessible by roller, fill shall be compacted with an approved hand operated power compactor to a density equal to that obtained in other areas which are accessible to rollers. Dumping, spreading, sprinkling, and compacting may be performed at the same time at different points along a section when there is sufficient area to permit these operations to proceed simultaneously. Compaction equipment shall be operated such that the strip being traversed by the roller shall overlap the rolled adjacent strip by not less than 3 feet.

Compact filter material and drain rock in 8-inch loose lift by two passes of a 10-ton vibratory smooth drum roller meeting the requirements in paragraph 3.11.1.2 VIBRATORY SMOOTH DRUM ROLLER. Adjacent to structures, or in areas inaccessible to the 10-ton vibratory smooth drum roller, these materials shall be compacted by two complete passes with a vibratory plate compactor meeting the requirements specified in paragraph 3.11.1.4 HAND OPERATED COMPACTORS. When a vibratory plate compactor is used, loose lift thickness shall be limited to 4-inches.

3.12 STOCKPILES

Weeds growing on stockpiled material shall be controlled with a non-residual herbicide such as Glyphosate. Herbicides and methods of application shall be reviewed by the Contacting Officer prior to weed control.

Suitable Soil Types, as described in 2.2 TYPES OF FILL MATERIALS, fill materials excavated from the levee during degrading operations may be temporarily stockpiled within the allowable working limits shown on the Plans. If adequate space is not available, excavated material shall be hauled to staging/stockpile areas shown on the Plans for stockpiling and processing. Levee slopes shall be restored as indicated on the plans or to preconstruction condition if not indicated on the plans. Soil Type 1 fill material excavated from the levee during degrading operations or excavations may be temporarily stockpiled outside the adjacent levee footprint. The unsuitable materials shall not be stockpiled on levee slopes.

3.13 BURIED WARNING AND IDENTIFICATION TAPE

Provide buried utility lines with utility identification tape. Bury tape 12 inches below finished grade; under pavements and slabs, bury tape 6 inches below top of subgrade.

3.14 BURIED DETECTION WIRE

Bury detection wire directly above non-metallic piping at a distance not to exceed 12 inches above the top of pipe. The wire shall extend continuously and unbroken, from manhole to manhole. The ends of the wire shall terminate inside the manholes at each end of the pipe, with a minimum of 3 feet of wire, coiled, remaining accessible in each manhole. The wire shall remain insulated over its entire length. The wire shall enter manholes between the top of the corbel and the frame, and extend up through the chimney seal between the frame and the chimney seal. For force mains, the wire shall terminate in the valve pit at the pump station end of the pipe.

3.15 FIELD QUALITY CONTROL

3.15.1 General

As a part of the Contractor Quality Control (CQC) system required by Section 01 45 00 QUALITY CONTROL, establish and maintain field quality control for foundation preparation, embankment and backfill operations to assure compliance with contract requirements and maintain detailed records of field quality control for all operations. Approximately 20 percent of tested locations will be selected for quality assurance by the Contracting Officer.

Submit all quality control testing results. Testing laboratories shall meet the requirement of ASTM D3740 and ER 1110-1-261. Supervision of tests and report preparation shall be by a professional civil or geotechnical engineer licensed in the State of California. All reports shall bear said professional engineer's signature and stamp. Distribution of the copies to the Contracting Officer shall be within 24 hours after sampling or initiating the test, except for test requirements that exceed 24 hours. For tests exceeding 24 hours, distribution shall be with 24 hours after completion of the test. Also refer to Section 01 45 00 QUALITY CONTROL.

3.15.2 Embankment and Fill Testing

Perform sufficient inspection and testing to ensure that the embankment is being constructed as specified. The testing program specified below shall be considered the minimum acceptable frequency of testing. This does not relieve the Contractor from the responsibility of performing additional testing if required to ensure compliance with these Specifications.

Testing shall be performed by a Corps-validated commercial testing laboratory or the Contractor's validated testing facility. If the Contractor elects to establish testing facilities, no work requiring testing will be permitted until the Contractor's facilities have been inspected, Corps validated, and approved by the Contracting Officer. Field in-place density shall be determined in accordance with ASTM D1556/D1556M or ASTM D6938. When test results indicate, as determined by the Contracting

Officer, that compaction is not as specified, the material shall be reworked to meet specification requirements, which may include additional compactive effort, scarification and moisture conditioning, or removal and replacement, if needed. Tests on re-compacted areas shall be performed to determine conformance with specification requirements. Inspections and test results shall be certified by a registered professional civil engineer. These certifications shall state that the tests and observations were performed by or under the direct supervision of the engineer and that the results are representative of the materials or conditions being certified by the tests.

a. Fill Material Testing

(1) (1) Moisture Density Relationships. The moisture-density relationships shall be determined in accordance with ASTM D698, Method A (a minimum of five (5) moisture-density relationship tests for each type of fill material used with five-points per test. The moisture-density curves will be compiled to form a family of curves representing the range of materials available for use which will be utilized to estimate optimum properties (maximum dry density and optimum moisture content) to be used with field density tests.

TABLE 8
FILL MATERIAL TESTING REQUIREMENTS

TEST METHOD	FREQUENCY
Moisture Density Relationship (ASTM D698)	Minimum of five (5) moisture-density relationship tests on representative samples of each type of fill material used with five points per test. One test for every 5,000 cubic yards fill placed with a minimum of one test per shift.
Soil Gradation (ASTM D6913), Percent Fines (ASTM D1140), Atterberg Limits (ASTM D4318)by wet preparation method), and Soil Classification (ASTM D2487)	One test for each moisture density relationship.

(2) Water (Moisture) Content Tests. Determination of water content shall be performed in accordance with ASTM D2216. ASTM D4643 may be used when rapid moisture content results are needed. If ASTM D4643 test method is used, a correlation between this method and D2216 test method shall be established and reviewed by the Contracting Officer. One water content test shall be performed for each in-place density test at the location of the in-place density test. Backfill and fills not meeting the required specifications for water content shall be retested after corrective measures have been applied.

(3) In-place Density Testing. The minimum in-place density testing is shown in the table below. The horizontal locations of tests shall be randomly staggered in the fill. At each field density test location, soil samples shall be obtained for three-point compaction test, moisture content, grain size analysis, percent fines, and Atterberg limits testing. For three-point compaction tests, one moisture content shall be at the in situ moisture content the other two moisture contents shall be above and below the in situ moisture content, in accordance with ASTM D5080. Fill not meeting the required specifications for in-place density shall be retested after the fill has been reworked.

TABLE 9
IN-PLACE DENSITY TESTING REQUIREMENTS

TEST METHOD	FREQUENCY
Nuclear Method (ASTM D6938) or Sand Cone (ASTM D1556/D1556M)	Levee embankment, roadway within levee footprint, and PP3 area: One (1) In-Place Density Test for every 300 cubic yards of completed fill unless otherwise specified. One in-place density test for every 300 square yards of subgrade to receive fill. Additionally, at least one (1) test for each lift of fill placed and material type. Seepage berm and all other areas to receive fill: One (1) In-Place Density Test for every 600 cubic yards of completed fill unless otherwise specified. One in-place density test for every 500 square yards of subgrade to receive fill. Additionally, at least one (1) test for each lift of fill placed and material type. Backfill in temporary trench for the deadman: One (1) In-Place Density Test for every foot of fill placement.
Sand Cone (ASTM D1556/D1556M)	One test for every ten (10) nuclear method tests and a minimum of one (1) test per shift and material type.

TABLE 9
IN-PLACE DENSITY TESTING REQUIREMENTS

TEST METHOD	FREQUENCY
Three-Point Compaction Tests (ASTM D5080), Soil Gradation (ASTM D6913), Percent Fines (ASTM D1140), Atterberg Limits (ASTM D4318) by wet preparation method, and Soil Classification (ASTM D2487)	At the location of each In-Place Density Test.

When the nuclear method is used for in-place density testing, according to ASTM D6938, the first test and every tenth test thereafter for each material type shall include a sand cone correlation test in accordance with ASTM D1556/D1556M.

Sand cone correlation tests shall be performed adjacent to the location of the nuclear test shall include a nominal 6 inch diameter sand cone, and shall include a minimum wet soil weight of 6 pounds extracted from the hole. Nuclear density testing equipment shall not be used during rain. The density correlations shall be submitted with test results within 24 hours after completing the test. Each transmittal including density test data shall include a summary of all density correlations for the job neatly prepared on a summary sheet including at a minimum:

(i) Meter serial number and operators initials.
(ii) Standard count for each test.
(iii) Material type.
(iv) Probe depth.
(v) Moisture content by each test method and the deviation.
(vi) Wet density by each test method and the deviation.
(vii) Density sand calibration

If soil appears to contain organics based on color or smell, the Contracting Officer will require the Contractor to test the material in accordance with ASTM D2487 to classify organic clay or organic silt (OH or OL). Organic clay or organic silt (OH or OL) are not suitable and shall be removed at the Contractor's expense.

(4) Additional Testing

The Government may request additional tests if there is reason to doubt the adequacy of the compaction, or special compaction procedures are being used, or materials change or if the Government determines that the Contractor's testing is inadequate. The Government may request additional tests if the Contractor is concentrating backfill and fill operations in a relatively small area.

3.15.3 Filter Material and Drain Rock Testing

Gradation testing per ASTM C136/C136M shall be performed on field samples of filter material and drain rock. One test shall be performed for every 600 cubic yards of material, with a minimum of one (1) test per shift. One durability index testing shall be performed on field samples of drain rock per ASTM D3744/D3744M for every 600 cubic yards, with a minimum of one (1) test per shift.

3.15.4 Levee Crown In-Place Lime Stabilization

Grade the entire area to conform to the lines, grades, and cross sections shown in the drawings prior to being processed. Soft or yielding subgrade areas shall be made stable with bridging stone or additional lime as approved by the Contracting Officer before construction is begun. Unsatisfactory material shall be removed and replaced as directed by the Government.

Installation, Compaction, Finishing, Sampling and Testing, and Field Quality Control should be in accordance with Section 32 11 29 LIME-MODIFIED SUBGRADE.

3.15.5 Reporting

On a daily basis, furnish the inspection records and all material testing results, the quantity of fill placed, as well as the records of corrective action taken, in accordance with Section 01 45 01 RESIDENT MANAGEMENT SYSTEM CONTRACTOR MODE (RMS CM).

Test data summaries comparing test results with specified requirements shall be provided in electronic format (Excel spreadsheets) and hard copy, demonstrate contract compliance, and be submitted with all requests for progress payments.

Complete post-construction verification surveys and submit a Construction Verification Survey Report that includes a description of equipment used, a description of methodology used, copies of the field notes, and the final data submitted. This report shall contain the certificate below, and be stamped and signed by the Professional Land Surveyor (or Civil Engineer, if legally allowed to practice surveying in the State of California) responsible for the survey work performed.

Surveyor's Levee Elevation Certificate:

I, the undersigned, do hereby state that I am licensed to perform surveying in the State of California, and I do hereby certify that the pre-construction and post-construction surveys for measuring the levee(s) and related berm(s) were performed by me or by qualified staff under my supervision. I further certify that the technologies and methods used for these surveys are in compliance with the specifications for this project and that the data from said surveys comply with tolerances specified for this project.

________________________________ __________________________

Surveyor's Name Date

CA PLS/CE No.:__________________________

3.16 ACCEPTANCE

Final acceptance of earthwork will be based upon the Contractor's quality control records, Contractor's quality control test results, and Government's quality assurance test results. Both the Contractor's and the Government's testing shall demonstrate that the Contract requirements are met prior to acceptance of the Work. If, during the course of construction, the Contractor's quality control testing indicates noncompliance with the Specifications, immediately notify the Contracting Officer in writing. Notification shall include the remedial action to be taken by the Contractor to bring work back into compliance.

At the sole discretion of the Contracting Officer, an occasional test result that falls outside of the specification limits stated above may be deemed to be acceptable if in the professional opinion of the Contracting Officer, the overall integrity and function of the constructed work will not be negatively impacted.

-- End of Section --

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DIVISION 31 - EARTHWORK

SECTION 31 05 22

GEOTEXTILES USED AS FILTERS

12/18

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SECTION 31 05 22

GEOTEXTILES USED AS FILTERS
12/18

PART 1 GENERAL

1.1 GENERAL

The application of the geotextile filter fabric for this project is to prevent soil particle intrusion into the new drain material. The drained berm feature using the geotextile filter fabric is shown on the drawing sheets.

1.2 REFERENCES

The publications listed below form a part of this specification to the extent referenced. The publications are referred to within the text by the basic designation only.

ASTM INTERNATIONAL (ASTM)

ASTM D123	(2015) Terminology Relating to Textiles
ASTM D4355/D4355M	(2014) Deterioration of Geotextiles from Exposure to Light, Moisture and Heat in a Xenon-Arc Type Apparatus
ASTM D4491/D4491M	(2015) Standard Test Methods for Water Permeability of Geotextiles by Permittivity
ASTM D4533/D4533M	(2015) Standard Test Method for Trapezoid Tearing Strength of Geotextiles
ASTM D4632/D4632M	(2015a) Grab Breaking Load and Elongation of Geotextiles
ASTM D4751	(2012) Determining Apparent Opening Size of a Geotextile
ASTM D6241	(2014) Standard Test Method for the Static Puncture Strength of Geotextiles and Geotextile-Related Products Using a 50-mm Probe
ASTM D4873/D4873M	(2016) Identification, Storage, and Handling of Geosynthetic Rolls and Samples

1.3 SUBMITTALS

Government approval is required for submittals with a "G" designation; submittals not having a "G" designation are for information only. When used, a designation following the "G" designation identifies the office that will review the submittal for the Government. Submit the following in accordance with Section 01 33 00 SUBMITTAL PROCEDURES:

SD-04 Samples

Geotextiles

Minimum of 60 days prior to the beginning of installation of the same textile

SD-06 Test Reports

Geotextiles

SD-07 Certificates

Geotextiles

Geotextile and all seams to be used will be accepted on the basis of mill certificates or affidavits. Submit duplicate copies of the mill certificate or affidavit signed by a legally authorized official from the company manufacturing the geotextile. The mill certificate or affidavit must attest that the geotextile meets the chemical, physical and manufacturing requirements stated in this specification and must be submitted a minimum of 60 days prior to schedule use.

1.4 DELIVERY, STORAGE, AND HANDLING

Deliver only approved geotextile rolls to the project site. All geotextile must be labeled, shipped, stored, and handled in accordance with ASTM D4873/D4873M. No hooks, tongs, or other sharp instruments must be used for handling geotextile.

PART 2 PRODUCTS

2.1 MATERIALS

2.1.1 General

Provide geotextile that is a woven monofilament pervious sheet of polypropylene yarns as defined by ASTM D123 matching or exceeding the minimum average roll values listed in TABLE 1. Strength values indicated in the table are for the weaker principal direction. The yarns are woven into a dimensional stable network in manner that maintains the yarns in their relative positions.

TABLE 1
MINIMUM PHYSICAL REQUIREMENTS FOR DRAINAGE GEOTEXTILE

PROPERTY	UNITS	ACCEPTABLE VALUES	TEST METHOD
GRAB STRENGTH	lb	180	ASTM D4632/D4632M
GRAB ELONGATION	Percent	15	ASTM D4632/D4632M
PUNCTURE	lb	370	ASTM D6241

TRAPEZOID TEAR	lb	60	ASTM D4533/D4533M
APPARENT OPENING SIZE	U.S. SIEVE	70	ASTM D4751
PERMITTIVITY	sec -1	0.2	ASTM D4491/D4491M
ULTRAVIOLET DEGRADATION	Percent	70 after 500 Hrs	ASTM D4355/D4355M

2.1.2 Geotextile Fiber

Fibers used in the manufacturing of the geotextile must consist of a long-chain synthetic polymer composed of at least 85 percent by weight of polyolefins, polyesters, or polyamides. Add stabilizers and/or inhibitors to the base polymer, if necessary to make the filaments resistant to deterioration caused by ultraviolet light and heat exposure. Reclaimed or recycled fibers or polymer must not be added to the formulation. Geotextile must be formed into a network such that the filaments or yarns retain dimensional stability relative to each other, including the edges. Finish the edges of the geotextile to prevent the outer fiber from pulling away from the geotextile.

2.1.3 Minimum Manufactured Width Seams

The minimum manufactured width of the geotextile from the factory/mill must be 12 feet. No seams are allowed to achieve the 12 feet minimum width.

2.1.4 Securing Pins

Securing pins must not be used to penetrate through the geotextile filter fabric. Other appropriate means to prevent movement such sand bags, and weights could also be used.

2.2 INSPECTIONS, VERIFICATIONS, AND TESTING

2.2.1 Manufacturing and Sampling

Geotextiles and factory seams must meet the requirements specified in TABLE 1.

2.2.1.1 Conformance Testing

Perform conformance testing in accordance with the manufacturers approved quality control manual. Submit manufacturer's quality control conformance test results.

2.2.1.2 Manufacturer Certification

Upon delivery of the geotextile, submit duplicate copies of the written certificate of compliance signed by a legally authorized official of the manufacturer. The certificate must state that the geotextile shipped to the site meets the chemical requirements and exceeds the minimum average roll value listed in TABLE 1. All brands of geotextile will be accepted on the basis of mill certificates or affidavits. Submit duplicate copies of the mill certificate or affidavit signed by a legally authorized official from the company manufacturing the geotextile. The mill certificate or affidavit must attest that the geotextile meets the chemical, physical and manufacturing requirements stated in this specification.

PART 3 EXECUTION

3.1 SURFACE PREPARATION

Prepare surface, on which the geotextile will be placed, to a relatively smooth surface condition in accordance with the applicable portion of this specification and must be free from obstruction, debris, depressions, erosion feature, or vegetation. Remove any irregularities so as to ensure continuous, intimate contact of the geotextile with all the surface. Any loose material, soft or low density pockets of material, must be removed; erosion features such as rills, gullies etc. must be graded out of the surface before geotextile placement.

3.2 INSTALLATION OF THE GEOTEXTILE

3.2.1 General

Place the geotextile in the manner and at the locations shown. At the time of installation, reject the geotextile if it has defects, rips, holes, flaws, deterioration or damage incurred during manufacture, transportation or storage.

3.2.2 Placement

Place the geotextile with the long dimension parallel to the width of the berm (perpendicular to the levee alignment), and laid smooth and free of tension, stress, folds, wrinkles, or creases. Place the strips to provide a minimum width of 18 inches of overlap for each joint and unless otherwise shown on the Contract drawing sheets. Adjust the actual length of the geotextile used based on initial installation experience. Temporary weights to on the geotextile will help hold it in place until the drain material or fill is placed will be allowed. Remove the weights as the drain material or fill is placed to relieve high tensile stress which may occur during placement of material on the geotextile. Perform trimming in such a manner that the geotextile is not damaged in any way. After placement is completed and prior to covering the geotextile with material, an inspection must be performed by the Contractor and Contracting Officer. Covering the geotextile must only be performed after approval from the Contracting Officer.

3.3 PROTECTION

Protect the geotextile at all times during construction from contamination by surface runoff; remove any geotextile so contaminated and replaced with uncontaminated geotextile. Replace any geotextile damaged during its installation or during placement of materials at no cost to the Government. Schedule the work so that the covering of the geotextile with a layer of the specified material is accomplished within 14 calendar days after placement of the geotextile. Failure to comply must require replacement of geotextile. Protect the geotextile from damage prior to and during the placement of drain material or other materials. Before placement of drain material or other materials, demonstrate to the Contracting Officer that the placement technique will not cause damage to the geotextile. Place materials starting at lower elevations and working upward. In no case shall material be allowed to drop onto the geotextile from a height greater than 2.5 feet. In no case shall any type of equipment be allowed on the unprotected geotextile.

3.4 OVERLAPPING

3.4.1 Overlapping

The overlap of geotextile panels must be 18 inches or as shown on the drawings. Appropriate measures will be taken to ensure required overlap exists during and after material placement.

-- End of Section --

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DIVISION 31 - EARTHWORK

SECTION 31 11 00

CLEARING, GRUBBING, AND STRIPPING

08/08

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SECTION 31 11 00

CLEARING, GRUBBING, AND STRIPPING
08/08

PART 1 GENERAL

1.1 SUBMITTALS

Government approval is required for submittals with a "G" designation; submittals not having a "G" designation are for information only. When used, a designation following the "G" designation identifies the office that will review the submittal for the Government. Submit the following in accordance with Section 01 33 00 SUBMITTAL PROCEDURES:

SD-01 Preconstruction Submittals

Work Plan; G

Pre-Construction Condition of Levee Crown, Roadway Gravel, Paving, and Levee Slope Area; G

Material Distribution and Stockpile Plan; G

Survey Data; G

SD-03 Product Data

Nonsaleable Materials; G

Herbicides; G

Mowing and Discing Plan: G

SD-04 Samples

Tree Wound Paint

1.1.1 Work Plan

Work Plan shall include:

Pre-Construction Condition of Levee Crown, Roadway Gravel, Paving, and Levee Slope Area

Documentation of pre-construction condition of levee crown roadway showing detail of levee slope areas and existing conditions.

Material Distribution and Stockpile Plan

Earth material distribution and stockpile plan that describes where material will be obtained, placed, and stockpiled for usage or for temporary disposal. This information shall be provided within ten days after the notice to proceed.

Survey Data

Copies of survey data in the form of cross section sections of the levee prior to construction and of the restored levee crown prior to road surface placement shall be submitted within ten days of performing field surveys.

1.1.2 Mowing and Discing Plan

The mowing and discing plan shall describe where mowing and discing will take place and where mowed and collected material will be stockpiled. This information shall be provided no less than ten days prior to mowing and discing activities beginning.

1.2 DELIVERY, STORAGE, AND HANDLING

Deliver materials to the site, and handle in a manner which will maintain the materials in their original manufactured or fabricated condition until ready for use.

1.2.1 Storage

Storage of herbicides in the project area will not be permitted.

1.2.2 Handling

Handle herbicides in accordance with the manufacturer's label and Safety Data Sheet (SDS), preventing contamination by dirt, water, and organic material. Protect herbicides from weather elements as recommended by the manufacturer's label and SDS. Spill kits must be maintained on herbicide control vehicles. Mixing of herbicides on the installation will not be permitted unless it is written into the contract.

1.3 DEFINITIONS

1.3.1 Levee Stripping

Levee stripping shall consist of the removal and stockpile of crops, weeds, grass, and other vegetative materials to the ground surface and removal of surface soil to the depth and extent specified herein or as shown on the plans.

1.3.2 Debris

Materials containing roots greater than ½ inch in diameter, debris, rubble, trash or other deleterious items shall be classified as debris.

PART 2 PRODUCTS

2.1 MATERIALS

2.1.1 Tree Wound Paint

Submit samples in cans with manufacturer's label of bituminous based paint of standard manufacture specially formulated for tree wounds.

2.1.2 Herbicides

Provide herbicides currently registered by the EPA or approved for such use by the appropriate agency of the host county and approved by the

Contracting Officer. Select an herbicide that is suitable for the climatic conditions at the project site. Submit manufacturer's label and SDS for herbicides proposed for use.

PART 3 EXECUTION

3.1 PROTECTION

3.1.1 Roads and Walks

Keep roads and walks free of dirt and debris at all times.

3.1.2 Trees, Shrubs, and Existing Facilities

Provide protection in accordance with Section 01 57 19 TEMPORARY ENVIRONMENTAL CONTROLS.

3.1.3 Utility Lines

Protect existing utility lines that are indicated to remain from damage. Notify the Contracting Officer immediately of damage to or an encounter with an unknown existing utility line. The Contractor is responsible for the repair of damage to existing utility lines that are indicated or made known to the Contractor prior to start of clearing and grubbing operations. When utility lines which are to be removed are encountered within the area of operations, notify the Contracting Officer in ample time to minimize interruption of the service. Section 00 73 05 SUPPLEMENTARY CONDITION REQUIREMENTS FOR PROJECTS: RIVERSIDE CANAL RELOCATION AND REACH B and Section 01 57 19 TEMPORARY ENVIRONMENTAL CONTROLS for additional utility protection.

3.2 APPLICATION

3.2.1 Herbicide Application

Adhere to safety precautions as recommended by the manufacturer concerning handling and application of the herbicide.

3.2.1.1 Clean Up, Disposal, And Protection

Once application has been completed, proceed with clean up and protection of the site without delay. Clean the site of all material associated with the treatment measures, according to label instructions, and as indicated. Remove and dispose of excess and waste material off Government property.

3.2.1.1.1 Disposal of Herbicide

Dispose of residual herbicides and containers off Government property, and in accordance with the approved disposal plan, label instructions and EPA requirements.

3.3 CLEARING

3.3.1 General

The clearing operations shall consist of the complete removal of obstructions above the ground surface as indicated on the Plans, except that only trees specifically designated on the Plans to be removed shall be removed. All other trees shall be protected even if within the designated limits of clearing and grubbing.

3.3.2 Location

All stumps, down timber, snags, brush, vegetation, old piling, rock, stone, concrete rubble, abandoned structures, retaining walls, irrigation piping, hoses, and sprinklers and similar materials and items shall be cleared within the construction limit as shown on the Plans.

Restricted habitat areas shall not be cleared. Refer to Section 3.1.2.2 for locations of tree removal.

3.3.2.1 Vegetation

Vegetation to be removed shall consist of all woody plants and other vegetation higher than 3 inches above the ground surface, except trees that are not designated on the Plans to be removed.

3.3.2.2 Tree Removal

Tree removal shall be done by others prior to this Contract. Tree trunk and root removal shall be per the details shown on the Plans.

3.3.2.3 Miscellaneous Structures and Debris

The Contractor shall also remove abandoned foundations, debris, concrete rubble, and other materials in areas designated for clearing and grubbing, and as shown on the Plans.

3.3.2.4 Irrigation Piping and Appurtenances

See the Special Provisions for requirements regarding irrigation piping and appurtenances to be removed and salvaged as a part of clearing and grubbing.

3.3.2.5 Debris Removal

Remove any debris within the construction limit shown on the Plans, or as designated for removal on the Plans or as directed by the Agency. Dispose of debris offsite in a legal manner.

3.4 PRUNING

Trees designated to be left standing within cleared areas shall be trimmed of dead branches 1-1/2 inches or more in diameter and have all branches trimmed to heights and in a manner as indicated. Neatly cut limbs and branches to be trimmed close to the bole of the tree or main branches. Paint cuts more than 1-1/4 inches in diameter with an approved tree wound paint.

3.5 GRUBBING

Grubbing consists of the removal and disposal of stumps, roots larger than 3 inches in diameter, and matted roots from the designated grubbing areas. Remove material to be grubbed, together with logs and other organic or metallic debris not suitable for foundation purposes, to a depth of not less than 36 inches below the original surface level of the ground in areas indicated to be grubbed and in areas indicated as construction areas under this contract, such as areas for buildings, and areas to be paved. Fill depressions made by grubbing with suitable material and compact to make the surface conform with the original adjacent surface of the ground.

3.6 STRIPPING

3.6.1 General

After inspection and approval of cleared and grubbed areas, stripping may proceed.

3.6.2 Description of Work

Strip surfaces of excavations and fill foundations of heavy growth of crops, grass weeds and other vegetation to the limits and depth as specified below. Greater depths of stripping may be necessary as specified below and as determined by the Contracting Officer.

a. Unless otherwise specified, the entire area within the limits of existing ground that is to be excavated or to receive fill or structures, together with strips 5 feet wide beyond and contiguous thereto (except in restricted habitat areas or mow and disc areas), shall be stripped to remove crops, weeds, grass, and other vegetative materials. Stripping shall be to a depth of 1.0 foot.

b. All stockpile areas shall be stripped to a depth of 6 inches before material is stockpiled.

c. No stripped or excavated material shall be stockpiled on existing levee slopes.

3.7 Mowing and Discing

3.7.1 General

Mowing and discing shall proceed after inspection and approval of cleared areas.

3.7.2 Description of Work

3.7.2.1 Mowing

Contractor shall mow grasses to a minimum height of 2 inches above grade in areas beneath the proposed seepage berm from Station 686+00 to Station 694+00. Mowing shall occur only in these areas and stripping activities shall not be performed.

3.7.2.2 Discing

After designated areas have been mowed and mowed material has been removed, Contractor shall disc subgrade to 6-inch depth for placement of fill materials. Subgrade shall not be compacted.

3.8 DISPOSAL OF MATERIALS

3.8.1 Nonsaleable Materials

Logs, stumps, roots, brush, rotten wood, and other refuse from the clearing and grubbing operations, except for salable timber, shall be disposed of outside the limits of Government-controlled land at the Contractor's responsibility, except when otherwise directed by the Contracting Officer.

3.9 REMOVAL OF AC PAVEMENT

The existing roadway structural section may be up to three feet thick and consists of asphalt concrete, Portland cement concrete and/or aggregate base. The Contractor may choose the method for removal of pavement materials. All asphalt and concrete roadway material shall be disposed of and recycled offsite.

3.10 FIELD QUALITY CONTROL

3.10.1 Clearing and Grubbing

he Contractor shall establish and maintain quality control for clearing and grubbing and stripping operations to assure compliance with contract requirements, and maintain records of the quality control for all construction operations. These records, as well as the records of corrective actions taken, shall be furnished to the Government in accordance with these specifications.

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DEWATERING

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SECTION 31 23 19

DEWATERING

PART 1 GENERAL

1.1 SCOPE OF WORK

a. This section specifies the definition, responsibilities, and execution for control of water associated with excavations at Natomas Basin Reach B. This includes but is not limited to dewatering for all project excavations including the Plant 3 outfall structure, Plant 3 wetwell structure, and the removal and backfilling of conduits and pipelines. Dewatering includes temporary cofferdams to prevent river and canal water from entering the site. Control of water shall consist of the design, furnishing, installation, operation, maintenance, monitoring, removal of a dewatering system or systems, and sheet pile system, as required, to achieve proper completion of all work performed under this Contract.

b. Submit separate Dewatering Plans for the Pumping Plant 3 canal excavations and construction and the Pumping Plant 3 conduit excavations if this excavation is staged separately.

1.2 DEFINITIONS

Aquifer - rock or sediment in a formation, group of formations, or part of a formation that is saturated and sufficiently permeable to transmit water to pumped wells, wellpoints, eductors and sumps.

Confining layer - a body of material of low hydraulic conductivity/permeability that is stratigraphically adjacent to one or more aquifer. It may lie above or below the aquifer and has a permeability lower than the adjacent aquifer.

Dewatering System - a system that will lower the water table, piezometric or potentiometric surface adequately to permit safe and dry construction.

Groundwater - water that is found in fully saturated soils, sediments and rocks below the surface of the ground and which flows primarily in response to gravitational forces.

Confined Groundwater - groundwater under pressure that is greater than atmospheric pressure. Confined groundwater is separated from direct contact with atmospheric pressure because of overlying impermeable or relatively low permeability layers of sediments or rock.

Groundwater (unconfined) - water in an aquifer that has a water table that is at atmospheric pressure.

Groundwater Table - is a particular potentiometric surface for an unconfined aquifer.

Potentiometric surface/Piezometric level - theoretical (imaginary) surface of the static head of groundwater in an aquifer. The water table is a particular potentiometric surface for an unconfined aquifer.

Sand/Gravel pack - a sand or gravel material which is placed in the annular space between a drilled hole and the well casing and/or well screen.

Saturated zone - the part of unconfined aquifer below the water table where the soil pores are completely filled with water.

Screen (well screen) - a cylinder of steel or plastic material with slots or perforations used to allow water to enter a well while preventing sediment or rock particles from entering the well.

Piezometer -A small diameter observation well used to measure the hydraulic head of groundwater.

Piezometric level/head - the level representing the total hydraulic head of groundwater in a confined aquifer.

Piezometric pressure - pore water pressure at a specific point.

Pore water pressure - the pressure of groundwater in a soil, measured relative to atmospheric pressure.

Pumped well - A hole in the ground with a casing in screen that includes its own motorized pump in the casing or screen to lift water to the surface.

Pumping Level - the level of water in a well casing or screen when pumping is in progress.

Observation Well - a non-pumping well used to observe changes in the elevation of the water table or the potentiometric surface/piezometric head.

Sub-grade - the finished grade level of an excavation as shown on the Plans, below any slab including excavation for foundation materials.

Wellpoint - a short slotted or perforated screen (usually steel or plastic and generally 6 inches or less in diameter and 5 feet long) attached to a 15 to 20 foot long riser pipe and typically jetted, driven or installed in a drilled hole.

Wellpoint System - a dewatering system that includes a number of well points, vacuum header, vacuum wellpoint pump and discharge pipe.

Sheet Piling - sections of steel with interlocking joints on each edge to permit being driven edge to edge to form continuous walls to retain earth or water.

1.3 AVAILABLE DATA

The Contractor may use the information presented in the following reports:

Groundwater Level Data Report - Update #1, Sacramento River East Levee, Construction Phases 1 through 3, Natomas Levee Improvement Program, Kleinfelder, March 22, 2010.

Groundwater Level Data Report - Update #9, Sacramento River East Levee, Construction Phases 1 through 3, Natomas Levee Improvement Program, Kleinfelder, February 5, 2013.

Piezometer Reading Summary, 2015-2016 Flood Season, Natomas Cross Canals, Sacramento and American Rivers, Kleinfelder, December 22, 2016.

Piezometer Reading Summary, 2016-2017 Flood Season, Natomas Cross Canals, Sacramento and American Rivers, Kleinfelder, February 22, 2018.

Piezometer Reading Summary, 2017-2018 Flood Season, Natomas Cross Canals, Sacramento and American Rivers, Kleinfelder, June 11, 2018.

However, the Contractor shall assume responsibility for the interpretation or use of all of the information presented in the above reports. The use of the available data and information in no way relieves the Contractor from the sole responsibility for proper design, installation, operation, maintenance, and any failure of any component of the dewatering systems for the duration of this Contract.

1.4 QUALITY ASSURANCE

a. The Contractor shall include, at minimum, all of the elements necessary for furnishing, installing, operating and maintaining the dewatering system. The Contractor shall employ the services of a specialty dewatering subcontractor who has at least ten (10) years experience in the field of dewatering system design, installation, operation, and maintenance, and can document successful completion of at least five (5) projects which include both large-diameter deep wells and wellpoints.

b. The Contractor shall employ materials, equipment, and construction methods commonly used and proven as suitable for the duration of construction dewatering. The Contractor shall provide submittals and/or product data that demonstrate the suitability of the materials and equipment proposed for use on these systems. The Contractor shall test the dewatering system to the reasonable satisfaction of the Engineer and make operational any deficiency prior to excavation.

c. The Contractor shall integrate all dewatering, shoring and excavation activities to ensure that dewatering, shoring and excavation activities do not impede or conflict to the detriment of the work. The Contractor shall be responsible for any impacts to the project from conflicts between dewatering, shoring and/or excavation.

1.5 SUBMITTALS

Government approval is required for submittals with a "G" designation; submittals not having a "G" designation are for information only. All calculations contained within the Dewatering Plans shall be stamped and signed by a Professional Civil Engineer licensed in the State of California. The following shall be submitted in accordance with Section 01330 SUBMITTAL PROCEDURES:

SD-01 Preconstruction Submittals

Dewatering Plan; G

Dewatering System Design Engineer; G

Dewatering Specialist; G

SD-06 Test Reports

Daily Dewatering Performance Reports; G

1.6 QUALIFIYING EXPERIENCE

1.6.1 Dewatering System Design Engineer

The dewatering system must be designed by a Professional Civil Engineer licensed in the State of California and has a minimum of 10 years of verifiable experience in the design, construction, and operation of dewatering systems including but not limited to pumping, deep wells, well points, sheet piles, and earthen cofferdam or settlement basins, under similar subsurface and site conditions. Provide a resume that demonstrates the required experience and a list and description of past dewatering projects of similar complexity for which the individual was the dewatering system designer. Submit the resume for approval 60 days before commencement of excavation and dewatering.

1.6.2 Dewatering Specialist

The contractor must have on staff and at the job site a Dewatering Specialist with a minimum of 10 years of verifiable experience in the installation, initial startup, testing, operation, and maintenance of dewatering facilities of a complexity comparable to this project. The Dewatering Specialist must oversee the installation and operation of the dewatering system. The Dewatering Specialist must be on the job site each day when the dewatering system is in operation. The Dewatering Specialist also must be on call in event of an emergency, and must be able to arrive on site within 90 minute, 24 hours per day. Submit a resume of the Contractor's dewatering specialist that demonstrates the required experience and a list and description of past dewatering projects in which the individual was responsible for the installation and operation of dewatering systems of similar complexity. Submit the resume for approval 60 days before commencement of excavation and dewatering.

1.7 DEWATERING PLAN

Contractor shall not begin excavation activities until dewatering plan is approved.

No more than 10 days after the notice to proceed is give contractor shall submit drawings and complete design data showing methods and equipment the Contractor proposes for dewatering, including relief of hydrostatic head, management of other water, sheet pile cofferdam, and in maintaining the excavation in a dewatered, hydrostatically controlled condition. Contractor shall provide a Groundwater Control Plan (GWCP) developed by a licensed engineer or hydrogeologist in the State of California with a minimum of 10 years experience in the design of groundwater control systems. Engineer will review submitted calculations and drawings for general compliance and layout only. The design of these facilities is the sole responsibility of the Contractor. The Contractor shall submit information sufficient for the Army Corps of Engineers to understand the dewatering system including, but not limited to, the following:

a. Specifications and manufacturer's literature of the materials and a description of the methods proposed for use in the construction of dewatering and monitoring system.

b. Drawings indicating the location and size of berms, dikes, ditches, wells, wellpoints, sumps, monitoring wells, gravel drains, treatment facilities, discharge lines, and outfall design. The drawings shall include, at a minimum, all dewatering system elements.

c. Capacities of pumps, prime movers, and standby equipment.

d. Temporary electrical power supply for the pumps.

e. Information supporting the location and number of any wells, wellpoints, gravel drains, sumps and discharge lines, and the adequacy of vacuum header, pressure header, discharge pipe sizes, pumps, filters/gravel packs, screens and treatment facilities.

f. Information supporting the design of the dewatering wells, gravel packs, wellpoints, and water treatment systems, including boring logs at all dewatering wells and filter pack design.

g. A photo log of all structures including walls, slabs, exposed piping that might be affected by settlement due to lowering of the groundwater.

h. Dewatering schedule, operation, maintenance, and abandonment procedures.

i. Project descriptions for dewatering projects of similar scope and size completed in the region by the Contractor s specialty dewatering subcontractor and licensed engineer or hydrogeologist.

j. Boring and construction logs for all dewatering and observation wells (within 48 hours of completion).

k. Daily water level measurements and flow measurements.

l. Fines (sand/silt) measurement equipment and procedures, and daily and weekly sand/silt content measurements.

m. Shop drawings and manufacturer's data on proposed sheet pile cofferdam.

n. Plans for cofferdam removal to minimize downstream resilting.

o. Information related to backup pumping systems, backup power systems, and warning systems to protect against power failure, system failure, and high groundwater.

1.8 DAILY DEWATERING PERFORMANCE REPORTS

Submit Daily Dewatering Performance Reports to the Contracting Officer daily. The daily report, covering a 24 hour period (from midnight to midnight), must include records, results, and data obtained from required testing, inspection, maintenance, and daily monitoring of systems to control surface water and groundwater. Include measurements of water levels in sumps and observation wells or piezometers, the quantity of water discharged from the settling tanks, and a description of the dewatering system's performance. The data must be provided as digital files (EXCEL), as approved. Submit the report no later than one day after the Record day.

PART 2 PRODUCTS

2.1 DEWATERING WELLS

Dewatering wells shall be designed by a California registered civil or geotechnical engineer. The well shall be backfilled with concrete or bentonite from the surface to the top of the minimum groundwater elevation. Filter pack should be placed only within sand layers. Bentonite may be used between the filter pack and the concrete/bentonite layer.

PART 3 EXECUTION

3.1 GENERAL CONDITIONS

a. The Contractor shall provide, operate, maintain, and decommission the dewatering systems that consists of deep wells and/or wellpoints and a monitoring system. The Contractor shall control groundwater so as to prevent softening of the bottom of excavations, or formation of quick conditions or boils during excavation. The Contractor shall depress water levels and hydrostatic pressures a minimum of 3 feet below the excavation bottom at all times under all conditions. The groundwater level shall be maintained at the required minimum depth under all excavated surfaces to be dewatered which includes final bottom grades and excavated slopes. The Contractor shall design, install, maintain, and operate the dewatering system so as to prevent removal of the natural soils in the state into which the system is installed.

b. The Contractor shall provide backup systems for all ordinary emergencies, including power outage and flooding, and shall have available at all times competent workers for the continuous and successful operation of the dewatering system. The Contractor shall not disable or shutdown the dewatering system between shifts, on holidays, or weekends, or during work stoppages, without written permission from the Contracting Officer. The Contractor shall be responsible for maintaining all electric power service connections to the dewatering system components and for the cost of electric power used in the operation of the dewatering system.

c. The Contractor shall control surface runoff so as to prevent entry or collection of water in excavations or in other isolated areas of the site. The Contractor shall employ sumps to pump any pocketed or undrained water not otherwise collected or removed. However, the Contractor shall not rely solely upon open and cased sumps for dewatering. The Contractor shall use sumps only where static groundwater levels are less than 3 feet above sub-grade or in areas where the potentiometric surface has been previously lowered to within 3 feet of sub-grade using wellpoints or pumped wells.

d. The dewatering system shall be designed by a California registered civil or geotechnical engineer using accepted and professional methods of design and engineering consistent with sound modern practice. The Contractor shall have, or shall employ the services of a subcontractor who has, experience in the field of dewatering system design, installation, operation, and maintenance. The dewatering system design, construction, and abandonment shall conform to all applicable U.S. Army Corps of Engineers requirements.

e. Before the commencement of any dewatering, the Contractor shall obtain acceptance by the Government for the design, materials, method, installation, and operation and maintenance details of sheet pile cofferdam, the dewatering system(s) and monitoring system the Contractor plans to install. Acceptance by the Government of the design, materials, method, installation, and operation and maintenance details submitted by the Contractor shall not in any way relieve the Contractor from responsibility for errors therein or from the entire responsibility for complete and adequate design, materials, installation, operation, maintenance and performance of the system in controlling the water level in the excavated areas and for control of the hydrostatic pressures to the depths herein specified. The Contractor shall bear sole responsibility for proper design, installation, operation, maintenance, and any failure of any component of the dewatering system and sheet pile cofferdam for the duration of this Contract.

f. After initiating dewatering operations, the Contractor shall operate, maintain and monitor the dewatering system or systems for the duration of the contract until specifically authorized in writing by the Contracting Officer to cease operation, maintenance or monitoring.

g. Dewatering well construction and well destruction shall be in accordance with STATE REGULATIONS and Sacramento County Standards.

h. The Contractor shall install, operate, and maintain a water treatment system to provide for settling of suspended solids in the discharge from any sumping, dewatering well or wellpoint system.

i. The Contractor shall dewater and dispose of the water in a manner that will not cause injury to public or private property, or to cause a nuisance or a menace to the public.

j. The Contractor shall not allow the water discharged from the dewatering system wells, wellpoints or supplemental water control systems (i.e. sumps) to degrade the water quality of the receiving waters. The Contractor shall cease all discharge to receiving waters when the discharge exceeds STATE SURFACE WATER QUALITY STANDARDS.

k. The Contractor shall pay any fines incurred as a result of discharges that exceed State Surface Water Quality Standards.

l. When failure to provide adequate dewatering and drainage causes disturbance of the soils below design foundation or excavation grade, provide adequate dewatering and excavate and re-fill the disturbed areas with approved, properly compacted fill material. Such work shall be at the Contractor's expense and at no additional cost to the Government.

3.2 MONITORING SYSTEM

a. The Contractor shall install necessary piezometers/observation wells to monitor effectiveness of the dewatering systems and as required to demonstrate required groundwater drawdowns at or below the required elevation during all excavation and backfill operations.

All dewatering wells shall be equipped with a device to measure the quantities of fines (sand/silt) in the water discharged by the system. Pumping from monitoring wells shall not be allowed unless designed in advance and process for conversion is addressed in the Dewatering Plan.

Piezometers/observation wells shall be installed throughout the excavation limits to monitor groundwater levels.

b. The Contractor shall provide in-line flow meters on all well and wellpoint system discharge pipes to ensure accurate measurement of the total flow from the dewatering system. The flow meters shall show flow in gallons per minute and total flow passing through the meter. The flow meter shall be sized and installed to accurately represent the flow through the meter. The Contractor shall test and document the accuracy of all installed flow meters. The Contractor shall provide flow meter calibration documentation to the Contracting Officer two weeks prior to any dewatering system pumping other than well or wellpoint development.

c. The Contractor shall maintain accurate and precise daily records of water level and flow measurements. The Contractor shall measure water levels in all pumping and monitoring wells to 0.01-foot precision and flow to within 5 gallons per minute.

e. The Contractor shall begin water level measurements within 24 hours of any well completion and development and continue daily measurements until the well is properly abandoned or the Contracting Officer approves cessation of measurement.

f. The Contractor shall begin water flow measurements within 4 hours of initiating pumping in any well or wellpoint system and continue measurements until the Contracting Officer approves cessation of measurement. The Contractor shall report to the Contracting Officer, any changes in dewatering discharge flow of 25 percent or more occurring within any 24-hour period within four hours following such a change. The Contractor shall notify the Contracting Officer anytime a pump fails, or is turned off or on, for a period of more than 4 hours. Additionally, the Contractor shall note and record when any well(s) or dewatering systems are turned off and back on. The Contractor shall provide water level and flow measurement records to the Contracting Officer daily in both hardcopy and digital form. Provide the data in the Daily Dewatering Performance Report and at the request of the Contracting Officer.

g. The Contractor may remove and replace or lower top of casings of monitoring wells as the work progresses, however, the Contractor shall bear full responsibility for the water level information provided by those wells and any consequences stemming from the lack of or error in the information. The Engineer shall be notified of any change in the measuring points of any well. The Contractor shall re-survey any shortened or lengthened observation well casing, and provide such data to the Contracting Officer.

h. The Contractor shall notify the Contracting Officer, one week prior to installation of any monitoring wells. The Contractor shall provide the Contracting Officer with driller's logs and formation samples at 5-foot intervals for each well.

3.3 FORMATION PROTECTION & WELL DEVELOPMENT

a. The Contractor shall design, construct, operate, and maintain the dewatering system such that the fine fraction of the foundation soils will not be removed upon pumping.

b. The Contractor shall develop all wells and wellpoints to remove fines resulting from drilling and construction and to increase the yield and hydraulic connection with the aquifer. The Contractor shall discharge all development water to the sediment settling tanks prior to discharge. The Contractor shall not discharge any development water directly to the ground surface or surface water body.

c. The Contractor shall develop dewatering wells until the sand/silt content of the discharge water during surging is less than 10 miligrams per liter (mg/L) as determined by a centrifugal separating meter such as a Rossum SAND TESTER (Journal AWWA, 46:123, February 1954), or equivalent.

d. The Contractor shall monitor total discharge from all parts of the system upstream of the outlet(s)to receiving water body to ensure that the sand/silt content of the discharge water does not exceed 30 mg/L as determined by a Rossum SAND TESTER or equivalent. The Contractor shall provide all of the equipment and fittings for monitoring sand content. The Contractor shall monitor sand/silt content daily for one week after installing any dewatering well or wellpoint and weekly thereafter. The Contractor shall take sand/silt content measurements in the presence of the Contracting Officer. The Contractor shall notify the Contracting Officer of the time of measurement and provide 24-hour notice of planned measurements.

3.4 STANDBY EQUIPMENT

The Contractor shall furnish and maintain on site sufficient power-generating and other equipment and materials to ensure continuous and successful operation of the dewatering system. The Contractor shall maintain on site, ready to operate, sufficient standby electrical generating capacity to operate all wells pumps and/or wellpoint pumps simultaneously. The Contractor shall test all backup electric systems monthly in the presence of the Contracting Officer. These tests shall include at least 24 hours of operation under full system load. The Contractor shall have on site, a backup pump for each type of pump in the dewatering system and sufficient pipe and fittings for any repair.

3.5 DISCHARGE PIPING, CONVEYANCE AND OUTLETS

Discharge piping layout shall be designed and installed in a manner which minimizes impacts to excavation or construction activities. The outlets to receiving waters shall be piped and bank protection shall be designed to protect from erosion. Permitted points of discharge to receiving water bodies are shown on the Plans.

If ditches are used for conveyance from pipe manifold to the receiving water body, the ditch layout shall be identified in the Dewatering Plan. Ditches shall be lined with plastic sheeting, or other erosion control method acceptable to Contracting Officer shall be implemented. Culverts shall be properly sized for total anticipated flow. Open ditches shall not be used adjacent to excavations slopes above the open excavation.

Monitoring of Total Suspended Solids (TSS) combined discharge shall be performed at outlets, immediately upstream of the receiving water body. Where necessary to limit TSS limits, the discharge shall be routed through Baker Tanks, or other pre-treatment methods shall be implemented upstream of outlet.

3.6 WATER SUPPLY FOR SYSTEM INSTALLATION AND ELECTRICAL SERVICE

The Contractor shall provide water supply and electrical service needed for the dewatering systems. The Contractor shall provide a completely separate power company source for the dewatering system electric service with its own meter or generator and which shall be dedicated solely for the dewatering system and separate from all other electric service.

3.7 DEWATERING SYSTEM PROTECTION

The Contractor shall take reasonable precautions to ensure continuous successful operation of the dewatering system. This includes establishing and/or maintaining adequate marking of all well, pump and pipeline locations. Wherever dewatering wells or discharge lines require crossing for access into, out of, or around an excavation, steel plates/ramps shall protect the system from vehicular traffic. All traffic plates shall have the strength to support the heaviest equipment on site and shall provide at least one (1) foot of clearance between the dewatering system element and the underside of the traffic plates. The Contractor shall identify all vehicular access points across the dewatering system with brightly colored flagged 8-foot high poles on each side of the access point. The Contractor shall valve all ramped pipelines on both sides of the ramp.

3.8 SYSTEM REMOVAL

A licensed water well contractor in accordance with STATE STANDARDS shall destroy all wells, wellpoints and observation wells installed by the Contractor. The Contractor shall also destroy all existing monitoring wells shown on the Plans to be removed in accordance with STATE STANDARDS and Sacramento County Standards. As a minimum, the Contractor shall seal any well, wellpoint hole, sump, gravel drain or other penetrations below the excavation with a cement grout mixture exhibiting a permeability less than 1 x 10-6 centimeters per second.

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METAL SHEET PILING

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METAL SHEET PILING
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PART 1 GENERAL

1.1 REFERENCES

The publications listed below form a part of this specification to the extent referenced. The publications are referred to within the text by the basic designation only.

AMERICAN WELDING SOCIETY (AWS)

AWS D1.1/D1.1M	(2015; Errata 1 2015; Errata 2 2016) Structural Welding Code - Steel

ASTM INTERNATIONAL (ASTM)

ASTM A572/A572M	(2018) Standard Specification for High-Strength Low-Alloy Columbium-Vanadium Structural Steel
ASTM A6/A6M	(2017a) Standard Specification for General Requirements for Rolled Structural Steel Bars, Plates, Shapes, and Sheet Piling

1.2 SUBMITTALS

Government approval is required for submittals with a "G" designation; submittals not having a "G" designation are for Contractor Quality Control approval. When used, a designation following the "G" designation identifies the office that will review the submittal for the Government. Submit the following in accordance with Section 01 33 00 SUBMITTAL PROCEDURES:

SD-02 Shop Drawings

Metal Sheet Piling; G

SD-03 Product Data

Driving; G
Pile Driving Equipment; G
Pulling and Redriving; G

SD-06 Test Reports

Materials Tests; G
Interlocked Joint Strength in Tension Test; G

SD-11 Closeout Submittals

Pile Driving Record; G

1.3 QUALITY ASSURANCE

1.3.1 Material Certificates

For each shipment, submit certificates identified with specific lots prior to installing piling. Include in the identification data piling type, dimensions, chemical composition, mechanical properties, section properties, heat number, and mill identification mark.

1.3.2 Interlocked Joint Tension Test

Submit, for approval, the procedure for testing the tension strength of piling interlocks prior to testing sheet piling.

1.4 DELIVERY, STORAGE, AND HANDLING

Materials delivered to the site shall be new and undamaged and shall be accompanied by certified test reports. Provide the manufacturer's logo and mill identification mark on the sheet piling as required by the referenced specifications. Store and handle sheet piling in the manner recommended by the manufacturer to prevent permanent deflection, distortion or damage to the interlocks; as a minimum, support on level blocks or racks spaced not more than 10 feet apart and not more than 2 feet from the ends. Storage of sheet piling should also facilitate required inspection activities and prevent damage to coatings and corrosion prior to installation.

1.5 PERMANENT SHEET PILING

All of the requirements in this specification apply to the permanent sheet piling.

1.6 TEMPORARY SHEET PILING

The specification requirements for the temporary sheet piling is applicable to this specification with the exception of the section modulus and type of steel. This is determined by the Contractor and submitted for review to the Contracting Officer in the submittal METAL SHEET PILING. Any modification to the sheet piling tip elevation shown on the drawings is to be submitted for approval to the Contracting Officer.

PART 2 PRODUCTS

2.1 METAL SHEET PILING

Submit detail drawings for sheet piling, including fabricated sections, showing complete piling dimensions and details, driving sequence and location of installed piling.

a. Include in the drawings details of top protection, special reinforcing tips, tip protection, lagging, splices, fabricated additions to plain piles, cut-off method, corrosion protection, and dimensions of templates and other temporary guide structures for installing piling. Provide details of the method for handling piling to prevent permanent deflection, distortion or damage to piling interlocks.

b. Metal sheet piling shall be hot-rolled steel sections conforming to ASTM A572/A572M, Grade 50, Type PZ, meeting the chemical and mechanical requirements of ASTM A572/A572M, Grade 50, Type PZ.

c. For protection of sheet piling, coat it in accordance with Section 09 97 13 COATING OF STEEL WATERFRONT STRUCTURES, ZERO VOC, (SZC) SPLASH ZONE COATING.

2.1.1 Interlocks

The interlocks of sheet piling shall be free-sliding, provide a swing angle suitable for the intended installation but not less than 5 degrees when interlocked, and maintain continuous interlocking when installed.

2.1.2 General Requirements

Sheet piling shall be full-length sections of the dimensions shown. Fabricated tees, wyes and cross pieces shall be fabricated of piling sections with a minimum web thickness of 1/2 inch. Provide sheet piling with standard pulling holes. Metalwork fabrication for sheet piling shall be as specified and in Section 05 50 13 MISCELLANEOUS METAL FABRICATIONS.

2.2 APPURTENANT METAL MATERIALS

Provide metal plates, shapes, bolts, nuts, rivets and other appurtenant fabrication and installation materials conforming to manufacturer's standards and to the requirements specified in the respective sheet piling standards and in Section 05 50 13 MISCELLANEOUS METAL FABRICATIONS.

2.3 TESTS, INSPECTIONS, AND VERIFICATIONS

Requirements for material tests, workmanship and other measures for quality assurance shall be as specified and in Section 05 50 13 MISCELLANEOUS METAL FABRICATIONS.

2.3.1 Materials Tests

Submit certified materials tests reports showing that sheet piling and appurtenant metal materials meet the specified requirements, for each shipment and identified with specific lots prior to installing materials. Material test reports shall meet the requirements of ASTM A6/A6M. Perform materials tests conforming to the following requirements. Sheet piling and appurtenant materials shall be tested and certified by the manufacturer to meet the specified chemical, mechanical and section property requirements prior to delivery to the site. Testing of sheet piling for mechanical properties shall be performed after the completion of all rolling and forming operations. Testing of sheet piling shall meet the requirements of ASTM A6/A6M.

2.3.2 Interlocked Joint Strength in Tension Test

Submit the procedure for testing sheet piling interlocked joint strength in tension, prior to testing piling. The interlocked joint strength in tension test shall conform to the piling manufacturer's standard test, include testing at least two 3 inch long coupons taken randomly from different as-produced pilings of each heat and shall t be approved. Submit a certified report showing results based on approved testing procedures.

PART 3 EXECUTION

3.1 EARTHWORK

Perform in accordance with Section 31 00 00 EARTHWORK.

3.2 INSTALLATION

3.2.1 Pile Driving Equipment

Submit complete descriptions of sheet piling driving equipment including hammers, extractors, protection caps and other installation appurtenances, prior to commencement of work. Descriptive information includes manufacturer's name, model numbers, capacity, rated energy, hammer details, cushion material, helmet, and templates. Provide pile driving equipment conforming to the following requirements.

3.2.1.1 Driving Hammers

Hammers shall be steam, air, or diesel drop, single-acting, double-acting, differential-acting , or vibratory type. The driving energy of the hammers shall be as recommended by the manufacturer for the piling weights and subsurface materials to be encountered. Repair damage to piling caused by use of a pile hammer with excess delivered force or energy.

3.2.2 Placing and Driving

3.2.2.1 Placing

Any excavation required within the area where sheet pilings are to be installed shall be completed prior to placing sheet pilings. Pilings properly placed and driven shall be interlocked throughout their length with adjacent pilings to form a continuous diaphragm throughout the length or run of piling wall.

a. Pilings shall be carefully located as indicated or directed. Pilings shall be placed plumb with out-of-plumbness not exceeding 1/8 inch per foot of length and true to line. Place the pile so the face will not be more than 6 inches from vertical alignment at any point. Top of pile at elevation of cut-off shall be within 1/2 inch horizontally and 2 inches vertically of the location indicated. Manipulation of piles to force them into position will not be permitted. Check all piles for heave. Redrive all heaved piles to the required tip elevation.

b. Provide temporary wales, templates, or guide structures to ensure that the pilings are placed and driven to the correct alignment. Use a system of structural framing sufficiently rigid to resist lateral and driving forces and to adequately support the sheet piling until design tip elevation is achieved. Use two templates, at least, when placing each piling. Templates shall not move when supporting sheet piling. Fit templates with wood blocking to bear against the web of each alternate sheet pile and hold the sheet pile at the design location alignment. Provide outer template straps or other restraints as necessary to prevent the sheets from warping or wandering from the alignment. Mark template for the location of the leading edge of each alternate sheet pile. If in view, also mark the second level to assure that the piles are vertical and in position. If two guide marks cannot be seen, other means shall be used to keep the sheet pile vertical along its leading edge.

3.2.2.2 Driving

Submit records of the completed sheet piling driving operations, including a system of identification which shows the disposition of approved piling in the work, driving equipment performance data, piling penetration rate data, piling dimensions and top and bottom elevations of installed piling. Prior to driving pilings in water, paint a horizontal line on both sides of each piling at a fixed distance from the bottom so that it will be visible above the water line after installation. This line shall indicate the profile of the bottom elevation of installed pilings and potential problem areas can be identified by abrupt changes in its elevation. Drive pilings with the proper size hammer and by approved methods so as not to subject the pilings to damage and to ensure proper interlocking throughout their lengths.

a. Maintain driving hammers in proper alignment during driving operations by use of leads or guides attached to the hammer. Caution shall be taken in the sustained use of vibratory hammers when a hard driving condition is encountered to avoid interlock-melt or damages. Discontinue the use of vibratory hammers and impact hammers employed when the penetration rate due to vibratory loading is one foot or less per minute.

b. Employ a protecting cap in driving when using impact hammers to prevent damage to the tops of pilings. Use cast steel shoe to prevent damage to the tip of the sheet piling. Remove and replace pilings damaged during driving or driven out of interlock at the Contractor's expense.

c. Drive pilings without the aid of a water jet.

d. Take adequate precautions to ensure that pilings are driven plumb. Where possible, drive Z-pile with the ball end leading. If an open socket is leading, a bolt or similar object placed in the bottom of the interlock will minimize packing material into it and ease driving for the next sheet. If at any time the forward or leading edge of the piling wall is found to be out-of-plumb in the plane of the wall the piling being driven shall be driven to the required depth and tapered pilings shall be provided and driven to interlock with the out-of-plumb leading edge or other approved corrective measures shall be taken to insure the plumbness of succeeding pilings. The maximum permissible taper for any tapered piling shall be 1/8 inch per foot of length.

e. Pilings in each run or continuous length of piling wall shall be driven alternately in increments of depth to the required depth or elevation. No piling shall be driven to a lower elevation than those behind it in the same run except when the pilings behind it cannot be driven deeper. Incrementally sequence driving of individual piles such that the tip of any sheet pile shall not be more than 4 feet below that of any adjacent sheet pile. When the penetration resistance exceeds five blows per inch, the tip of any sheet pile shall not be more than 2 feet below any adjacent sheet pile. If the piling next to the one being driven tends to follow below final elevation it may be pinned to the next adjacent piling.

f. If obstructions restrict driving a piling to the specified penetration, the obstructions shall be removed or penetrated with a chisel beam. If the Contractor demonstrates that removal or penetration is impractical, make changes in the design alignment of the piling structure as directed to ensure the adequacy and stability of the structure. Pilings shall be driven to depths shown and shall extend up to the elevation indicated for the top of pilings. Piling driven to rock shall be seated individually on the rock. A tolerance of 0 inches above the indicated top elevation will be permitted. Pilings shall not be driven within 100 feet of concrete less than 7 days old.

3.2.3 Cutting-Off and Splicing

Pilings driven to refusal or to the point where additional penetration cannot be attained and are extending above the required top elevation in excess of the specified tolerance shall be cut off to the required elevation. Pilings driven below the required top elevation and pilings damaged by driving and cut off to permit further driving shall be extended as required to reach the top elevation by splicing when directed at no additional cost to the Government. If directed, pilings shall be spliced as required to drive them to depths greater than shown and extend them up to the required top elevation.

a. Pilings adjoining spliced pilings shall be full length unless otherwise approved. Splicing of pilings shall be as indicated. Ends of pilings to be spliced shall be squared before splicing to eliminate dips or camber. Pilings shall be spliced together with concentric alignment of the interlocks so that there are no discontinuities, dips or camber at the abutting interlocks. Spliced pilings shall be free sliding and able to obtain the maximum swing with contiguous pilings. Welding of splices shall conform to the requirements of Section 05 50 13 MISCELLANEOUS METAL FABRICATIONS. Shop and field welding, qualification of welding procedures, welders, and welding operators shall be in accordance with AWS D1.1/D1.1M.

b. The tops of pilings excessively battered during driving shall be trimmed when directed, at no cost to the Government. Piling cut-offs except for Government furnished pilings shall become the property of the Contractor and shall be removed from the site.

c. Cut holes in pilings for bolts, rods, drains or utilities in a neat and workmanlike manner, as shown or as directed. Use a straight edge in cuts made by burning to avoid abrupt nicks. Bolt holes in steel piling shall be drilled or may be burned and reamed by approved methods which will not damage the surrounding metal. Holes other than bolt holes shall be reasonably smooth and the proper size for rods and other items to be inserted. All holes in steel pilings on the wet side of cofferdams shall be made watertight by welding steel plates over the holes after the piling installation is completed. Do not use explosives for cutting.

3.2.4 Inspection of Driven Piling

Perform continuous inspection during pile driving. Inspect all piles for compliance with tolerance requirements. Bring any unusual problems which may occur to the attention of the Contracting Officer. Inspect the interlocked joints of driven pilings extending above ground. Pilings found to be out of interlock shall be removed and replaced at the Contractor's expense.

3.2.5 Pulling and Redriving

Submit the proposed method of pulling sheet piling, prior to pulling any piling. Pull, as directed, selected pilings after driving to determine the condition of the underground portions of pilings. Any piling so pulled and found to be damaged, to the extent that its usefulness in the structure is impaired, shall be removed and replaced at the Contractor's expense. Pilings pulled and found to be in satisfactory condition shall be redriven when directed.

3.3 REMOVAL

The removal of sheet pilings shall consist of pulling, sorting, cleaning the interlocks, inventorying and storing previously installed sheet pilings as shown and directed.

3.3.1 Pulling

The method of pulling piling shall be approved. Provide pulling holes in pilings, as required. Extractors shall be of suitable type and size. Care shall be exercised during pulling of pilings to avoid damaging piling interlocks and adjacent construction. If the Contracting Officer determines that adjacent permanent construction has been damaged during pulling, the Contractor will be required to repair this construction at no cost to the Government. Pull pilings one sheet at a time. Pilings fused together shall be separated prior to pulling, unless the Contractor demonstrates, to the satisfaction of the Contracting Officer, that the pilings cannot be separated. The Contractor will not be paid for the removal of pilings damaged beyond structural use due to proper care not being exercised during pulling.

3.3.2 Sorting, Cleaning, Inventorying and Storing

Pulled pilings shall be sorted, cleaned, inventoried and stored by type into groups as:

a. Piling usable without reconditioning.

b. Piling requiring reconditioning.

c. Piling damaged beyond structural use.

3.4 INSTALLATION RECORDS

Maintain a pile driving record for each sheet pile driven. Indicate on the installation record: installation dates and times, type and size of hammer, rate of operation, total driving time, dimensions of driving helmet and cap used, blows required per foot for each foot of penetration, final driving resistance in blows for final 6 inches, pile locations, tip elevations, ground elevations, cut-off elevations, and any reheading or cutting of piles. Record any unusual pile driving problems during driving. Submit complete records to the Contracting Officer.

-- End of Section --

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DIVISION 32 - EXTERIOR IMPROVEMENTS

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AGGREGATE BASE COURSE

08/08

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SECTION 32 11 23

AGGREGATE BASE COURSE
08/08

PART 1 GENERAL

Aggregate base course shall be constructed on a lime modified subgrade.

1.1 REFERENCES

The publications listed below form a part of this specification to the extent referenced. The publications are referred to in the text by basic designation only.

AMERICAN ASSOCIATION OF STATE HIGHWAY AND TRANSPORTATION OFFICIALS (AASHTO)

AASHTO T 180	(2017) Standard Method of Test for Moisture-Density Relations of Soils Using a 4.54-kg (10-lb) Rammer and a 457-mm (18-in.) Drop
AASHTO T 224	(2010) Standard Method of Test for Correction for Coarse Particles in the Soil Compaction Test

ASTM INTERNATIONAL (ASTM)

ASTM C117	(2017) Standard Test Method for Materials Finer than 75-um (No. 200) Sieve in Mineral Aggregates by Washing
ASTM C127	(2015) Standard Test Method for Density, Relative Density (Specific Gravity), and Absorption of Coarse Aggregate
ASTM C128	(2015) Standard Test Method for Density, Relative Density (Specific Gravity), and Absorption of Fine Aggregate
ASTM C131/C131M	(2014) Standard Test Method for Resistance to Degradation of Small-Size Coarse Aggregate by Abrasion and Impact in the Los Angeles Machine
ASTM C136/C136M	(2014) Standard Test Method for Sieve Analysis of Fine and Coarse Aggregates
ASTM C88	(2013) Standard Test Method for Soundness of Aggregates by Use of Sodium Sulfate or Magnesium Sulfate
ASTM D1556/D1556M	(2015; E 2016) Standard Test Method for Density and Unit Weight of Soil in Place by Sand-Cone Method

ASTM D1557	(2012; E 2015) Standard Test Methods for Laboratory Compaction Characteristics of Soil Using Modified Effort (56,000 ft-lbf/ft3) (2700 kN-m/m3)
ASTM D1883	(2016) Standard Test Method for California Bearing Ratio (CBR) of Laboratory-Compacted Soils
ASTM D2216	(2010) Laboratory Determination of Water (Moisture) Content of Soil and Rock by Mass
ASTM D2487	(2017) Standard Practice for Classification of Soils for Engineering Purposes (Unified Soil Classification System)
ASTM D4318	(2017; E 2018) Standard Test Methods for Liquid Limit, Plastic Limit, and Plasticity Index of Soils
ASTM D4643	(2017) Standard Test Method for Determination of Water Content of Soil and Rock by Microwave Oven Heating
ASTM D4791	(2010) Flat Particles, Elongated Particles, or Flat and Elongated Particles in Coarse Aggregate
ASTM D4959	(2016) Determination of Water (Moisture) Content of Soil by Direct Heating
ASTM D5821	(2013) Standard Test Method for Determining the Percentage of Fractured Particles in Coarse Aggregate
ASTM D6938	(2017a) Standard Test Method for In-Place Density and Water Content of Soil and Soil-Aggregate by Nuclear Methods (Shallow Depth)
ASTM D75/D75M	(2014) Standard Practice for Sampling Aggregates
ASTM E11	(2016) Standard Specification for Woven Wire Test Sieve Cloth and Test Sieves

STATE OF CALIFORNIA DEPARTMENT OF TRANSPORTATION (CALTRANS)

CDT SS 26	(2015) Standard Specifications, SECTION 26: AGGREGATE BASES

1.2 STATE SPECIFICATIONS

CALIFORNIA DEPARTMENT OF TRANSPORTATION (Caltrans), STANDARD SPECIFICATIONS, 2015 edition (including all subsequent supplements and updates), are referred to herein as State Specifications. Paragraphs pertaining to measurement and payment in the State Specifications shall not be used. References to State or Engineer shall be understood to be the Contracting Officer. The State Specifications form a part of this specification only to the extent referenced.

1.3 DEFINITIONS

For the purposes of this specification, the following definitions apply.

1.3.1 Aggregate Base Course

Aggregate base course (AB) is well graded, durable aggregate uniformly moistened and mechanically stabilized by compaction.

1.3.2 Degree of Compaction

Degree of compaction required, except as noted in the second sentence, is expressed as a percentage of the maximum laboratory dry density obtained by the test procedure presented in ASTM D1557 abbreviated as a percent of laboratory maximum dry density. Since ASTM D1557 applies only to soils that have 30 percent or less by weight of their particles retained on the 3/4 inch sieve, the degree of compaction for material having more than 30 percent by weight of their particles retained on the 3/4 inch sieve are expressed as a percentage of the laboratory maximum dry density in accordance with AASHTO T 180 Method D and corrected with AASHTO T 224.

1.4 SUBMITTALS

Government approval is required for submittals with a "G" designation; submittals not having a "G" designation are for information only. When used, a designation following the "G" designation identifies the office that will review the submittal for the Government. Submit the following in accordance with Section 01 33 00 SUBMITTAL PROCEDURES:

SD-03 Product Data

Plant, Equipment, and Tools

SD-06 Test Reports

Sampling and Testing; G
Field Density Tests; G

1.5 QUALITY CONTROL

Sampling and testing are the responsibility of the Contractor and performed by a testing laboratory approved in accordance with Section 01 45 00 QUALITY CONTROL. Work requiring testing will not be permitted until the testing laboratory has been inspected and approved. Test the materials to establish compliance with the specified requirements; perform testing at the specified frequency. The Contracting Officer may specify the time and location of the tests. Furnish copies of test results to the Contracting Officer within 24 hours of completion of the tests.

1.5.1 Sampling

Take samples for laboratory testing in conformance with ASTM D75/D75M. When deemed necessary, the sampling will be observed by the Contracting Officer.

1.5.2 Tests

Perform the following tests in conformance with the applicable standards listed.

1.5.2.1 Sieve Analysis

Make sieve analysis in conformance with ASTM C117 and ASTM C136/C136M. Sieves shall conform to ASTM E11. .

1.5.2.2 Liquid Limit and Plasticity Index

Determine liquid limit and plasticity index in accordance with ASTM D4318.

1.5.2.3 Moisture-Density Determinations

Determine the laboratory maximum dry density and optimum moisture content in accordance with ASTM D1557 or AASHTO T 180, Method D and corrected with AASHTO T 224.

1.5.2.4 Field Density Tests

Measure field density in accordance with ASTM D1556/D1556M, except that method ASTM D6938 may be used. For the method presented in ASTM D6938 check the calibration curves and adjust them, if necessary, using only the sand cone method as described in paragraph Calibration, of the ASTM publication. Check the calibration of the density gauge prior to the first use of each different type of material encountered and at intervals as directed by the Contracting Officer, and submit curves and results within 24 hours of running the test. Both ASTM D1556/D1556M and ASTM D6938 result in a wet unit weight of soil and when using either of these methods, use only method ASTM D2216 to determine the moisture content for calculating in-place dry density of the soil. For a rough estimate of in-place density to control field activities only, the Contractor may perform moisture content testing by method ASTM D4643 or ASTM D4959 in conjunction with density testing by method ASTM D6938. If the nuclear gauge method ASTM D6938 is used for compliance testing, those test values shall be checked against tests performed in accordance with the sand cone method ASTM D1556/D1556M at a minimum frequency of one sand cone test per lift for every six or fraction thereof tests by the nuclear gauge method. Density test results determined by ASTM D1556/D1556M shall govern over those determined by ASTM D6938. If differing results are consistently obtained, use of the nuclear gauge shall be discontinued and only sand cone method ASTM D1556/D1556M shall be used.

1.5.2.5 Wear Test

Perform wear tests on AB course material in conformance with ASTM C131/C131M.

1.5.2.6 Soundness

Perform soundness tests on ABC in accordance with ASTM C88.

1.5.2.7 California Bearing Ratio (CBR)

Perform CBR test on AB course material in conformance with ASTM D1883. Results need to show CBR values at 95 percent and at 100 percent of laboratory maximum density.

1.5.2.8 Percent Flat, Elongated

Percent flat and elongated particles in coarse aggregate, shall be determined in accordance with ASTM D4791

1.5.3 Testing Frequency

1.5.3.1 Initial Tests

Perform one of each of the following tests, on the proposed material prior to commencing construction, to demonstrate that the proposed material meets all specified requirements when furnished. If materials from more than one source are going to be utilized, this testing shall be completed for each source.

a. Sieve Analysis .

b. Liquid limit and plasticity index.

c. Moisture-density relationship.

d. Wear.

e. Soundness.

f. California Bearing Ratio (CBR)

g. Percent Flat, Elongated

1.5.3.2 In Place Tests

Perform each of the following tests on samples taken from the placed and compacted AB. Samples shall be taken and tested at the rates indicated. Perform sampling and testing of recycled concrete aggregate at twice the specified frequency until the material uniformity is established.

a. Perform density tests on every lift of material placed and at a frequency of one set of tests for every 200 square yards or portion thereof, of completed area.

b. Perform sieve analysis on every lift of material placed and at a frequency of one sieve analysis for every 250 square yards, or portion thereof, of material placed.

c. Perform liquid limit and plasticity index tests at the same frequency as the sieve analysis.

d. Measure the total thickness of the base course at intervals, in such a manner as to ensure one measurement for each 200 square yards of base course. Measurements shall be made in minimum 3 inch diameter test holes penetrating the base course.

1.5.4 Approval of Material

Select the source of the material 30 days prior to the time the material will be required in the work. Tentative approval of material will be based on initial test results. Final approval of the materials will be based on sieve analysis, liquid limit, and plasticity index tests performed on samples taken from the completed and fully compacted course(s).

1.6 ENVIRONMENTAL REQUIREMENTS

Perform construction when the atmospheric temperature is above 35 degrees F. When the temperature falls below 35 degrees F, protect all completed areas by approved methods against detrimental effects of freezing. Correct completed areas damaged by freezing, rainfall, or other weather conditions to meet specified requirements.

PART 2 PRODUCTS

2.1 PLANT, EQUIPMENT, AND TOOLS

All plant, equipment, and tools used in the performance of the work will be subject to approval before the work is started and shall be maintained in satisfactory working condition at all times. Submit a list of proposed equipment, including descriptive data. Provide adequate equipment having the capability of producing the required compaction, meeting grade controls, thickness control, and smoothness requirements as set forth herein.

2.2 AGGREGATES

Provide AB consisting of clean, sound, durable particles of crushed stone, crushed gravel, angular sand, or other approved material. AB shall be free of lumps of clay, organic matter, and other objectionable materials or coatings. The portion retained on the No. 4 sieve is known as coarse aggregate; that portion passing the No. 4 sieve is known as fine aggregate.

2.2.1 Coarse Aggregate

Provide coarse aggregates with angular particles of uniform density. When the coarse aggregate is supplied from more than one source, aggregate from each source shall meet the specified requirements and shall be stockpiled separately.

a. Crushed Gravel: Crushed gravel manufactured by crushing gravels, and meets all the requirements specified below.

b. Crushed Stone: Provide crushed stone consisting of freshly mined quarry rock, meeting all the requirements specified below.

2.2.1.1 Aggregate Base Course

The aggregate base course material shall conform to State Specification CDT SS 26 AGGREGATE BASES, Class 2, Gradation 3/4-inch maximum, and the requirements specified herein for aggregate base course. The State Specification acceptance of processed reclaimed asphalt concrete, portland cement concrete (PCC), lean concrete base (LCB), or cement treated base (CTB) as aggregate material is not approved and must not be utilized. Additionally, the State Specification allowance to substitute Gradation 1 1/2-inch maximum material is not allowed. Aggregate base course construction shall conform to the requirements specified herein.

AB coarse aggregate shall not show more than 50 percent loss when subjected to the Los Angeles abrasion test in accordance with ASTM C131/C131M. The amount of flat and elongated particles shall not exceed 30 percent. A flat particle is one having a ratio of width to thickness greater than 3; an elongated particle is one having a ratio of length to width greater than 3. In the portion retained on each sieve specified, the crushed aggregates shall contain at least 50 percent by weight of crushed pieces having two or more freshly fractured faces determined in accordance with ASTM D5821. When two fractures are contiguous, the angle between planes of the fractures must be at least 30 degrees in order to count as two fractured faces. Crushed gravel shall be manufactured from gravel particles 50 percent of which, by weight, are retained on the maximum size sieve listed in TABLE 1.

2.2.2 Fine Aggregate

Fine aggregates shall be angular particles of uniform density. When the fine aggregate is supplied from more than one source, aggregate from each source shall meet the specified requirements.

2.2.2.1 Aggregate Base Course

AB fine aggregate shall consist of screenings, angular sand, crushed recycled concrete fines, or other finely divided mineral matter processed or naturally combined with the coarse aggregate.

2.2.3 Gradation Requirements

Apply the specified gradation requirements to the completed base course. The aggregates shall be continuously well graded within the limits specified in TABLE 1. Sieves shall conform to ASTM E11.

TABLE 1. GRADATION OF AGGREGATES
CLASS 2 AGGREGATE BASE

Percentage by Weight Passing Square-Mesh Sieve		
Sieve Designation	Operating Range	Contract Compliance
2 inch	---	---
1-1/2 inch	---	---
1 inch	100	100
3/4 inch	90-100	87-100
No. 4	35-60	30-65
No. 30	10-30	5-35
No. 200	2-9	0-12

<table>
<tr><td colspan="3">TABLE 1. GRADATION OF AGGREGATES
CLASS 2 AGGREGATE BASE</td></tr>
<tr><td colspan="3">Percentage by Weight Passing Square-Mesh Sieve</td></tr>
<tr><td>Sieve Designation</td><td>Operating Range</td><td>Contract Compliance</td></tr>
<tr><td colspan="3">NOTE 1: Particles having diameters less than No. 635 shall not be in excess of 3 percent by weight of the total sample tested.</td></tr>
<tr><td colspan="3">NOTE 2: The values are based on aggregates of uniform specific gravity. If materials from different sources are used for the coarse and fine aggregates, they shall be tested in accordance with ASTM C127 and ASTM C128 to determine their specific gravities. If the specific gravities vary by more than 10 percent, the percentages passing the various sieves shall be corrected as directed by the Contracting Officer.</td></tr>
</table>

2.3 LIQUID LIMIT AND PLASTICITY INDEX

Apply liquid limit and plasticity index requirements to the completed course and to any component that is blended to meet the required gradation. The portion of any component or of the completed course passing the No. 40 sieve shall be either nonplastic or have a liquid limit not greater than 25 and a plasticity index not greater than 5.

PART 3 EXECUTION

3.1 GENERAL REQUIREMENTS

When the AB is constructed in more than one layer, clean the previously constructed layer of loose and foreign matter by sweeping with power sweepers or power brooms, except that hand brooms may be used in areas where power cleaning is not practicable. Provide adequate drainage during the entire period of construction to prevent water from collecting or standing on the working area. Provide line and grade stakes as necessary for control. Grade stakes shall be in lines parallel to the centerline of the area under construction and suitably spaced for string lining.

3.2 OPERATION OF AGGREGATE SOURCES

Clearing, stripping, and excavating are the responsibility of the Contractor. Operate the aggregate sources to produce the quantity and quality of materials meeting the specified requirements in the specified time limit. Aggregate sources on private lands shall be conditioned in agreement with local laws or authorities.

3.3 STOCKPILING MATERIAL

Clear and level storage sites prior to stockpiling of material. Stockpile all materials, including approved material available from excavation and grading, in the manner and at the locations designated. Aggregates shall be stockpiled on the cleared and leveled areas designated by the

Contracting Officer to prevent segregation. Materials obtained from different sources shall be stockpiled separately.

3.4 PREPARATION OF UNDERLYING COURSE

Prior to constructing the base course(s), the underlying course or subgrade shall be cleaned of all foreign substances. At the time of construction of the base course(s), the underlying course shall contain no frozen material. The surface of the underlying course or subgrade shall meet specified compaction and surface tolerances. The underlying course shall conform to Section 31 00 00 EARTHWORK and Section 32 11 29 LIME-MODIFIED SUBGRADE. Ruts or soft yielding spots in the underlying courses, areas having inadequate compaction, and deviations of the surface from the requirements set forth herein shall be corrected by loosening and removing soft or unsatisfactory material and by adding approved material, reshaping to line and grade, and recompacting to specified density requirements. For cohesionless underlying courses containing sands or gravels, as defined in ASTM D2487, the surface shall be stabilized prior to placement of the base course(s). Stabilization shall be accomplished by mixing ABC into the underlying course and compacting by approved methods. The stabilized material shall be considered as part of the underlying course and shall meet all requirements of the underlying course. The finished underlying course shall not be disturbed by traffic or other operations and shall be maintained in a satisfactory condition until the base course is placed.

3.5 INSTALLATION

3.5.1 Mixing the Materials

Mix the coarse and fine aggregates in a stationary plant, or in a traveling plant or bucket loader on an approved paved working area. Make adjustments in mixing procedures or in equipment, as directed, to obtain true grades, to minimize segregation or degradation, to obtain the required water content, and to insure a satisfactory base course meeting all requirements of this specification.

3.5.2 Placing

Place the mixed material on the prepared subgrade or subbase in layers of uniform thickness with an approved spreader. When a compacted layer 6 inches or less in thickness is required, place the material in a single layer. When a compacted layer in excess of 6 inches is required, place the material in layers of equal thickness. No layer shall be thicker than 6 inches or thinner than 3 inches when compacted. The layers shall be so placed that when compacted they will be true to the grades or levels required with the least possible surface disturbance. Where the base course is placed in more than one layer, the previously constructed layers shall be cleaned of loose and foreign matter by sweeping with power sweepers, power brooms, or hand brooms, as directed. Such adjustments in placing procedures or equipment shall be made as may be directed to obtain true grades, to minimize segregation and degradation, to adjust the water content, and to insure an acceptable base course.

3.5.3 Grade Control

The finished and completed base course shall conform to the lines, grades, and cross sections shown. Underlying material(s) shall be excavated and prepared at sufficient depth for the required base course thickness so that the finished base course and the subsequent surface course will meet the designated grades.

3.5.4 Edges of Base Course

The base course(s) shall be placed so that the completed section will be a minimum of 2 feet wider, on all sides, than the next layer that will be placed above it. Additionally, place approved fill material along the outer edges of the base course in sufficient quantities to compact to the thickness of the course being constructed, or to the thickness of each layer in a multiple layer course, allowing in each operation at least a 2 foot width of this material to be rolled and compacted simultaneously with rolling and compacting of each layer of base course. If this base course material is to be placed adjacent to another pavement section, then the layers for both of these sections shall be placed and compacted along this edge at the same time.

3.5.5 Compaction

Compact each layer of the base course, as specified, with approved compaction equipment. Maintain water content during the compaction procedure to within plus or minus 2 percent of the optimum water content determined from laboratory tests as specified in this Section. Begin rolling at the outside edge of the surface and proceed to the center, overlapping on successive trips at least one-half the width of the roller. Alternate trips of the roller shall be slightly different lengths. Speed of the roller shall be such that displacement of the aggregate does not occur. In all places not accessible to the rollers, the mixture shall be compacted with hand-operated power tampers. Continue compaction until each layer has a degree of compaction that is at least 100 percent of laboratory maximum density through the full depth of the layer. Make such adjustments in compacting or finishing procedures as may be directed to obtain true grades, to minimize segregation and degradation, to reduce or increase water content, and to ensure a satisfactory base course. Any materials that are found to be unsatisfactory shall be removed and replaced with satisfactory material or reworked, as directed, to meet the requirements of this specification.

3.5.6 Thickness

Construct the compacted thickness of the base course as indicated. No individual layer shall be thicker than 6 inches nor be thinner than 3 inches in compacted thickness. The total compacted thickness of the base course(s) shall be within 1/4 inch of the thickness indicated. Where the measured thickness is more than 1/4 inch deficient, correct such areas by scarifying, adding new material of proper gradation, reblading, and recompacting as directed. Where the measured thickness is more than 1/4 inch thicker than indicated, the course shall be considered as conforming to the specified thickness requirements. Average job thickness shall be the average of all thickness measurements taken for the job, but shall be within 1/4 inch of the thickness indicated. The total thickness of the base course shall be measured at intervals in such a manner as to ensure one measurement for each 500 square yards of base course. Measurements shall be made in 3 inch diameter test holes penetrating the base course.

3.5.7 Finishing

The surface of the top layer of base course shall be finished after final compaction and proof rolling by cutting any overbuild to grade and rolling with a steel-wheeled roller. Thin layers of material shall not be added to the top layer of base course to meet grade. If the elevation of the top layer of base course is 1/2 inch or more below grade, then the top layer should be scarified to a depth of at least 3 inches and new material shall be blended in and compacted to bring to grade. Adjustments to rolling and finishing procedures shall be made as directed to minimize segregation and degradation, obtain grades, maintain moisture content, and insure an acceptable base course. Should the surface become rough, corrugated, uneven in texture, or traffic marked prior to completion, the unsatisfactory portion shall be scarified, reworked and recompacted or it shall be replaced as directed.

3.5.8 Smoothness

The surface of the top layer shall show no deviations in excess of 3/8 inch when tested with a 12 foot straightedge. Take measurements in successive positions parallel to the centerline of the area to be paved. Measurements shall also be taken perpendicular to the centerline at 50 foot intervals. Deviations exceeding this amount shall be corrected by removing material and replacing with new material, or by reworking existing material and compacting it to meet these specifications.

3.6 TRAFFIC

Completed portions of the base course may be opened to limited traffic, provided there is no marring or distorting of the surface by the traffic. Heavy equipment shall not be permitted except when necessary to construction, and then the area shall be protected against marring or damage to the completed work.

3.7 MAINTENANCE

Maintain the base course in a satisfactory condition until the full pavement section is completed and accepted. Maintenance shall include immediate repairs to any defects and shall be repeated as often as necessary to keep the area intact. Any base course that is not paved over prior to the onset of winter, shall be retested to verify that it still complies with the requirements of this specification. Any area of base course that is damaged shall be reworked or replaced as necessary to comply with this specification.

3.8 DISPOSAL OF UNSATISFACTORY MATERIALS

Dispose of any unsuitable materials that must be removed outside the limits of Government-controlled land, except as otherwise approved by the Contracting Officer. No additional payments will be made for materials that must be replaced.

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SECTION 32 11 29

LIME-MODIFIED SUBGRADE
11/09

PART 1 GENERAL

1.1 SUMMARY

The work specified consists of the construction of a lime-modified subgrade course. Perform the work in accordance with this specification conforming to the lines, grades, notes, and typical sections shown in the drawings. Select sources of materials well in advance of the time when materials will be required in the work.

1.2 REFERENCES

The publications listed below form a part of this specification to the extent referenced. The publications are referred to within the text by the basic designation only.

ASTM INTERNATIONAL (ASTM)

ASTM C136/C136M	(2014) Standard Test Method for Sieve Analysis of Fine and Coarse Aggregates
ASTM C1602/C1602M	(2012) Standard Specification for Mixing Water Used in Production of Hydraulic Cement Concrete
ASTM C25	(2011; E 2016) Standard Test Methods for Chemical Analysis of Limestone, Quicklime, and Hydrated Lime
ASTM C50/C50M	(2013) Sampling, Sample Preparation, Packaging, and Marking of Lime and Limestone Products
ASTM C977	(2010) Quicklime and Hydrated Lime for Soil Stabilization
ASTM D1556/D1556M	(2015; E 2016) Standard Test Method for Density and Unit Weight of Soil in Place by Sand-Cone Method
ASTM D1557	(2012; E 2015) Standard Test Methods for Laboratory Compaction Characteristics of Soil Using Modified Effort (56,000 ft-lbf/ft3) (2700 kN-m/m3)
ASTM D1632	(2007) Standard Practice for Making and Curing Soil-Cement Compression and Flexure Test Specimens in the Laboratory
ASTM D2216	(2010) Laboratory Determination of Water (Moisture) Content of Soil and Rock by Mass

ASTM D4318	(2017; E 2018) Standard Test Methods for Liquid Limit, Plastic Limit, and Plasticity Index of Soils
ASTM D4643	(2017) Standard Test Method for Determination of Water Content of Soil and Rock by Microwave Oven Heating
ASTM D4959	(2016) Determination of Water (Moisture) Content of Soil by Direct Heating
ASTM D6938	(2017a) Standard Test Method for In-Place Density and Water Content of Soil and Soil-Aggregate by Nuclear Methods (Shallow Depth)
ASTM D75/D75M	(2014) Standard Practice for Sampling Aggregates
ASTM D977	(2013; E 2014) Emulsified Asphalt
ASTM E11	(2016) Standard Specification for Woven Wire Test Sieve Cloth and Test Sieves

1.3 DEFINITIONS

1.3.1 Lime-Modified Course

Lime-modified course, as used in this specification, is a mixture of lime and in-place or borrow material uniformly blended, wetted, and thoroughly compacted to produce a pavement course which meets the criteria set forth in the plans and this specification.

1.3.2 Degree of Compaction

Degree of compaction required is expressed as a percentage of the maximum density obtained by the test procedure presented in ASTM D1557abbreviated as percent laboratory maximum density.

1.4 SUBMITTALS

Government approval is required for submittals with a "G" designation; submittals not having a "G" designation are for information only. When used, a designation following the "G" designation identifies the office that will review the submittal for the Government.

SD-03 Product Data

Plant, Equipment, Machines, and Tools; G

Submit certified waybills and delivery tickets for all materials actually used. Submit copies of waybills or delivery tickets during the progress of the work. Before the final payment is allowed, waybills and certified delivery tickets shall be furnished for all lime and bituminous materials used in the construction.

SD-06 Test Reports

Sampling and Testing
Field Density

SD-07 Certificates

Bituminous Material.
Lime
Laboratory

1.5 ENVIRONMENTAL REQUIREMENTS

Do not work during freezing temperatures. When the temperature is below 40 degrees F, protect the completed modified materials against freezing by a sufficient covering of straw, or by other approved methods, until the course has dried out. Any areas of completed modified materials that are damaged by freezing, rainfall, or other weather conditions shall be brought to a satisfactory condition without additional cost to the Government. Do not apply lime when the atmospheric temperature is less than 40 degrees F or to soils that are frozen or contain frost, or when the underlying material is frozen. If the temperature falls below 35 degrees F completed lime-treated areas shall be protected against any detrimental effects of freezing.

PART 2 PRODUCTS

2.1 PLANT, EQUIPMENT, MACHINES, AND TOOLS

Submit list of proposed equipment to be used in performance of construction work including descriptive data.

2.1.1 General Requisites

Plant, equipment, machines, and tools used in the work shall be subject to approval and maintained in satisfactory working condition at all times. Other equipment may be used in lieu of that specified, where it can be demonstrated that the results are equivalent. Provide protective equipment, apparel, and barriers to protect the eyes, respiratory system, and the skin of workers exposed to contact with lime dust or slurry.

2.1.2 Steel-Wheeled Rollers

Steel wheeled rollers shall be the self propelled type. Unless otherwise provided, non-vibratory steel-wheel rollers shall be of the tandem or 3-wheel self-propelled type or steel-wheel trailer type weighing not less than 5 tons. When drive rolls or trailer type rolls produce a compressive force of not less than 200 pounds per linear inch of contact area, a roller weighing less than 5 tons may be used. Equip wheels of the rollers with adjustable scrapers. The use of vibratory rollers is optional.

2.1.3 Pneumatic-Tired Rollers

Pneumatic-tired rollers shall have 4 or more tires, inflated to a minimum pressure of 90 psi. The loading shall be equally distributed to all wheels, and the tires shall be uniformly inflated. Also provide pneumatic-tired towing equipment.

2.1.4 Tamping-Type Roller

The tamping type roller, under working conditions, shall have a minimum weight of 90 pounds per linear inch of length of drum and a minimum load on each sheeps-foot of 100 pounds per square inch of cross sectional area of the sheeps-foot in contact with the ground. Maximum area of the face of each sheeps-foot shall not be more than 12 square inches. The feet on the sheeps-foot roller shall project not less than 7 inches from the face of the drum, and the roller shall be equipped with teeth-cleaning devices. Space the feet in adjacent rows so that the distance from center to center of adjacent parallel rows is not less than 6 inches nor more than 11 inches. Individual drums of the roller shall not exceed 5 feet in width and shall oscillate independently. Roller and tractor for pulling shall travel at a speed of approximately 3 to 6 mph.

2.1.5 Mechanical Spreader

Mechanical spreader shall be self-propelled or attached to a propelling unit capable of moving the spreader and material truck. The device shall be steerable and shall have variable speeds forward and reverse. The spreader and propelling unit shall be carried on tracks, rubber tires, or drum-type steel rollers that will not disturb the underlying material. Provide a spreader containing a hopper, an adjustable screed, and outboard bumper rolls; designed to have a uniform, steady flow of material from the hopper; and capable of laying material without segregation, across the full width of the lane, to a uniform thickness and to a uniform loose density so that when compacted, the layer or layers conform to thickness and grade requirements indicated. The Contracting Officer may require a demonstration of the spreader prior to approving use in performance of the work.

2.1.6 Pulvimixer

The pulverizing and mixing equipment shall be self-propelled, four-wheel drive, and capable of pulverizing the soil in a single pass for the full depth to be stabilized. The mixing action shall be capable of uniformly blending and mixing the required lime content with the subgrade soil. The rotor shall be capable of up or down cutting. The rotor shall be equipped with tap-in, knock-out, bullet-type teeth.

2.1.7 Slurry Mixer/Distributor

Mix the lime with water in trucks with approved distributors and applied as a thin water suspension or slurry. Apply commercial lime slurry with a lime percentage not less than that applicable for the grade used. Attain the distribution of lime by successive passes over a measured section of subgrade until the proper amount of lime has been spread. The amount of lime spread shall be the amount required for mixing to the specified depth that will result in the percentage determined in the job mix formula. The distributor truck shall continually agitate the slurry to keep the mixture uniform.

2.1.8 Central Mixing Plant

A lime-slurry central mixing plant shall consist of a lime storage silo, water supply tank, lime and water metering devices, and a lime-water mixer. Provide storage tanks for lime-water slurry with mechanical agitation to maintain the lime-water slurry in suspension.

2.1.9 Sprinkling Equipment

Provide sprinkling equipment consisting of tank trucks, pressure distributors, or other approved equipment designed to apply controlled quantities of water uniformly over variable widths of surface.

2.1.10 Tampers

Provide tampers of an approved mechanical type, having sufficient weight and striking power to produce the compaction required.

2.1.11 Straightedge

Furnish and maintain at the site, in good condition, one 12 foot straightedge for use in the testing of the finished surface. Straightedge shall be made available for Government use. Straightedges shall be constructed of aluminum or other lightweight metal with blades of box or box-girder cross section with flat bottom reinforced to insure rigidity and accuracy. Straightedges shall have handles to facilitate movement on pavement.

2.2 MATERIALS

2.2.1 Lime

Submit copies of certified test data. Lime shall be a standard brand of quicklime or hydrated lime conforming to ASTM C977 and the following physical and chemical requirements. Sample lime in accordance with ASTM C50/C50M.

a. Gradation that 97 percent passes a No. 30 sieve and a minimum of 75 percent passes a No. 200 sieve.

b. Combined calcium oxide and magnesium oxide not less than 90 percent.

c. Lime does not exceed 5 percent Carbon Dioxide or 2 percent free moisture (taken at the point of manufacture).

2.2.2 Bituminous Material

Submit copies of certified test data. Material conforming to one of the following:

2.2.2.1 Emulsified Asphalt

ASTM D977, Type SS-1.

2.2.3 Material to be Modified

Material to be modified shall consist of borrow material. Provide material free of deleterious substances such as sticks, debris, organic matter, and stones greater than 3 inches in any dimension. At least 30 percent of the material shall pass the No. 40 sieve. Plasticity index shall be greater than 18.

2.2.4 Water

Water shall be clean, fresh, and free from injurious amounts of oil, acid, salt, alkali, organic matter, and other substances deleterious to the lime or soil-lime mixture, and shall be subject to approval. Water shall be tested and conform to the requirements of ASTM C1602/C1602M including the optional requirements of Table 2. Potable water sources may be used without testing.

2.3 STOCKPILING MATERIALS

Stockpile borrow material, including approved material available from excavation and grading, in the manner and at the locations designated. Before stockpiling material, clear storage sites and slope to drain. Separately stockpile materials obtained from different sources.

PART 3 EXECUTION

3.1 LIME MODIFICATION MIXTURE

The Contractor shall construct a working platform for new pavement construction by lime-modifying the subgrade soil. To accomplish this, the Contractor shall incorporate at least 6 percent hydrated lime by weight (based on oven-dry weight of the soil) or at least 4.5 percent granular quicklime by weight (based on the oven-dry weight of soil) to the subgrade. The subgrade soil shall be lime-modified to a minimum depth of at least 8-inches, or deeper if necessitated by conditions encountered and as approved by the Contracting Officer. The subgrade material to be modified shall be thoroughly pulverized and,when lime is applied in the dry state, the mix shall be thoroughly blended at a moisture content below optimum. After blending, water shall be added into the dry mix in amounts necessary to bring the moisture content to a minimum of 3 percent above optimum. Control field moisture content within plus 2 or minus 1 percent of optimum. When the modified course is constructed in more than one layer, clean the previously constructed layer of loose and foreign matter by sweeping with power sweeper or power brooms, except that hand brooms may be used in areas where power cleaning is not practicable. Provide adequate drainage during the entire construction period to prevent water from collecting or standing on the area to be modified or on pulverized, mixed, or partially mixed material. Provide line and grade stakes as necessary for control. Place grade stakes in lines parallel to the centerline of the area under construction and suitably spaced for string lining.

3.2 PREPARATION OF AREA TO BE MODIFIED

Clean the area of debris, roots, thrash, organic and other deleterious materials. The area will be inspected for adequate compaction and shall be capable of withstanding, without displacement, the compaction specified for the soil-lime mixture. Debris and removed unsatisfactory in-place material shall be disposed of as specified.

3.2.1 In-Place Material to be Modified

Grade the entire area to conform to the lines, grades, and cross sections shown in the drawings prior to being processed. Soft or yielding subgrade areas shall be made stable with bridging stone or additional lime as approved by the Contracting Officer before construction is begun. Unsatisfactory material shall be removed and replaced as directed by the Government.

3.2.2 Grade Control

Excavate underlying material to sufficient depth for the required modified-course thickness so that the finished modified course with the subsequent surface course will meet the fixed grade. Finished and completed treated area shall conform to the lines, grades, cross section, and dimensions indicated.

3.3 INSTALLATION

3.3.1 Mixed In-Place Method

3.3.1.1 Scarifying and Pulverizing of Soil

Prior to application of lime, the soil shall be scarified and pulverized to the depth shown. Scarification shall be controlled so that the layer beneath the layer to be treated is not disturbed. Depth of pulverizing shall not exceed the depth of scarification.

3.3.1.2 Application of Lime

Shape pulverized material to approximately the cross section indicated. Apply lime so that when uniformly mixed with the soil, the specified lime content is obtained, and a sufficient quantity of lime-treated soil is produced to construct a compacted lime-treated course conforming to the lines, grades, and cross section indicated. Lime shall be spread only on areas where the mixing operations can be completed during the same work shift or day. Use mechanical spreaders in applying bulk lime. Apply lime as a slurry, and use distributors in applying slurry. If lime is spread by hand, the bags shall be spotted accurately on the area being stabilized so that when the bags are opened the lime will be dumped and spread uniformly on the area being processed. Limit hand spreading to areas inaccessible to mechanical spreaders. No equipment, except that used in spreading and mixing, shall pass over the freshly applied lime.

3.3.1.3 Initial Mixing

Mix the lime and soil immediately after the lime has been distributed. Initial mixing shall be sufficient to alleviate any dusting or wetting of the lime that might occur in the event of wind or rainstorms. This may be accomplished several days in advance of the final application and mixing.

3.3.1.4 Water Application and Moist Mixing

Determine moisture content of the mixture in preparation for final mixing. Moisture in the mixture following final mixing shall not be less than the water content determined to be optimum based on dry weight of soil and shall not exceed the optimum water content by more than 2 percentage points. Water may be added in increments as large as the equipment will permit; however, such increment of water shall be partially incorporated in the mix to avoid concentration of water near the surface. After the last increment of water has been added, continue mixing until the water is uniformly distributed throughout the full depth of the mixture, including satisfactory moisture distribution along the edges of the section. Soil shall be mixed in two stages, allowing for an intervening 24 to 48 hour mellowing period. The modified mixture should mellow sufficiently to allow the chemical reaction to alter (break down) the material. The duration of this mellowing period shall be identified in the mix design and should be based on soil type. After mellowing, the soil shall be remixed before compaction.

3.3.1.5 Confined Areas

In areas inaccessible to machinery, excavate soils to be modified and move to an area where machine mixing may be performed, processed, and placed back in the original location. Place material in its final location within 24 hours of initial mixing, and prior to final mixing and compaction.

3.3.2 Edges of Modified Course

Place approved material along the edges of the modified course in a quantity that will compact to the thickness of the course being constructed, or to the thickness of each layer in a multiple-layer course, allowing at least a 1 foot width of the shoulder to be rolled and compacted simultaneously with the rolling and compacting of each layer of the modified course.

3.3.3 Central-Plant Method

Provide a plant capable of producing a uniform lime-treated mixture at the specified lime and moisture contents. Haul the mixture to the job in trucks equipped with protective covers. Underlying course shall be thoroughly moistened and the mixture then placed on the prepared area in a uniform layer with mechanical spreaders. The layer shall be uniform in thickness and surface contour; and the completed layer, after compaction, shall conform to the required grade and cross section.

3.3.4 Traveling-Plant Method

Traveling plant shall move at a uniform rate of speed and shall accomplish thorough mixing of the materials in one pass. Deliver water and lime from supply trucks or bins at a predetermined rate. Windrows of prepared soil-lime mixture shall cover a predetermined width to the indicated compacted thickness.

3.3.5 Layer Thickness

Compacted thickness of the modified course shall be as indicated. No layer shall be more than 8 inches or less than 3 inches in compacted thickness.

3.3.6 Compaction

Before compaction operations are started and as a continuation of the mixing operation, the mixture shall be thoroughly loosened and pulverized to the full depth. Start compaction immediately after final mixing is completed. During final compaction moisten the surface, if necessary, and shape it to the required lines, grades, and cross section. Density of compacted mixture shall be at least 92 percent of laboratory maximum density. Begin rolling at the outside edge of the surface and proceed to the center, overlapping on successive trips at least one-half the width of the roller. Make alternate trips of the roller slightly different lengths. At all times, the speed of the roller shall not cause displacement of the mixture to occur. Compact areas inaccessible to the rollers with mechanical tampers; shape and finish the areas by hand methods.

3.3.7 Finishing

Finish the surface of the top layer to the grade and cross section shown.

The surface shall be of uniform texture. Light blading during rolling may be necessary for the finished surface to conform to the lines, grades, and cross sections. If for any reason the surface becomes rough, corrugated, uneven in texture, or traffic-marked prior to completion, the unsatisfactory portions shall be scarified, reworked, relaid, or replaced as directed. If any portion of the course, when laid, becomes watersoaked for any reason, that portion shall be removed immediately, and the mix placed in a windrow and aerated until a moisture content within the limits specified is obtained; and then spread, shaped, and rolled as specified above.

3.3.8 Construction Joints

At the end of each phase of construction, form a straight transverse construction joint by cutting back into the completed work to form a true vertical face free of loose or shattered material. Material along construction joints not properly compacted shall be removed and replaced with soil-lime mixture that is mixed, moistened, and compacted as specified.

3.3.9 Curing and Protection

Immediately after the soil-lime area has been finished as specified above, the surface shall be protected against rapid drying for 7 days by the application of a bituminous material.

Uniformly apply bituminous material by means of a bituminous distributor within a temperature range of 70 to 160 degrees F for SS-1, and 110 to 160 degrees F for RS-2. Bituminous material shall be applied in quantities of not less than 0.1 gallon/square yard nor more than 0.25 gallon/square yard. Areas inaccessible to or missed by the distributor shall be properly treated using the manually operated hose attachment. Apply bituminous material only to the top layer. At the time the bituminous material is applied, the surface of the area shall be free of loose or foreign matter and shall contain sufficient moisture to prevent excessive penetration of the bituminous material. When necessary, sprinkle the area immediately before the bituminous material is applied. Treated surface shall be sanded to prevent the bituminous material from being picked up by traffic.

3.4 SAMPLING AND TESTING

Submit calibration curves and related test results prior to using the device or equipment being calibrated. Furnish copies of field test results within 24 hours after the tests are performed. Submit certified copies of test results of materials and sources not less than 30 days before material is required for the work.

3.4.1 General Requirements

Perform sampling and testing using an approved commercial testing laboratory or facilities furnished by the Contractor. Work requiring testing will not be permitted until the facilities have been inspected and approved. The first inspection will be at the expense of the Contractor. Cost incurred for any subsequent inspection required because of failure of the facilities to pass the first inspection will be charged to the Contractor. Perform tests in sufficient numbers and at the locations and times directed to ensure that materials and compaction meet specified requirements. Furnish certified copies of the test results to the Contracting Officer within 24 hours of completion.

3.4.2 Results

Results shall verify that the material complies with the specification. Whendeficiencies are found, repeat the initial analysis including mix design studies if the material source is changed, and retest the material already placed to determine the extent of unacceptable material. Replace all in-place unacceptable material.

3.4.3 Sampling

Take all aggregate samples for laboratory testing in accordance with ASTM D75/D75M. Take samples of lime in accordance with ASTM C50/C50M. Prepare specimens for the unconfined compression tests in accordance with ASTM D1632.

3.4.4 Sieve Analysis

Before starting work, test one sample of material to be modified in accordance with ASTM C136/C136M on sieves conforming to ASTM E11. After the initial test, perform a minimum of one analysis for each 1000 tons of material placed, with a minimum of three analyses for each day's run until the course is completed.

3.4.5 Liquid Limit and Plasticity Index

Perform one liquid limit and plasticity index for each sieve analysis. Liquid limit and plasticity index shall be in accordance with ASTM D4318.

3.4.6 Chemical Analysis

Test lime for the specified chemical requirements in accordance with ASTM C25.

3.5 FIELD QUALITY CONTROL

Determine the laboratory maximum dry density and optimum moisture for the existing subgrade soil and for the lime-soil mixture in accordance with ASTM D1557. Results of field quality control testing shall verify that materials comply with this specification. When deficiencies are found, the initial analysis shall be repeated and the material already placed shall be retested to determine the extent of unacceptable material. All in-place unacceptable material shall be replaced or repaired, as directed by the Contracting Officer, at no additional cost to the Government.

3.5.1 Treatment Depth Checks

The depth of stabilization shall be measured at a frequency of at least one test every 1000 square yards of lime-modified subgrade. Measurements shall be made in test holes soil by spraying with a pH indicator such as phenolphthalein. Phenolphthalein changes from clear to red between pH 8.3 and 10. The color change indicates the location of the bottom of the mixing zone. Other pH indicators can measure higher pH levels if there is reason to suspect that inadequate lime has been mixed into the soil.

3.5.2 Thickness Control

Completed thicknesses of the modified course shall be within 1/2 inch of the thickness indicated. Where the measured thickness of the modified course is more than 1/2 inch deficient, correct such areas by scarifying, adding mixture of proper gradation, reblading, and recompacting as directed. Where the measured thickness of the modified course is more than 1/2 inch thicker than indicated, it shall be considered as conforming to the specified thickness requirement. Average job thickness shall be the average of all thickness measurements taken for the job, but shall be within 1/4 inch of the thickness indicated. Thickness of the modified course shall be measured at intervals which ensure one measurement for each 1000 square yards of modified course. Measurements shall be made in 3 inch diameter test holes penetrating the modified course.

3.5.3 Field Density

Determine field in-place density in accordance with ASTM D1556/D1556M or ASTM D6938. When ASTM D6938 is used, the calibration curves shall be checked, and adjusted if necessary, using the sand cone method as described in paragraph Calibration of the ASTM publication. ASTM D6938 may be used to determine both the wet unit weight and the moisture content of the soil. The calibration curves furnished with the moisture gauges shall be checked along with density calibration checks as described in ASTM D6938. Both ASTM D1556/D1556M and ASTM D6938 result in a wet unit weight of soil and when using either of these methods, use only method ASTM D2216 to determine the moisture content for calculating in-place dry density of the soil. For a rough estimate of in-place density to control field activities only, the Contractor may perform moisture content testing by method ASTM D4643 or ASTM D4959 in conjunction with density testing by method ASTM D6938. If ASTM D6938 is used, in-place densities shall be checked by ASTM D1556/D1556M at least once per lift and at a frequency not to exceed one test under ASTM D1556/D1556M per 6 tests performed under ASTM D6938. Furnish calibration curves and calibration tests results to the Contracting Officer within 24 hours of conclusion of the tests. Perform at least one field density test for each 1000 square yards of each layer of modified material.

3.5.4 Smoothness Test

The surface of a modified layer shall show no deviations in excess of 1/2 inch when tested with the 12- foot straightedge. Deviations exceeding this amount shall be corrected by removing material and replacing with new material, or by reworking existing material and compacting, as directed. Take measurements for deviation from grade and cross section shown in successive positions parallel to the pavement centerline with a 12- foot straightedge. Measurements shall also be taken perpendicular to the pavement centerline at 50-foot intervals.

3.6 TRAFFIC

Completed portions of the lime-treated soil area may be opened to light traffic after a period of 3 days if cured with a bituminous material provided the curing is not damaged. After the curing period has elapsed, completed areas may be opened to all traffic, provided the modified course has hardened sufficiently to prevent marring or distorting of the surface by equipment or traffic. Heavy equipment is not permitted on the area during the curing period. Protect finished portions of lime-modified soil, that are traveled on by equipment used in constructing an adjoining section, in a manner to prevent equipment from marring or damaging completed work.

3.7 MAINTENANCE

Maintain modified area in a satisfactory condition until the completed work is accepted. Maintenance shall include immediate repairs of any defects and shall be repeated as often as necessary to keep the area intact. Correct defects as specified herein.

3.8 DISPOSAL OF UNSATISFACTORY MATERIALS

Dispose of removed in-place materials that are unsuitable for stabilization, material that is removed for the required correction of defective areas, waste material, and debris in accordance with specification Section 31 00 00 EARTHWORK.

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BITUMINOUS TACK COATS
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PART 1 GENERAL

1.1 REFERENCES

The publications listed below form a part of this specification to the extent referenced. The publications are referred to within the text by the basic designation only.

AMERICAN ASSOCIATION OF STATE HIGHWAY AND TRANSPORTATION OFFICIALS (AASHTO)

AASHTO T 102	(2009; R 2013) Standard Method of Test for Spot Test of Asphaltic Materials
AASHTO T 40	(2002; R 2006) Sampling Bituminous Materials

ASTM INTERNATIONAL (ASTM)

ASTM D140/D140M	(2016) Standard Practice for Sampling Asphalt Materials
ASTM D2397/D2397M	(2013) Standard Specification for Cationic Emulsified Asphalt
ASTM D2995	(1999; R 2009) Determining Application Rate of Bituminous Distributors
ASTM D977	(2013; E 2014) Emulsified Asphalt

1.2 SUBMITTALS

Government approval is required for submittals with a "G" designation; submittals not having a "G" designation are for information only. When used, a designation following the "G" designation identifies the office that will review the submittal for the Government. Submit the following in accordance with Section 01 33 00 SUBMITTAL PROCEDURES:

SD-06 Test Reports

Sampling and Testing

Copies of all test results for emulsified asphalt, and bituminous materials, within 24 hours of completion of tests. Certified copies of the manufacturer's test reports indicating temperature viscosity relationship for cutback asphalt, compliance with applicable specified requirements, not less than 30 days before the material is required in the work.

1.3 DELIVERY, STORAGE, AND HANDLING

Inspect the materials delivered to the site for contamination and damage. Unload and store the materials with a minimum of handling.

1.4 ENVIRONMENTAL REQUIREMENTS

Apply bituminous coat only when the surface to receive the bituminous coat is dry. Apply bituminous coat only when the atmospheric temperature in the shade is 50 degrees F or above and when the temperature has not been below 35 degrees F for the 12 hours prior to application, unless otherwise directed.

PART 2 PRODUCTS

2.1 PLANT, EQUIPMENT, MACHINES AND TOOLS

Plant, equipment, machines and tools used in the work are subject to approval and must be maintained in a satisfactory working condition at all times. Calibrated equipment such as asphalt distributors, scales, batching equipment, spreaders and similar equipment, must have been recalibrated by a calibration laboratory within 12 months prior to commencing work and every 6 months thereafter, by such laboratory from the date of recalibration, during the term of the contract.

2.1.1 Bituminous Distributor

Provide a distributor with pneumatic tires of such size and number that the load produced on the base surface does not exceed 650 psi of tire width to prevent rutting, shoving or otherwise damaging the base surface or other layers in the pavement structure. Design and equip the distributor to spray the bituminous material in a uniform coverage at the specified temperature, at readily determined and controlled rates from 0.05 to 2.0 gallons per square yard, with a pressure range of 25 to 75 psi and with an allowable variation from the specified rate of not more than plus or minus 5 percent, and at variable widths. Include with the distributor equipment a separate power unit for the bitumen pump, full-circulation spray bars, tachometer, pressure gauges, volume-measuring devices, adequate heaters for heating of materials to the proper application temperature, a thermometer for reading the temperature of tank contents, and a hand hose attachment suitable for applying bituminous material manually to areas inaccessible to the distributor. Equip the distributor to circulate and agitate the bituminous material during the heating process.

2.1.2 Heating Equipment for Storage Tanks

The equipment for heating the bituminous material shall be steam, electric, or hot oil heaters. Provide steam heaters consisting of steam coils and equipment for producing steam, so designed that the steam cannot get into the material. Fix an armored thermometer to the tank with a temperature range from 40 to 400 degrees F so that the temperature of the bituminous material may be determined at all times.

2.1.3 Power Brooms and Power Blowers

Use power brooms and power blowers suitable for cleaning the surfaces to which the bituminous coat is to be applied.

2.2 TACK COAT

2.2.1 Emulsified Asphalt

Provide emulsified asphalt conforming to ASTM D977, Type SS-1 or SS1h ASTM D2397/D2397M, Type CSS-1 or CSS-1h. Dilute the emulsified asphalt with equal parts of water. The base asphalt used to manufacture the emulsion shall show a negative spot when tested in accordance with AASHTO T 102 using standard naphtha.

PART 3 EXECUTION

3.1 PREPARATION OF SURFACE

Immediately before applying the bituminous coat, remove all loose material, dirt, clay, or other objectionable material from the surface to be treated by means of a power broom or blower supplemented with hand brooms. The surface shall be dry and clean at the time of treatment.

3.2 APPLICATION RATE

The exact quantities within the range specified, which may be varied to suit field conditions, will be determined by the Contracting Officer.

3.2.1 Tack Coat

Apply bituminous material for the tack coat in quantities of not less than 0.05 gallon nor more than 0.15 gallon per square yard of pavement surface.

3.3 APPLICATION TEMPERATURE

3.3.1 Viscosity Relationship

Asphalt application temperature shall provide an application viscosity between 10 and 60 seconds, Saybolt Furol, or between 20 and 120 centistokes, kinematic. Furnish the temperature viscosity relation to the Contracting Officer.

3.3.2 Temperature Ranges

The viscosity requirements determine the application temperature to be used. The following is a normal range of application temperatures:

Emulsions	Degrees F
SS-1	70-160
SS-1h	70-160
CSS-1	70-160
CSS-1h	70-160

3.4 APPLICATION

3.4.1 General

Following preparation and subsequent inspection of the surface, apply the bituminous tack coat with the Bituminous Distributor at the specified rate with uniform distribution over the surface to be treated. Properly treat all areas and spots missed by the distributor with the hand spray. Until the succeeding layer of pavement is placed, maintain the surface by protecting the surface against damage and by repairing deficient areas at no additional cost to the Government. If required, spread clean dry sand to effectively blot up any excess bituminous material. No smoking, fires, or flames other than those from the heaters that are a part of the equipment are permitted within 25 feet of heating, distributing, and transferring operations of bituminous material other than bituminous emulsions. Prevent all traffic, except for paving equipment used in constructing the surfacing, from using the underlying material, whether primed or not, until the surfacing is completed. The bituminous coat shall conform to all requirements as described herein.

3.4.2 Tack Coat

Apply tack coat at the locations shown on the drawings. Apply the tack coat when the surface to be treated is dry. Immediately following the preparation of the surface for treatment, apply the bituminous material by means of the bituminous distributor, within the limits of temperature specified herein and at a rate as specified above in paragraph APPLICATION RATE. Apply the bituminous material so that uniform distribution is obtained over the entire surface to be treated. Treat lightly coated areas and spots missed by the distributor with the bituminous material. Following the application of bituminous material, allow the surface to cure without being disturbed for period of time necessary to permit setting of the tack coat. Apply the bituminous tack coat only as far in advance of the placing of the overlying layer as required for that day's operation. Maintain and protect the treated surface from damage until the succeeding course of pavement is placed.

3.5 CURING PERIOD

Following application of the bituminous material and prior to application of the succeeding layer of pavement, allow the bituminous coat to cure and to obtain evaporation of any volatiles or moisture. Maintain the coated surface until the succeeding layer of pavement is placed, by protecting the surface against damage and by repairing and recoating deficient areas.

3.6 FIELD QUALITY CONTROL

Samples of the bituminous material shall be tested for compliance with the applicable specified requirements. A sample shall be obtained and tested by the Contractor for every 1,000 gallons, or fraction thereof, of bituminous material used.

3.7 SAMPLING AND TESTING

Submit copies of all test results for emulsified asphalt, and bituminous materials, within 24 hours of completion of tests. Perform sampling and testing by an approved commercial testing laboratory or by facilities furnished by the Contractor. No work requiring testing will be permitted until the facilities have been inspected and approved.

3.7.1 Sampling

The samples of bituminous material, unless otherwise specified, shall be in accordance with ASTM D140/D140M or AASHTO T 40. Sources from which bituminous materials are to be obtained shall be selected and notification furnished the Contracting Officer within 15 days after the award of the contract.

3.7.2 Calibration Test

Furnish all equipment, materials, and labor necessary to calibrate the bituminous distributor. Calibration shall be made with the approved job material and prior to applying the bituminous coat material to the prepared surface. Calibrate the bituminous distributor in accordance with ASTM D2995.

3.7.3 Trial Applications

Before providing the complete bituminous coat, apply three lengths of at least 100 feet for the full width of the distributor bar to evaluate the amount of bituminous material that can be satisfactorily applied.

3.7.3.1 Tack Coat Trial Application Rate

Unless otherwise authorized, apply the trial application rate of bituminous tack coat materials in the amount of 0.05 gallons per square yard. Other trial applications shall be made using various amounts of material as may be deemed necessary.

3.7.4 Sampling and Testing During Construction

Perform quality control sampling and testing as required in paragraph FIELD QUALITY CONTROL.

3.8 TRAFFIC CONTROLS

Keep traffic off surfaces freshly treated with bituminous material. Provide sufficient warning signs and barricades so that traffic will not travel over freshly treated surfaces.

-- End of Section --

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HOT-MIX ASPHALT (HMA) FOR ROADS

08/09

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SECTION 32 12 16

HOT-MIX ASPHALT (HMA) FOR ROADS
08/09

PART 1 GENERAL

1.1 REFERENCES

The publications listed below form a part of this specification to the extent referenced. The publications are referred to within the text by the basic designation only.

AMERICAN ASSOCIATION OF STATE HIGHWAY AND TRANSPORTATION OFFICIALS (AASHTO)

AASHTO M 156	(2013; R 2017) Standard Specification for Requirements for Mixing Plants for Hot-Mixed, Hot-Laid Bituminous Paving Mixtures
AASHTO M 320	(2017) Standard Specification for Performance-Graded Asphalt Binder
AASHTO T 304	(2011; R 2015) Standard Method of Test for Uncompacted Void Content of Fine Aggregate

ASPHALT INSTITUTE (AI)

AI MS-2	(2015) Asphalt Mix Design Methods

ASTM INTERNATIONAL (ASTM)

ASTM C117	(2017) Standard Test Method for Materials Finer than 75-um (No. 200) Sieve in Mineral Aggregates by Washing
ASTM C127	(2015) Standard Test Method for Density, Relative Density (Specific Gravity), and Absorption of Coarse Aggregate
ASTM C128	(2015) Standard Test Method for Density, Relative Density (Specific Gravity), and Absorption of Fine Aggregate
ASTM C131/C131M	(2014) Standard Test Method for Resistance to Degradation of Small-Size Coarse Aggregate by Abrasion and Impact in the Los Angeles Machine
ASTM C136/C136M	(2014) Standard Test Method for Sieve Analysis of Fine and Coarse Aggregates
ASTM C142/C142M	(2017) Standard Test Method for Clay Lumps and Friable Particles in Aggregates

ASTM C29/C29M	(2017a) Standard Test Method for Bulk Density ("Unit Weight") and Voids in Aggregate
ASTM C566	(2013) Standard Test Method for Total Evaporable Moisture Content of Aggregate by Drying
ASTM C88	(2013) Standard Test Method for Soundness of Aggregates by Use of Sodium Sulfate or Magnesium Sulfate
ASTM D140/D140M	(2016) Standard Practice for Sampling Asphalt Materials
ASTM D1461	(2017) Standard Test Method for Moisture or Volatile Distillates in Asphalt Mixtures
ASTM D2172/D2172M	(2017; E 2018) Standard Test Methods for Quantitative Extraction of Asphalt Binder from Asphalt Mixtures
ASTM D2419	(2014) Sand Equivalent Value of Soils and Fine Aggregate
ASTM D242/D242M	(2009; R 2014) Mineral Filler for Bituminous Paving Mixtures
ASTM D2489/D2489M	(2016) Standard Test Method for Estimating Degree of Particle Coating of Asphalt Mixtures
ASTM D2950/D2950M	(2014) Density of Bituminous Concrete in Place by Nuclear Methods
ASTM D3665	(2012; R 2017) Standard Practice for Random Sampling of Construction Materials
ASTM D3666	(2016) Standard Specification for Minimum Requirements for Agencies Testing and Inspecting Road and Paving Materials
ASTM D4125/D4125M	(2010) Asphalt Content of Bituminous Mixtures by the Nuclear Method
ASTM D4791	(2010) Flat Particles, Elongated Particles, or Flat and Elongated Particles in Coarse Aggregate
ASTM D4867/D4867M	(2009; R 2014) Effect of Moisture on Asphalt Concrete Paving Mixtures
ASTM D5444	(2015) Mechanical Size Analysis of Extracted Aggregate
ASTM D546	(2017) Standard Test Method for Sieve Analysis of Mineral Filler for Asphalt Paving Mixtures

ASTM D6307	(2016) Standard Test Method for Asphalt Content of Hot Mix Asphalt by Ignition Method
ASTM D6926	(2016) Standard Practice for Preparation of Asphalt Mixture Specimens Using Marshall Apparatus
ASTM D6927	(2015) Standard Test Method for Marshall Stability and Flow of Bituminous Mixtures

STATE OF CALIFORNIA DEPARTMENT OF TRANSPORTATION (CALTRANS)

CDT SS 39	(2015) Standard Specifications, SECTION 39: HOT MIX ASPHALT
CTM 526	(2012) Methof of Test for Operation of California Profilograph and Evaluation of Profiles

U.S. ARMY CORPS OF ENGINEERS (USACE)

COE CRD-C 171	(1995) Standard Test Method for Determining Percentage of Crushed Particles in Aggregate

1.1.1 STATE SPECIFICATIONS

CALIFORNIA DEPARTMENT OF TRANSPORTATION (Caltrans), STANDARD SPECIFICATIONS, 2015 edition (including all subsequent supplements and updates), are referred to herein as State Specifications. Paragraphs pertaining to measurement and payment in the State Specifications shall not be used. References to State or Engineer shall be understood to be the Contracting Officer. The State Specifications form a part of this specification only to the extent referenced.

1.2 SUBMITTALS

Government approval is required for submittals with a "G" designation; submittals not having a "G" designation are for information only. When used, a designation following the "G" designation identifies the office that will review the submittal for the Government. Submit the following in accordance with Section 01 33 00 SUBMITTAL PROCEDURES:

SD-03 Product Data

Mix Design; G

Quality Control; G

Material Acceptance; G

SD-04 Samples

Asphalt Cement Binder

Aggregates

SD-06 Test Reports

Aggregates tests; G

QC Monitoring

SD-07 Certificates

Asphalt Cement Binder; G

Testing Laboratory

1.3 ENVIRONMENTAL REQUIREMENTS

Do not place the hot-mix asphalt upon a wet surface or when the surface temperature of the underlying course is less than specified in Table 3. The temperature requirements may be waived by the Contracting Officer, if requested; however, meet all other requirements, including compaction.

Table 3. Surface Temperature Limitations of Underlying Course

Mat Thickness, inches	Degrees F
3 or greater	40
Less than 3	45

PART 2 PRODUCTS

2.1 SYSTEM DESCRIPTION

Perform the work consisting of pavement courses composed of mineral aggregate and asphalt material heated and mixed in a central mixing plant and placed on a prepared course. HMA designed and constructed in accordance with this section shall conform to the lines, grades, thicknesses, and typical cross sections indicated. Construct each course to the depth, section, or elevation required by the drawings and roll, finish, and approve it before the placement of the next course.

2.1.1 Asphalt Mixing Plant

Plants used for the preparation of hot-mix asphalt shall conform to the requirements of AASHTO M 156, includng additional plant requirements specified herein. The plant shall be a batch type, continuous mix type or drum-dryer mixer type, and shall have sufficient capacity to handle the new bituminous construction. Minimum plant capacity shall be 100 tons per hour. The mixing plant and equipment shall remain accessible at all times for inspecting operation, verifying weights, proportions and character of materials, and checking mixture temperatures.

2.1.1.1 Truck Scales

Weigh the asphalt mixture on approved, certified scales at the Contractor's expense. Inspect and seal scales at least annually by an approved calibration laboratory.

2.1.1.2 Testing Facilities

Provide laboratory facilities at the plant for the use of the Government's acceptance testing and the Contractor's quality control testing.

2.1.1.3 Inspection of Plant

Provide the Contracting Officer with access at all times, to all areas of the plant for checking adequacy of equipment; inspecting operation of the plant; verifying weights, proportions, and material properties; checking the temperatures maintained in the preparation of the mixtures and for taking samples. Provide assistance as requested, for the Government to procure any desired samples.

2.1.1.4 Storage bins

Use of storage bins for temporary storage of hot-mix asphalt will be permitted as follows:

a. The asphalt mixture may be stored in non-insulated storage bins for a period of time not exceeding 3 hours.

b. The asphalt mixture may be stored in insulated storage bins for a period of time not exceeding 8 hours. The mix drawn from bins shall meet the same requirements as mix loaded directly into trucks.

2.1.2 Hauling Equipment

Provide trucks for hauling hot-mix asphalt having tight, clean, and smooth metal beds. To prevent the mixture from adhering to them, the truck beds shall be lightly coated with a minimum amount of paraffin oil, lime solution, or other approved material. Petroleum based products shall not be used as a release agent. Each truck shall have a suitable cover to protect the mixture from adverse weather. When necessary to ensure that the mixture will be delivered to the site at the specified temperature, truck beds shall be insulated or heated and covers (tarps) shall be securely fastened.

2.1.3 Asphalt Pavers

Provide asphalt pavers which are self-propelled, with an activated screed, heated as necessary, and capable of spreading and finishing courses of hot-mix asphalt which will meet the specified thickness, smoothness, and grade. The paver shall have sufficient power to propel itself and the hauling equipment without adversely affecting the finished surface.

2.1.3.1 Receiving Hopper

Provide paver with a receiving hopper of sufficient capacity to permit a uniform spreading operation and equipped with a distribution system to place the mixture uniformly in front of the screed without segregation. The screed shall effectively produce a finished surface of the required evenness and texture without tearing, shoving, or gouging the mixture.

2.1.3.2 Automatic Grade Controls

Equip the paver with a control system capable of automatically maintaining the specified screed elevation. The control system shall be automatically actuated from either a reference line and/or through a system of mechanical sensors or sensor-directed mechanisms or devices which will maintain the paver screed at a predetermined transverse slope and at the proper elevation to obtain the required surface. The transverse slope controller shall be capable of maintaining the screed at the desired slope within plus or minus 0.1 percent. A transverse slope controller shall not be used to control grade. Provide controls capable of working in conjunction with any of the following attachments:

a. Ski-type device of not less than 30 feet in length.

b. Taut stringline set to grade.

c. Short ski or shoe for joint matching.

d. Laser control.

2.1.4 Rollers

Rollers shall be in good condition and shall be operated at slow speeds to avoid displacement of the asphalt mixture. The number, type, and weight of rollers shall be sufficient to compact the mixture to the required density while it is still in a workable condition. Do not use equipment which causes excessive crushing of the aggregate.

2.2 AGGREGATES

Provide aggregates consisting of crushed stone, crushed gravel, crushed slag, screenings, natural sand and mineral filler, as required. Submit sufficient materials to produce 200 lb of blended mixture for mix design verification. The portion of material retained on the No. 4 sieve is coarse aggregate. The portion of material passing the No. 4 sieve and retained on the No. 200 sieve is fine aggregate. The portion passing the No. 200 sieve is defined as mineral filler. Submit all aggregate test results and samples to the Contracting Officer at least 14 days prior to start of construction.

2.2.1 Coarse Aggregate

Provide coarse aggregate consisting of sound, tough, durable particles, free from films of material that would prevent thorough coating and bonding with the asphalt material and free from organic matter and other deleterious substances. All individual coarse aggregate sources shall meet the following requirements:

a. The percentage of loss shall not be greater than 40 percent after 500 revolutions when tested in accordance with ASTM C131/C131M.

b. The percentage of loss shall not be greater than 18 percent after five cycles when tested in accordance with ASTM C88 using magnesium sulfate or 12 percent when using sodium sulfate.

c. At least 75 percent by weight of coarse aggregate shall have at least two or more fractured faces when tested in accordance with COE CRD-C 171. Fractured faces shall be produced by crushing.

d. The particle shape shall be essentially cubical and the aggregate shall not contain more than 20 percent percent, by weight, of flat and elongated particles (3:1 ratio of maximum to minimum) when tested in accordance with ASTM D4791.

e. Slag shall be air-cooled, blast furnace slag, with a compacted weight of not less than 75 lb/cu ft when tested in accordance with ASTM C29/C29M.

f. Clay lumps and friable particles shall not exceed 0.3 percent, by weight, when tested in accordance with ASTM C142/C142M.

2.2.2 Fine Aggregate

Fine aggregate shall consist of clean, sound, tough, durable particles free from coatings of clay, silt, or any objectionable material and containing no clay balls.

a. All individual fine aggregate sources shall have a sand equivalent value not less than 45 when tested in accordance with ASTM D2419.

b. The fine aggregate portion of the blended aggregate shall have an uncompacted void content not less than 45.0 percent when tested in accordance with AASHTO T 304 Method A.

c. The quantity of natural sand (noncrushed material) added to the aggregate blend shall not exceed 25 percent by weight of total aggregate.

d. Clay lumps and friable particles shall not exceed 0.3 percent, by weight, when tested in accordance with ASTM C142/C142M

2.2.3 Mineral Filler

Mineral filler shall be nonplastic material meeting the requirements of ASTM D242/D242M.

2.2.4 Aggregate Gradation

The combined aggregate gradation shall conform to gradations specified in Table 4, when tested in accordance with ASTM C136/C136M and ASTM C117, and shall not vary from the low limit on one sieve to the high limit on the adjacent sieve or vice versa, but grade uniformly from coarse to fine.

Table 4. Aggregate Gradations

Sieve Size, inch	Intermediate Course Gradation 2 Percent Passing by Mass	Surface Course Gradation 3 Percent Passing by Mass
1	---	---
3/4	100	---
1/2	76-96	100
3/8	69-89	76-96
No. 4	53-73	58-78

Table 4. Aggregate Gradations

Sieve Size, inch	Intermediate Course Gradation 2 Percent Passing by Mass	Surface Course Gradation 3 Percent Passing by Mass
No. 8	38-60	40-60
No. 16	26-48	28-48
No. 30	18-38	18-38
No. 50	11-27	11-27
No. 100	6-18	6-18
No. 200	3-6	3-6

2.3 ASPHALT CEMENT BINDER

Submit a 5 gallon sample for mix design verification. Asphalt cement binder shall conform to AASHTO M 320 Performance Grade (PG) 64-10. Test data indicating grade certification shall be provided by the supplier at the time of delivery of each load to the mix plant. Submit copies of these certifications to the Contracting Officer. The supplier is defined as the last source of any modification to the binder. The Contracting Officer may sample and test the binder at the mix plant at any time before or during mix production. Obtain samples for this verification testing in accordance with ASTM D140/D140M and in the presence of the Contracting Officer. Furnish these samples to the Contracting Officer for the verification testing, which shall be at no cost to the Contractor. Submit samples of the asphalt cement specified for approval not less than 14 days before start of the test section. Submit copies of certified test data, amount, type and description of any modifiers blended into the asphalt cement binder.

2.4 MIX DESIGN

a. Develop the mix design. The asphalt mix shall be composed of a mixture of well-graded aggregate, mineral filler if required, and asphalt material. The aggregate fractions shall be sized, handled in separate size groups, and combined in such proportions that the resulting mixture meets the grading requirements of the job mix formula (JMF). Submit proposed JMF; do not produce hot-mix asphalt for payment until a JMF has been approved. The hot-mix asphalt shall be designed in accordance with Marshall (MS-02)procedures and the criteria shown in Table 5. Use the hand-held hammer to compact the specimens for Marshall mix design. If the Tensile Strength Ratio (TSR) of the composite mixture, as determined by ASTM D4867/D4867M is less than 75, the aggregates shall be rejected or the asphalt mixture treated with an approved anti-stripping agent. The amount of anti-stripping agent added shall be sufficient to produce a TSR of not less than 75. Provide an antistrip agent, if required, at no additional cost. Sufficient materials to produce 200 pound of blended mixture shall be provided to the Contracting Officer for verification of mix design at least 14 days prior to construction of test section.

b. At the Contractor's election, a currently used DOT hot mix design as specified herein may be used. Asphalt concrete shall conform to State Specification CDT SS 39 HOT MIX ASPHALT, Type A.

c. In lieu of Table 4 Gradation, aggregate for asphalt concrete may conform to State Specification CDT SS 39 HOT MIX ASPHALT, aggregates for surface course shall be per Caltrans Section 39-2.02B(4)(b) Type A ½" Mix, and that intermediate course shall be ¾" Mix or ½" Mix ..

2.4.1 JMF Requirements

Submit in writing the job mix formula for approval at least 14 days prior to the start of the test section including as a minimum:

a. Percent passing each sieve size.

b. Percent of asphalt cement.

c. Percent of each aggregate and mineral filler to be used.

d. Asphalt viscosity grade, penetration grade, or performance grade.

e. Number of blows of hand-held hammer per side of molded specimen.

f. Laboratory mixing temperature.

g. Lab compaction temperature.

h. Temperature-viscosity relationship of the asphalt cement.

i. Plot of the combined gradation on the 0.45 power gradation chart, stating the nominal maximum size.

j. Graphical plots of stability), air voids, voids in the mineral aggregate, and unit weight versus asphalt content as shown in AI MS-2.

k. Specific gravity and absorption of each aggregate.

l. Percent natural sand.

m. Percent particles with 2 or more fractured faces (in coarse aggregate).

n. Fine aggregate angularity.

po. Percent flat or elongated particles (in coarse aggregate).

p. Tensile Strength Ratio(TSR).

q. Antistrip agent (if required) and amount.

r. List of all modifiers and amount.

r. Correlation of hand-held hammer with mechanical hammer.

Table 5. Mix Design Criteria	
Test Property	50 Blows
Stability, pounds, minimum (NA for Superpave)	*1350
Flow, 0.01 inch, (NA for Superpave)	8-18
Air voids, percent	3-5
Percent Voids in mineral aggregate (VMA),(minimum)	
Gradation 2	14.0
Gradation 3	15.0
TSR, minimum percent	75
* This is a minimum requirement. The average during construction shall be significantly higher than this number to ensure compliance with the specifications.	
** Calculate VMA in accordance with AI MS-2, based on ASTM C127 and ASTM C128 bulk specific gravity for the aggregate.	

2.4.2 Adjustments to Field JMF

Keep the Laboratory JMF for each mixture in effect until a new formula is approved in writing by the Contracting Officer. Should a change in sources of any materials be made, perform a new laboratory jmf design and a new JMF approved before the new material is used. The Contractor will be allowed to adjust the Laboratory JMF within the limits specified below to optimize mix volumetric properties with the approval of the Contracting Officer. Adjustments to the Laboratory JMF shall be applied to the field (plant) established JMF and limited to those values as shown. Adjustments shall be targeted to produce or nearly produce 4 percent voids total mix (VTM).

TABLE 6. Field (Plant) Established JMF Tolerances	
Sieves	Adjustments (plus or minus), percent
1/2 inch	3
No. 4	3
No. 8	3
No. 200	1
Binder Content	0.4

If adjustments are needed that exceed these limits, develop a new mix design. Tolerances given above may permit the aggregate grading to be outside the limits shown in Table 4; while not desirable, this is acceptable, except for the No. 200 sieve, which shall remain within the aggregate grading of Table 4.

PART 3 EXECUTION

3.1 PREPARATION OF ASPHALT BINDER MATERIAL

Heat the asphalt cement material avoiding local overheating and providing a continuous supply of the asphalt material to the mixer at a uniform temperature. The temperature of unmodified asphalts shall be no more than 325 degrees F when added to the aggregates. Performance-Graded (PG) asphalts shall be within the temperature range of 265 - 320 degrees F when added to the aggregate.

3.2 PREPARATION OF MINERAL AGGREGATE

Heat and dry the aggregate for the mixture prior to mixing. No damage shall occur to the aggregates due to the maximum temperature and rate of heating used. The temperature of the aggregate and mineral filler shall not exceed 350 degrees F when the asphalt cement is added. The temperature shall not be lower than is required to obtain complete coating and uniform distribution on the aggregate particles and to provide a mixture of satisfactory workability.

3.3 PREPARATION OF HOT-MIX ASPHALT MIXTURE

The aggregates and the asphalt cement shall be weighed or metered and introduced into the mixer in the amount specified by the JMF. Mix the combined materials until the aggregate obtains a uniform coating of asphalt binder and is thoroughly distributed throughout the mixture. Wet mixing time shall be the shortest time that will produce a satisfactory mixture, but no less than 25 seconds for batch plants. Establish the wet mixing time for all plants based on the procedure for determining the percentage of coated particles described in ASTM D2489/D2489M, for each individual plant and for each type of aggregate used. The wet mixing time will be set to at least achieve 95 percent of coated particles. The moisture content of all hot-mix asphalt upon discharge from the plant shall not exceed 0.5 percent by total weight of mixture as measured by ASTM D1461.

3.4 PREPARATION OF THE UNDERLYING SURFACE

Immediately before placing the hot mix asphalt, clean the underlying course of dust and debris. Apply a tack coat in accordance with the contract specifications.

3.5 Spraying of Contact Surfaces

Spray contact surfaces of previously constructed pavement with a thin coat of bituminous materials to act as an anti-stripping agent, conforming to Section 32 12 10 BITUMINOUS TACK COATS if applicable. Paint contact surfaces of structures with a thin coat of emulsion or other approved bituminous material prior to placing the bituminous mixture.

3.6 TEST SECTION

Prior to full production, place a test section for each JMF used. Construct a test section 250 - 500 feet long and two paver passes wide placed for two lanes, with a longitudinal cold joint. The test section shall be of the same thickness as the course which it represents. The underlying grade or pavement structure upon which the test section is to be constructed shall be the same as the remainder of the course represented by the test section. The equipment and personnel used in construction of the test section shall be the same equipment to be used on the remainder of the course represented by the test section. Place the test section as part of the project pavement, as approved by the Contracting Officer.

3.6.1 Sampling and Testing for Test Section

Take one random sample at the plant, triplicate specimens compacted, and tested for stability, flow, and laboratory air voids. Test a portion of the same sample for theoretical maximum density (TMD), aggregate gradation and asphalt content. Take four randomly selected cores from the finished pavement mat, and four from the longitudinal joint, and tested for density. Random sampling shall be in accordance with procedures contained in ASTM D3665. The test results shall be within the tolerances shown in Table 7 for work to continue. If all test results meet the specified requirements, the test section shall remain as part of the project pavement. If test results exceed the tolerances shown, the test section shall be removed and replaced at no cost to the Government and another test section shall be constructed. The test section shall be paid for with the first lot of paving

Table 7. Test Section Requirements for Material and Mixture Properties

Property	Specification Limit
Aggregate Gradation-Percent Passing (Individual Test Result)	
No. 4 and larger	JMF plus or minus 8
No. 8, No. 16, No. 30, and No. 50	JMF plus or minus 6
No. 100 and No. 200	JMF plus or minus 2.0
Asphalt Content, Percent (Individual Test Result)	JMF plus or minus 0.5
Laboratory Air Voids, Percent (Average of 3 specimens)	JMF plus or minus 1.0
VMA, Percent (Average of 3 specimens)	14 minimum
Stability, pounds (Average of 3 specimens)	1350 minimum for 50 blows
Flow, 0.01 inch (Average of 3 specimens) (NA for Superpave)	8 - 18 for 50 blows
Mat Density, Percent of TMD (Average of 4 Random Cores)	92.0 - 96.0

Table 7. Test Section Requirements for Material and Mixture Properties	
Property	Specification Limit
Joint Density, Percent of TMD (Average of 4 Random Cores)	90.5 - 92.5

3.6.2 Additional Test Sections

If the initial test section should prove to be unacceptable, make the necessary adjustments to the JMF, plant operation, placing procedures, and/or rolling procedures and place a second test section. Additional test sections, as required, shall be constructed and evaluated for conformance to the specifications. Full production shall not begin until an acceptable section has been constructed and accepted.

3.7 TESTING LABORATORY

Submit certification of compliance and Plant Scale Calibration Certification. Use a laboratory to develop the JMF that meets the requirements of ASTM D3666. The Government will inspect the laboratory equipment and test procedures prior to the start of hot mix operations for conformance to ASTM D3666. The laboratory shall maintain the Corps certification for the duration of the project. A statement signed by the manager of the laboratory stating that it meets these requirements or clearly listing all deficiencies shall be submitted to the Contracting Officer prior to the start of construction. The statement shall contain as a minimum:

a. Qualifications of personnel; laboratory manager, supervising technician, and testing technicians.

b. A listing of equipment to be used in developing the job mix.

c. A copy of the laboratory's quality control system.

d. Evidence of participation in the AASHTO Materials Reference Laboratory (AMRL) program.

3.8 TRANSPORTING AND PLACING

3.8.1 Transporting

Transport the hot-mix asphalt from the mixing plant to the site in clean, tight vehicles. Schedule deliveries so that placing and compacting of mixture is uniform with minimum stopping and starting of the paver. Provide adequate artificial lighting for night placements. Hauling over freshly placed material will not be permitted until the material has been compacted as specified, and allowed to cool to 140 degrees F. To deliver mix to the paver, use a material transfer vehicle operated to produce continuous forward motion of the paver.

3.8.2 Placing

Place and compact the mix at a temperature suitable for obtaining density, surface smoothness, and other specified requirements. Upon arrival, place the mixture to the full width by an asphalt paver; it shall be struck off in a uniform layer of such depth that, when the work is completed, it will have the required thickness and conform to the grade and contour indicated. Regulate the speed of the paver to eliminate pulling and tearing of the asphalt mat. Unless otherwise permitted, placement of the mixture shall begin along the centerline of a crowned section or on the high side of areas with a one-way slope. Place the mixture in consecutive adjacent strips having a minimum width of 10 feet. The longitudinal joint in one course shall offset the longitudinal joint in the course immediately below by at least 1 foot; however, the joint in the surface course shall be at the centerline of the pavement. Transverse joints in one course shall be offset by at least 10 feet from transverse joints in the previous course. Transverse joints in adjacent lanes shall be offset a minimum of 10 feet. On isolated areas where irregularities or unavoidable obstacles make the use of mechanical spreading and finishing equipment impractical, the mixture may be spread and luted by hand tools.

3.9 COMPACTION OF MIXTURE

After placing, the mixture shall be thoroughly and uniformly compacted by rolling. Compact the surface as soon as possible without causing displacement, cracking or shoving. The sequence of rolling operations and the type of rollers used shall be at the discretion of the Contractor. The speed of the roller shall, at all times, be sufficiently slow to avoid displacement of the hot mixture and be effective in compaction. Any displacement occurring as a result of reversing the direction of the roller, or from any other cause, shall be corrected at once. Furnish sufficient rollers to handle the output of the plant. Continue rolling until roller marks are eliminated and course has a density of at least 96 percent but not more than 100 percent of that attained in a laboratory specimen of the same mixture prepared in accordance with ASTM D6927. To prevent adhesion of the mixture to the roller, keep the wheels properly moistened but excessive water will not be permitted. In areas not accessible to the roller, the mixture shall be thoroughly compacted with hand tampers. Any mixture that becomes loose and broken, mixed with dirt, contains check-cracking, or is in any way defective shall be removed full depth, replaced with fresh hot mixture and immediately compacted to conform to the surrounding area. This work shall be done at the Contractor's expense. Skin patching will not be allowed.

3.10 JOINTS

The formation of joints shall be performed ensuring a continuous bond between the courses and to obtain the required density. Carefully make joints between old and new pavement or within new pavements in a manner to ensure a thorough and continuous bond between old and new sections of the course. Vertical contact surfaces of previously constructed sections that are coated with dust, sand, or other objectionable material shall be painted with a thin uniform coat of emulsion or other approved bituminous material just before placing fresh mixture. All joints shall have the same texture as other sections of the course and meet the requirements for smoothness and grade.

3.10.1 Transverse Joints

Do not pass the roller over the unprotected end of the freshly laid mixture, except when necessary to form a transverse joint. When necessary to form a transverse joint, it shall be made by means of placing a bulkhead or by tapering the course. The tapered edge shall be cut back to its full depth and width on a straight line to expose a vertical face prior to placing material at the joint. Remove the cutback material from the project. In both methods, all contact surfaces shall be given a light tack coat of asphalt material before placing any fresh mixture against the joint.

3.10.2 Longitudinal Joints

Longitudinal joints which are irregular, damaged, uncompacted, cold (less than 175 degrees F at the time of placing adjacent lanes), or otherwise defective, shall be cut back a maximum of 3 inches from the top of the course with a cutting wheel to expose a clean, sound vertical surface for the full depth of the course. All cutback material shall be removed from the project. All contact surfaces shall be given a light tack coat of asphalt material prior to placing any fresh mixture against the joint. The Contractor will be allowed to use an alternate method if it can be demonstrated that density, smoothness, and texture can be met.

3.11 QUALITY CONTROL

3.11.1 General Quality Control Requirements

Develop and submit an approved Quality Control Plan. Submit aggregate and QC test results. Do not produce hot-mix asphalt for payment until the quality control plan has been approved addressing all elements which affect the quality of the pavement including, but not limited to:

a. Mix Design

b. Aggregate Grading

c. Quality of Materials

d. Stockpile Management

e. Proportioning

f. Mixing and Transportation

g. Mixture Volumetrics

h. Moisture Content of Mixtures

i. Placing and Finishing

j. Joints

k. Compaction

l. Surface Smoothness

3.11.2 Testing Laboratory

Provide a fully equipped asphalt laboratory located at the plant or job site and meeting the pertinent requirements in ASTM D3666. Laboratory facilities shall be kept clean and all equipment maintained in proper working condition. The Contracting Officer shall be permitted unrestricted access to inspect the Contractor's laboratory facility, to witness quality control activities, and to perform any check testing desired. The Contracting Officer will advise the Contractor in writing of any noted deficiencies concerning the laboratory facility, equipment, supplies, or testing personnel and procedures. When the deficiencies are serious enough to adversely affect test results, the incorporation of the materials into the work shall be suspended immediately and will not be permitted to resume until the deficiencies are corrected.

3.11.3 Quality Control Testing

Perform all quality control tests applicable to these specifications and as set forth in the Quality Control Program. The testing program shall include, but shall not be limited to, tests for the control of asphalt content, aggregate gradation, temperatures, aggregate moisture, moisture in the asphalt mixture, laboratory air voids, stability (NA for Superpave), flow (NA for Superpave), in-place density, grade and smoothness. Develop a Quality Control Testing Plan as part of the Quality Control Program.

3.11.3.1 Asphalt Content

A minimum of two tests to determine asphalt content will be performed per lot (a lot is defined in paragraph MATERIAL ACCEPTANCE) by one of the following methods: the extraction method in accordance with ASTM D2172/D2172M, Method A or B, the ignition method in accordance with ASTM D6307, or the nuclear method in accordance with ASTM D4125/D4125M. Calibrate the ignition oven or the nuclear gauge for the specific mix being used. For the extraction method, determine the weight of ash, as described in ASTM D2172/D2172M, as part of the first extraction test performed at the beginning of plant production; and as part of every tenth extraction test performed thereafter, for the duration of plant production. The last weight of ash value obtained shall be used in the calculation of the asphalt content for the mixture.

3.11.3.2 Gradation

Determine aggregate gradations a minimum of twice per lot from mechanical analysis of recovered aggregate in accordance with ASTM D5444. When asphalt content is determined by the ignition oven or nuclear method, aggregate gradation shall be determined from hot bin samples on batch plants, or from the cold feed on drum mix plants. For batch plants, test aggregates in accordance with ASTM C136/C136M using actual batch weights to determine the combined aggregate gradation of the mixture.

3.11.3.3 Aggregates Tests

a. Gradation: ASTM C136/C136M.

b. Mineral Filler Content: ASTM D546.

c. Abrasion: ASTM C131/C131M for wear (Los Angeles test). Perform one test initially prior to incorporation into the work and each time the source is changed.

3.11.3.4 Temperatures

Check temperatures at least four times per lot, at necessary locations, to determine the temperature at the dryer, the asphalt cement in the storage tank, the asphalt mixture at the plant, and the asphalt mixture at the job site.

3.11.3.5 Aggregate Moisture

Determine the moisture content of aggregate used for production a minimum of once per lot in accordance with ASTM C566.

3.11.3.6 Moisture Content of Mixture

Determine the moisture content of the mixture at least once per lot in accordance with ASTM D1461 or an approved alternate procedure.

3.11.3.7 Laboratory Air Voids, Marshall Stability and Flow

Take mixture samples at least four times per lot compacted into specimens, using 50 blows per side with the hand-held Marshall hammer as described in ASTM D6926. After compaction, determine the laboratory air voids of each specimen. Stability and flow shall be determined for the Marshall-compacted specimens, in accordance with ASTM D6927.

3.11.3.8 In-Place Density

Conduct any necessary testing to ensure the specified density is achieved. A nuclear gauge may be used to monitor pavement density in accordance with ASTM D2950/D2950M.

3.11.3.9 Thickness

Determine thickness of intermediate and surface courses from samples taken for the field density test. The maximum allowable deficiency at any point shall not be more than 1/4 inch less than the thickness for the indicated course. Average thickness of course or of combined courses shall be not less than the indicated thickness. Where a deficiency exceeds the specified tolerances, correct each such representative area or areas by removing the deficient pavement and replacing with new pavement.

3.11.3.10 Grade and Smoothness

Conduct the necessary checks to ensure the grade and smoothness requirements are met in accordance with paragraph MATERIAL ACCEPTANCE.

3.11.3.11 Additional Testing

Any additional testing, which the Contractor deems necessary to control the process, may be performed at the Contractor's option.

3.11.3.12 QC Monitoring

Submit all QC test results to the Contracting Officer on a daily basis as the tests are performed. The Contracting Officer reserves the right to monitor any of the Contractor's quality control testing and to perform duplicate testing as a check to the Contractor's quality control testing.

3.11.4 Sampling

When directed by the Contracting Officer, sample and test any material which appears inconsistent with similar material being produced, unless such material is voluntarily removed and replaced or deficiencies corrected by the Contractor. All sampling shall be in accordance with standard procedures specified.

3.11.5 Control Charts

For process control, establish and maintain linear control charts on both individual samples and the running average of last four samples for the parameters listed in Table 8, as a minimum. These control charts shall be posted as directed by the Contracting Officer and kept current at all times. The control charts shall identify the project number, the test parameter being plotted, the individual sample numbers, the Action and Suspension Limits listed in Table 8 applicable to the test parameter being plotted, and the Contractor's test results. Target values from the JMF shall also be shown on the control charts as indicators of central tendency for the cumulative percent passing, asphalt content, and laboratory air voids parameters. When the test results exceed either applicable Action Limit, take immediate steps to bring the process back in control. When the test results exceed either applicable Suspension Limit, halt production until the problem is solved. Use the control charts as part of the process control system for identifying trends so that potential problems can be corrected before they occur. Make decisions concerning mix modifications based on analysis of the results provided in the control charts. The Quality Control Plan shall indicate the appropriate action to be taken to bring the process into control when certain parameters exceed their Action Limits.

Table 8. Action and Suspension Limits for the Parameters to be Plotted on Individual and Running Average Control Charts

	Individual Samples		Running Average of Last Four Samples	
Parameter to be Plotted	Action Limit	Suspension Limit	Action Limit	Suspension Limit
No. 4 sieve, Cumulative percent passing, deviation for JMF target; plus or minus values	6	8	4	5
No. 30 sieve, Cumulative percent passing, deviation for JMF target; plus or minus values	4	6	3	4
No. 200 sieve, Cumulative percent passing, deviation for JMF target; plus or minus values	1.4	2.0	1.1	1.5
Stability, pounds (minimum)				
50 Blow JMF	1000	900	1100	1000
Flow, 0.01 inch (NA for Superpave)				
50 Blow JMF	8 min.	7 min.	9 min.	8 min.
	18 max.	19 max.	17 max.	18 max.
Asphalt content, percent deviation from JMF target; plus or minus value	0.4	0.5	0.2	0.3
Laboratory Air Voids, percent deviation from JMF target value	No specific action and suspension limits set			

Table 8. Action and Suspension Limits for the Parameters to be Plotted on Individual and Running Average Control Charts				
	Individual Samples		Running Average of Last Four Samples	
Parameter to be Plotted	Action Limit	Suspension Limit	Action Limit	Suspension Limit
In-place Mat Density, percent of TMD	No specific action and suspension limits set			
In-place Joint Density, percent of TMD	No specific action and suspension limits set			

3.12 MATERIAL ACCEPTANCE

Testing for acceptability of work will be performed by an independent laboratory hired by the Contractor. Forward test results daily to the Contracting Officer. Acceptance of the plant produced mix and in-place requirements will be on a lot to lot basis. A standard lot for all requirements will be equal to 8 hours of production. Where appropriate, adjustment in payment for individual lots of hot-mix asphalt will be made based on in-place density, laboratory air voids, grade and smoothness in accordance with the following paragraphs. Grade and surface smoothness determinations will be made on the lot as a whole. Exceptions or adjustments to this will be made in situations where the mix within one lot is placed as part of both the intermediate and surface courses, thus grade and smoothness measurements for the entire lot cannot be made. In order to evaluate laboratory air voids and in-place (field) density, each lot will be divided into four equal sublots.

3.12.1 Sublot Sampling

One random mixture sample for determining laboratory air voids, theoretical maximum density, and for any additional testing the Contracting Officer desires, will be taken from a loaded truck delivering mixture to each sublot, or other appropriate location for each sublot. All samples will be selected randomly, using commonly recognized methods of assuring randomness conforming to ASTM D3665 and employing tables of random numbers or computer programs. Laboratory air voids will be determined from three laboratory compacted specimens of each sublot sample in accordance with ASTM D6926. The specimens will be compacted within 2 hours of the time the mixture was loaded into trucks at the asphalt plant. Samples will not be reheated prior to compaction and insulated containers will be used as necessary to maintain the temperature.

3.12.2 Additional Sampling and Testing

The Contracting Officer reserves the right to direct additional samples and tests for any area which appears to deviate from the specification requirements. The cost of any additional testing will be paid for by the Government. Testing in these areas will be in addition to the lot testing, and the requirements for these areas will be the same as those for a lot.

3.12.3 Grade

Finish grades of each course placed shall not vary from the finish elevations, profiles, and cross sections indicated by more than 1/2 inch.

Finished surface of the final surface course will be tested by the Contractor, and report submitted to the Contracting Officer, by running lines of levels at intervals of 25 feet longitudinally and transversely to determine elevations of completed pavement. Within 5 working days, after the completion of a particular lot incorporating the final wearing surface course, test the final wearing surface course of the pavement for conformance with the specified plan grade and perform a level survey at the specified grid spacing. Elevations not in conformance with the specified tolerance shall be noted on the plan in an approved manner. The survey shall be performed by a registered land surveyor. The Contracting Officer will inform the Contractor in writing of paved areas that fail to meet the final grades indicated within the specified tolerances. Correct deficient paved areas by removing existing work and replacing with new materials that meet the specifications. Skin patching for correcting low areas is prohibited. Diamond grinding may be used to remove high spots to meet grade requirements. Skin patching for correcting low areas or planing or milling for correcting high areas will not be permitted.

3.12.4 Surface Smoothness

Use one of the following methods to test and evaluate surface smoothness of the pavement. Perform all testing in the presence of the Contracting Officer. Keep detailed notes of the results of the testing and furnish a copy to the Government immediately after each day's testing. Use the profilograph method for all longitudinal testing, except where the runs would be less than 200 feet in length and the ends where the straightedge will be used. Where drawings show required deviations from a plane surface (crowns, drainage inlets, etc.), the surface shall be finished to meet the approval of the Contracting Officer.

3.12.4.1 Smoothness Requirements

3.12.4.1.1 Straightedge Testing

The finished surfaces of the pavements shall have no abrupt change of 1/4 inch or more, and all pavements shall be within the tolerances of 1/4 inch in both the longitudinal and transverse directions, when tested with an approved 12 feet straightedge.

3.12.4.1.2 Profilograph Testing

The finished surfaces of the pavements shall have no abrupt change of 1/8 inch or more, and each 0.1 mile segment of each pavement lot shall have a Profile Index not greater than 9 inches/mile when tested with an approved California-type profilograph. If the extent of the pavement in either direction is less than 200 feet, that direction shall be tested by the straightedge method and shall meet requirements specified above.

3.12.4.2 Testing Method

After the final rolling, but not later than 24 hours after placement, test the surface of the pavement in each entire lot in such a manner as to reveal all surface irregularities exceeding the tolerances specified above. Separate testing of individual sublots is not required. If any pavement areas are ground, these areas shall be retested immediately after grinding. Test each lot of the pavement in both a longitudinal and a transverse direction on parallel lines. Set the transverse lines 15 feet or less apart, as directed. The longitudinal lines shall be at the centerline of each paving lane for lanes less than 20 feet wide and at the third points for lanes 20 feet or wider. Also test other areas having obvious deviations. Longitudinal testing lines shall be continuous across all joints.

3.12.4.2.1 Straightedge Testing

Hold the straightedge in contact with the surface and move it ahead one-half the length of the straightedge for each successive measurement. Determine the amount of surface irregularity by placing the freestanding (unleveled) straightedge on the pavement surface and allowing it to rest upon the two highest spots covered by its length, and measuring the maximum gap between the straightedge and the pavement surface in the area between these two high points.

3.12.4.2.2 Profilograph Testing

Perform profilograph testing using approved equipment and procedures described in CTM 526. The equipment shall utilize electronic recording and automatic computerized reduction of data to indicate "must-grind" bumps and the Profile Index for each 0.1 mile segment of each pavement lot. Grade breaks on parking lots shall be accommodated by breaking the profile segment into shorter sections and repositioning the blanking band on each segment. The "blanking band" shall be 0.2 inches wide and the "bump template" shall span 1 inch with an offset of 0.3 inch. Compute the Profile Index for each pass of the profilograph in each 0.1 mile segment. The Profile Index for each segment shall be the average of the Profile Indices for each pass in each segment. The profilograph shall be operated by a DOT approved operator. Furnish a copy of the reduced tapes to the Government at the end of each day's testing.

3.13 PROTECTION

Do not permir vehicular traffic, including heavy equipment, on pavement until surface temperature has cooled to no more than 120 degrees F. Measure surface temperature by approved surface thermometers or other satisfactory methods.

-- End of Section --

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SECTION 32 15 00

AGGREGATE SURFACING
05/17

PART 1 GENERAL

1.1 REFERENCES

The publications listed below form a part of this specification to the extent referenced. The publications are referred to within the text by the basic designation only.

AMERICAN ASSOCIATION OF STATE HIGHWAY AND TRANSPORTATION OFFICIALS (AASHTO)

AASHTO T 180	(2017) Standard Method of Test for Moisture-Density Relations of Soils Using a 4.54-kg (10-lb) Rammer and a 457-mm (18-in.) Drop
AASHTO T 224	(2010) Standard Method of Test for Correction for Coarse Particles in the Soil Compaction Test

ASTM INTERNATIONAL (ASTM)

ASTM C127	(2015) Standard Test Method for Density, Relative Density (Specific Gravity), and Absorption of Coarse Aggregate
ASTM D1556/D1556M	(2015; E 2016) Standard Test Method for Density and Unit Weight of Soil in Place by Sand-Cone Method
ASTM D1557	(2012; E 2015) Standard Test Methods for Laboratory Compaction Characteristics of Soil Using Modified Effort (56,000 ft-lbf/ft3) (2700 kN-m/m3)
ASTM D2216	(2010) Laboratory Determination of Water (Moisture) Content of Soil and Rock by Mass
ASTM D3740	(2012a) Minimum Requirements for Agencies Engaged in the Testing and/or Inspection of Soil and Rock as Used in Engineering Design and Construction
ASTM D4643	(2017) Standard Test Method for Determination of Water Content of Soil and Rock by Microwave Oven Heating
ASTM D4959	(2016) Determination of Water (Moisture) Content of Soil by Direct Heating
ASTM D6938	(2017a) Standard Test Method for In-Place

	Density and Water Content of Soil and Soil-Aggregate by Nuclear Methods (Shallow Depth)

STATE OF CALIFORNIA DEPARTMENT OF TRANSPORTATION (CALTRANS)

CDT Std Specs	(2015) State of California Department of Transportation (CALTRANS) Standard Specifications

1.2 DEGREE OF COMPACTION

Degree of compaction required, except as noted in the second sentence, is expressed as a percentage of the maximum laboratory dry density obtained by the test procedure presented in ASTM D1557 abbreviated as a percent of laboratory maximum dry density. Since ASTM D1557 applies only to soils that have 30 percent or less by weight of their particles retained on the 3/4 inch sieve, the degree of compaction for material having more than 30 percent by weight of their particles retained on the 3/4 inch sieve will be expressed as a percentage of the laboratory maximum dry density in accordance with AASHTO T 180 Method D and corrected with AASHTO T 224.

1.3 SUBMITTALS

Government approval is required for submittals with a "G" designation; submittals not having a "G" designation are for information only. When used, a designation following the "G" designation identifies the office that will review the submittal for the Government. Submit the following in accordance with Section 01 33 00 SUBMITTAL PROCEDURES:

SD-06 Test Reports

In-Place Tests; G

1.4 EQUIPMENT, TOOLS, AND MACHINES

All plant, equipment, and tools used in the performance of the work will be subject to approval by the Contracting Officer before the work is started. Maintain all plant, equipment, and tools in satisfactory working condition at all times. Submit a list of proposed equipment, including descriptive data. Provide adequate equipment having the capability of minimizing segregation, producing the required compaction, meeting grade controls, thickness control, and smoothness requirements as set forth herein.

1.5 QUALITY ASSURANCE

Sampling and testing are the responsibility of the Contractor. Perform sampling and testing using a laboratory approved in accordance with Section 01 45 00 QUALITY CONTROL. Work requiring testing will not be permitted until the testing laboratory has been inspected and approved. Test the materials to establish compliance with the specified requirements and perform testing at the specified frequency. The Contracting Officer may specify the time and location of the tests. Furnish copies of test results to the Contracting Officer within 24 hours of completion of the tests.

1.5.1 Sampling and Testing

Sampling and testing shall be the responsibility of the Contractor.

Sampling and testing shall be performed by an approved commercial testing laboratory or by the Contractor, subject to review by the Government. If the Contractor elects to establish its own testing facilities, approval of such facilities will be based on compliance with ASTM D3740. No work requiring testing will be permitted until the Contractor's facilities have been inspected and reviewed.

1.6 ENVIRONMENTAL REQUIREMENTS

Perform construction when the atmospheric temperature is above 35 degrees F. It is the responsibility of the Contractor to protect, by approved method or methods, all areas of surfacing that have not been accepted by the Contracting Officer. Bring surfaces damaged by freeze, rainfall, or other weather conditions to a satisfactory condition.

PART 2 PRODUCTS

2.1 AGGREGATES

Provide aggregate surfacing in compliance with CALTRANS Standard Specifications (CDT Std Specs Section 26, Aggregate Bases), Class 2 Aggregate Base (3/4 inch maximum) with a minimum bulk specific gravity of 2.68 or greater per ASTM C127.

PART 3 EXECUTION

3.1 STOCKPILING MATERIAL

Prior to stockpiling the material, clear and level the storage sites. Stockpile all materials, including approved material available from excavation and grading, in the manner and at the locations designated. Stockpile aggregates in such a manner that will prevent segregation. Stockpile aggregates and binders obtained from different sources separately.

3.2 GRADE CONTROL

During construction, maintain the lines and grades including crown and cross slope indicated for the aggregate surface course by means of line and grade stakes placed by the Contractor in accordance with the SPECIAL CONTRACT REQUIREMENTS.

3.3 MIXING AND PLACING MATERIALS

Mix and place the materials to obtain uniformity of the material and a uniform optimum water content for compaction. Make adjustments in mixing, placing procedures, or in equipment to obtain the true grades, to minimize segregation and degradation, to obtain the desired water content, and to ensure a satisfactory surface course.

3.4 LAYER THICKNESS

Place the aggregate material in layers of uniform thickness. Compact the completed aggregate surface course to the thickness indicated. No individual layer may be thicker than 6 inches nor be thinner than 3 inches in compacted thickness. Compact the aggregate surface course to a total thickness that is within 1/2 inch of the thickness indicated. Where the measured thickness is more than 1/2 inch deficient, correct such areas by scarifying, adding new material of proper gradation, reblading, and recompacting as directed. Where the measured thickness is more than 1/2 inch thicker than indicated, the course will be considered as conforming to the specified thickness requirements. The average job thickness will be the average of all thickness measurements taken for the job and must be within 1/4 inch of the thickness indicated. Measure the total thickness of the aggregate surface course at intervals of one measurement for each 500 square yards of surface course. Measure total thickness using 3 inch diameter test holes penetrating the aggregate surface course.

3.5 COMPACTION

Degree of compaction is a percentage of the maximum density obtained by the test procedure presented in ASTM D1557 abbreviated herein as percent laboratory maximum density. Compact each layer of the aggregate surface course with approved compaction equipment, as required in the following paragraphs. Maintain the water content during the compaction procedure at optimum or at the percentage specified by the Contracting Officer. Compact the mixture with mechanical tampers in locations not accessible to rollers. Continue compaction until each layer through the full depth is compacted to at least 95 percent of laboratory maximum density. Remove any materials that are found to be unsatisfactory and replace them with satisfactory material or rework them to produce a satisfactory material.

3.6 EDGES OF AGGREGATE SURFACE COURSE

Place approved material along the edges of the aggregate surface course in such quantity as to compact to the thickness of the course being constructed. Simultaneously roll and compact at least 1 foot of shoulder width with the rolling and compacting of each layer of the surface course when the course is being constructed in two or more layers.

3.7 SMOOTHNESS TEST

Construct each layer so that the surface shows no deviations in excess of 3/8 inch when tested with a 10 foot straightedge applied both parallel with and at right angles to the centerline of the area to be paved. Correct deviations exceeding this amount by removing material, replacing with new material, or reworking existing material and compacting, as directed.

3.8 FIELD QUALITY CONTROL

3.8.1 Field Density Tests

Determine the in-place density in accordance with ASTM D1556/D1556M, except that method ASTM D6938 may be used, as further qualified hereinafter, to determine in-place density of materials. When ASTM D6938 is used, check the calibration curves as described in ASTM D6938 and adjust using only the sand cone method as described in paragraph Calibration of the ASTM publication. Check the calibration of the density gauge prior to the first use of each different type of material encountered and at intervals as directed by the Contractor Officer, and submit curves and results within 24 hours of running the test. Both ASTM D1556/D1556M and ASTM D6938 result in a wet unit weight of soil and when using either of these methods, use only method ASTM D2216 to determine the moisture content for calculating in-place dry density of the soil. For a rough estimate of the in-place density to control field activities only, the Contractor may perform moisture content testing by method ASTM D4643 or ASTM D4959 in conjunction with density testing by method ASTM D6938. If the nuclear gauge method ASTM D6938 is used for compliance testing, those test values shall be checked against tests performed in accordance with the sand cone method

ASTM D1556/D1556M at a minimum frequency of one sand cone test per lift for every six or fraction thereof tests by the nuclear gauge method. Density test results determined by ASTM D1556/D1556M shall govern over those determined by ASTM D6938. If differing results are consistently obtained, use of the nuclear gauge shall be discontinued and only sand cone method, ASTM D1556/D1556M, shall be used.

3.8.2 In-Place Tests

Perform each of the following tests on samples taken from the placed and compacted aggregate surface course. Take samples and test at the rates indicated.

a. Perform density tests on every lift of material placed and at a frequency of one set of tests for every 250 square yards, or portion thereof, of completed area.

b. Perform sieve analysis on every lift of material placed and at a frequency of one sieve analysis for every 500 square yards, or portion thereof, of material placed.

c. Perform liquid limit and plasticity index tests at the same frequency as the sieve analysis.

d. Measure the thickness of the aggregate surface course at intervals providing at least one measurement for each 500square yards of base course or part thereof. Measure the thickness using test holes, at least 3 inch in diameter through the aggregate surface course.

3.8.3 Approval of Material

Final approval of the materials will be based on tests for gradation, liquid limit, and plasticity index performed on samples taken from the completed and full coompacted aggregate surface course.

3.9 MAINTENANCE

Maintain the aggregate surface course in a condition that will meet all specification requirements until accepted.

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PAVEMENT MARKINGS
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PART 1 GENERAL

1.1 REFERENCES

The publications listed below form a part of this specification to the extent referenced. The publications are referred to in the text by the basic designation only.

AMERICAN ASSOCIATION OF STATE HIGHWAY AND TRANSPORTATION OFFICIALS (AASHTO)

AASHTO M 247	(2013) Standard Specification for Glass Beads Used in Pavement Markings
AASHTO M 249	(2012; R2016) Standard Specification for White and Yellow Reflective Thermoplastic Striping Material (Solid Form)

ASTM INTERNATIONAL (ASTM)

ASTM D4061	(2013) Standard Test Method for Retroreflectance of Horizontal Coatings
ASTM D4505	(2012; R 2017) Standard Specification for Preformed Retroflective Pavement Marking Tape for Extended Service Life
ASTM D6628	(2003; R 2015) Standard Specification for Color of Pavement Marking Materials
ASTM E1710	(2011) Standard Test Method for Measurement of Retroreflective Pavement Marking Materials with CEN-Prescribed Geometry Using a Portable Retroreflectometer
ASTM E2177	(2011) Standard Test Method for Measuring the Coefficient of Retroreflected Luminance (RL) of Pavement Markings in a Standard Condition of Wetness
ASTM E2302	(2003; R 2016) Standard Test Method for Measurement of the Luminance Coefficient Under Diffuse Illumination of Pavement Marking Materials Using a Portable Reflectometer

INTERNATIONAL CONCRETE REPAIR INSTITUTE (ICRI)

ICRI 03732	(1997) Selecting and Specifying Concrete Surface Preparation for Sealers, Coatings, and Polymer Overlays

STATE OF CALIFORNIA DEPARTMENT OF TRANSPORTATION (CALTRANS)

CALTRANS STD SPEC	(2015) State of California Department of Transportation (CALTRANS) Standard Specifications
CDT MUTCD	(2014) California Manual on Uniform Traffic Control Devices, Revision 1
CDT Std Plans	(2015) State of California Department of Transportation Standard Plans

1.2 SUBMITTALS

Government approval is required for submittals with a "G" designation; submittals not having a "G" designation are for information only or as otherwise designated. When used, a designation following the "G" designation identifies the office that will review the submittal for the Government. Submit the following in accordance with Section 01 33 00 SUBMITTAL PROCEDURES:

SD-03 Product Data

Surface Preparation Equipment List; G

Application Equipment List; G

Exterior Surface Preparation

Material Safety Data Sheets (MSDS)for proposed materials; G

Reflective media for roads; G

Waterborne Paint; G

Thermoplastic compound; G

Raised Pavement Markers Primers and Adhesives; G

SD-06 Test Reports

Reflective Media for Roads; G

Waterborne Paint; G

Thermoplastic Compound; G

Raised Pavement Markers Primers and Adhesives; G

Test Reports

SD-07 Certificates

Qualifications; G

Reflective Media for Roads

Waterborne Paint

Volatile Organic Compound, (VOC); G

Thermoplastic Compound

SD-08 Manufacturer's Instructions

Waterborne Paint; G

Thermoplastic Compound; G

1.3 QUALITY CONTROL

1.3.1 Regulatory Requirements

Submit certificate stating that the proposed pavement marking paint meets the Volatile Organic Compound, (VOC) regulations of the local Air Pollution Control District having jurisdiction over the geographical area in which the project is located. Submit Material Safety Data Sheets (MSDS) for each product.

1.3.2 Qualifications

Submit documentation certifying that pertinent personnel are qualified for equipment operation and handling of applicable chemicals. The documentation should include experience on five projects of similar size and scope with references for all personnel.

1.4 DELIVERY AND STORAGE

Deliver paint materials, thermoplastic compound materials, and reflective media in original sealed containers that plainly show the designated name, specification number, batch number, color, date of manufacture, manufacturer's directions, and name of manufacturer.

Provide storage facilities at the job site, only in areas approved by the Contracting Officer, for maintaining materials at temperatures recommended by the manufacturer. Make available paint stored at the project site or segregated at the source for sampling not less than 30 days prior to date of required approval for use to allow sufficient time for testing. Notify the Contracting Officer when paint is available for sampling.

1.5 PROJECT/SITE CONDITIONS

1.5.1 Environmental Requirements

1.5.1.1 Weather Limitations for Application

Apply pavement markings to clean, dry surfaces, and unless otherwise approved, only when the air and pavement surface temperature is at least 5 degrees F above the dew point and the air and pavement temperatures are within the limits recommended by the pavement marking manufacturer. Allow pavement surfaces to dry after water has been used for cleaning or rainfall has occurred prior to striping or marking. Test the pavement surface for moisture before beginning work each day and after cleaning. Do not commence marking until the pavement is sufficiently dry and the pavement condition has been approved by the Contracting Officer. Employ the "plastic wrap method" to test the pavement for moisture as specified in paragraph TESTING FOR MOISTURE.

1.5.1.2 Weather Limitations for Removal of Pavement Markings on Roads and Parking Areas

Pavement surface must be free of snow, ice, or slush; with a surface temperature of at least 40 degrees F and rising at the beginning of operations, except those involving shot or sand blasting or grinding. Cease operation during thunderstorms, or during rainfall, except for waterblasting and removal of previously applied chemicals. Cease waterblasting where surface water accumulation alters the effectiveness of material removal.

1.5.2 Traffic Controls

Place warning signs conforming to CDT MUTCD near the beginning of the worksite and well ahead of the worksite for alerting approaching traffic from both directions. Place small markers along newly painted lines or freshly placed raised markers to control traffic and prevent damage to newly painted surfaces or displacement of raised pavement markers. Mark painting equipment with large warning signs indicating slow-moving painting equipment in operation.

When traffic must be rerouted or controlled to accomplish the work, provide necessary warning signs, flag persons, and related equipment for the safe passage of vehicles.

1.5.3 Lighting

When night operations are necessary, provide all necessary lighting and equipment. The Government reserves the right to accept or reject night work on the day following night activities by the Contractor.

PART 2 PRODUCTS

2.1 EQUIPMENT

2.1.1 Surface Preparation Equipment for Roads and Parking Areas

Submit a surface preparation equipment list by serial number, type, model, and manufacturer. Include descriptive data indicating area of coverage per pass, pressure adjustment range, tank and flow capacities, and safety precautions required for the equipment operation. Mobile equipment must allow for removal of markings without damaging the pavement surface or joint sealant. Maintain machines, tools, and equipment used in the performance of the work in satisfactory operating condition.

2.1.1.1 Sandblasting Equipment

Use mobile sandblasting equipment capable of producing a pressurized stream of sand and air that effectively removes paint from the surface without filling voids with debris in asphalt or tar pavements or removing joint sealants in portland cement concrete pavements. Include with the equipment and air compressor, hoses, and nozzles of adequate size and capacity for removing paint. Equip the compressor with traps and coalescing filters that maintain the compressed air free of oil and water.

2.1.1.2 Waterblasting Equipment

Use mobile waterblasting equipment capable of producing a pressurized stream of water that effectively removes paint from the pavement surface without significantly damaging the pavement. Provide equipment, tools, and machinery which are safe and in good working order at all times.

2.1.1.3 Shotblasting Equipment

Use mobile self propelled shotblasting equipment capable of producing an adjustable depth of paint removal and of propelling abrasive particles at high velocities on the paint for effective removal. Ensure each unit is self cleaning and self contained. Use equipment able to confine the abrasive, any dust that is produced, and removed paint and is capable of recycling the abrasive for reuse.

2.1.1.4 Grinding or Scarifying Equipment

Use equipment capable of removing surface contaminates, paint build-up, or extraneous markings from the pavement surface without leaving any residue. Clean the surface by hydro blast to remove surface contaminates and ash after a weed torch is used to remove paint.

2.1.1.5 Chemical Removal Equipment

Use chemical equipment capable of applying and removing chemicals and paint from the pavement surface, leaving only non-toxic biodegradable residue without scarring or other damage to the pavement or joints and joint seals.

2.1.2 Application Equipment

Submit application equipment list appropriate for the material(s) to be used. Include manufacturer's descriptive data and certification for the planned use that indicates area of coverage per pass, pressure adjustment range, tank and flow capacities, and all safety precautions required for operating and maintaining the equipment. Provide and maintain machines, tools, and equipment used in the performance of the work in satisfactory operating condition, or remove them from the work site. Provide mobile and maneuverable application equipment to the extent that straight lines can be followed and normal curves can be made in a true arc.

2.1.2.1 Paint Application Equipment

2.1.2.1.1 Hand-Operated, Push-Type Machines

Provide hand-operated push-type applicator machine of a type commonly used for application of water based paint or two-component, chemically curing paint, thermoplastic, or preformed tape, to pavement surfaces for small marking projects, such as legends and cross-walks, parking areas, or surface painted signs. Provide applicator machine equipped with the necessary tanks and spraying nozzles capable of applying paint uniformly at coverage specified. Hand operated spray guns may be used in areas where push-type machines cannot be used.

2.1.2.1.2 Self-Propelled or Mobile-Drawn Spraying Machines

Provide self-propelled or mobile-drawn spraying machine with suitable arrangements of atomizing nozzles and controls to obtain the specified results. Provide machine having a speed during application capable of applying the stripe widths indicated at the paint coverage rate specified herein and of even uniform thickness with clear-cut edges.

2.1.2.1.2.1 Road Marking

Provide equipment used for marking roads capable of placing the prescribed number of lines at a single pass as solid lines, intermittent lines, or a combination of solid and intermittent lines using a maximum of three different colors of paint as specified.

2.1.2.1.2.2 Hand Application

Provide spray guns for hand application of paint in areas where the mobile paint applicator cannot be used.

2.1.2.2 Thermoplastic Application Equipment

2.1.2.2.1 Thermoplastic Material

Apply thermoplastic material with equipment that is capable of providing continuous uniformity in the dimensions and reflectorization of the marking.

2.1.2.2.2 Application Equipment

a. Provide application equipment capable of continuous mixing and agitation of the material, with conveying parts which prevent accumulation and clogging between the main material reservoir and the extrusion shoe or spray gun. All parts of the equipment which come into contact with the material must be easily accessible and exposed for cleaning and maintenance. All mixing and conveying parts up to and including the extrusion shoes and spray guns must maintain the material at the required temperature with heat-transfer oil or electrical-element-controlled heat.

b. Provide application equipment constructed to ensure continuous uniformity in the dimensions of the stripe. Provide an applicator with a means for cleanly cutting off stripe ends squarely and providing a method of applying "skiplines." Provide equipment capable of applying varying widths of traffic markings.

c. Provide mobile and maneuverable application equipment allowing straight lines to be followed and normal curves to be made in a true arc. Provide equipment used for the placement of thermoplastic pavement markings of two general types: mobile applicator and portable applicator.

d. Equip the applicator with a pressurized or drop-on type bead dispenser capable of uniformly dispensing reflective glass spheres at controlled rates of flow. The bead dispenser must operate automatically to begin flow prior to the flow of binder to assure that the strip is fully reflectorized.

2.1.2.2.3 Mobile Application Equipment

Provide a truck-mounted, self-contained pavement marking machine that is capable of hot applying thermoplastic by either the extrusion or spray method.

a. Equip the unit to apply the thermoplastic marking material at temperatures according to the manufacturer's instructions, at widths varying from 3 to 12 inches, with an automatic pressurized or drop-on bead dispensing system, capable of operating continuously, and of installing a minimum of 20,000 lineal feet of longitudinal markings in an 8-hour day.

b. Equip the mobile unit with a melting kettle which holds a minimum of 6000 pounds of molten thermoplastic material; capable of heating the thermoplastic composition to temperatures as recommended by the manufacturer. Use a thermostatically controlled heat transfer liquid. Heating of the composition by direct flame is not allowed. Oil and material temperature gauges must be visible at both ends of the kettle.

c. Equip mobile units for application of extruded markings with a minimum of two extrusion shoes; located one on each side of the truck, capable of marking simultaneous edge line and centerline stripes; each being a closed, oil-jacketed unit; holding the molten thermoplastic at a temperature as recommended by the manufacturer; and capable of extruding a line of 3 to 8 inches in width; and at a thickness of not less than 0.120 inch nor more than 0.190 inch, of generally uniform cross section.

d. Equip mobile units for application of spray markings with a spray gun system capable of marking simultaneous edgeline and centerline stripes. Surround (jacket) the spray system with heating oil to maintain the molten thermoplastic at a temperature of 375 to 425 degrees F, capable of spraying a stripe of 3 to 12 inches in width, and in thicknesses varying from 0.060 inch to 0.098 inch, of generally uniform cross section.

e. Equip the mobile unit with an electronic programmable line pattern control system, capable of applying skip or solid lines in any sequence, through any and all of the extrusion shoes, or the spray guns, and in programmable cycle lengths. In addition, equip the mobile unit with an automatic counting mechanism capable of recording the number of lineal feet of thermoplastic markings applied to the pavement surface with an accuracy of 0.5 percent.

2.1.2.2.4 Portable Application Equipment

Provide portable hand-operated equipment, specifically designed for placing special markings such as crosswalks, stop bars, legends, arrows, and short lengths of lane, edge and centerlines; and capable of applying thermoplastic pavement markings by the extrusion method. Equip the portable applicator with all the necessary components, including a materials storage reservoir, bead dispenser, extrusion shoe, and heating accessories, capable of holding the molten thermoplastic at the temperature recommended by the manufacturer, and of extruding a line of 3 to 12 inches in width, and in thickness of not less than 0.120 inch nor more than 0.190 inch and of generally uniform cross section.

2.1.2.3 Reflective Media Dispenser

Attach the dispenser for applying the reflective media to the paint or thermoplastic dispenser and designed to operate automatically and simultaneously with the applicator through the same control mechanism. The bead applicator must be capable of adjustment and designed to provide uniform flow of reflective media over the full length and width of the stripe at the rate of coverage specified in paragraph APPLICATION.

2.1.2.4 Preformed Tape Application Equipment

Provide and use mechanical application equipment for the placement of preformed marking tape which is a mobile pavement marking machine specifically designed for use in applying pressure-sensitive pavement marking tape of varying widths. Equip the applicator with rollers, or other suitable compaction device to provide initial adhesion of the material with the pavement surface. Use additional tools and devices as needed to properly seat the applied material as recommended by the manufacturer.

2.2 MATERIALS

Use reflectorized waterborne paintor thermoplasticraised pavement markers for roads. The maximum allowable VOC content of pavement markings is 150 grams per liter. Color of markings are indicated on the drawings and must conform to ASTM D6628 for roads and parking areas. Provide materials conforming to the requirements specified herein.

2.2.1 Waterborne Paint

Waterborne paint must conform to PTWB_01R2

2.2.2 Thermoplastic Compound

2.2.2.1 Composition Requirements

Thermoplastic compound must conform to AASHTO M 249. Formulate the binder component as an alkyd resin.

2.2.2.2 Primer

a. Asphalt concrete primer: Provide thermosetting adhesive primer with a solids content of pigment reinforced synthetic rubber and synthetic plastic resin dissolved or dispersed in a volatile organic solvent for asphaltic concrete pavements. The solids content must not be less than 10 percent by weight at 70 degrees F and 60 percent relative humidity. A wet film thickness of 0.005 inch, plus or minus 0.001 inch, must dry to a tack-free condition in less than 5 minutes.

b. Portland cement concrete primer: Provide an epoxy resin primer for portland cement concrete pavements, of the type recommended by the manufacturer of the thermoplastic composition.

2.2.3 Preformed Tape

Provide adherent reflectorized strip preformed tape in accordance with ASTM D4505 Retroreflectivity Level II, Class 1, 2 or 3, Skid Resistance Level B.

2.2.4 Raised Pavement Markers Primers and Adhesives

Use either metallic or nonmetallic markers of the button or prismatic reflector type. Provide permanent color markers as specified for pavement marking, which retain the color and brightness under the action of traffic. Place button markers in conformance with CDT Std Plans. Provide button markers with rounded surfaces presenting a smooth contour to traffic and not projecting more than 3/4 inch above level of pavement.

2.2.5 Reflective Media

2.2.5.1 Reflective Media for Roads

AASHTO M 247, Type 1.

PART 3 EXECUTION

3.1 EXAMINATION

3.1.1 Testing for Moisture

Test the pavement surface for moisture before beginning pavement marking after each period of rainfall, fog, high humidity, or cleaning, or when the ambient temperature has fallen below the dew point. Do not commence marking until the pavement is sufficiently dry and the pavement condition has been approved by the Contracting Officer or authorized representative.

Employ the "plastic wrap method" to test the pavement for moisture as follows: Cover the pavement with a 12 inch by 12 inch section of clear plastic wrap and seal the edges with tape. After 15 minutes, examine the plastic wrap for any visible moisture accumulation inside the plastic. Do not begin marking operations until the test can be performed with no visible moisture accumulation inside the plastic wrap. Re-test surfaces when work has been stopped due to rain.

3.1.2 Surface Preparation Demonstration

Prior to surface preparation, demonstrate the proposed procedures and equipment. Prepare areas large enough to determine cleanliness, adhesion of remaining coating and rate of cleaning. Perform a demonstration removal of pavement marking in an area designated by the Contracting Officer.

3.1.3 Test Stripe Demonstration

Prior to paint application, demonstrate test stripe application within the work area using the proposed materials and equipment. Apply separate test stripes in each of the line widths and configurations required herein using the proposed equipment. Make the test stripes long enough to determine the proper speed and operating pressures for the vehicle(s) and machinery, but not less than 50 feet long.

3.1.4 Application Rate Demonstration

During the Test Stripe Demonstration, demonstrate compliance with the application rates specified herein. Document the equipment speed and operating pressures required to meet the specified rates in each configuration of the equipment and provide a copy of the documentation to the Contracting Officer prior to proceeding with the work.

3.1.5 Retroreflective Value Demonstration

After the test stripes have cured to a "no-track" condition, demonstrate compliance with the average retroreflective values specified herein. Take a minimum of ten readings on each test stripe with a Retroreflectometer with a direct readout in millicandelas per square meter per lux (mcd/m2/lx). Conform testing per ASTM D4061, ASTM E1710, ASTM E2177, and ASTM E2302.

3.1.6 Level of Performance Demonstration

The Contracting Officer will be present at the application demonstrations to observe the results obtained and to validate the operating parameters of the vehicle(s) and equipment. If accepted by the Contracting Officer, the test stripe is the measure of performance required for this project. Do not proceed with the work until the demonstration results are satisfactory to the Contracting Officer.

3.2 EXTERIOR SURFACE PREPARATION

Allow new pavement surfaces to cure for a period of not less than 30 days before application of marking materials. Thoroughly clean surfaces to be marked before application of the paint. Remove dust, dirt, and other granular surface deposits by sweeping, blowing with compressed air, rinsing with water, or a combination of these methods as required. Remove rubber deposits, existing paint markings, residual curing compounds, and other coatings adhering to the pavement by water blasting.

a. For Portland Cement Concrete pavement, grinding, light shot blasting, or light scarification, to a resulting profile equal to ICRI 03732 CSP 2, CSP 3, and CSP 4, respectively, can be used in addition to water blasting on most pavements, to either remove existing coatings, or for surface preparation.

3.2.1 Early Painting of Rigid Pavements

Pretreat rigid pavements that require early painting with an aqueous solution containing 3 percent phosphoric acid and 2 percent zinc chloride. Apply the solution to the areas to be marked.

3.2.2 Early Painting of Asphalt Pavements

For asphalt pavement systems requiring painting application at less than 30 days, apply the paint and beads at half the normal application rate, followed by a second application at the normal rate after 30 days.

3.3 APPLICATION

Apply pavement markings to dry pavements only.

3.3.1 Paint

Apply paint pneumatically with approved equipment at rate of coverage specified herein. Provide guidelines and templates as necessary to control paint application. Take special precautions in marking numbers, letters, and symbols. Manually paint numbers, letters, and symbols. Sharply outline all edges of markings. The maximum drying time requirements of the paint specifications will be strictly enforced, to prevent undue softening of bitumen, and pickup, displacement, or discoloration by tires of traffic. If there is a deficiency in drying of the markings, painting operations must cease until the cause of the slow drying is determined and corrected.

3.3.1.1 Waterborne Paint

3.3.1.1.1 Roads

Apply paint in conformance with CALTRANS STD SPEC Section 84-2.03C(3).

3.3.2 Thermoplastic Compound

Place thermoplastic pavement markings, free from dirt or tint, upon dry pavement. The temperature must be a minimum of 40 degrees F and rising at the time of installation. Apply all centerline, skipline, edgeline, and other longitudinal type markings with a mobile applicator. Place all special markings, crosswalks, stop bars, legends, arrows, and similar patterns with a portable applicator, using the extrusion method.

3.3.2.1 Primer

After surface preparation has been completed, prime the asphalt or concrete pavement surface with spray equipment. Allow primer materials to "set-up" prior to applying the thermoplastic composition. Allow the asphalt concrete primer to dry to a tack-free condition, usually occurring in less than 10 minutes. Apply asphalt concrete primer to all asphalt concrete pavements at a wet film thickness of 0.005 inch, plus or minus 0.001 inch (265 to 400 square feet per gallon).

After the primer has "set-up", apply the thermoplastic at temperatures no lower than 375 degrees F nor higher than 425 degrees F at the point of deposition. Apply all extruded thermoplastic markings at the specified width and at a thickness of not less than 0.125 inch nor more than 0.190 inch. Apply all sprayed thermoplastic markings at the specified width and the thickness designated in the contract plans. If the plans do not specify a thickness, apply centerline markings at a wet thickness of 0.090 inch, plus or minus 0.005 inch, and edgeline markings at a wet thickness of 0.060 inch, plus or minus 0.005 inch.

Extrude or spray thermoplastic reflectorized pavement marking compound in a molten state onto a primed pavement surface. Following a surface application of glass beads and upon cooling to normal pavement temperatures, the marking must be an adherent reflectorized strip of the specified thickness and width that is capable of resisting deformation by traffic.

3.3.2.2 Reflective Media

Immediately after installation of the thermoplastic material, mechanically apply drop-on reflective glass spheres conforming to AASHTO M 247 Type 2 at the rate of one pound per 10 square feet such that the spheres are held by and imbedded in the surface of the molten material. Accomplish drop-on application of the glass spheres to ensure even distribution at the specified rate of coverage. If there is a malfunction of either thermoplastic applicator or reflective media dispenser, discontinue operations until deficiency is corrected.

3.3.3 Raised Pavement Markers

Align prefabricated markers carefully at the spacing indicated on the drawings and permanently fix in place by means of epoxy adhesives. To ensure good bond prior to applying adhesive, thoroughly clean all areas where markers are to be set by water blasting and use of compressed air.

3.3.4 Preformed Tape

The pavement surface and ambient air temperature must be a minimum of 60 degrees F and rising. Place the preformed markings in accordance with the manufacturer's written instructions.

3.3.5 Cleanup and Waste Disposal

Keep the worksite clean and free of debris and waste from the removal and application operations. Dispose of debris at approved sites.

3.4 FIELD QUALITY CONTROL

3.4.1 Sampling and Testing

As soon as the paint and thermoplastic materials and reflective media are available for sampling, obtain by random selection from the sealed containers, four quart samples of each batch in the presence of the Contracting Officer. Two quarts will be for sampling and testing by the Contractor and two quarts will be for retention by the Government. Accomplish adequate mixing prior to sampling to ensure a uniform, representative sample. A batch is defined as that quantity of material processed by the manufacturer at one time and identified by number on the label. Clearly identify samples by designated name, specification number, batch number, project contract number, intended use, and quantity involved.

Test samples by an approved laboratory. If a sample fails to meet specification, replace the material in the area represented by the samples and retest the replacement material as specified above. Submit certified copies of the test reports, prior to the use of the materials at the jobsite. Include in the report of test results a listing of any specification requirements not verified by the test laboratory. At the discretion of the Contracting Officer, samples provided may be tested by the Government for verification.

3.4.2 Material Inspection

Examine material at the job site to determine that it is the material referenced in the report of test results or certificate of compliance. A certificate of compliance shall be accompanied by test results substantiating conformance to the specified requirements.

3.4.3 Dimensional Tolerances

Apply all markings in the standard dimensions provide in the drawings. New markings may deviate a maximum of 10 percent larger than the standard dimension. The maximum deviation allowed when painting over an old marking is up to 20 percent larger than the standard dimensions.

3.4.4 Bond Failure Verification

Inspect newly applied markings for signs of bond failure based on visual inspection and comparison to results from Test Stripe Demonstration paragraph.

3.4.5 Reflective Media and Coating Application Verification

Use a wet film thickness gauge to measure the application of wet paint. Use a microscope or magnifying glass to evaluate the embedment of glass beads in the paint. Verify the glass bead embedment with approximately 50 percent of the individual bead spheres embedded and 50 percent of the individual bead spheres exposed.

3.4.6 Retroreflective Markings

Collect and record readings for white and yellow retroreflective markings at the rate of one reading per 1000 linear feet. The minimum acceptable average for white markings is 250 millicandelas per square meter per lux (mcd/m2/lx) (measured with Retroreflectometer). The minimum acceptable average for yellow markings is 125 millicandelas per square meter per lux (mcd/m2/lx). Compute readings by averaging a minimum of 10 readings taken within the area at random locations. Re-mark areas not meeting the retroreflective requirements stated above.

3.4.7 Material Bond Verification and Operations Area Cleanup for Airfields

Vacuum sweep the aircraft operating area before it is opened for aircraft operations to preclude potential foreign object damaged to aircraft engines. Visually inspect the pavement markings and the material captured by the vacuum. Verify that no significant loss of reflective media has occurred to the pavement marking due to the vacuum cleaning.

-- End of Section --

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SECTION 32 31 13

CHAIN LINK FENCES AND GATES
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PART 1 GENERAL

1.1 Description of Work

The work in this Section shall include the removal of existing fences and gates, and the construction of new fences and gates, as specified herein, as shown on the Drawings, or as otherwise directed by the Engineer.

Removal and reinstallation of fencing and gates shall be performed in a manner that will protect the integrity of the enclosed property and encroachment of unauthorized persons.

1.1.1 Related Sections

1. SUMMARY OF WORK, Section 01 11 00

2. DEMOLITION, Section 02 41 00

1.2 REFERENCES

The publications listed below form a part of this specification to the extent referenced. The publications are referred to within the text by the basic designation only.

ASTM INTERNATIONAL (ASTM)

ASTM A123/A123M	(2017) Standard Specification for Zinc (Hot-Dip Galvanized) Coatings on Iron and Steel Products
ASTM A153/A153M	(2016) Standard Specification for Zinc Coating (Hot-Dip) on Iron and Steel Hardware
ASTM A176	(2009) Standard Specification for Stainless and Heat-Resisting Chromium Steel Plate, Sheet, and Strip
ASTM A36/A36M	(2014) Standard Specification for Carbon Structural Steel
ASTM A392	(2011a; R 2017) Standard Specification for Zinc-Coated Steel Chain-Link Fence Fabric
ASTM A478	(1997; R 2013) Standard Specification for Chromium-Nickel Stainless Steel Weaving and Knitting Wire
ASTM A500/A500M	(2018) Standard Specification for Cold-Formed Welded and Seamless Carbon Steel Structural Tubing in Rounds and Shapes

ASTM A53/A53M	(2018) Standard Specification for Pipe, Steel, Black and Hot-Dipped, Zinc-Coated, Welded and Seamless
ASTM A780/A780M	(2009; R 2015) Standard Practice for Repair of Damaged and Uncoated Areas of Hot-Dip Galvanized Coatings
ASTM F1043	(2018) Standard Specification for Strength and Protective Coatings on Steel Industrial Fence Framework
ASTM F1083	(2018) Standard Specification for Pipe, Steel, Hot-Dipped Zinc Coated (Galvanized) Welded, for Fence Structures
ASTM F1911	(2015) Standard Practice for Installation of Barbed Tape
ASTM F1916	(1998) Standard Specifications for Selecting Chain Link Barrier Systems With Coated Chain Link Fence Fabric and Round Posts for Detention Applications
ASTM F567	(2014a) Standard Practice for Installation of Chain Link Fence
ASTM F626	(2014) Standard Specification for Fence Fittings
ASTM F900	(2011; R 2017) Standard Specification for Industrial and Commercial Swing Gates

INSTITUTE OF ELECTRICAL AND ELECTRONICS ENGINEERS (IEEE)

IEEE C2	(2017; Errata 1-2 2017; INT 1 2017) National Electrical Safety Code

UNDERWRITERS LABORATORIES (UL)

UL 467	(2013; Reprint Jun 2017) UL Standard for Safety Grounding and Bonding Equipment

1.3 SUBMITTALS

Government approval is required for submittals with a "G" designation; submittals not having a "G" designation are for Contractor Quality Control approval. Submit the following in accordance with Section 01 33 00 SUBMITTAL PROCEDURES:

SD-02 Shop Drawings

Details of new fence, gates, fittings, anchorages, including finishes

SD-03 Product Data

New fence and gate materials

SD-06 Test Reports

Test Reports for compliance of installation of chain link fence and gates

SD-08 Manufacturer's Instructions

Manufacturer's product literature on all fence and gate system components, hardware, and coating systems

1.3.1 Shop Drawings

Details of new fence, gates, fittings, anchorages, including finishes shall be submitted.

1.3.2 Product Data

New fence and gate materials product data shall be submitted.

1.3.3 Manufacturer's Instructions

Test Reports for compliance of installation of chain link fence and gates shall be submitted.

1.3.4 Manufacturer's Instructions

Manufacturer's product literature on all fence and gate system components, hardware, and coating systems shall be submitted.

Include materials, sizes and thicknesses of components, fasteners, bracing, hardware, barbed wire, barbed obstacle tape, and accessory items.

1.4 QUALITY CONTROL

Design, supply of equipment and components, installation, and on-call service shall be product of individual company with record of installations meeting requirements specified.

1.4.1 Pre-installation Conference

Conduct conference at Project Site with fence and gate installer to verify layout.

1.5 ACCESS CONTROL

See Specification Section 01 11 00, SUMMARY OF WORK, for access control during construction.

PART 2 PRODUCTS

2.1 Chain Link Fence Fabric

A. Galvanized fabric conforming to ASTM A392, Type II, Class 1, 1.2 ounces per square foot; galvanized after weaving.

B. Height: 8-foot (plus 1-foot barbed tape, where required), unless otherwise shown.

C. Core Wire Gauge: No. 9.

D. Pattern: 1-inch diamond-mesh.

E. Diamond Count: Manufacturer's standard and consistent for fabric furnished of same height.

F. Loops of Knuckled Selvages: Closed or nearly closed with space not exceeding diameter of wire.

G. Wires of Twisted Selvages:

1. Twisted in a closed helix three full turns

2. Cut at an angle to provide sharp barbs that extend minimum 1/4 inch beyond twist

2.2 POSTS

2.2.1 General

1. Strength and Stiffness Requirements: ASTM F1043, heavy industrial fence, except as modified in this section

2. Round Steel Pipe, Schedule 40: ASTM F1083

3. Lengths: Manufacturer's standard with allowance for minimum embedment below finished grade of 34 inches, or as shown on the plans.

4. Protective Coatings: ASTM F1043, Type A external and internal coating

5. All posts/pipes without extension arms shall be furnished with caps.

6. Fabric shall be attached to line posts with 9-gage hot-dip galvanized steel ties at 14-inch maximum intervals.

2.2.2 Line Posts

1. Round Steel Pipe, 2.375 inch outside diameter, 3.65 pounds per foot

2.2.3 End, Corner, Angle, and Pull Posts

Round Steel Pipe, 2.875 inch outside diameter, 5.79 pounds per foot

2.2.4 Latch Posts for Swing Gates

Round Steel Pipe, 4.0 inch outside diameter, 9.12 pounds per foot

2.2.5 Hinge Posts for Swing Gates

1. Gate Leafs 18-Foot or Less - ASTM F900 Round Steel Pipe, 6.625 inch outside diameter, 18.02 pounds per foot

2. Gate Leafs 18-foot to 24-Foot - ASTM F900 Round Steel Pipe, 8.625 inch outside diameter, 27.12 pounds per foot

2.3 TOP, MID, AND BRACE RAILS

2.3.1 Galvanized Round Steel Pipe

ASTM F1083, 1.66 inch outside diameter, 2.27 pounds per foot.

2.3.2 Protective Coatings

Protective Coatings as specified for posts.

2.3.3 Strength and Stiffness Requirements

ASTM F1043, heavy industrial fence

2.4 FENCE FITTINGS

2.4.1 General

In conformance with ASTM F626, except as modified by this Section.

2.4.2 Post and Line Caps

Designed to accommodate passage of top rail through cap, where top rail required.

2.4.3 Tension and Brace Bands

No exceptions to ASTM F626.

2.4.4 Tension Bars

1. One-piece

2. Length not less than 2 inches shorter than full height of chain link fabric

3. Provide one bar for each gate and end post, and two for each corner and pull post.

2.4.5 Truss Rod Assembly

3/8-inch diameter, steel, hot-dip galvanized after threading rod and turnbuckle or other means of adjustment.

2.4.6 Tie Wires, Clips, and Fasteners

According to ASTM F626.

2.4.7 Barbed Tape Supporting Arms

Pressed steel or cast iron with clips, slots, or other means for attaching coils of barbed tape integral with post cap for each post, with V shaped arms for supporting coils of barbed tape. Arms shall withstand 250 pounds of downward pull at outermost ends of the arms without failure.

2.5 TENSION WIRE

Zinc-coated steel marcelled tension wire conforming to ASTM A824, Type II, Class 2.

2.6 TOPPING

Fence topping shall consist of four strands of barbed wire fastened on "V" arms installed on fence posts. Barbed obstacle tape (razor ribbon) shall be laid in the "V" and attached to each strand of barbed wire with hog rings 12-inches on center. The "V" arms shall be of one piece construction, adjustable arms are not allowed. Wire locks or wire ties shall be installed on all "V" arms that do not have a wire restraining system incorporated in their design.

Barbed wire shall be 2-strand, 12½-gage galvanized wire with 14-gage, 4-point barbs at 4 to 5-inch centers.

Barbed obstacle tape (razor ribbon):

1. ASTM A176 reinforced barbed tape, double coil fabricated from 430 series stainless steel with a hardness range of Rockwell (30N) 37-45 minimum.

2. Strips: 0.025 inch thick by 1 inch wide before fabrication, with 1.2 inch long barbs in groups of 4 spaced 4 inches on center.

3. Core Wire: ASTM A478 0.098 inch diameter stainless steel with a minimum tensile strength of 140 psi.

Clips: 0.065-inch thick by 0.375-inch wide stainless steel.

Tie Wires: 0.065-inch diameter, stainless steel.

2.7 GATES

2.7.1 General

2.7.1.1 Gate Operation

Opened and closed easily by one person.

2.7.1.2 Metal Pipe and Tubing

Galvanized steel. Comply with ASTM F1043 and ASTM F1083 for materials and protective coatings.

2.7.1.3 Frames and Bracing

Fabricate members from round galvanized steel tubing with outside dimension and weight according to ASTM F900.

2.7.1.4 Gate Frames

Rigid construction, free from sags and twist with intermediate horizontal tubular members and two 3/8-inch diagonal truss rods. For gate leaves greater than 8-feet long, provide a vertical tubular brace at midpoint of leaf and two 1/2-inch diagonal truss rods each bay.

2.7.1.5 Gate Fabric Height

Same as for adjacent fence height.

2.7.1.6 Welded Steel Joints

Welded steel joing shall be painted with zinc-based paint.

2.7.1.7 Chain Link Fabric

Attached securely to gate frame at intervals not exceeding 15 inches.

2.7.1.8 Gate Posts and Frame Members

Extend gateposts and frame end members above top of chain-link fabric at both ends of gate frame to attach 3 strands of barbed wire and barbed tape assemblies. Close any gaps in razor ribbon between gate post and gate frame extension toppings to prevent climbing of gate posts.

2.7.1.9 Tack Welding

All gate hardware and fasteners shall be tack welded after installation. Treat areas with galvanizing repair paint after tack welding.

2.7.2 Swing Gates

2.7.2.1 Leaf Width

Leaf width as shown.

2.7.2.2 Hinges

Hinges shall be of offset type, malleable iron.

2.7.2.3 Latches/Locking Device

Latches/Locking Devices shall be fabricated of steel padlock assembly as shown on the drawings, hot dip galvanized after fabrication.

2.7.2.4 Hold-Open Keepers

Hold-Open Keepers shall be designed to automatically engage gate leaf and hold it in open position until manually released.

2.8 CONCRETE

A. Concrete for post anchorage shall be portland cement concrete which complies with State Standard Specification Section 90 for "Minor Concrete" with not less than 550 pounds of cementitious material per cubic yard.

2.9 FENCE GROUNDING

2.9.1 Conductors

Conductors shall be of bare, solid wire for No. 6 AWG and smaller; stranded wire for No. 4 AWG and larger:

1. Material above Finished Grade: Copper.

2. Material on or below Finished Grade: Copper.

3. Bonding Jumpers: Braided copper tape, 1-inch wide, woven of No. 30 AWG bare copper wire, terminated with copper ferrules.

2.9.2 Connectors and Grounding Rods

Connectors and Grounding Rods shall comply with UL 467.

1. Connectors for Below-Grade Use: Exothermic welded type.

2. Grounding Rods: Copper-clad steel.

2.10 STEEL FABRICATIONS

2.10.1 Steel Plates, Shapes, and Bars

ASTM A36/A36M.

2.10.2 Steel Tubing

ASTM A500/A500M, cold-formed steel tubing.

2.10.3 Steel Pipe

ASTM A53/A53M, standard weight (Schedule 40) unless otherwise indicated.

2.11 MISCELLANEOUS MATERIALS

2.11.1 Welding Rods and Bare Electrodes

Select according to AWS specifications for metal alloy welded.

2.11.2 Galvanizing Repair Paint

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

2.12 2.12 FABRICATION GENERAL

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

Form exposed work exposed to view with accurate angles and surfaces and straight edges. Grind smooth all welds and joints.

Weld Corners and seams continuously to comply with the following:

1. Use materials and methods that minimize distortion and develop strength and corrosion resistance of base metals.

2. Obtain fusion without undercut or overlap.

3. Remove welding flux immediately.

4. At exposed connections, finish exposed welds and surfaces smooth and blended so no roughness shows after finishing and contour of welded surface matches that of adjacent surface.

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

2.13 STEEL AND IRON FINISHES

2.13.1 Galvanizing

Hot-dip galvanize all items unless noted otherwise, to comply with ASTM A153/A153M for steel and iron hardware and with ASTM A123/A123M for other steel and iron products.

PART 3 EXECUTION

3.1 GENERAL

Install chain link fences and gates in accordance with ASTM F567, except as modified in this section, and in accordance with fence manufacturer's recommendations, as approved by Engineer. Erect fencing in straight lines between angle points.

Provide necessary hardware for a complete fence and gate installation.

Any damage to galvanized surfaces, including welding, shall be repaired with paint containing zinc dust in accordance with ASTM A780/A780M.

Lubricate the rollers and other gate hardware after installation and coating.

3.2 PRODUCT DELIVERY, STORAGE, AND HANDLING

3.2.1 Delivery of Materials

Manufactured materials shall be delivered in containers or packages approved by the manufacturer. Gate products shall have tags bearing the names of the manufacturer and item.

3.2.2 Storage

Products shall be carefully stored above ground in a manner acceptable to the manufacturer, in an area that is protected from all deleterious elements. Storage conditions shall prevent damage to the product or marring of finishes.

3.3 PREPARATION

Obstructions which interfere with the proper alignment of gates shall be removed. The Contractor shall verify any grade change and surface irregularities and make adjustments as needed.

Stake locations of fence lines, gates, and terminal posts. Do not exceed intervals of 500 feet or line of sight between stakes. Indicate locations of utilities, lawn sprinkler system, underground structures, benchmarks, and property monuments.

Embedment Coating: Coat portion of galvanized or aluminum-coated steel posts that will be embedded in concrete as specified. Extend coating 1 inch above top of concrete.

Discrepancies between the shop drawings and field conditions shall be brought to the attention of the Engineer immediately upon discovery.

3.4 POST SETTING

Drill or hand-excavate holes for posts to diameters and spacing indicated, in firm, undisturbed soil. Driven posts are not acceptable. Postholes shall be clear of loose materials. Waste materials from postholes shall be removed from site.

Posthole Depth

1. Minimum 3 feet below finished grade

2. 2 inches deeper than post embedment depth below finish grade

Set posts with minimum embedment below finished grade of 34 inches and with top rail at proper height above finished grade. Verify posts are set plumb, aligned, and at correct height and spacing. Brace posts, as necessary, to maintain correct position and plumbness until concrete sets.

Backfill postholes with concrete to 2 inches above finished grade. Vibrate or tamp concrete for consolidation. Protect above ground portion of posts from concrete splatter.

Before concrete sets, crown and finish top of concrete to readily shed water.

Terminal Posts: Locate terminal end, corner, and gate posts in accordance with ASTM F567 and terminal pull posts at changes in horizontal or vertical alignment of 15 degrees or more.

Line Posts: Space line posts uniformly at 10 feet on centers between terminal end, corner, and gate posts.

3.5 POST BRACING

Install according to ASTM F567, maintaining plumb position, and alignment of fencing. Install braces at gate, end, pull, and corner posts diagonally to adjacent line posts to ensure stability. Install braces on both sides of corner and pull posts.

Locate horizontal braces at mid-height of fabric or higher, on fences with top rail, and 2/3-fabric height on fences without top rail. Install so posts are plumb when diagonal truss rod assembly is under proper tension.

3.6 TOP RAILS

Install according to ASTM F567, maintaining plumb position and alignment of fencing. Run rail continuously through line post caps and terminating into rail end attached to posts or posts caps fabricated to receive rail at terminal posts. Install top rail sleeves with springs at 105 feet maximum spacing to permit expansion in rail.

3.7 BARBED WIRE SUPPORT ARMS

Barbed wire support arms shall be installed as indicated and as recommended by manufacturer. Bolt or rivet supporting arm to top of post in a manner to prevent easy removal with hand tools.

3.8 TENSION WIRE

Install according to ASTM F567 and ASTM F1916, maintaining plumb position and alignment of fencing. Pull wire taut, without sags. Fasten fabric to tension wire with tie wires at a maximum spacing of 24 inches on center.

Install tension wire within 6 inches of bottom of fabric and tie to each post with not less than same diameter and type of wire.

3.9 CHAIN LINK FABRIC

Do not install fabric until concrete has cured minimum 7 days.

Apply fabric to outside of enclosing framework. Pull fabric taut to provide a smooth and uniform appearance free from sag, without permanently distorting fabric diamond or reducing fabric height. Tie fabric to posts, rails, and tension wires. Anchor to framework so fabric remains under tension after pulling force is released.

Splicing shall be accomplished according to ASTM F1916 by weaving a single picket into the ends of the rolls to be joined.

Leave 2 inches between finish grade and bottom selvage, unless otherwise indicated.

Tension or Stretcher Bars: Thread through fabric and secure to end, corner, pull, and gate posts with tension bands spaced not more than 15 inches on center.

T ie Wires: Fasten ties to wrap a full 360 degrees around rail or post and a minimum of one complete diamond of fabric. Twist ends of tie wire three full twists, and cut off protruding ends to preclude untwisting by hand.

1. Maximum Spacing: Tie fabric to line posts at 12 inches on center and to brace and top rails at 24 inches on center.

3.10 BARBED WIRE AND RAZOR RIBBON

Secure to support arms to prevent movement or displacement according to ASTM F1911.

3.11 GATES

Install gates according to manufacturer's written instructions, level, plumb and secure for full opening without interference. Attach fabric and hardware to gate using tamper-resistant or concealed means. Adjust hardware for smooth operation and lubricate where necessary so gates operate satisfactorily from open or closed position.

3.12 ELECTRICAL GROUNDING

Ground fences in accordance with applicable requirements of IEEE C2, National Electrical Safety Code.

Protection at Crossings of Overhead Electrical Power Lines: Ground fence at location of crossing and at a maximum distance of 150 feet on each side of crossing.

Grounding Method: At each grounding location, drive a grounding rod vertically until top is 6 inches below finished grade. Connect rod to fence with No. 6 AWG conductor. Connect conductor to each fence component at grounding location.

3.13 ADJUSTING AND CLEANING

3.13.1 Galvanized Surfaces

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

3.14 FIELD QUALITY CONTROL

3.14.1 Post and Fabric Testing

Test fabric tension and line post rigidity according to ASTM F1916.

3.14.2 Gate Tests

1. Prior to acceptance of installed gates, demonstrate proper operation of gates under each possible open and close condition specified.

2. Adjust gate to operate smoothly, easily, and quietly, free of binding, warp, excessive deflection, distortion, nonalignment, misplacement, disruption, or malfunction, throughout entire operational range.

3. Confirm that latches and locks engage accurately and securely without forcing and binding.

3.15 CLEANUP

Remove excess fencing materials and other debris from site.

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PIPE GATES AND POST & CABLE FENCES

04/08

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SECTION 32 31 26

PIPE GATES AND POST & CABLE FENCES
04/08

PART 1 GENERAL

1.1 REFERENCES

The publications listed below form a part of this specification to the extent referenced. The publications are referred to within the text by the basic designation only.

ASTM INTERNATIONAL (ASTM)

ASTM A1085/A1085M	(2015) Standard Specification for Cold-Formed Welded Carbon Steel Hollow Structural Sections (HSS)
ASTM A153/A153M	(2016) Standard Specification for Zinc Coating (Hot-Dip) on Iron and Steel Hardware
ASTM A641/A641M	(2009a; R 2014) Standard Specification for Zinc-Coated (Galvanized) Carbon Steel Wire
ASTM A702	(2013) Standard Specification for Steel Fence Posts and Assemblies, Hot Wrought
ASTM A780/A780M	(2009; R 2015) Standard Practice for Repair of Damaged and Uncoated Areas of Hot-Dip Galvanized Coatings
ASTM C94/C94M	(2017a) Standard Specification for Ready-Mixed Concrete
ASTM F1083	(2018) Standard Specification for Pipe, Steel, Hot-Dipped Zinc Coated (Galvanized) Welded, for Fence Structures
ASTM F1145	(2011) Standard Specification for Turnbuckles, Swaged, Welded, Forged
ASTM F1184	(2016) Industrial and Commercial Horizontal Slide Gates
ASTM F626	(2014) Standard Specification for Fence Fittings
ASTM F900	(2011; R 2017) Standard Specification for Industrial and Commercial Swing Gates

1.2 SUBMITTALS

Submit the following in accordance with Section 01 33 00 SUBMITTAL PROCEDURES:

SD-02 Shop Drawings

Installation Drawings
Fence Installation
Location of gate, corner, end, and pull posts
Gate Assembly
Gate Hardware and Accessories

SD-03 Product Data

Manufacturer's Instructions (if using a pre manufactured pipe gate approved by the Agency)
Gate Assembly
Gate Hardware and Accessories

SD-04 Samples

Turnbuckles
Gate Lock Box Assembly

1.3 QUALITY ASSURANCE

Provide manufacturer's instructions that detail proper assembly and materials in the design for fence, gate assembly, gate hardware and accessories. Submit Installation drawings clearly indicating Fence Installation Location of gate, corner, end, and pull posts; Gate Assembly, Gate Hardware, catalog data and Accessories.

1.4 DELIVERY, STORAGE, AND HANDLING

Deliver materials to site in an undamaged condition. Store materials off the ground to provide protection against oxidation caused by ground contact. Prior to shipment of final products all submittals in section 1.2 shall have been reviewed

PART 2 PRODUCTS

2.1 FENCE CABLE

Provide 1/4 inch Diameter Galvanized steel wire meeting specifications of ASTM A641/A641M.

2.2 PIPE GATE PIPES

Provide gate type and swing shown conforming to ASTM F900 and/or ASTM F1184, ASTM A153/A153M. Gate frames shall conform to strength and coating requirements of ASTM F1083 for Group IA, steel pipe, with external coating Type A, nominal pipe size (NPS) 3. Gate leaves more than 8 feet wide shall have either intermediate members and diagonal truss rods or tubular members as necessary to provide rigid construction, free from sag or twist. Gate leaves less than 8 feet wide shall have truss rods or intermediate braces. Furnish latches, hinges, stops, keepers, gate lock box, and other hardware items as required for the operation of the gate. Provide stops for holding the gates in the open position.

2.3 GATE & FENCE POSTS AND PIPE BRACING

2.3.1 Metal Fence Posts

Provide metal posts conforming to ASTM A702 zinc-coated, length as indicated, galvanized steel pipe A53 Grade B, nominal pipe size NPS 2-1/2 and accessories conforming to ASTM A702.

2.3.2 Hollow Structural Sections (HSS) Metal Gate Posts

Provide HSS posts to the dimensions and sizes shown in the plans that meet the specifications of ASTM A1085/A1085M.

2.4 BRACES AND TRUSS RODS

Fence pipe braces shall meet the specifications of ASTM F1083 and shall be zinc-coated, Group IA, steel pipe, size NPS 1-1/4. Truss rods shall meet the specifications of ASTM F626 and shall be a diameter of 3/8 inches.

2.5 CONCRETE

ASTM C94/C94M, using 3/4 inch maximum size aggregate, and having minimum compressive strength of 4000 psi at 28 days. Provide grout consisting of one part portland cement to three parts clean, well-graded sand and the minimum amount of water to produce a workable mix.

2.6 TURNBUCKLE

Provide turnbuckles conforming to ASTM F1145, 5/16 inch diameter with 4-1/2 inch adjustments.

2.7 GATE LOCK BOX

Provide an access gate lock box assembly for each gate as specified in plans.

PART 3 EXECUTION

3.1 INSTALLATION

Install fence to the lines and grades indicated. Clear the area identified to construct the fence or pipe gate. Space fence posts equal distant at intervals not exceeding 10 feet. Set terminal (corner, gate, and pull) posts at abrupt changes in vertical and horizontal alignment and for runs to not exceed 1000 feet. Provide continuous cable up to and after terminal post sections. Cable runs shall not exceed 1000 feet. Terminal posts on relatively flat runs and at gates shall be braced with 1-1/4 inch braces at the top and 3/8 inch truss rods crossed diagonally as shown in plans. For terminal runs at corners or on changes in slope shall be braced diagonally with 1-1/4 inch brace. Any damage to galvanized surfaces, including welding, shall be repaired with paint containing zinc dust in accordance with ASTM A780/A780M.

3.2 EXCAVATION

Clear loose material from all post holes. Spread waste material on levee slopes, inside the O&M corridor, but not atop aggregate base or as directed by the Agency. Eliminate ground surface irregularities along the fence line to the extent necessary to maintain a clearance adequate to install any bracing pipes, truss rods and any associated fitting hardware.

3.3 POST INSTALLATION

For fence and gate posts set posts plumb and in proper alignment. Drive metal posts or set in concrete as indicated. Gate HSS posts are to be filled with concrete and weld a 1/4 inch cap to top of HSS posts, weld hinges to the main gate post and weld lock box to cap on gate locking post as shown on plans.

3.4 GATE ASSEMBLY

Weld and assemble gate as shown on plans or as specified by the gate manufacturer instructions if using a pre manufactured gate approved by the Agency.

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EROSION CONTROL SEEDING

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SECTION 32 92 19

EROSION CONTROL SEEDING

PART 1 GENERAL

1.1 SCOPE

Perform erosion control seeding on reconstructed levee side slopes and restored access and haul roads and staging areas as specified herein, as shown on the Plans, or as otherwise indicated on the storm water pollution prevention plan.

1.2 QUALITY ASSURANCE

There shall be no substitutions of seed species or variety as shown in seed mix tables unless authorized by the Contracting Officer.

Seed materials, including the seed mix, fertilizer, and mulch, shall be delivered by the Contractor to the job site with durable, waterproof labels indicating the correct species, variety, percent live seed (PLS) and other certifications, and the supplier's name, in conformance to these Specifications. The Contracting Officer will observe the seed mix, fertilizer, and mulch material as it is being delivered to the site for conformity to these Specifications. Such reviews shall not impair the right of additional observations during further progress of the work.

The Contractor shall be responsible for storing and maintaining the seed mix, fertilizer, and mulch as delivered throughout the Construction Period.

1.3 SUBMITTALS

Government approval is required for submittals with a "G" designation; submittals not having a "G" designation are for information only. When used, a designation following the "G" designation identifies the office that will review the submittal for the Government. Submit the following in accordance with Section 01 33 00 SUBMITTAL PROCEDURES:

SD-04 Samples

SEED MATERIALS; G

SD-07 Certificates

Invoices

1.4 SEED MATERIALS

The Government may at any time request, test, and analyze seed materials including the seed mix, fertilizer, or mulch to ensure their conformance to these Specifications. The Contractor shall furnish, at no additional cost, the requested materials for the Government's use. Seed materials not meeting the Government's approval shall immediately be removed from the project site at the Contractor's expense. The Contractor shall incur any additional expenses required because of materials not meeting the requirements of these Specifications. The following shall be submitted by the Contractor according to submittal procedures included in the Contract. The Contractor shall furnish, at no additional cost, the requested materials for the Government's review.

1. Seed mix verification by way of certified mix labels from supplier in sealed seed mix bags. In addition, the Contractor shall submit a 5 pound bag of the seed mix for review before any seeding operations.

2. Before delivery of the straw and fertilizer material to the project site, the Contractor shall provide the material order and the name, address and telephone number of the material supplier. In addition, the Contractor shall submit mulch and fertilizer material samples in 5 pound bags, each, for review before any seeding operations.

1.5 INVOICES

Duplicate copies of invoices for all materials. Invoices for fertilizer shall show the grade furnished.

PART 2 PRODUCTS

2.1 MATERIALS

2.1.1 Seed

2.1.1.1 Seed Species and Planting Rates

The following grass seeds shall be applied at the following Pure rates.

Botanical Name	Common Name	**Qty**
Bromus carinatus	California brome	5 lbs/acre
Bromus hordeaceous	Blando brome	15 lbs/acre
Eschscholzia californica	California poppy	5 lbs/acre
Leymus triticoides	Creeping wildrye	5 lbs/acre
Lupinus bicolor	Miniature lupine	3 lbs/acre
Trifolium wildenovii	Tomcat clover	3 lbs/acre
Vulpia microstachys	Three week fescue	5 lbs/acre
Vulpia myuros	Zorro fescue	10 lbs/acre

2.1.2 Fertilizer

Fertilizer shall be liquid, of the concentrations indicated below:

Item	Ratio
Nitrogen (nitrate)	8
Phosphorus (Ammonium Polyphoshate)	24
Potassium (Potassium Sulfate)	3
Zinc (Zinc Sulfate)	0.25
Sulfur (Ammonium Thiosulfate)	2.5

Fertilizer shall be delivered in containers labeled in accordance with applicable State regulations and bearing the warranty of the producer for the grade furnished.

2.1.3 Fiber Mulch

Fiber mulch shall be dyed wood cellulose fiber specially prepared for hydroseeding.

2.1.4 Straw Mulch

Straw mulch shall be derived from rice, seedless wheat or native grass hay. The Contractor shall furnish evidence that clearance has been obtained from the County Agricultural Commissioner, as required by law, before straw obtained from outside the county in which it is to be used is delivered to the site of the work. Straw that has been used for stable bedding shall not be used. Straw shall be free of mold. Straw shall be cured and dry with no water added after baling.

2.1.5 Water

Water shall be furnished by the Contractor, in conformance with these Specifications, and shall be free of chemicals detrimental to the seed mixture.

2.1.6 Stabilizing Emulsion (Tackifier)

Stabilizing emulsion shall be in a dry powder form, may be re-emulsifiable and shall be a processed organic derivative of Plantago insularis used as a soil binder.

PART 3 EXECUTION

3.1 PREPARATION

3.1.1 General

The Contractor shall be responsible for coordinating all site preparation and seeding operations with seasonal water levels.

3.1.2 Debris Removal

Prior to ground surface preparation operations, Contractor shall remove and dispose of all wire, rubbish, stones, and other material that might hinder proper grading and subsequent maintenance.

3.1.3 Surface Preparation

Slopes shall be prepared consistent with 31 00 00 EARTHWORK, section 3.4.4 "Topsoil" prior to application of seeding. When conditions are such, by reason of excessive moisture or other factors, that satisfactory results are not likely to be obtained, the work shall be stopped and shall be resumed only when directed by the Contracting Officer.

3.2 METHOD OF SEEDING

3.2.1 Hydroseeding

The seed and fertilizer shall be mixed with cellulose fiber and water to form a slurry. Mix the slurry in tanks having continuous agitation so that a homogeneous mixture is discharged hydraulically through hoses on the area to be seeded.

a. Apply seed, fertilizer, and mulch in suspension at the following rates:

   Seed - At rates specified in the Seed Mix Tables

   Fertilizer - 150 pounds per acre

   Fiber Mulch - 500 pounds per acre

b. Following the application of seed mix, straw mulch shall be pneumatically applied to the area seeded, at a rate of 3,000 pounds per acre.

c. Following the application of straw mulch, a stabilizing emulsion and fiber mulch mixture shall be hydraulically applied to the area strawed, at the following rates:

   Stabilizing emulsion - 100 pounds per acre

   Fiber Mulch - 1,000 pounds per acre

3.3 ESTABLISHMENT

3.3.1 Period

The Contractor shall be responsible for the proper care of the seeded areas until May 1 of the year following the seeding, or until the desired stand of vegetation is established. The desired stand of vegetation is defined as a minimum of 85 percent coverage of the area seeded. The need for repairing and reseeding (as described herein) within the establishment period shall be as determined by the Government.

3.3.2 Protection

Protect areas susceptible to vehicular or heavy foot traffic by erecting suitable barricades immediately after seeding is completed and/or by placing warning signs of a type reviewed by the Government.

3.4 REPAIR

3.4.1 General

When any portion of the ground surface becomes rilled, gullied or otherwise damaged following seeding within the period of Contractor's responsibility, repair the affected portion to re-establish the condition and grade of the soil prior to planting and then reseed as specified for initial planting, all at no cost to the Government.

3.4.2 Reseeding

When it becomes evident that the seeding has been unsuccessful, the Government will require that these areas be reseeded with the same seed and quantity as specified for the initial seeding. Complete reseeding within fifteen (15) days following notification. Prepare the area to be reseeded as directed by the Contracting Officer. Reseeding due to damaged or deficient seed material or improper application will be completed at no additional cost to the Government.

3.4.3 Replacement of Straw Mulch, Fiber, and Tackifier

Slopes of 3:1 or steeper where erosion has occurred, or where straw mulch has blown or washed away within the period of Contractor's responsibility shall have straw, fiber, and tackifier reapplied at the rate and method described in Sections 3.3.1 at no additional cost to the Government.

3.5 FIELD QUALITY CONTROL

During the course of work or upon completion of the Project, a check of the quantities of materials will be made against the areas treated, and if the minimum rates of application have not been met, the Contracting Officer will require the distribution of additional quantities of those materials to make up the minimum applications specified.

-- End of Section --

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RELIEF WELLS
04/08

PART 1 GENERAL

1.1 SCOPE

The work covered by this Section consists of furnishing all labor, equipment, and materials for installing new relief wells and drain pipe outlet works in accordance with these Specifications and applicable Drawings. Installation of the relief wells and outlet works includes but is not limited to the following:

a. Drilling pilot hole and wells, including sampling and laboratory testing.
b. Installing relief wells and associated components including filter pack.
c. Performing pumping tests.
d. Installing relief well outlet works.
e. Logging well drilling, relief well installation, and pumping tests.

1.2 REFERENCES

The publications listed below form a part of this specification to the extent referenced. The publications are referred to within the text by the basic designation only.

AMERICAN WATER WORKS ASSOCIATION (AWWA)

AWWA A100	(2015) Water Wells
AWWA C104	Cement-Mortar Lining for Ductile-Iron Pipe and Fittings for Water
AWWA C110	Ductile-Iron and Gray-Iron Fittings for Water
AWWA C151	Ductile-Iron Pipe, Centrifugally Cast, for Water or Other Liquids

ASTM INTERNATIONAL (ASTM)

ASTM A312/A312M	(2017) Standard Specification for Seamless, Welded, and Heavily Cold Worked Austenitic Stainless Steel Pipes
ASTM A53/A53M	(2018) Standard Specification for Pipe, Steel, Black and Hot-Dipped, Zinc-Coated, Welded and Seamless
ASTM C136	(2006) Standard Test Method for Sieve Analysis of Fine and Coarse Aggregates
ASTM C33/C33M	(2018) Standard Specification for Concrete Aggregates

ASTM C94/C94M	(2017a) Standard Specification for Ready-Mixed Concrete
ASTM D6913	(2017) Particle-Size Distribution of Soils using Sieve Analysis

STATE OF CALIFORNIA DEPARTMENT OF WATER RESOURCES (DWR)

Bulletin 74-90	(1991) California Well Standards

1.3 QUALITY CONTROL

1.3.1 General

The Contractor shall perform inspections, sampling and testing, and corrective actions and shall submit the required reports to substantiate compliance with this Section. The Contractor shall have personnel sufficient in number and qualifications to monitor at all times the relief well construction activities. The relief well construction must be performed by a licensed well driller holding a valid California C-57 Contractors license. The Contractor shall submit a resume or statement of Qualifications for the project manager, and submit qualifications, certifications, and key staff for commercial testing laboratories or engineering firms that will perform material sampling, testing, and inspection.

1.3.2 Inspection

The Contractor shall be responsible to observe and control, for compliance with the Specifications, all relief well construction including, but not limited to, the following:

A. Survey Layout
B. Materials and material storage
C. Drilling methods
D. Well pipe assembly and installation, including joints and end cap
E. Filter pack installation
F. Cleaning, development, and pumping tests
G. Installing relief well outlet works.

The detailed inspection may be assigned to the construction foreman supervising the work.

1.3.3 Sampling and Testing

The Contractor shall verify that all relief well materials conform to these Specifications before delivery to the project site.

1.3.4 Corrective Action

When quality control monitoring or testing detects non-conformance with these Specifications, corrective action shall be taken. The details of the non-conformance and the actions taken to correct them shall be reported immediately to the Government and shall be included in the daily Contractor Quality Control report. Corrective action shall include steps taken to assure against recurrence of the non-conformance.

1.3.5 Protection

Completed relief wells shall be protected against damage and contamination.

1.4 DEFINITIONS

1.4.1 Relief Well

Relief wells as used in this Section refer to vertically installed wells that include a well screen surrounded by a filter material that is designed to prevent in-wash of foundation materials into the well and provide release of excess pore water pressure.

1.4.2 Well Driller

The Contractor shall submit a resume or statement of qualifications for the well driller. The Well Driller shall be a Contractor licensed in accordance with the provisions of the California Contractors Licenses Law (Chapter 9, Division 3, of the Business and Professional Code) and holding a valid California C-57 Contractors license.

1.4.3 Relief Well Specialist

The Contractor shall submit a resume or statement of qualifications for the relief well specialist. A relief well specialist is an individual who has had five (5) years of experience in the drilling and installation of relief wells or water wells and has knowledge in all aspects of relief well construction, which includes, but is not limited to:

A. Drilling, sampling, and setting of large diameter conductor casings;
B. Drilling of large diameter relief wells;
C. Installation of well casing and screen assembly;
D. Placing gravel pack;
E. Development of completed wells;
F. Conducting pumping tests.

1.5 SUBMITTALS

The following shall be submitted in accordance with Section 01 33 00 SUBMITTAL PROCEDURES:

SD-01 Preconstruction Submittals

Qualifications; G

Relief Well Installation Plan; G, DO, RO

Well Development Plan; G, DO

Materials; G, DO

Permits

SD-06 Test Reports

Grain Size Data; G, DO

SD-11 Closeout Submittals

As-built Drawings and Records; G, DO

1.6 QUALIFICATIONS

A. Resumes or statement of qualifications for project manager, relief well specialist, and well driller. Drilling of large diameter relief wells;

B. Qualifications, certifications, and key staff for commercial testing laboratories or engineering firms that will perform material sampling, testing, and inspection.

1.7 RELIEF WELL INSTALLATION PLAN

Provide a plan for drilling pilot holes at least 8 weeks in advance of the beginning of relief well construction. The plan shall include, but not be limited to:

A. Well driller, equipment and methods of drilling for relief well boreholes.

B. Sources and manufacturers' information for all materials to be used and details of construction or installation methods. This includes but is not limited to well screen, filter pack material, method for placing filter pack material, and cement grout mixture proportions.

C. Length of time between ordering and delivery to the site (lead time) for relief well screens, casing pipe, filter pack materials, and other components of the relief wells that require a lead time of more than one (1) week.

D. Methods and equipment proposed for developing the well and for performing pumping tests.

E. Details of specific methods to be employed to control potential contamination or pollution arising from well installation activities.

F. Work plan for T-Flange installation.

G. Mix design and material information from the suppliers for grout, CLSM and concrete to be placed at the top of the well.

H. Details of drain pipe outlet works including installation methods.

I. Copies of all applicable local, state, and federal permits.

J. Trench excavation and preservation of existing geotextile, including tying of new geotextile to existing geotextile.

K. Excavation and backfill plan. Backfill needs to be in accordance with embankment construction for Soil Type 3 criteria, per Section 31 00 00 EARTHWORK, whenever re-using excavated soil from slopes.

1.8 MATERIALS

A. Before installation all materials for relief well construction shall be s ubmitted to the Government for approval at least 30 days before relief well installation. This includes but not limited to all well screen, filter pack material, well casing, conductor casing, and cement grout proportions.

B. Collect and provide samples of subsurface material as instructed by the Government.

1.9 PERMITS

All work shall conform to the requirements of the State of California, Department of Water Resources; Sacramento County, Environmental Health Services; and any local health departments as applicable. All permitting, licensing, and submittal requirements are the responsibility of the Contractor.

1.10 GRAIN SIZE DATA

Submit grain size distribution for filter pack.

1.11 AS-BUILT DRAWINGS AND RECORDS

Upon completion of the installation of the relief well and drainage systems, the Contractor shall submit to the Agency, As-Built Drawings which shall accurately depict details of the relief well and drainage system construction. The As-Built Drawings shall include:

A. Well casing and screen details including materials, size, length, slot size, and installation details and data;

B. Outlet works details;

C. Schedule of Materials describing the length of each section of well screen and casing used to meet the total lengths specified for each well.

D. Pumping test data.

E. Well Development Data

F. Map with survey locations.

1.12 RELIEF WELL DESIGN

The typical relief well design is shown on the Drawings. The Government anticipates that the depths of the completed holes, screen slot size, screen locations, and screen lengths may differ from those shown on the Drawings. As such, the Contractor shall wait for the Government's final well designs before ordering well casing and well screens. In any case, well screens shall be ordered by the Contractor in lengths consistent with the Government's final design not to exceed 20 feet per screen section. The final design lengths for the well construction will be determined by the Government based on the samples from the previously drilled boreholes at the well locations. The Contractor shall wait for the Government to provide final designs for the relief wells. The depths will be field verified during installation.

1.13 DISPOSAL OF DEBRIS

The Contractor shall legally dispose of all debris resulting from relief well construction operations off-site.

PART 2 PRODUCTS

2.1 CONDUCTOR CASING

2.1.1 General

The conductor casing shall be of black steel pipe, conforming to ASTM A53/A53M.

The casing shall be 20-inches in outer diameter with a wall thickness of 1/4-inch. Joints, if any, shall be field welded and inspected in accordance with AWS requirements.

2.2 WELL SCREEN AND CASING

2.2.1 General

Well screen and casing shall be of the type and dimensions specified in this Section and as shown on the Plans. Screen openings shall be uniform in size and pattern and shall be spaced approximately equally around the circumference of the pipe. Before installation, all well screen shall be reviewed by the Government.

2.2.2 Stainless Steel Well Screen and Casing

2.2.2.1 General

The well screen shall be of the continuous slot, wire-wound design and shall be fabricated by circumferentially wrapping a triangularly shaped wire around a circular array of internal rods. The wire configuration shall produce inlet slots with sharp outer edges, widening inwardly so as to minimize clogging. Each juncture between the horizontal wire and the vertical rods shall be fusion welded under water by the electrical resistance method.

2.2.2.2 Materials

All pipes, rods, bars, wire, couplings and any other fittings shall be stainless steel conforming to ASTM A312/A312M Grade TP-316L, for both screen and casing.

2.2.2.3 Well Screen

The well screen shall have a minimum clear inside diameter of 8 inches and a maximum outer diameter of 8-5/8 inches. The width of the clear space between the wire wrappings (slot size) shall be either 0.010-inch, 0.030 inch, or 0.040-inch as directed by the Contracting Officer based on results of the drilled borehole sampling and shall provide a total open area as recommended by the manufacturer for the specific screen size. Collapse, column, and tensile strengths of the well screens shall be designed to allow safe installation and development of wells for a 70-foot design. It is anticipated that the screened interval in some of the holes will need to be lengthened or shortened from that shown on the Drawings. The Contractor shall provide well screen as per the final well designs.

2.2.2.4 Well Screen Coupling

Couplings for the stainless steel well screen shall be fitted with weld rings consisting of the same material as the well screen and casing. The couplings shall conform in design to the couplings recommended by the manufacturer of the well screen and casing. Joints shall be designed and constructed to support the weight of a casing assembly (70-foot to provide a safety factor).

2.2.2.5 Well Casing

The relief well casing shall be Schedule 10 wall thickness with a minimum inside diameter of 8 inches. The casing and fittings shall be manufactured from stainless steel conforming to ASTM A312/A312M Grade TP-316L. The pipe roundness, wall thickness, and straightness shall meet the applicable ASTM specifications. Discharge details at the top of the casing shall be as shown on the Drawings.

2.2.2.6 Riser Pipe

The relief well riser pipe material and method of manufacture shall conform to the requirements specified in paragraph 2.2.2 Stainless Steel Well Screen and Casing and shall be schedule 10 wall thickness. The relief well riser pipe shall have an inside diameter approximately equal to the nominal well diameters provided on the Drawings but not less the inside diameter of the well screens to which they are attached. Discharge details shall be as shown on the Drawings. Couplings to the well screen and between the riser pipe sections shall be as specified for well pipes.

2.2.2.7 Tail Pipe

The relief well shall be fitted with 2-foot sections of tail pipe as shown in the Drawings, to be constructed below the well screen from the type of stainless steel material used for the well casing as specified in paragraph 2.2.2.5 Well Casing. The purpose of the tail pipe assembly is to provide a sediment trap for materials entering the well through the well screen.

2.2.2.8 Bottom Plug for Tail Pipe

The bottom plug for each tail pipe shall be made of the same material and at least the same minimum thickness as the tail pipe. Plugs shall be the same diameter as the outside of the screen and fastened to the bottom of the tail pipe portion in an approved manner.

2.2.3 Drainage Gates

Drainage Gates shall be heavy-duty with circular opening and double-hinged. Top pivot points shall be adjustable. The seat shall be one-piece cast iron with a raised section around the perimeter of the waterway opening to provide the seating face. The seating face of the seat shall be bronze. The cover shall be one-piece cast iron with necessary reinforcing rib, lifting eye for manual operation, and bosses to provide a pivot point connection with the links. The seating face of the cover shall be bronze. Links or hinge arms shall be cast or ductile iron. Holes of pivot points shall be bronze brushed. All fasteners shall be either galvanized steel, bronze or stainless steel. The drainage gates shall be designed to close at an angle of 5 Degrees from the vertical. Means of adjusting the position of the flap shall be provided to ensure proper seating. The gates shall be provided by a manufacturer regularly engaged in the production of this type of equipment. New gates shall be painted with a water resistant, rust preventative paint.

2.3 RELIEF WELL OUTLET WORKS

Provide drain pipes, enclosures, and other outlet works components according to the sizes and materials shown on the Drawings. Drain pipe shall be ductile iron pipe conforming to AWWA C104, AWWA C110, and AWWA C151.

2.4 FILTER PACK MATERIALS

2.4.1 General

Material for the filter pack around the casings and screens shall be washed fine sand, coarse sand, or fine gravel composed of hard, non-carbonate, durable particles free from adherent coating. The filter pack material shall not contain detrimental quantities of organic matter or soft, friable, thin, or elongated particles.

2.4.2 Filter Pack Gradation

The filter pack design will be based on data collected from the previously drilled boreholes at the well locations. The Government will provide the final filter pack gradation. The Contractor shall submit a sample and grain distribution of the procured filter pack prior to placement.

Samples taken from the aquifer show the following minimum to maximum ranges which may be used to inform bidders on the aquifer and possible filter pack composition prior to completion of the pilot hole.

U.S. Standard Sieve No.	Percent by Weight Passing
2-inch	100
1-inch	90 - 100
No. 4	57 - 100
No. 10	27 - 85
No. 20	9 - 35
No. 40	3 - 15
No. 60	0 - 12

Filter pack gradation examples are provided below for 0.010-inch, 0.030-inch and 0.040-inch screen openings:

2.4.2.1 Filter Pack for Well Screen with a 0.010-inch Slot Size (Filter Pack 1)

Filter Pack 1: Gradation of filter pack for the wells which will be constructed using 0.010-inch well screen openings shall conform to ASTM C33 sand or the following:

U.S. Standard Sieve No.	Percent by Weight Passing
3/8-inch	100
No. 4	95 - 100
No. 8	80 - 100
No. 16	50 - 85
No. 30	25 - 60
No. 50	5 - 30
No. 100	0 - 10

2.4.2.2 Filter Pack for Well Screen with a 0.030-inch Slot Size (Filter Pack 2)

Filter Pack 2: Gradation of filter pack for the wells which will be constructed using 0.030-inch well screen openings shall conform to Cemex special blend #2/16 (16 x 30) or the following:

U.S. Standard Sieve No.	Percent by Weight Passing
No. 12	100
No. 16	89 - 99
No. 20	6 - 38
No. 30	0 - 6

2.4.2.3 Filter Pack for Well Screen with a 0.040-inch Slot Size (Filter Pack 3)

Filter Pack 3: Gradation of filter pack for the wells which will be constructed using 0.040-inch well screen openings shall conform to Cemex 8 mesh (8 x 16) or the following:

U.S. Standard Sieve No.	Percent by Weight Passing
No. 6	100
No. 8	98 - 100
No. 12	25 - 55
No. 16	1 - 7
No. 20	0 - 4

2.4.3 Particle Size Distribution Testing

The filter pack material shall be sampled from material stockpiled at the source for review by the Government prior to delivery and from material stockpiled at the site, and tested by the Contractor. One grain size test shall be performed to confirm supplier certification. No later than 48 hours prior to being placed in the relief well, the particle size distribution of the filter pack material shall be supplied to the Government. The filter pack material and its gradation shall be reviewed by the Government before it is placed in the well.

The laboratory test procedures shall conform to ASTM C136 for filter pack and shall conform to ASTM D6913 for in-situ soil testing. All points on individual grading curves obtained from representative samples of filter pack material shall lie between the boundary limits as defined by smooth curves drawn through the tabulated grading limits plotted on a mechanical analysis diagram. The individual grading curves within these limits shall not exhibit abrupt changes in slope denoting skip grading, scalping of certain sizes, or other irregularities, which would be detrimental to the proper functioning of the filter pack envelope.

2.5 PUMPING TEST EQUIPMENT

2.5.1 Pump

TThe Contractor shall provide a deep-well, submersible pump capable of producing 250 gallons per minute from a depth of 50 feet, considering head losses, sufficient to satisfactorily perform the pumping test specified. The Contractor shall provide, without additional cost to the Government, the electrical power, control box, and the necessary wiring, which shall be removed at the completion of the pumping test.

2.5.2 Water Level

The Contractor shall provide means for accurately determining the water level in the well to nearest 0.01-foot, under all conditions.

2.5.3 Flow Meter

The Contractor shall furnish and install a calibrated flow meter of standard design for the purpose of measuring the discharge from the well during the pumping test. The calibration of the flow meter shall be checked at regular intervals. The flow meter shall be accurate to within 2 percent of the measured flow for flows as small as 2 gpm and as great as 50 gpm. The flow meter shall have a totalizing register as a minimum. The meter shall be installed in strict accordance with the meter manufacturer's directions.

2.5.4 Automated Data Logger

The Contractor shall provide automated data logger and related equipment to conduct step test and required pumping tests.

2.5.5 Rossum Sand Tester

The Contractor shall furnish and have thorough knowledge of the use of an approved Rossum centrifugal sand tester and appurtenant piping and valving for accurate determination of the discharge sand content.

2.6 CONCRETE

2.6.1 Cast-in-Place Concrete

The Contractor shall submit mix designs for concrete grout to seal around the conductor casing and well casing and for cast-in-place concrete pad and collar. Concrete shall conform to ASTM C94/C94M, as a minimum, unless otherwise reviewed by the Government, and shall be suitable for placement around the conductor casing and well casing when used for that purpose.

2.7 CONTROLLED LOW STRENGTH MATERIAL (CLSM)

Controlled low strength material shall conform to Section 31 00 00 EARTHWORK.

PART 3 EXECUTION

3.1 DRILLING

3.1.1 General

The Contractor will ensure that the execution of the work shall be by competent workmen and performed under the direct supervision of an experienced well driller and the general supervision of the relief well specialist. The relief wells shall be drilled straight, plumb, and circular from top to bottom.

3.1.2 Drilling and Setting Conductor Casing

A 20-inch outside diameter conductor casing shall be furnished and placed to a depth as indicated on the Drawings. The Contractor shall install the conductor casing such that, at the completion of construction of each relief well, the top of the casing will correspond to the elevation shown on the Plans. The hole for the conductor casing shall be drilled to a sufficient size to leave a concentric annular space of not less than 4-inches between the outside of the conductor casing and the walls of the hole. The method of drilling shall be reviewed by the Government and shall conform to all state and local standards for well construction. The annular space between the outer casing and the walls of the holes shall be filled with 10.3 sack sand/cement grout, in accordance with Bulletin 74-90. Acceptable methods of grouting are detailed in AWWA A100. No method will be approved that does not install the grout using a tremie pipe installed to within 5-feet of the bottom of the borehole maintaining a positive displacement with a cement grout pump during placement. Grouting shall be done continuously in such a manner as will ensure that the entire annular space is filled in one operation. After grouting is completed, drilling operations shall not be resumed for at least 72 hours to allow proper curing of the grout. Excavated material shall be disposed of as specified in Section 02 41 00 DEMOLITION.

The Contractor will provide samples of the subsurface material as requested by the Government to assist in field verification of the relief well design.

3.1.3 Relief Wells

After grout around the conductor casing has set, an 18-inch diameter borehole shall be drilled through the conductor casing to the depth specified in the Plans, or as determined by the Government. The relief wells shall be drilled by fluid supporting method with casing or other method as reviewed by the Government, in such a manner which will prevent heaving at the bottom of the hole, caving of the hole before or during the placement of the well screen, casing, and filter pack. Methods which involve significant displacement of the formation, or which may reduce the yield of the well, will not be permitted. Water based drilling fluid may use a guar gum product such as Revert, or an approved alternative. Bentonite fluids are not acceptable for use as a relief well drilling fluid. Drilling and installation of well screen and filter pack shall be completed for each well without interruption. Excavated material shall be disposed of as specified in Section 02 41 00 DEMOLITION. Before the drilling operation begins on each well, the Contractor shall demonstrate that all material, equipment, and experienced personnel are mobilized and that all equipment necessary for the job is adequate for an efficient operation and is operating in a satisfactory manner. Loss of a hole or well because of lack of material, inadequate or faulty equipment, or careless operating procedures will be considered cause for a destroyed well due to fault of the Contractor. The digging of mud pits or similar excavations will not be allowed.

3.1.4 Obstructions Encountered

If obstructions are encountered in the foundation which, in the opinion of the Government, render it impracticable to complete the well to the directed depth, the Government may adjust the depth to conform to that of the obstruction. Alternatively, the Government may direct the Contractor to destroy the well and construct another well at an adjacent site. Where obstructions are encountered, drilling shall be continued until it is demonstrated to the Government that further efforts to advance the drill hole are impracticable.

3.1.5 Conditioning of Drilling Fluids Prior to Well Construction

Once the Contractor has drilled to the full specified well depth, the Contractor shall circulate and condition the drilling fluid until the drilling fluid properties are within the following ranges:

Mud Weight: less than 8.9 pounds per gallon

Marsh Funnel Viscosity: less than 30 seconds per quart

The Contractor shall continue to circulate drilling fluids, conditioning the fluids as necessary, until all of the following have occurred:

a. Fluid circulated out of the borehole does not contain drill cuttings.

b. Circulation has continued for a minimum of 60 minutes, or until two borehole volumes have been circulated, whichever is longer.

c. Three consecutive measurements of drilling fluid properties, made a minimum of 30 minutes apart, confirm that the specified drilling fluid properties have been obtained.

3.2 INSTALLATION OF WELL CASING AND SCREEN

3.2.1 Assembly

All material to construct the well casing and screen shall be in new and undamaged condition before installation and all couplings and other necessary parts shall be securely fastened in place. The successive lengths of pipe shall be arranged to provide accurate placement of the screen sections in the soil strata. The well casing shall be equipped with a minimum of one (1) centering guide above and below the well screen.

3.2.2 Casing Joints

Sections of casing pipe shall be jointed together as specified in Paragraph 2.2.2.4 Well Screen Coupling. Joints shall be designed and constructed to have the strength capable of supporting 10 times the weight of the relief well casing assembly as it is lowered into the hole.

3.2.3 Installation

The well casing, screen, and tail pipe assembly shall be placed in the hole in such a manner as to avoid jarring impacts and to ensure that the assembly is not damaged. After the casing assembly has been placed, a filter pack shall be installed around the screen section as specified in Paragraph 3.3 PLACING OF FILTER PACK, and the well developed as specified in Paragraph 3.4 DEVELOPMENT. The Contractor shall be responsible for ensuring that the top of the casing is at the elevation designated on the Drawings prior to placement of the filter pack of the well. The well casing assembly shall be hung in the borehole for installation. At no time will the well assembly rest on the bottom of the borehole.

3.2.4 Plumbness and Alignment

Each well shall be installed and maintained straight and plumb during the entire construction process. Immediately before placing the gravel pack and with the top of the well fastened securely in a vertical and horizontal position, the Contracting Officer may elect to perform plumbness and alignment tests. These tests, if performed, will be performed by Government personnel using Government-owned equipment. A variation of 12-inches per 100-feet will be permitted in the combined length of screen and riser pipe of the well. If the well fails to conform to the standard described above, the contractor shall correct the plumbness of the well at no additional expense to the Government.

3.3 PLACING OF FILTER PACK

3.3.1 General

After the well casing and screen have been placed, the Contractor shall place the filter pack using the tremie method.

3.3.2 Installation of Filter Pack

The approved filter pack shall be constructed around the screen by filling the annular space between the casing assembly and the borehole to the depths designated on the Plans. The filter pack shall have a minimum thickness as shown on the Drawings between the outside of the well screen and the outside of the filter pack and shall be placed to location as shown on the plans. The filter pack shall be installed continuously and without interruption until it has been installed to the specified level. Prior to and during placement of the filter pack the top of the well casing shall be covered or otherwise shielded to prevent the filter pack from entering the casing.

If temporary casing is used during drilling, the filter pack shall be placed in increments not to exceed 2 feet. The temporary casing shall be raised in small increments approximately equal to the increments of the filter pack placed, except at no time prior to the completion of placement of the filter pack shall the bottom of the casing be less than 1 foot below the top of the filter pack in the hole. The placing of filter pack material and withdrawing of the temporary casing shall be continued until the filter pack has been placed to the level shown on the Drawings.

3.3.2.1 Measurement

The Contractor shall provide a weighted tape or other approved means of measuring the filter pack depth in the hole. The Contractor shall continuously measure the depth to the top of the filter pack during the entire filling process to insure it is installed to the proper depth.

3.4 DEVELOPMENT

3.4.1 General

Following placement of filter pack material the Contractor shall develop the relief well by swabbing and simultaneous pumping. At the time of development, the well shall be free of drawdown or surging effects due to pump testing, developing or drilling at another location. The Contractor shall be responsible for maintaining the needed access and work areas at the relief well and the necessary clearance in the relief well to accomplish development. The Contractor shall furnish, install or construct the necessary discharge line and troughs to conduct and dispose of the discharge a sufficient distance from the work areas to prevent damage.

Development shall be conducted to achieve a stable well of maximum efficiency and shall be continued until sand-free clear water is provided. As development proceeds, filter pack material shall be added to the annular space around the screen to maintain the specified elevation. If at any time during the development process it becomes apparent, in the opinion of the Government, that the well may be damaged, operations shall be immediately curtailed. The Government may require a change in method if the Contractor's method does not accomplish the desired results. If after initial development and 6 hours of additional development, a well continues to produce excessive sand, the Government may order the Contractor to abandon the well as specified in paragraph 3.8 DESTROYED RELIEF WELL. All materials pulled into the well by the development process shall be removed prior to performing the pumping test.

3.4.2 Well Development Methods

3.4.2.1 Scope of work

Work shall include the following:

Developing each well by bailing and air lift-swabbing for the minimum times specified, or until each well meets the sand requirement, whichever is longer.

Removing foreign material and sediment from each relief well.

A Well Development Plan shall be submitted.

3.4.2.2 Materials and Equipment

3.4.2.2.1 Bailing Equipment

Bailing equipment shall be capable of removing sediment from bottom of the relief well.

Bailing equipment shall be adequate to perform all well development as specified.

3.4.2.2.2 Air Lift-Swab Tool

The air lift-swab tool shall attach to a 4-inch drop pipe, and shall consist of two (2) 1-inch thick rubber flanges. The rubber flanges shall be spaced no more than 5 feet apart. The outside diameter of the rubber flanges shall be no more than 1/8-inch smaller than the inside diameter of the well screen.

3.4.2.2.3 Dispersant Chemical

The only approved dispersant chemical is Baroid Industrial Products AQUA-CLEAR PFD. No other dispersant chemical may be used without the pre-authorization of the Government.

The Contractor shall spot one quart of AQUA-CLEAR PFD in the screen section of each well.

3.4.2.2.4 Water Level Measurement Device

Water level measurement device shall be capable of measuring water levels to the nearest 0.01 foot.

3.4.2.2.5 Stop Watch

Stop watch or other similar device shall be capable of measuring the elapsed time during well development to the nearest second.

3.4.2.2.6 Water Volume Measurement Device

Water volume measurement device shall be capable of measuring the volume of water produced during well development to the nearest 10 gallons per minute.

3.4.2.2.7 Sediment Removal Equipment

The Contractor shall bail all sediment out of the well sump after pump-swab development.

3.4.2.2.8 Well Disinfection

The well shall be disinfected using a solution and following methods conforming to all state, federal and local standards for well construction. Minimum contact time, per the standards, shall be provided before pumping the well to waste and flushing the solution from the distribution system.

3.4.2.2.9 Well Pump

A submersible pump, capable of pumping 250 gallons per minute with a lift of 50 feet.

3.4.2.3 Methods

3.4.2.3.1 Record-Keeping

The Contractor shall maintain detailed records during well development, and shall make records available to the Government upon request. Static water level shall be recorded at the beginning of each day of well development, before any water has been moved. The following parameters shall be recorded at least every 30 minutes during well development:

Time, measured to the nearest minute.

Flow rate, measured to the nearest gallon per minute.

Water level, measured to the nearest 0.1 Foot.

Any observations of unusual or changed conditions, including: odor, gas, color, or other conditions.

3.4.2.3.2 Well Development

Well development, consisting of bailing and air lift-swabbing, shall continue for a minimum of eight (8) hours for each well. The Contractor shall commence well development with bailing, and shall continue bailing until all drilling fluid is removed from the well. Air lift-swab development shall begin at the bottom of the screen section and work upward. Air lift-swabbing shall be conducted by moving air lift-swab tool uniformly up and down over the screen section.

3.4.2.3.3 Removal of Sediment

The Contractor shall bail the sediment at the conclusion of air lift-swab well development.

3.4.2.3.4 Development Pumping

The Contractor shall install the test pump and conduct pumping and surging for a minimum of six (6) hours for each well. The pumping water level and sand production shall be measured for each pumping cycle.

3.4.3 Filter Pack Replenishment During Development

During the development of the well, the top of the filter pack material shall be maintained to the elevation specified in the Drawings. Material which may have entered the well assembly shall be removed before development of the well is commenced and after well development has been completed.

3.5 WELL SEALING

After each new well has been developed and pump tested and the results have been reviewed by the Government, the annular space between the well casing pipe and conductor casing above the filter pack shall be filled with fine sand, in accordance with ASTM C33/C33M, and 10.3 sack sand/cement grout, in accordance with Bulletin 74-90, as shown on the Drawings. The top of the conductor casing shall be sealed to the well casing by welding a 3/8-inch thick steel plate annulus ring of the same material as the conductor casing to the well casing and the conductor casing with a continuous weld to form a water tight seal as shown on the Drawings. Welding of the annulus ring to the well casing shall be accomplished using E309-type filler metal or other approved filler metal appropriate for the materials being welded.

3.6 WELL TESTING

3.6.1 Scope of Work

Perform 2-hour specific capacity test on each well in accordance with the specifications.

3.6.2 Materials and Equipment

The equipment shall be the same as provided in Paragraph 3.4, DEVELOPMENT.

3.6.3 Methods

3.6.3.1 General Testing Requirements

Well testing shall begin within 2 to 60 hours of well development. The well shall not have been pumped within 2 hours of the beginning of any well and aquifer test. No test pumping of a well shall be performed concurrently with drilling or pumping of any other well within 500-feet therefrom. If any interruptions in pumping occur that are longer than ten percent of the elapsed pumping time, the contractor shall discontinue the test, allow for full water level recovery, and restart the test. No payment will be made for the discontinued test.

3.6.3.2 Record-Keeping

The Contractor shall maintain detailed records during well and aquifer testing, and shall make records available to the Government upon request. The actual time when each measurement is made shall be recorded, even if it differs from the measurement schedule. The following measurements shall be recorded at the beginning of each well and aquifer test, before any water has been pumped:

Static water level, measured to the nearest 0.01 foot.

Water levels (and clock times) in all adjacent relief wells and observation wells within a radius of 500 feet.

Totalizer reading, measured to the smallest unit on the totalizer register.

The following measurements shall be recorded during and after the pumping test:

Elapsed time, measured to the nearest 1 minute.

Flow rate, calculated using totalizer readings to the nearest gallon per minute.

Totalizer reading, measured to the smallest unit on the totalizer register.

Water level, measured to the nearest 0.01 foot.

Drawdown from static water level, calculated to the nearest 0.01 foot.

Sand production, to the nearest 0.1 part per million by volume.

Any adjustments to the flow rate, interruptions in pumping, or other changes in testing conditions.

Just before the end of the test, measure water levels in all adjacent relief wells and observation wells within a radius of 500 feet.

3.6.3.3 Measurement Schedule

The times specified in this section are elapsed times since the pump is started or stopped, or the pumping rate is changed. Measurements shall continue for the specified duration of pumping and recovery. Elapsed time and water level measurements shall be made according to the following schedule:

1, 2, 3, 4, 5, 6, 7, 8, 9, 10, 11, and 12 minutes.

14, 16, 18, and 20 minutes.

25, 30, 35, 40, 45, 50, 55, and 60 minutes.

70, 80, 90, 100, 110, and 120 minutes.

150, 180, 210, and 240 minutes.

Sand production measurements shall be made at least once every fifteen minutes for the duration of each test. Flow rate and totalizer measurements shall be made during pumping at least once, or once every hour, whichever is more frequent. A final water level measurement shall be made 24 hours after the pump is turned off and the clock time noted.

3.6.4 Additional Testing

In addition to the test described above the Government may direct the Contractor to perform additional testing. Such additional testing shall conform in general to the requirements specified above with the exception that the duration of the tests and the approximate drawdown will be determined by the Government. The test, to be successful, shall be continuous throughout the specified period.

3.6.5 Sand Test

Sand content of pumped water shall be measured at 100 gallons per minute unless otherwise determined by the Government. Sand content of pumped water shall be measured with a centrifugal ("Rossum") sand tester in accordance with manufacturer's instructions (Roscoe Moss Company Technical Bulletin 005-7). The average sand content of water pumped over any five (5) minute period shall not exceed five (5) parts per million over the duration of pumping.

3.6.6 Step-Drawdown Test

A step-drawdown tests shall be conducted on two (2) of the relief wells installed, and involve pumping the well at varying discharge rates while drawdown is measured using automated data loggers in the pumping well. A backup transducer should also be used to measure the drawdown in the pumping well to ensure data is not lost. Additionally, manual readings/measurements shall be taken every 15 minutes to confirm the automated readings. A minimum of 5 steps shall be conducted per step-drawdown test. Pumping shall be conducted until drawdown within the well stabilizes, and then increased to a higher constant rate until drawdown stabilizes again; steps may vary (i.e. anticipated to be an hour to 1.5 hours). The Government can assist in further refining a framework for analyzing acquired data and provide references or assist in performing example analyses approaches if desired. Estimated flow rates for each step, are 25, 50, 100, 150, 250 gpm.

Pump tests and data analyses shall be conducted using established and accepted procedures (e.g. as described in "Analysis and Evaluation of Pumping Test Data", Kruseman and de Ridder, 2000, and relevant ASTM standards).

3.6.7 Specific Capacity Test

Following the step-drawdown test, each installed well will have a specific capacity test performed for a duration of 4 hours (the pump rate will be based on step-drawdown testing results/performance and will be established in consultation with the Government). Water levels in the pumping well shall be measured using an automated data logger and backup transducer. Manual readings/measurements taken every 15 minutes to confirm the automated readings.

3.6.8 Additional Pumping Test Measurements

In addition to the measurements and record-keeping required of the Contractor, the Government or its representative may require access to the well to perform additional water level measurements in the pumped well and nearby relief wells.

3.6.9 Records

The Contractor shall obtain and furnish to the Government for record purposes the data specified in Paragraph 3.6.3.2 Record-Keeping, recorded on an approved form reviewed by the Government.

Upon completion of the installation of the relief well and enclosure structures, the Contractor shall submit to the Government, as-built Drawings which shall accurately depict details of the relief well and drainage system construction. The As-Built Drawings shall include:

a. Well casing and screen details including materials, size, length, slot size, and installation details;

b. Enclosure details;

c. Schedule of Materials describing the length of each section of well screen and casing used to meet the total lengths specified for each well.

d. Pumping test data.

3.7 RELIEF WELL OUTLET WORKS INSTALLATION

3.7.1 General

Install drain pipes, utility boxes, and other associated components for the relief well outlet works at the locations and elevations shown in the

Drawings or as directed by the Government.

3.7.2 Trenching

Excavate trenches as shown on the Drawings and as required for the installation of the relief well outlet works components. Trenches for drain pipes shall be excavated such that the trench width at any point below the pipe is not greater than the outside diameter of the pipe plus 12 inches, or as shown on the Drawings, to permit satisfactory joining and thorough tamping of the backfill under and around the pipe. Minimize over-excavation to that required to install the required backfill.

3.7.3 Placing Relief Well Outlet Works Components

Carefully examine each component prior to installation. Defective or damaged components shall not be used. Dewater trenches as needed to place the backfill and maintain a dry bottom during installation of the components. No component may be placed on a disturbed subgrade, in standing water, or weather conditions unsuitable for such work. Place components to the lines and grades shown on the Drawings. Pipes shall be placed in straight lines; avoid the formation of dips and low points. Support pipes at proper elevation and grade. Secure firm, uniform support. Wood support blocking will not be permitted. Lay pipe so that the full length of each section of pipe will rest solidly on the pipe bedding; excavate recesses to accommodate joints and couplings. Provide anchors and supports where necessary for fastening work in place. Anchor the pipe to prevent floating or displacement of the pipe during backfilling. The anchors shall be spaced to ensure a continuous even grade in the flow line of the pipe.

3.7.4 Backfilling

Place Controlled Low Strength Material (CLSM) backfill in maximum 6-inch thick loose layers. Place backfill evenly on both sides of and underneath pipes for the full length of the pipe and as indicated on the Drawings. Place backfill evenly behind previously placed or existing structures. Ensure support of backfill under haunches of pipe and other previously placed structures by shovel slicing or light tamping.

3.7.5 Protection

Protect pipe and other outlet works from damage during construction. If damage occurs, the Contractor shall replace damaged sections at no additional cost to the Government.

3.8 DESTROYED RELIEF WELLS

Any new wells or partially completed wells that cannot be put into service as relief wells shall be destroyed as specified by state and Government guidelines and in accordance with the requirements of Section 02 41 00 DEMOLITION.

3.9 SURVEYS AND MARKINGS

Coordinates and elevations shall be established for each relief well. Determine horizontal coordinates to the closest 1.0 foot and referenced to the State Plane Coordinate System. A ground elevation to the closest 0.1 foot shall be obtained at each well. The highest point on the top of the riser pipe shall serve as a measurement point; reference this elevation and survey to the nearest 0.01 foot using the National Geodetic Vertical Datum of 1988 (NGVD 88). The location, identification, coordinates, and elevations of the well and monuments shall be plotted on maps with a scale large enough to show their location with reference to other structures. Wells shall be marked and labeled in the field for future reference and identification.

-- End of Section --

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SECTION 33 40 00

STORM DRAINAGE UTILITIES
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PART 1 GENERAL

1.1 REFERENCES

The publications listed below form a part of this specification to the extent referenced. The publications are referred to within the text by the basic designation only.

AMERICAN ASSOCIATION OF STATE HIGHWAY AND TRANSPORTATION OFFICIALS (AASHTO)

AASHTO M 294	(2017) Standard Specification for Corrugated Polyethylene Pipe, 300- to 1500-mm (12- to 60-in.) Diameter

ASTM INTERNATIONAL (ASTM)

ASTM A123/A123M	(2017) Standard Specification for Zinc (Hot-Dip Galvanized) Coatings on Iron and Steel Products
ASTM A929/A929M	(2018) Standard Specification for Steel Sheet, Metallic-Coated by the Hot-Dip Process for Corrugated Steel Pipe
ASTM C1103	(2014) Standard Practice for Joint Acceptance Testing of Installed Precast Concrete Pipe Sewer Lines
ASTM C425	(2004; R 2013) Standard Specification for Compression Joints for Vitrified Clay Pipe and Fittings
ASTM C443	(2012; R 2017) Standard Specification for Joints for Concrete Pipe and Manholes, Using Rubber Gaskets
ASTM C828	(2011) Low-Pressure Air Test of Vitrified Clay Pipe Lines
ASTM C877	(2008) External Sealing Bands for Concrete Pipe, Manholes, and Precast Box Sections
ASTM C923	(2008; R 2013; E 2016) Standard Specification for Resilient Connectors Between Reinforced Concrete Manhole Structures, Pipes and Laterals
ASTM C969	(2017) Standard Practice for Infiltration and Exfiltration Acceptance Testing of Installed Precast Concrete Pipe Sewer Lines

ASTM C990	(2009; R 2014) Standard Specification for Joints for Concrete Pipe, Manholes and Precast Box Sections Using Preformed Flexible Joint Sealants
ASTM D2321	(2018) Standard Practice for Underground Installation of Thermoplastic Pipe for Sewers and Other Gravity-Flow Applications
ASTM D3350	(2012) Polyethylene Plastics Pipe and Fittings Materials
ASTM F1417	(2011a) Standard Test Method for Installation Acceptance of Plastic Gravity Sewer Lines Using Low Pressure Air
ASTM F714	(2013) Polyethylene (PE) Plastic Pipe (SDR-PR) Based on Outside Diameter
ASTM F894	(2013) Polyethylene (PE) Large Diameter Profile Wall Sewer and Drain Pipe

1.2 SUBMITTALS

Government approval is required for submittals with a "G" designation; submittals not having a "G" designation are for information only. When used, a designation following the "G" designation identifies the office that will review the submittal for the Government. Submit the following in accordance with Section 01 33 00 SUBMITTAL PROCEDURES:

SD-04 Samples

Pipe for Culverts and Storm Drains

SD-07 Certificates

Resin Certification

Oil Resistant Gasket

Leakage Test

Post-Installation Inspection Report

SD-08 Manufacturer's Instructions

Placing Pipe

SD-11 Closeout Submittals

Lid Verification Report; G

1.3 DELIVERY, STORAGE, AND HANDLING

1.3.1 Delivery and Storage

Materials delivered to site shall be inspected for damage, unloaded, and stored with a minimum of handling. Materials shall not be stored directly on the ground. The inside of pipes and fittings shall be kept free of dirt and debris. Before, during, and after installation, plastic pipe and fittings shall be protected from any environment that would result in damage or deterioration to the material. Keep a copy of the manufacturer's instructions available at the construction site at all times and follow these instructions unless directed otherwise by the Contracting Officer. Solvents, solvent compounds, lubricants, elastomeric gaskets, and any similar materials required to install plastic pipe shall be stored in accordance with the manufacturer's recommendations and shall be discarded if the storage period exceeds the recommended shelf life. Solvents in use shall be discarded when the recommended pot life is exceeded.

1.3.2 Handling

Materials shall be handled in a manner that ensures delivery to the trench in sound, undamaged condition. Pipe shall be carried to the trench, not dragged.

PART 2 PRODUCTS

2.1 PIPE FOR CULVERTS AND STORM DRAINS

Pipe for culverts and storm drains shall be of the sizes indicated and shall conform to the requirements specified.

2.1.1 Polyethylene (PE) Pipe

Submit the pipe manufacturer's resin certification, indicating the cell classification of PE used to manufacture the pipe, prior to installation of the pipe. The minimum cell classification for polyethylene plastic shall apply to each of the seven primary properties of the cell classification limits in accordance with ASTM D3350.

2.1.1.1 Smooth Wall PE Pipe

ASTM F714, maximum DR of 21 for pipes 3 to 24 inches in diameter and maximum DR of 26 for pipes 26 to 48 inches in diameter. Pipe shall be produced from PE certified by the resin producer as meeting the requirements of ASTM D3350, minimum cell class 335434C.

2.1.1.2 Corrugated PE Pipe

AASHTO M 294, Type C. For slow crack growth resistance, acceptance of resins shall be determined by using the notched constant ligament-stress (NCLS) test meeting the requirements of AASHTO M 294. Pipe walls shall have the following properties:

Nominal Size (inch))	Minimum Wall Area (square in/ft)	Minimum Moment of Inertia of Wall Section (in. to the 4th/in.)
12	1.5	0.024
15	1.91	0.053
18	2.34	0.062

Nominal Size (inch))	Minimum Wall Area (square in/ft)	Minimum Moment of Inertia of Wall Section (in. to the 4th/in.)
24	3.14	0.116
30	3.92	0.163
36	4.50	0.222
42	4.69	0.543
48	5.15	0.543
54	5.67	0.800
60	6.45	0.800

2.1.1.3 Profile Wall PE Pipe

ASTM F894, RSC 160, produced from PE certified by the resin producer as meeting the requirements of ASTM D3350, minimum cell class 334433C. Pipe walls shall have the following properties:

Nominal Size (inch)	Minimum Wall Area (square in/ft)	Minimum Moment of Inertia of Wall Section (in to the 4th/in)	
		Cell Class 334433C	Cell Class 335434C
18	2.96	0.052	0.038
21	4.15	0.070	0.051
24	4.66	0.081	0.059
27	5.91	0.125	0.091
30	5.91	0.125	0.091
33	6.99	0.161	0.132
36	7.81	0.202	0.165
42	8.08	0.277	0.227
48	8.82	0.338	0.277

2.2 DRAINAGE STRUCTURES

2.2.1 Flared End Sections

Sections shall be of a standard design fabricated from zinc coated steel sheets meeting requirements of ASTM A929/A929M.

2.3 MISCELLANEOUS MATERIALS

2.3.1 Joints

2.3.1.1 Flexible Watertight Joints

a. Flexible watertight joints shall be made with plastic or rubber-type gaskets for concrete pipe and with factory-fabricated resilient materials for clay pipe. The design of joints and the physical requirements for preformed flexible joint sealants shall conform to ASTM C990, and rubber-type gaskets shall conform to ASTM C443. Factory-fabricated resilient joint materials shall conform to ASTM C425. Gaskets shall have not more than one factory-fabricated splice, except that two factory-fabricated splices of the rubber-type gasket are permitted if the nominal diameter of the pipe being gasketed exceeds 54 inches.

b. Rubber gaskets shall comply with the oil resistant gasket requirements of ASTM C443. Certified copies of test results shall be delivered to the Contracting Officer before gaskets or jointing materials are installed. Alternate types of watertight joint may be furnished, if specifically approved.

2.3.1.2 External Sealing Bands

Requirements for external sealing bands shall conform to ASTM C877.

2.3.1.3 Smooth Wall PE Plastic Pipe

Pipe shall be joined using butt fusion method as recommended by the pipe manufacturer.

2.4 STEEL LADDER

Steel ladder shall be provided where the depth of the storm drainage structure exceeds 12 feet. These ladders shall be not less than 16 inches in width, with 3/4 inch diameter rungs spaced 12 inches apart. The two stringers shall be a minimum 3/8 inch thick and 2-1/2 inches wide. Ladders and inserts shall be galvanized after fabrication in conformance with ASTM A123/A123M.

2.5 RESILIENT CONNECTORS

Flexible, watertight connectors used for connecting pipe to manholes and inlets shall conform to ASTM C923.

PART 3 EXECUTION

3.1 INSTALLATION OF PIPE CULVERTS, STORM DRAINS, AND DRAINAGE STRUCTURES

Excavation of trenches, and for appurtenances and backfilling for culverts and storm drains, shall be in accordance with the applicable portions of Section 31 00 00 EARTHWORK and the requirements specified below.

3.1.1 Trenching

The width of trenches at any point below the top of the pipe shall be not greater than the outside diameter of the pipe plus 18 inches to permit satisfactory jointing and thorough tamping of the bedding material under and around the pipe. Sheeting and bracing, where required, shall be placed within the trench width as specified, without any overexcavation. Where trench widths are exceeded, redesign with a resultant increase in cost of stronger pipe or special installation procedures will be necessary. Cost of this redesign and increased cost of pipe or installation shall be borne by the Contractor without additional cost to the Government.

3.1.2 Removal of Rock

Rock in either ledge or boulder formation shall be replaced with suitable materials to provide a compacted earth cushion having a thickness between unremoved rock and the pipe of at least 8 inches or 1/2 inch for each foot of fill over the top of the pipe, whichever is greater, but not more than three-fourths the nominal diameter of the pipe. Where bell-and-spigot pipe is used, the cushion shall be maintained under the bell as well as under the straight portion of the pipe. Rock excavation shall be as specified and defined in Section 31 00 00 EARTHWORK.

3.1.3 Removal of Unstable Material

Where wet or otherwise unstable soil incapable of properly supporting the pipe, as determined by the Contracting Officer, is unexpectedly encountered in the bottom of a trench, such material shall be removed to the depth required and replaced to the proper grade with select granular material, compacted as provided in paragraph BACKFILLING. When removal of unstable material is due to the fault or neglect of the Contractor while performing shoring and sheeting, water removal, or other specified requirements, such removal and replacement shall be performed at no additional cost to the Government.

3.2 BEDDING

The bedding surface for the pipe shall provide a firm foundation of uniform density throughout the entire length of the pipe.

3.2.1 Plastic Pipe

Bedding for PVC, PE, SRPE and PP pipe shall meet the requirements of ASTM D2321. Use Class IB or II material for bedding, haunching, and initial backfill. Use Class I, II, or III material for PP pipe bedding, haunching and initial backfill.

3.3 PLACING PIPE

Each pipe shall be thoroughly examined before being laid; defective or damaged pipe shall not be used. Plastic pipe, excluding SRPE pipe shall be protected from exposure to direct sunlight prior to laying, if necessary to maintain adequate pipe stiffness and meet installation deflection requirements. Pipelines shall be laid to the grades and alignment indicated. Proper facilities shall be provided for lowering sections of pipe into trenches. Lifting lugs in vertically elongated pipe shall be placed in the same vertical plane as the major axis of the pipe. Pipe shall not be laid in water, and pipe shall not be laid when trench conditions or weather are unsuitable for such work. Diversion of drainage or dewatering of trenches during construction shall be provided as necessary. Deflection of installed flexible pipe shall not exceed the following limits:

TYPE OF PIPE	MAXIMUM ALLOWABLE DEFLECTION (percent)
Plastic (PVC, PE, SRPE, and PP)	5

Note post installation requirements of paragraph DEFLECTION TESTING in PART 3 of this specification for all pipe products including deflection testing requirements for flexible pipe.

3.3.1 PE, SRPE, and Dual Wall and Triple Wall PP Pipe

Laying shall be with the separate sections joined firmly on a bed shaped to line and grade and shall follow manufacturer's guidelines.

3.4 JOINTING

3.4.1 Concrete and Clay Pipe

3.4.1.1 Plastic Sealing Compound Joints for Tongue-and-Grooved Pipe

Sealing compounds shall follow the recommendation of the particular manufacturer in regard to special installation requirements. Surfaces to receive lubricants, primers, or adhesives shall be dry and clean. Sealing compounds shall be affixed to the pipe not more than 3 hours prior to installation of the pipe, and shall be protected from the sun, blowing dust, and other deleterious agents at all times. Sealing compounds shall be inspected before installation of the pipe, and any loose or improperly affixed sealing compound shall be removed and replaced. The pipe shall be aligned with the previously installed pipe, and the joint pulled together. If, while making the joint with mastic-type sealant, a slight protrusion of the material is not visible along the entire inner and outer circumference of the joint when the joint is pulled up, the pipe shall be removed and the joint remade. After the joint is made, all inner protrusions shall be cut off flush with the inner surface of the pipe. If non-mastic-type sealant material is used, the "Squeeze-Out" requirement above will be waived.

3.4.1.2 Flexible Watertight Joints

Gaskets and jointing materials shall be as recommended by the particular manufacturer in regard to use of lubricants, cements, adhesives, and other special installation requirements. Surfaces to receive lubricants, cements, or adhesives shall be clean and dry. Gaskets and jointing materials shall be affixed to the pipe not more than 24 hours prior to the installation of the pipe, and shall be protected from the sun, blowing dust, and other deleterious agents at all times. Gaskets and jointing materials shall be inspected before installing the pipe; any loose or improperly affixed gaskets and jointing materials shall be removed and replaced. The pipe shall be aligned with the previously installed pipe, and the joint pushed home. If, while the joint is being made the gasket becomes visibly dislocated the pipe shall be removed and the joint remade.

3.5 BACKFILLING

3.5.1 Backfilling Pipe in Trenches

After the pipe has been properly bedded, selected material from excavation or borrow, at a moisture content that will facilitate compaction, shall be placed along both sides of pipe in layers not exceeding 6 inches in compacted depth. The backfill shall be brought up evenly on both sides of pipe for the full length of pipe. The fill shall be thoroughly compacted under the haunches of the pipe. Each layer shall be thoroughly compacted with mechanical tampers or rammers. This method of filling and compacting shall continue until the fill has reached an elevation equal to the midpoint (spring line) of concrete pipe or has reached an elevation of at least 12 inches above the top of the pipe for flexible pipe. The remainder of the trench shall be backfilled and compacted by spreading and rolling or compacted by mechanical rammers or tampers in layers not exceeding 6 inches. Tests for density shall be made as necessary to ensure conformance to the compaction requirements specified below. Where it is necessary, in the opinion of the Contracting Officer, that sheeting or portions of bracing used be left in place, the contract will be adjusted accordingly. Untreated sheeting shall not be left in place beneath structures or pavements.

3.5.2 Backfilling Pipe in Fill Sections

For pipe placed in fill sections, backfill material and the placement and compaction procedures shall be as specified below. The fill material shall be uniformly spread in layers longitudinally on both sides of the pipe, not exceeding 6 inches in compacted depth, and shall be compacted by rolling parallel with pipe or by mechanical tamping or ramming. Prior to commencing normal filling operations, the crown width of the fill at a height of 12 inches above the top of the pipe shall extend a distance of not less than twice the outside pipe diameter on each side of the pipe or 12 feet, whichever is less. After the backfill has reached at least 12 inches above the top of the pipe, the remainder of the fill shall be placed and thoroughly compacted in layers not exceeding 12 inches. Use select granular material for this entire region of backfill for flexible pipe installations.

3.5.3 Movement of Construction Machinery

When compacting by rolling or operating heavy equipment parallel with the pipe, displacement of or injury to the pipe shall be avoided. Movement of construction machinery over a culvert or storm drain at any stage of construction shall be at the Contractor's risk. Any damaged pipe shall be repaired or replaced.

3.5.4 Compaction

3.5.4.1 General Requirements

Cohesionless materials include gravels, gravel-sand mixtures, sands, and gravelly sands. Cohesive materials include clayey and silty gravels, gravel-silt mixtures, clayey and silty sands, sand-clay mixtures, clays, silts, and very fine sands. When results of compaction tests for moisture-density relations are recorded on graphs, cohesionless soils will show straight lines or reverse-shaped moisture-density curves, and cohesive soils will show normal moisture-density curves.

3.5.4.2 Minimum Density

Backfill over and around the pipe and backfill around and adjacent to drainage structures shall be compacted at the approved moisture content to the following applicable minimum density, which will be determined as specified below.

a. Under airfield and heliport pavements, paved roads, streets, parking areas, and similar-use pavements including adjacent shoulder areas, the density shall be not less than 90 percent of maximum density for cohesive material and 95 percent of maximum density for cohesionless material, up to the elevation where requirements for pavement subgrade materials and compaction shall control.

b. Under unpaved or turfed traffic areas, density shall not be less than 90 percent of maximum density for cohesive material and 95 percent of maximum density for cohesionless material.

c. Under nontraffic areas, density shall be not less than that of the surrounding material.

3.6 FIELD QUALITY CONTROL

3.6.1 Tests

Testing is the responsibility of the Contractor. Perform all testing and retesting at no additional cost to the Government.

3.6.1.1 Leakage Test

Lines shall be tested for leakage by low pressure air or water testing or exfiltration tests, as appropriate, prior to completing backfill. Low pressure air testing for vitrified clay pipes shall conform to ASTM C828. Low pressure air testing for concrete pipes shall conform to ASTM C969. Low pressure air testing for plastic pipe shall conform to ASTM F1417. Low pressure air testing procedures for other pipe materials shall use the pressures and testing times prescribed in ASTM C828 or ASTM C969, after consultation with the pipe manufacturer. Testing of individual joints for leakage by low pressure air or water shall conform to ASTM C1103. Prior to exfiltration tests, the trench shall be backfilled up to at least the lower half of the pipe. If required, sufficient additional backfill shall be placed to prevent pipe movement during testing, leaving the joints uncovered to permit inspection. Visible leaks encountered shall be corrected regardless of leakage test results. When the water table is 2 feet or more above the top of the pipe at the upper end of the pipeline section to be tested, infiltration shall be measured using a suitable weir or other device acceptable to the Contracting Officer. An exfiltration test shall be made by filling the line to be tested with water so that a head of at least 2 feet is provided above both the water table and the top of the pipe at the upper end of the pipeline to be tested. The filled line shall be allowed to stand until the pipe has reached its maximum absorption, but not less than 4 hours. After absorption, the head shall be reestablished. The amount of water required to maintain this water level during a 2-hour test period shall be measured. Leakage as measured by the exfiltration test shall not exceed zero (0). When leakage exceeds zero, satisfactory correction shall be made and retesting accomplished.

3.6.1.2 Deflection Testing

Conduct deflection test no sooner than 30 days after completion of final backfill and compaction testing. Clean or flush all lines prior to testing. Perform a deflection test on entire length of installed flexible pipeline upon completion of work adjacent to and over the pipeline, including backfilling, placement of fill, grading, paving, placement of concrete, and any other superimposed loads. Deflection of pipe in the installed pipeline under external loads shall not exceed limits in paragraph PLACING PIPE above as percent of the average inside diameter of pipe. Use a laser profiler or mandrel to determine if allowable deflection has been exceeded.

3.6.1.2.1 Laser Profiler

Inspect pipe interior with laser profiling equipment. Utilize low barrel distortion video equipment for pipe sizes 48 inches or less. Use a camera with suitable lighting to allow a clear picture of the entire periphery of the pipe interior. Center the camera in the pipe both vertically and horizontally. The camera must be able to pan and tilt to a 90 degree angle with the axis of the pipe rotating 360 degrees. Use equipment to move the camera through the pipe that will not obstruct the camera's view or interfere with proper documentation of the pipe's condition. The video image shall be clear, focused, and relatively free from roll static or other image distortion qualities that would prevent the reviewer from evaluating the condition of the pipe. For initial post installation inspections for pipe sizes larger than 48 inches, a visual inspection shall be completed of the pipe interior.

3.6.1.2.2 Mandrel

Pass the mandrel through each run of pipe by pulling it by hand. If deflection readings in excess of the allowable deflection of average inside diameter of pipe are obtained, stop and begin test from the opposite direction. The mandrel must meet the Pipe Manufacture's recommendations and the following requirements. Provide a Mandrel that is rigid, nonadjustable, has a minimum of 9 fins, pulling rings at each end, and is engraved with the nominal pipe size and mandrel outside diameter. The mandrel must be 5 percent less than the certified-actual pipe diameter for Plastic Pipe, 5 percent less than the certified-actual pipe diameter for Corrugated Steel and Aluminum, 3 percent less than the certified-actual pipe diameter for Concrete-Lined Corrugated Steel and Ductile Iron Culvert. The Government will verify the outside diameter(OD)of the Contractor provided mandrel through the use of Contractor provided proving rings.

3.6.2 Inspection

3.6.2.1 Post-Installation Inspection

Visually inspect each segment of concrete pipe for alignment, settlement, joint separations, soil migration through the joint, cracks, buckling, bulging and deflection. An engineer must evaluate all defects to determine if any remediation or repair is required.

3.6.2.1.1 Flexible Pipe

Check each flexible pipe (PE, PVC, PP, Corrugated Steel and Aluminum) for rips, tears, joint separations, soil migration through the joint, cracks, localized bucking, bulges, settlement and alignment.

3.6.2.1.2 Post-Installation Inspection Report

The deflection results and final post installation inspection report must include: a copy of all video taken, pipe location identification, equipment used for inspection, inspector name, deviation from design, grade, deviation from line, deflection and deformation of flexible pipe, inspector notes, condition of joints, condition of pipe wall (e.g.

distress, cracking, wall damage dents, bulges, creases, tears, holes, etc.).

3.6.2.2 Low Impact Development Inspection

Inspect Low Impact Development (LID) features indicated on the design portion of the LID Verification Report. Certify LID features were constructed according to plans and specifications or by submitting as-built drawings in accordance with UFGS 01 78 00 Closeout Submittals. When as-built drawings show deviations to the LID features, document the deviations on the LID Verification Report.

3.6.3 Repair Of Defects

3.6.3.1 Leakage Test

When leakage exceeds the maximum amount specified, correct source of excess leakage by replacing damaged pipe and gaskets and retest.

3.6.3.2 Deflection Testing

When deflection readings are in excess of the allowable deflection of average inside diameter of pipe are obtained, remove pipe which has excessive deflection and replace with new pipe. Retest 30 days after completing backfill, leakage testing and compaction testing.

3.6.3.3 Inspection

Replace pipe or repair defects indicated in the Post-Installation Inspection Report.

3.6.3.3.1 Flexible Pipe

Replace pipes having cracks or splits.

3.7 PROTECTION

Protect storm drainage piping and adjacent areas from superimposed and external loads during construction.

3.8 WARRANTY PERIOD

Pipe segments found to have defects during the warranty period must be replaced with new pipe and retested.

-- End of Section --

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01/08

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SECTION 35 31 19

STONE AND CHANNEL PROTECTION FOR STRUCTURES
01/08

PART 1 GENERAL

1.1 SCOPE

The work specified herein provides direction for placement of rock slope protection material. The work shall be performed in accordance with this specification and shall conform to the lines, grades, notes and typical sections shown in the plans.

1.2 REFERENCES

The publications listed below form a part of this specification to the extent referenced. The publications are referred to within the text by the basic designation only.

ASTM INTERNATIONAL (ASTM)

ASTM C127	(2015) Standard Test Method for Density, Relative Density (Specific Gravity), and Absorption of Coarse Aggregate
ASTM C295	(2012) Petrographic Examination of Aggregates for Concrete
ASTM D3740	(2012a) Minimum Requirements for Agencies Engaged in the Testing and/or Inspection of Soil and Rock as Used in Engineering Design and Construction
ASTM D5312/D5312M	(2012; R 2013) Evaluation of Durability of Rock for Erosion Control Under Freezing and Thawing Conditions
ASTM D4992	(2014; E 2015) Evaluation of Rock to be Used for Erosion Control

U.S. ARMY CORPS OF ENGINEERS (USACE)

COE CRD-C 144	(1992) Standard Test Method for Resistance of Rock to Freezing and Thawing
COE CRD-C 148	(1969) Method of Testing Stone for Expansive Breakdown on Soaking in Ethylene Glycol
COE CRD-C 169	(1997) Standard Test Method for Resistance of Rock to Wetting and Drying

1.3 DEFINITIONS

1.3.1 Rock Slope Protection

The terms "Rock Slope Protection Material" or "RSP Section" or "Stone" as used in these specifications is defined as the RSP Type A and RSP Type B rock fill material to be placed at the outfall structure as shown in the plans.

1.4 SUBMITTALS

Government approval is required for submittals with a "G" designation; submittals not having a "G" designation are for information only. When used, a designation following the "G" designation identifies the office that will review the submittal for the Government. The following shall be submitted in accordance with Section 01 33 00 SUBMITTAL PROCEDURES:

SD-04 Samples

Stone; G

Suitable stone samples prior to delivery of any such material to the worksite.

SD-06 Test Reports

Gradation Test; G

Evaluation Testing of Stone; G

Bulk Specific Gravity

At least 15 calendar days in advance of shipment of stone to the work site, a copy of bulk specific gravity test results for each gradation range of stone proposed to be furnished. The information shall be furnished prior to preparation of pre-production demonstration stockpiles.

SD-07 Certificates

Rock Slope Protection Materials; G

Certificates of compliance attesting that the materials meet specification requirements.

Laboratory

Weigh Scale Certification

Certified Weight Scale Tickets

1.4.1 Gradation Test

The gradation tests using USACE ENG FORM 4794-R for riprap or stone.

1.4.2 Evaluation Testing of Stone

A copy of the laboratory inspection report along with actions taken to correct deficiencies and a copy of the test reports, prior to delivery of such material to the worksite; since quality test on the stone in accordance with PART 2 paragraph EVALUATION TESTING OF STONE is the responsibility of the Contractor.

1.4.3 Laboratory

A copy of the documents, provided by the Materials Testing Center, that validates that the laboratory can perform the required tests. The individual tests shall be listed for which the validation covers along with the date of the inspection.

1.4.4 Weigh Scale Certification

A copy of the certification from the regulation agency attesting to the scale's accuracy.

1.4.5 Certified Weight Scale Tickets

A copy of each certified weight scale ticket 5 working day(s) after weighing.

1.5 QUALITY ASSURANCE

1.5.1 Rock Slope Protection Materials

1.5.1.1 General

All stone shall be durable material as reviewed by the Government. Stone shall be of a suitable quality to ensure permanence in the structure and in the climate in which it is to be used. It shall be free from cracks, blast fractures, bedding, seams and other defects that would tend to increase its deterioration from natural causes. Inspections for cracks, fractures, seams and defects shall be made by visual examination. If, by visual examination, it is determined that 10 percent (by volume) or more of the stone produced contains hairline cracks, then all stone produced by the means and measures which caused the fractures shall be rejected. A hairline crack that is defined as being detrimental shall have a minimum width of 4 mil and shall be continuous for one-third the dimension of at least two sides of the stone. The stone shall be clean and reasonably free from soil, quarry fines, and shall contain no refuse.

1.5.1.2 Sources

Stone shall be furnished from a source designated by the Contractor and accepted by the Contracting Officer, subject to the conditions herein stated. Satisfactory service records on other work may be acceptable. In order for stone to be acceptable on the basis of service records, stone of a similar size must have been placed in a similar thickness and exposed to weathering under similar conditions as are anticipated for this contract, and must have satisfactorily withstood such weathering for a minimum of 20 years. If no such records are available, the Contractor will conduct tests to assure the acceptability of the stone.

b. Selection of Source. Designate in writing only one source or one combination of sources from which he proposes to furnish stone. If the Contractor proposes to furnish stone from a source not listed at the end of paragraph 2.1.3, RIP RAP AND QUARRY STONE SOURCES, he may designate only a single unlisted source for stone and he shall notify the Contracting Officer at least 60 workdays before the stone leaves the quarry. It is the Contractor's responsibility to determine that the stone source or combination of sources selected is capable of providing the quality, quantities and gradation needed and at the rate needed to maintain the scheduled progress of the work. Samples for acceptance testing shall be provided in accordance with paragraph EVALUATION TESTING below.

c. Acceptance of Materials. Acceptance of a source of stone is not to be construed as acceptance of all material from that source. The right is reserved to reject materials from certain localized areas, zones, strata, or channels, when such materials are unsuitable for stone as determined by the Contracting Officer. The Contracting Officer also reserves the right to reject individual units of produced specified materials in stockpiles at the quarry, all transfer points, and at the project construction site when such materials are determined to be unsuitable. During the course of the work, the stone may be tested by the Government, if the Contracting Officer determines that testing is necessary. If such tests are determined necessary, the testing will be done in a commercial laboratory selected by the Government. Materials produced from a listed or unlisted source shall meet all the requirements herein. The cost of testing will be at the Government's expense.

1.5.1.3 Evaluation Testing of Stone

The tests to which the stone may be subjected will include petrographic analysis, specific gravity, unit weight, absorption, wetting and drying, freezing and thawing and such other tests as may be considered necessary to demonstrate that the stone is of a satisfactory quality which is at least equivalent to stone from the sources listed at the end of this section.

a. Saturated Surface Dry (SSD) Bulk Specific Gravity and Absorption. Stone shall weigh more than 155 pounds per cubic foot and have an SSD bulk specific gravity greater than 2.65. The stone shall have an absorption less than 2 percent unless other tests and service records show that the stone is satisfactory. The method of test for SSD bulk specific gravity and absorption will be ASTM C127.

b. Samples. Samples of stone from a source not listed at the end of this section shall be taken by a representative of the quarry under the supervision of the Contracting Officer for testing and acceptance prior to delivery of any stone from this source to the site of the work. Samples shall consist of at least three pieces of stone, roughly cubical in shape and weighing not less than 150 pounds each from each unit that will be used in the production of the required stone. If the source is an undeveloped quarry, or if the operation has been dormant for more than one year such that fresh samples are not available, expose fresh rock for 20 feet horizontally and for the full height of the face proposed for production, prior to the field evaluation.

c. Tests. The tests will be conducted in accordance with applicable Corps of Engineers methods of tests given in the Handbook for Concrete and Cement or ASTM methods of tests.

1.5.1.4 Drop Test

A drop test provides an immediate evaluation of the durability of very large stone during handling of the stone including placement into a structure. For comparability, the test stone(s) shall be dropped from a bucket or by other means from a height of not less than half the average diameter of the stone onto a rigid surface or second stone of comparable size. Dumping from a truck is not acceptable. The stone shall be examined carefully before as well as after the completion of the test. Failure criteria is the development of new cracks, opening of old cracks, and the loss of piece from the surface of the stone. Each stone shall be dropped a total of five times for evaluation purposes with examination after each drop. Provide all necessary equipment and operating personnel to help perform the testing.

1.6 REGULATORY REQUIREMENTS

The regulatory requirements listed below form a part of this specification to the extent referenced. The regulatory requirements are referred to in the text by basic designation only.

CALIFORNIA STATE HIGHWAY AND TRANSPORTATION DEPARTMENT ()

72 Standard Specifications for Highway Construction

1.7 CONSTRUCTION TOLERANCES

The finished surface and stone layer thickness shall not deviate from the lines and grades shown by more than the tolerances listed below. Tolerances are measured perpendicular to the indicated neatlines. Extreme limits of the tolerances given shall not be continuous in any direction for more than five times the nominal stone dimension nor for an area greater than 200 square feet of the structure surface.

NEATLINE TOLERANCES		
MATERIAL	ABOVE NEATLINE (inches)	BELOW NEATLINE (inches)
RSP Type A and RSP Type B	6	0

The intention is that the work shall be built generally to the required elevations, slope and grade and that the outer surfaces shall be even and present a neat appearance. Placed material not meeting these limits shall be removed or reworked as directed by the Contracting Officer. Payment will not be made for excess material which the Contracting Officer permits to remain in place.

PART 2 PRODUCTS

2.1 STONE

2.1.1 General

2.1.1.1 Evaluation Testing of Stone

If the Contractor proposes to furnish stone from an unlisted source, have evaluation tests performed on stone samples collected from the proposed source. The quarry investigation shall be performed by a registered geologist or registered engineer. The tests to which the stone shall be subjected include petrographic examination (ASTM C295), bulk specific gravity (SSD), absorption (ASTM C127), resistance of stone to freezing and thawing (COE CRD-C 144, ASTM D5312/D5312M), and if argillaceous limestone and sandstone are used, resistance to wetting and drying (COE CRD-C 169). The laboratory to perform the required testing shall be validated based on relevant paragraphs of ASTM D3740, and no work requiring testing shall be permitted until the laboratory has been inspected and validated. The first inspection of the facilities shall be at the expense of the Government and any subsequent inspections required because of failure of the first inspection shall be at the expense of the Contractor.

a. Unit Weight and Absorption. Stone shall weigh more than 155 pounds per cubic foot and have an SSD bulk specific gravity greater than 2.65. The stone shall have an absorption less than 2 percent unless other tests and service records show that the stone is satisfactory. The method of test for unit weight and absorption shall be ASTM C127.

b. Petrographic Examination. Stone shall be evaluated in accordance with ASTM C295 which shall include information required by ASTM D4992, paragraph 10. COE CRD-C 148 shall be used to perform Ethylene glycol tests required on rocks containing smectite as specified in ASTM D4992 and on samples identified to contain swelling clays.

c. Resistance to Freezing and Thawing. Stone shall have a maximum loss of 5 percent after the number of cycles specified in ASTM D5312/D5312M, Figure 1, when determining the durability of stone when subjected to freezing and thawing in accordance with COE CRD-C 144, except the surface area of one side of the sample shall be between 144 and 2304 square inches.

d. Resistance of Rock to Wetting and Drying. Stone shall have a maximum loss of 1 percent when determining the durability of stone when subject to wetting and drying in accordance with COE CRD-C 169, except the surface area of one side of the sample shall be between 144 and 2304 square inches.

e. Samples. Samples of stone taken by a representative of the Quarry under the supervision of the Contracting Officer for testing and acceptance prior to delivery of any stone from this source to the site of the work. Information provided with the samples shall include the location within the quarry from which the sample was taken along with a field examination of the quarry. The field examination shall include the information outline in ASTM D4992, paragraph 7. Samples shall consist of at least three pieces of stone, roughly cubical in shape and weighing not less than 150 pounds each from each unit that shall be used in the production of the required stone. If the source is an undeveloped quarry, or if the operation has been dormant for more than one year such that fresh samples are not available, expose fresh rock for 20 feet horizontally and for the full height of the face proposed for production, prior to the field evaluation. The Contracting Officer may also require documentation of subsurface exploration of an undeveloped quarry in order to determine whether or not sufficient reserves are available. The samples shall be shipped at the Contractor's expense to a laboratory validated by the Government to perform the required tests.

f. Tests. Conduct the tests in accordance with applicable ASTM and Corps of Engineers methods of tests, given in the Handbook for Concrete and Cement, in a laboratory validated by the Government. The cost of testing shall be borne by the Contractor.

2.1.1.2 Gradation Test

Perform a gradation test or tests on the riprap, stone, or rock slope protection at the quarry in accordance with paragraph GRADATION TEST METHOD FOR RIPRAP, GRADED STONE, AND ROCK SLOPE PROTECTION. Take the sample in the presence of the Contracting Officer. Notify the Contracting Officer not less than 3 days in advance of each test. At least one gradation test(s) shall be performed per 25,000 tons of each size of riprap, stone, or rock slope protection placed, but not less than one test shall be performed. The gradation tests shall be reported using the forms USACE ENG FORM 4794-R. Failure of the test on the initial sample and on an additional sample will be considered cause for rejection of the quarry and/or quarry process, and all riprap, stone, or rock slope protection represented by the failed tests shall be set aside and not incorporated into the work. Any additional tests required because of the failure of an initial test sample will not be considered as one of the other required tests. If collected by the truckload, each truckload shall be representative of the gradation requirements. Each pit excavated for an in-place test sample shall be refilled and reworked to provide a surface void of signs of disturbance. If the gradation test fails, additional gradation tests will be required at the Contractor's expense to delineate the limits of unacceptable stone. The additional gradation tests shall not count as part of the minimum number of gradation tests required. The unacceptable stone shall either be reworked to bring the stone within the specified gradation or the stone shall be removed from the project site as determined by the Contracting Officer. Provide all necessary screens, scales and other equipment, and operating personnel, to grade the sample. Certification and test results shall represent riprap, stone, or rock slope protection shipped from the quarry. Certification and tests results must be received by the Contracting Officer at the jobsite before the riprap, stone. or rock slope protection is used in the work.

2.1.1.3 Proportional Dimension Limitations

The maximum aspect ratio (greatest dimension:least dimension) of any piece of stone for size ranges which are not graded with a screen or grizzly, shall be not greater than 3:1 when measured across mutually perpendicular axis. Not more than 25 percent (25%) of the stones within a gradation range shall have an aspect ratio greater than 2.5:1.

2.1.1.4 Stone Stockpile

Storage of stone at the worksite is not to be confused with off-site stockpiling of riprap, stone, or rock slope protection. If the Contractor elects to provide off-site stockpiling areas, the Contracting Officer shall be notified of all such areas. The Contractor's stockpile shall be a maximum of 12 feet high and formed by a series of layers of truckload dumps, where the rock essentially remains where it is placed. Subsequent layers shall be started 10 feet from the edge of the previous layer so that the rock will not roll down the edges of the previous layers. The first layer shall be a maximum of 6 feet high. After being stockpiled, any riprap, stone, or rock slope protection which has become contaminated with soil or refuse shall not be put into the work unless the contaminating material has been removed from the riprap, stone, or rock slope protection prior to placement.

a. Worksite Stockpile. Riprap, stone, or rock slope protection delivered to the work sites, which requires temporary storage shall be placed in a container suitable for storing the riprap, stone, or rock slope protection without waste The container shall be subject to reviewal prior to delivery of the riprap, stone, or rock slope protection. Upon completion of the work, the storage areas shall be cleaned of all storage residues and returned to their natural condition.

b. Off-site Stockpile. In areas where riprap, stone, or rock slope protection is stockpiled for placement, the area shall have excess rock removed prior to completion of work. All rock and spalls greater than 3 inches in diameter shall be removed. Where rocks may have become buried due to soft ground or operation of the equipment, the rock shall be disposed of as directed . After the rock has been removed, the storage area shall be graded, dressed, and filled to return the ground surface as near as practical to the condition that existed prior to construction.

2.1.2 Rock Slope Protection

Only quarried stone shall be used. Stone shall be well graded and shall conform to the table(s) below.

TABLE 2-1 - FOR RSP TYPE A MATERIAL	
ROCK SIZE	PERCENT LARGER THAN
1/4 Ton	0 - 5
200 Lb.	50 - 100
25 Lb.	95 - 100

TABLE 2-2 - FOR RSP TYPE B MATERIAL	
ROCK SIZE	PERCENT LARGER THAN
25 LB	0 - 5
5 LB	25 - 75
1 LB	90 - 100

2.1.3 Rip Rap and Quarry Stone Sources

The following is a list of sources provided as a convenience to the Contractor. The Contractor is not limited to obtaining Rip Rap and Quarry Stone from one of, or any combination of, the provided sources. Other sources may exist which have not been included on the following list.

Quarry Name	Location	Information
Cool Cave Quarry	2601 Highway 49, Cool, CA 95614	(530) 885-4244 http://goo.gl/EUitXx
Spring Valley Rock Quarry	10163 Spring Valley Rd Marysville, CA 95901	(530) 673-7877 http://goo.gl/aQ9XCm
Ione Quarry	Ione Michigan Bar Road, Ione, CA	(866) 266-8504 http://goo.gl/dx3Rpr
Napa Quarry	2301 Napa-Vallejo HWY., Napa, CA 94558-6242	(707) 224-6202 http://goo.gl/3sNlRC
Hogan Quarry	3650 Hogan Dam Rd Valley Springs, CA 95252	(209) 772-2775
San Rafael Rock Quarry	1000 Point San Pedro San Rafael, CA 94901	(415) 459-7740 http://goo.gl/tbxt8l
Table Mountain Quarry	2216 Table Mountain Blvd Oroville, CA	(530) 534-4517
Parks Bar Quarry	Parks Bar Road, Smartsville, CA 95977	(530) 639-2408 http://goo.gl/xJ9fhb
Woods Creek Quarry	16655 Hwy 108 Jamestown, CA 95327	(209) 984-5307
Carmichael Rock Quarry (Vina)	Rock Quarry Rd Vina, CA	(530) 742-7124 http://goo.gl/xJ9fhb
Bangor Quarry	Near Bangor, CA	(530) 241-6102
Jackson Valley Quarry	3421 Jackson Valley Rd, Ione, CA	(209) 274-2018

PART 3 EXECUTION

3.1 PLACEMENT OF ROCK SLOPE PROTECTION MATERIAL

3.1.1 General

A rock fill layer shall be placed on the prepared subgrade, in accordance with the details shown on the contract drawings, and within the limits shown on the contract drawings or staked in the field.

3.1.2 Placement of RSP Type A and RSP Type B Materials

RSP Type A and RSP Type B materials shall be spread uniformly on the prepared subgrade to the lines and grades as indicated in the contract drawings and in such manner as to avoid damage to the prepared subgrade. RSP Type A and RSP Type B materials shall be placed in such a manner as to avoid segregation and provide a thoroughly distributed mass with a minimum of voids. Contractor shall have sufficient crews on hand during placement of RSP Type A and RSP Type B materials to rearrange loose rock fragments and fill voids with smaller rock to provide a stable and uniform mass. Placement shall begin at the bottom of the area to be covered and continue up slope. Subsequent loads of material shall be placed against previously placed material in such a manner as to ensure a homogenous mass of rock with a minimum of voids and uniform surface. Any damage to the surface of the prepared subgrade during placement of RSP material shall be repaired before proceeding with the work. Compaction of RSP material is not required but the material surface shall be finished to provide an even, uniform surface, free from mounds and abrupt changes in grade. Equipment shall not be allowed on the finished rock surface.

3.2 TESTS AND INSPECTIONS

3.2.1 Pre-Production

3.2.1.1 Bulk Specific Gravity

Quantity determinations are contingent upon the range of bulk specific gravity (saturated surface dry (SSD) basis) of stone to be supplied. Therefore, during the process of selecting a source or sources of stone for the project, make an investigation to determine the lowest and highest bulk specific gravity (SSD) of stone available at the source or sources proposed to be utilized for each gradation range of stone. Tests shall be performed at a Government approved testing laboratory. The testing results shall be submitted in accordance with paragraph SUBMITTALS. Test results which display an extraordinarily wide range of values may necessitate additional testing to determine whether the source contains stratas with stones of an acceptable range of bulk specific gravity. For Category I sources which have been acceptably tested not more than two years earlier, and the material is of an acceptable quality and bulk specific gravity, the Contracting Officer may waive the requirement for bulk specific gravity testing.

3.2.1.2 Material Quality

Before selecting a source for preparation of a demonstration stockpile, be reasonably certain that the source is capable of meeting the quality and source requirements specified in paragraphs SOURCES and EVALUATION TESTING OF STONE, including their respective subparagraphs.

3.2.1.3 Borderline Material Quality

If the Government's evaluation of a demonstration stockpile results in not being able to determine by visual examination whether the material is acceptable or unacceptable, the COR will select at least one but not more than three representative stones from the demonstration stockpile to be prepared for shipment to the Government's laboratory for testing in accordance with paragraph EVALUATION TESTING OF STONE. Where specified sizes are in excess of 2,000 pounds, cut or break a representative piece, weighing approximately 2,000 pounds each, off of the selected stones. For specified stone sizes of less than 2,000 pounds but more than 500 pounds, individual samples shall be the size of the largest stone specified for the size range. Samples of stone groupings with a maximum size less than 500 pounds shall contain at least two (2) stones representative of the higher limit of the stone weights specified. In addition, the sample shall be representative of the gradation specified and the minimum weight of the total sample shall be not less than 500 pounds. The sampling and testing procedures shall be repeated for each strata being quarried. Ship the samples to the laboratory as specified in paragraph EVALUATION TESTING OF STONE. If the laboratory testing reveals the materials are unacceptable, submit a replacement source for reviewal and proceed with the demonstration stockpile procedures anew.

3.2.1.4 Demonstration Stockpile at Source

Following submittal of the Contractor's Quality Control (CQC) Plan and selection of a source, but prior to the Government's reviewal of a source and the CQC Plan, make arrangements to provide a pre-production demonstration stockpile for each of the stone size ranges for the project. The stockpiles shall be located at the source of the stone and be shaped in windrow fashion. The stones with a size range greater than three (3) tons shall be placed in a single layer with one (1) foot of clear space around each stone. Stones under three (3) tons in weight shall not be stacked higher than four (4) feet. The stones placed in the demonstration stockpiles shall be representative of the overall quality of materials in the source and shall not consist of the best specimens unless it is reasonable to determine that the source will provide the required amount of stone of the applicable size range with a degree of quality no less than that existent in the demonstration stockpile. The quantity of stone in each demonstration stockpile shall be dependent upon the gradation size range to be produced for the project.

The stones placed in the stockpile shall have been preselected by the Contractor's Quality Control Plan (CQCP) inspector or supervisor and acceptable stones over 500 pounds in size shall have been marked with spray paint on three mutually perpendicular sides with a coded mark to denote acceptability for a certain size range. A stockpile of representative reject stones marked with a red "X" shall also be maintained at the site as examples of unacceptable materials or shapes.

3.2.2 Quality Control and Inspection

3.2.2.1 General

Perform gradation tests to assure compliance with contract requirements and shall maintain detailed records. The bedding material, filter materials and/or sand fill shall be sampled in accordance with ASTM D75/D75M and tested in accordance with ASTM C136. Perform the tests before and after surveys of each layer of stone protection material placed.

3.2.3 Placement Control

3.2.3.1 Quality Control Measures

Establish and maintain quality control for all work performed at the job site under this section to assure compliance with contract requirements. Maintain records of the quality control tests, inspections and corrective actions. Quality control measures shall cover all construction operations including, but not limited to, the placement of all materials to the slope and grade lines shown and in accordance with this section.

3.2.3.2 Check Surveys

Surveys made by the Contractor are required on each material placed for determining that the materials are acceptably placed in the work. Make checks as the work progresses to verify lines, grades and thicknesses established for completed work. At least one (1) check survey below shall be made for each 100 foot section as soon as practicable after completion. Approval of cross sections based upon check surveys shall not constitute final acceptance of work. Cross sections shall be taken at a minimum of 100 feet apart and on station along the control line shown in the plans, with readings at 5-foot intervals and at changes in grade. Additional cross sections and/or alternate spacing and reading intervals may be used if determined appropriate by the Government. The surveys shall be conducted in the presence of the Contracting Officer.

3.2.3.3 Inspection of RSP Type A and RSP Type B Materials

Inspections of rock materials shall be performed to ensure that a dense, rough surface of well-keyed and graded rock is obtained, that layers are placed in such a manner that voids are minimized, and to the lines and grades shown in the plans.

3.2.3.4 Reporting

Reporting shall be in accordance with paragraph GRADATION TEST.

3.2.4 Gradation Test Method for Riprap, Graded Stone, and Rock Slope Protection

a. Select a representative sample (Note No. 1), weigh and dump on hard stand.

b. Select specific sizes (see example) on which to run "individual weight larger than" test. (See Note No. 2). Procedure is similar to the standard aggregate gradation test for "individual weight retained".

c. Determine the largest size stone in the sample. (100 percent size)

d. Separate by "size larger than" the selected weights, starting with the larger sizes. Use reference stones, with identified weights, for visual comparison in separating the obviously "larger than" stones. Stones that appear close to the specific weight must be individually weighed to determine size grouping. Weigh each size group, either individually or cumulatively.

e. Paragraph d above will result in "individual weight retained" figures. Calculate individual percent retained (heavier than), cumulative percent retained, and cumulative percent passing (lighter than). Plot percent passing, along with the specification curve on ENG Form 4794-R.

NOTE NO. 1: Sample Selection: The most important part of the test and the least precise is the selection of a representative sample. No "standard" can be devised; larger quarry run stone is best sampled at the shot or stockpile by given direction to the loader; small graded stone is best sampled by random selection from the transporting vehicles. If possible, all parties should take part in the sample selection and agree before the sample is run that the sample is representative.

NOTE NO. 2: Selection of Size for Separation: It is quite possible and accurate to run a gradation using any convenient sizes for the separation, without reference to the specifications. After the test is plotted on a curve, then the gradation limits may be plotted. Overlapping gradations with this method are no problem. However, it is usually more convenient to select points from the gradation limits, such as the minimum 50 percent size, the minimum 15 percent size, and one or two others, as separation points.For these types of stone gradations the separation points need to be selected as the smallest size stone at each break in the gradation specified.

F O R

E X A M P L E

O N L Y

EXAMPLE GRADATION SPECIFICATIONS	
PERCENT LIGHTER BY WEIGHT	STONE WEIGHT IN LBS
100	400 - 160
50	160 - 80
15	80-30

EXAMPLE WORKSHEET				
STONE SIZE LBS	INDIVIDUAL WT. RETAINED	INDIVIDUAL PERCENT RETAINED	CUMULATIVE RETAINED	PERCENT PASSING
400	0	0	0	100
160	9600	30	30	70
80	11,200	35	65	35
30	8000	25	90	10
<30	3200	10	100	-
TOTAL	32,000 pounds			
NOTE: Largest stone 251 pounds				

G R A D A T I O N   T E S T   D A T A   S H E E T

Quarry ______________________________ Type of Stone Tested

Date of Test ________________________ Testing Rate ________________________

T E S T R E P R E S E N T S		
Contract No.	District	Tons
	TOTAL	

G R A D A T I O N					
			Cumulative		
Stone Size (lbs)	Weight Retained	Individual % Retained	Percent Retained	Percent Passing	Specification % Finer by Wt
Total Weight					
Max Size Stone					
Remarks:					

I certify that the above stone sample is representative of the total tonnage covered by this test report.

Contractor Representative ______________________________

Government Representative ______________________________

STONE SOURCES		
LATITUDE/LONGITUDE	QUARRY LOCATION, ADDRESS, & TELEPHONE	MAIN OFFICE ADDRESS & TELEPHONE NUMBER
STATE		
STATE		

-- End of Section --

SECTION TABLE OF CONTENTS

DIVISION 35 - WATERWAY AND MARINE CONSTRUCTION

SECTION 35 45 01

VERTICAL PUMPS, AXIAL-FLOW AND MIXED-FLOW IMPELLER-TYPE

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SECTION 35 45 01

VERTICAL PUMPS, AXIAL-FLOW AND MIXED-FLOW IMPELLER-TYPE
02/16

PART 1 GENERAL

1.1 REFERENCES

The publications listed below form a part of this specification to the extent referenced. The publications are referred to within the text by the basic designation only.

AMERICAN PETROLEUM INSTITUTE (API)

API RP 686	(2009) Recommended Practice for Machinery Installation and Installation Design

AMERICAN WATER WORKS ASSOCIATION (AWWA)

AWWA C200	(2012) Steel Water Pipe - 6 In. (150 mm) and Larger
AWWA C203	(2008) Coal-Tar Protective Coatings and Linings for Steel Water Pipelines - Enamel and Tape - Hot-Applied
AWWA C207	(2013) Standard for Steel Pipe Flanges for Waterworks Service-Sizes 100 mm through 3600 mm 4 in. through 144 in.
AWWA C208	(2017) Dimensions for Fabricated Steel Water Pipe Fittings
AWWA M11	(2016) Steel Pipe: A Guide for Design and Installation

AMERICAN WELDING SOCIETY (AWS)

AWS D1.1/D1.1M	(2015; Errata 1 2015; Errata 2 2016) Structural Welding Code - Steel

ASME INTERNATIONAL (ASME)

ASME B17.1	(1967; R 2017) Keys and Keyseats
ASME B31.1	(2016; Errata 2016) Power Piping
ASME B36.10M	(2015; Errata 2016) Welded and Seamless Wrought Steel Pipe
ASME B46.1	(2009) Surface Texture, Surface Roughness, Waviness and Lay
ASME BPVC SEC IX	(2010) BPVC Section IX-Welding and Brazing Qualifications

ASTM INTERNATIONAL (ASTM)

ASTM A108	(2013) Standard Specification for Steel Bar, Carbon and Alloy, Cold-Finished
ASTM A126	(2004; R 2014) Standard Specification for Gray Iron Castings for Valves, Flanges, and Pipe Fittings
ASTM A217/A217M	(2014) Standard Specification for Steel Castings, Martensitic Stainless and Alloy, for Pressure-Containing Parts, Suitable for High-Temperature Service
ASTM A27/A27M	(2017) Standard Specification for Steel Castings, Carbon, for General Application
ASTM A276/A276M	(2017) Standard Specification for Stainless Steel Bars and Shapes
ASTM A285/A285M	(2012) Standard Specification for Pressure Vessel Plates, Carbon Steel, Low- and Intermediate-Tensile Strength
ASTM A312/A312M	(2017) Standard Specification for Seamless, Welded, and Heavily Cold Worked Austenitic Stainless Steel Pipes
ASTM A351/A351M	(2016) Standard Specification for Castings, Austenitic, for Pressure-Containing Parts
ASTM A352/A352M	(2017) Standard Specification for Steel Castings, Ferritic and Martensitic, for Pressure-Containing Parts, Suitable for Low-Temperature Service
ASTM A36/A36M	(2014) Standard Specification for Carbon Structural Steel
ASTM A48/A48M	(2003; R 2012) Standard Specification for Gray Iron Castings
ASTM A609/A609M	(2012) Standard Specification for Castings, Carbon, Low-Alloy, and Martensitic Stainless Steel, Ultrasonic Examination Thereof
ASTM A668/A668M	(2017) Standard Specification for Steel Forgings, Carbon and Alloy, for General Industrial Use
ASTM B148	(2014) Standard Specification for Aluminum-Bronze Sand Castings
ASTM B584	(2014) Standard Specification for Copper Alloy Sand Castings for General Applications

ASTM B98/B98M	(2013) Standard Specification for Copper-Silicon Alloy Rod, Bar, and Shapes
ASTM E709	(2015) Standard Guide for Magnetic Particle Examination
ASTM F1476	(2007; R 2013) Standard Specification for Performance of Gasketed Mechanical Couplings for Use in Piping Applications

HYDRAULIC INSTITUTE (HI)

HI 9.1-9.5	(2000) Pumps - General Guidelines for Types, Applications, Definitions, Sound Measurements and Documentation
HI 9.6.4	(2009) Rotodynamic Pumps for Vibration Analysis and Allowable Values
HI ANSI/HI 14.6	(2011) Rotodynamic Pumps for Hydraulic Performance Acceptance Tests - A136

INTERNATIONAL ORGANIZATION FOR STANDARDIZATION (ISO)

ISO 1940-1	(2003; R 2008) Mechanical Vibration - Balance Quality Requirements for Rotors in a Constant (Rigid) State - Part 1: Specification and Verification of Balance Tolerances

INTERNATIONAL SOCIETY OF AUTOMATION (ISA)

ISA RP2.1	(1978) Manometer Tables

U.S. DEPARTMENT OF DEFENSE (DOD)

UFC 3-310-04	(2013; with Change 1) Seismic Design of Buildings

1.2 SUBMITTALS

Government approval is required for submittals with a "G" designation; submittals not having a "G" designation are for information only. When used, a designation following the "G" designation identifies the office that will review the submittal for the Government. Submit the following in accordance with Section 01 33 00 SUBMITTAL PROCEDURES:

SD-02 Shop Drawings

Detail Drawings; G

Pump Base Plate And The Anchoring Bolts; G

SD-03 Product Data

Humidity-Controlled Storage

Materials; G

Spare Parts

Total Head; G

Shipping Bills

Pump Curves; G

Preliminary Pump Curves; G

Installation and Erection Instructions Manual

Field Tests

Impeller Weight

SD-04 Samples

Materials; G

SD-05 Design Data

Dynamic Analysis; G

Stress-Relieving Procedure; G

Piping; G

Baseplates and the Anchoring Bolts

SD-06 Test Reports

Witness Test.

Factory Test

Balancing Procedure; G

Results Of Impeller Balancing

SD-07 Certificates

Qualified Welders

Examination Procedure And Qualification Of The Examiner; G

SD-10 Operation and Maintenance Data

Operation and Maintenance Instructions Manual; G

1.3 QUALITY ASSURANCE

Furnish one or more competent erecting engineers fluent in English language who is knowledgeable about the installation of vertical pumps and associated drive machinery. Erecting engineers provided by this section include those from the Contractor's suppliers. When so requested, erecting engineers must provide and be responsible for providing complete and correct direction during initial starting and subsequent operation of equipment until field tests are completed. The erecting engineer must initiate instructions for actions necessary for proper receipt, inspection, handling, uncrating, assembly, and testing of equipment. The Erecting Engineer(s) must also keep a record of measurements taken during erection, and furnish one copy to the Contracting Officer on request or on completion of installation of the assembly or part. The erecting engineer must instruct the Contracting Officer in operation and maintenance features of work.

1.3.1 Detail Drawings

Submit drawings of sufficient size to be easily read, within 30 days of notice of award of contract. Submit information in the English language. Provide with English (IP) dimensions. Drawings must consist of complete designs of the pump, pump installation instructions, performance charts, brochures, and other information required to illustrate that the entire pumping system (including the pump and motor) has been coordinated and will function as a unit.

a. Outline drawings of the pump showing pertinent dimensions and weight of each component of the pump. Prepare drawings to scale.

b. Drawing showing details and dimensions of pump mounting design or layout including any embedded items and the FSI.

c. Cross-sectional drawings of the pump showing each component. Show major or complicated sections of the pump in detail. Indicate on each drawing an itemized list of components showing type, grade, and class of material used and make and model number of standard component used.

d. Drawings covering erection and installation, that are intended to be furnished to the erecting engineer.

e. Drawings of the pump and base plate showing its dimensions. Include calculations used in the design of the thickness of the pump base plate and the anchoring bolts to ensure that the proper forces (shear, torsion, etc.) have been considered.

1.3.2 Welding

For all welding, procedures and welders must be qualified in accordance with ASME BPVC SEC IX. Welding procedures qualified by others, and welders and welding operators qualified by a previously qualified employer may be accepted as permitted by ASME B31.1. Perform welder qualification tests for each welder whose qualifications are not in compliance with the referenced standards. Notify the Contracting Officer 24 hours in advance of qualification tests. Perform the qualification tests at the work site if practical. The welder or welding operator must apply their assigned symbol near each weld made as a permanent record.

The names of all qualified welders, their identifying symbols, and the qualifying procedures for each welder including support data such as test procedures used, and standards tested to.

1.4 DELIVERY, STORAGE, AND HANDLING

1.4.1 General

Furnish major pump components with lifting lugs or eye bolts to facilitate handling. Design and arrange lugs or bolts to allow safe handling of pump components singly or collectively as required during shipping, installation, and maintenance. Submit copies of certified shipping bills to the Contracting Officer or memorandums of all shipments of finished pieces or members to designated site, giving designation mark and weight of each piece, number of pieces, total weight, and if shipped by rail in carload lots, car initial and number.

1.4.2 Processing for Storage

Prepare pumps (and spare parts) for storage indoors. Indoor storage consists of a permanent building that has a leak-proof roof, full walls to contain stored equipment, and a concrete floor or temporary trailers. A temporary structure may also be built at the job site for equipment storage that will contain features of the permanent building above except that provision for ventilation will be provided and floor may be crushed rock. A vapor barrier will be provided below the crushed rock. Crushed rock will be of sufficient thickness so that settlement of equipment will not occur. Equipment stored on crushed rock will have cribbing under each support location so that equipment does not come in contact with crushed rock. A plastic barrier will be placed between equipment and wood cribbing. Submit a list of equipment and materials requiring humidity-controlled storage to the Contracting Officer no later than 30 days prior to shipment of pumping units. Store long term (greater than 6 months) in accordance with pump manufacturer's recommendations.

1.5 PROJECT/SITE CONDITIONS

1.5.1 Datum

Elevations shown or referred to in specifications, are above or below mean sea level National American Vertical Datum (NGVD) 1988.

1.5.2 Static and Pool-To-Pool Head

Static head is the difference, in feet, between water surface elevation in the sump immediately inside trash rack and top of discharge pipe at highest elevation. Total head includes static head, friction losses outside of equipment being furnished, plus velocity head loss.

Pool-to-pool head is the difference in feet between the water surface elevation in the sump and water surface elevation in the river. The pump manufacturer must determine total head. Submit computations of total head and losses. Total head includes losses from the water surface on the suction side of the pump to discharge water surface.

1.6 MAINTENANCE

1.6.1 Special Tools

Furnish one set of all "special tools" required to completely assemble, disassemble, or maintain the pumps. "Special tools" refer to oversized or specially dimensioned tools, special attachments or fixtures, or any similar items. If required, provide a device for temporarily supporting the pump shaft and impeller during assembly, disassembly, and reassembly of the motor when the thrust bearing is not in place. Provide a portable steel cabinet large enough to accommodate all "special tools" furnished under this paragraph and as required by Section 26 29 01 ELECTRIC MOTORS, 3-PHASE VERTICAL INDUCTION TYPE. Mount the cabinet on four rubber-tired casters. Provide drawers to accommodate tools. Fit front of cabinet with doors hinged to swing horizontally. Furnish doors with necessary stops, catches, and hasps for completely securing the cabinet with a padlock. Furnish the padlock complete with three keys. Pack "special tools" in wooden boxes if the size and weight do not permit storage in the tool cabinet. Provide slings if the box and tools are heavier than 75 pounds.

1.6.2 Extra Materials

Furnish the following spare parts:

a. One complete replacement set of bearings, bearing shells, journal sleeves, shaft coupling, if applicable, and seals for each size pump.

b. One complete replacement set of wearing parts for the packing gland for each size pump, and sufficient packing for all pumps.

gc Provide copies of manufacturer's complete parts list showing all parts, spare parts, and bulletins for each size pump. Clearly show all details and parts, and adequately describe parts or have proper identification marks.

1.7 WARRANTY

The manufacturer of the axial-flow impeller-type vertical pumps must provide a warranty all equipment furnished under this section against defective workmanship, materials, design, and performance for a period of one (1) year from the date the equipment is accepted. If the equipment or any part thereof does not conform to these warranties, and the Government so notifies the manufacturer within a reasonable time after its discovery, the manufacturer must thereupon promptly correct such nonconformity by repair or replacement. Coordinate the down time for the equipment with the Government, and be kept to a minimum duration that is mutually agreed to by the manufacturer and the Government. The manufacturer is liable during the warranty period for the direct cost of removal of the equipment from the installed location, transportation to the manufacturer's factory or service shop for repair and return, and reinstallation on site. The manufacturer will be given the opportunity to perform the removal and reinstallation and to select the means of transportation. The expense of removing adjacent apparatus, installing spare equipment, costs of supplying temporary service, is not included in this warranty provision.

PART 2 PRODUCTS

2.1 SYSTEM DESCRIPTION

Design, furnish, and install vertical mixed-flow, single stage impeller-type pumps, as indicated. The pumping systems include pumps. The pump manufacturer is responsible for the equipment of the entire pumping systems. Therefore, the electric motors, should be selected by the pump manufacturer.

2.1.1 Design Requirements

a. Pumps are for the purpose of pumping water from a drainage canal into the Sacramento River. Water pumped will not exceed 80 degrees F, will be relatively turbid, and may contain sand, silt, and vegetative trash capable of passing through the trash rack.

b. Drive the pumps with the vertical motors described in Section 26 29 01 ELECTRIC MOTORS, 3-PHASE VERTICAL INDUCTION TYPE as indicated.

c. Design pumps so that no major modifications, alterations, or additions will be required to the pumping station or suction bays to accommodate them. However, requests for changes in setting of pump, supports, and accessories that would involve only minor modifications, will be considered. Design pump so that pump parts will fit within the limiting horizontal and vertical dimensions shown. Pumps must be capable of being lowered through floor openings shown with a minimum of 1 inch clearance around each side.

d. Each pump must discharge into discharge system shown. System loss curve, which includes friction losses from pump discharge elbow to end of discharge line, including bend losses, exit loss, and velocity head, is included in this section to permit determination of total head. Determine losses within the pump.

d. Each pump discharge system downstream of pump discharge must be designed by the pump manufacturer. It must be of type shown and fit within limiting dimensions and elevations shown. Determine all losses for discharge system and submit for approval.

d. Accomplish priming of siphon without assistance of vacuum equipment.

f. The design (drawings, computations, etc.) must be signed and sealed by a professional engineer registered in the State of California.

2.1.2 Capacities

a. PMP-100
Minimum Required Priming Operation (Static Head) - 44.5 cfs at 35.5 FT TDH
Siphon Operation (Pool-to-Pool Head) - 45 cfs at 35 FT TDH
Maximum Pump Speed - 900 rpm
Maximum Pump Motor hp - 250 hp

b. PMP-200
Minimum Required Priming Operation (Static Head) - 44.5 cfs at 35.5 FT TDH
Siphon Operation (Pool-to-Pool Head) - 45 cfs at 35 FT TDH
Maximum Pump Speed - 900 rpm
Maximum Pump Motor hp - 250 hp

c. PMP-300
Minimum Required Priming Operation (Static Head) - 56.35 cfs at 34.6 FT TDH
Siphon Operation (Pool-to-Pool Head) - 57 cfs at 34 FT TDH
Maximum Pump Speed - 900 rpm
Maximum Pump Motor hp - 300 hp

d. PMP-400
Minimum Required Priming Operation (Static Head) - 66.8 cfs at 35.75 FT TDH
Siphon Operation (Pool-to-Pool Head) - 68 cfs at 35.75 FT TDH
Maximum Pump Speed - 900 rpm
Maximum Pump Motor hp - 350 hp

2.1.2.1 Design Criteria

The pumps provided shall be capable of meeting the priming and siphon operating conditions as specified herein. System curves developed are provided at the end of this specification section. The following has been utilized as a basis of design; the field conditions shall reflect the pump size accordingly.

Minimum Sump Elevation - 8.3 FT
Maximum Sump Elevation - 13.0 FT (100-year)
Minimum Sacramento River Elevation - 7.5 FT
100-yr Flood Sacramento River Elevation - 36.7 FT
200-yr Flood Sacramento River Elevation - 37.6 FT
Pipe Apex Invert Elevation - 38.45 FT

2.1.2.2 Start-Up Condition

Upon startup, each pump must discharge sufficient water for the pumps to become primed and siphon recovery to begin. Since the head conditions will be higher prior to the pump discharge pipe becoming filled, the pump may be operated at a higher speed for a short period of time. The pump flow must be sufficient to result in a flow velocity in the discharge pipe of no less than 7 feet per second. The pump speeds may be changed during the pump priming period, but after priming is accomplished, the pumps will operate as constant-speed pumps. Siphon breaker valves will be used to help prime the pumps.

2.1.3 Pump Curves

Indicate on the pump curves for the submitted pumps that the pumps are capable of operating over the entire total head corresponding to the full pool-to-pool and static head range.

Submit preliminary pump curves with the initial pump submittal. Indicate the pump's expected total head, static heads, brake horsepower, and efficiency, as ordinates. Plot against the pump discharge as the abscissa. The curves must indicate that the pump meets all specified conditions of capacity, head, brake horsepower, and efficiency.

2.2 MATERIALS

Material selection not specified is guided by HI 9.1-9.5 for corrosion, erosion, and abrasion resistance. Submit copies of purchase orders, deviations from the specified materials, mill orders, shop orders for materials, and work orders, including orders placed or extended by each supplier. Furnish a list designating materials to be used for each item at time of submittal of drawings. Furnish, within 60 days of notice of award, names of manufacturers of machinery and other equipment contemplated to be incorporated in the work, together with performance capacities and other relevant information pertaining to the equipment. Submit samples of materials as directed. Equipment, materials, and articles installed or used without the approval of the Contracting Officer are at risk of subsequent rejection.

a. Identify each pump by means of a separate nameplate permanently affixed in a conspicuous location. The plate must bear the manufacturer's name, model designation, serial number if applicable, and other pertinent information such as horsepower, speed, capacity, type, direction of rotation, etc. Make the plate of corrosion-resisting metal with raised or depressed lettering and a contrasting background.

b. Equip each pump with suitably located instruction plates, including any warnings and cautions, describing any special and important procedures to be followed in starting, operating, and servicing the equipment. Make the plates of corrosion-resisting metal with raised or depressed lettering and contrasting background.

c. Provide safety guards and/or covers wherever necessary to protect the operators from accidental contact with moving parts. Make guards and covers of sheet steel, expanded metal, or another acceptable material and removable for disassembly of the pump.

2.3 METALWORK FABRICATION

2.3.1 Designated Materials

Designated materials must conform to the following specifications, grades, and classifications.

MATERIALS	SPECIFICATION	GRADE, CLASS
Aluminum-Bronze	ASTM B148	Alloy No. C95500 Castings
Cast Iron	ASTM A48/A48M	Class Nos. 150A 150B, and 150C; 30A, 30B, and 30C
Cast Steel	ASTM A27/A27M	Grade 65-35, annealed
Coal Tar Protective Coatings	AWWA C203	
Cold-Rolled Steel Bars	ASTM A108	min, Wt. Strm 65,000 psi
Copper Alloy Castings	ASTM B584	Alloy No. C93700
Corrosion-Resistant Alloy Casting	ASTM A217/A217M	Grade CA15
	ASTM A352/A352M	CA6NM
	ASTM A351/A351M	CF8M
Dimensions for Steel Water Piping Fittings	AWWA C208	
Ring Flanges	AWWA C207	Class B

MATERIALS	SPECIFICATION	GRADE, CLASS
Seamless and Welded Austenitic Stainless Steel Pipe	ASTM A312/A312M	
Stainless Bars and Shapes	ASTM A276/A276M	Grades S30400 and S41000
Steel Forging	ASTM A668/A668M	Class F
Steel Pipe 6 inch and Larger	AWWA C200	
Steel Plate, Structural Quality	ASTM A285/A285M	Grade B
Structural Steel	ASTM A36/A36M	
Surface Texture (Surface Roughness, Waviness, and Lay)	ASME B46.1	

2.3.2 Bolted Connections

2.3.2.1 Bolts, Nuts, and Washers

Bolts, nuts, and washers must conform to requirements of paragraph MATERIALS AND METALWORK FABRICATION, subparagraph DESIGNATED MATERIALS, and paragraph VERTICAL PUMPS, subparagraph PUMP COLUMN AND DISCHARGE ELBOW, subparagraph NUTS AND BOLTS for types required. Use beveled washers where bearing faces have a slope of more than 1:20 with respect to a plane normal to bolt axis.

2.3.2.2 Materials Not Specifically Described

Materials not specifically described must conform to latest ASTM specification or to other listed commercial specifications covering class or kinds of materials to be used.

2.3.3 Metalwork

2.3.3.1 Flame Cutting of Material

Flame cutting of material other than steel is subject to approval of the Contracting Officer. Shear accurately, and neatly finish all portions of work. Steel may be cut by mechanically guided or hand-guided torches, provided an accurate profile with a smooth surface free from cracks and notches is secured. Prepare surfaces and edges to be welded in accordance with AWS D1.1/D1.1M. Chipping and/or grinding will not be required except where specified and as necessary to remove slag and sharp edges of mechanically guided or hand-guided cuts not exposed to view. Visible or exposed hand-guided cuts must be chipped, ground, or machined to metal free of voids, discontinuities, and foreign materials.

2.3.3.2 Alignment of Wetted Surfaces

Exercise care to assure that correct alignment of wetted surfaces being joined by a flanged joint is being obtained. Where plates of the water passage change thickness, transition on the outer surface, leaving inner surface properly aligned. When welding has been completed and welds have been cleaned, but prior to stress relieving, carefully check joining of plates in the presence of the Government inspector for misalignment of adjoining parts. Localized misalignment between inside or wetted surfaces of an adjoining flange-connected section of pump or formed suction intake cannot exceed the amount shown in Column 4 of Table 1 for the respective radius or normal distance from the theoretical flow centerline. Correct misalignments greater than the allowable amount by grinding away offending metal, providing the maximum depth to which metal is to be removed does not exceed amount shown in Column 5 of Table 1. Do not remove metal until assuring the Contracting Officer that no excessive stresses will occur in the remaining material and that excessive local vibration will not result from removal of the material. Where required correction is greater than the amount in Column 5 of Table 1, reject pipe for use. Proposed procedure for all corrective work, other than minor grinding, must be approved by the Contracting Officer prior to start of corrective work. Finish corrective work by grinding corrected surface to a smooth taper. Length of the taper along each flow line element must be 10 times the depth of the offset error at the flow line. Wetted surface irregularities that might have existed in an approved model cannot be reason for accepting comparable surface irregularities in the prototype pump.

TABLE 1

(1)	(2)	(3)	(4)	(5)
Pipe Diameter (inches)	Pipe Radius or Distance (inches)	Pipe Thickness (inches)	Maximum Offset (inches)	Grind-Not More Than (inches)
24	12	3/8	1/16	3/32
30	15	3/8	1/16	3/32
36	18	3/8	3/32	3/32
42	21	1/2	3/32	1/8
48	24	1/2	1/8	1/8

2.3.3.3 Stress-Relieving Procedure

After all fabrication welding is completed, and prior to any machining, stress-relieve the bell and the impeller (if it is fabricated) by heat treatment. Submit proposed stress-relieving procedure.

2.3.4 Examination of Castings

Clean and carefully examine all castings for surface defects. Further examine all defects by nondestructive means. Examination personnel must be qualified/certified in accordance with applicable ASTM requirements. Submit the examination procedure and qualification of the examiner. Conduct examination tests in the presence of the Contracting Officer.

Choose the examination procedure best suited for the application.

2.3.4.1 Examination Procedures

2.3.4.1.1 Ultrasonic

Conform inspection to the applicable provisions of ASTM A609/A609M.

2.3.4.1.2 Magnetic Particle

Conform inspection to the applicable provisions of ASTM E709.

2.3.4.2 Acceptance and Repair Criteria

Acceptance and repair criteria must be in accordance with Section 05 50 13 MISCELLANEOUS METAL FABRICATIONS.

2.4 VERTICAL PUMPS

2.4.1 Speed

Rotative speed of pump must be no greater than 900 rpm.

2.4.2 Reverse Rotation and Flow

Each pump must withstand, with no damage, full rotative speed caused by subjecting the pump to reverse flow. The head used to determine this reverse rotative speed is calculated from specified highest discharge side water elevation and lowest pump intake side water elevation.

Pump must withstand, with no damage, the full force exerted on it, with the impeller subjected to reverse flow and the upper end locked in place by a backstop. Calculate the head to determine the force developed by this reverse flow from the specified highest discharge side water elevation and lowest pump intake side water elevation. Reverse rotative speed must be 0.0 with instantaneous activation of the backstop.

2.4.3 Efficiency

Efficiency at head-capacity condition(s) specified in paragraph CAPACITIES must not be less than shown when calculated as follows:

$$\text{Efficiency} = \frac{Q \times H}{3960 \times BHP} \times 100$$

Where: Q = Discharge, gallons per minute
H = Total head, feet
BHP = Pump brake horsepower

Pump efficiency, as defined in HI ANSI/HI 14.6, must include losses from the suction bell to the discharge elbow outlet and must not be less than specified at the head-capacity condition(s) specified.

2.4.4 Suction Bell

Make each suction bell of cast iron. Provide a flanged connection for mating with the impeller bowl with a rabbet fit or four equally spaced dowels installed in the vertical position for initial alignment purposes and to maintain concentric alignment of the pump. Each suction bell must be made in one piece. Support each suction bell entirely by the pump casing. Supports from sump floor will not be acceptable.

2.4.5 Impeller Bowl

Make each impeller bowl of ASTM A48/A48M Class cast iron. Heat-treat and stress-relieve welds before final machining. Provide flanges for mating with the suction bell and the impeller bowl or two-piece construction of the impeller. Provide flanged connections with the suction bell or split construction with a rabbet fit or four equally spaced dowels installed in the vertical position for initial alignment purposes and to maintain concentric alignment of the pump. Machine finish the impeller-swept area in the impeller bowl to at least 125 microinch rms and concentric with the impeller axis. For mixed-flow impellers, the angle in the impeller bowl must equal the outside angle of the impeller blade tips. Tolerance for concentricity of the impeller with the impeller axis is not greater than 20 percent of the operating clearance between the impeller and the impeller bowl.

2.4.6 Pump Column and Discharge Elbow

2.4.6.1 Column and Discharge Elbow

Make each column and discharge elbow of cast iron. Do not use turning vanes. Design column and discharge elbow to withstand internal pressures and external loadings associated with various conditions of pump operation. Flanges must have rabbeted fits or four equally spaced dowels installed in flanges for initial alignment purposes and to maintain concentric alignment. Terminate the elbow in a plain-end circular section. Provide diameter of discharge end of elbow as indicated and allow standard diameter flexible couplings to be used. Use adjustable thrust rods and thrust lugs to transfer the load by bridging the coupling between the pump discharge elbow and discharge piping. Determine the size and number of thrust rods needed for the expected loading. Use a minimum of four thrust rods. Maintain complete access to the discharge piping until the discharge pipe installation is complete, inspected, and approved.

2.4.6.2 Column and Discharge Elbow Support

Design pump column and discharge elbow for suspension from a baseplate assembly specified in paragraph BASE-PLATE AND SUPPORTS and located at operating floor level.

2.4.6.3 Flanges

Machine flanges and drill bolt holes concentric with pump shaft vertical centerline, having a tolerance of plus or minus one fourth of the clearance between the bolt and bolt hole. When fabricated from steel plate, flanges must not be less than 1 inch thick after machining. Flange thickness after machining cannot vary more than 10 percent of greatest flange thickness. Provide external stiffeners, if needed. Construct fabricated flanges, as a minimum, to the dimensions of AWWA C207, Class B. Design flanges on major components of pump casing (suction bell, impeller bowl, and column and elbow piping) such that blind holes necessitating use of cap screws or stud bolts are not used. Design flanges for connection to column pipe by at least two continuous fillet welds. Connect the inside diameter of the flange to pump column with one weld, and connect the outside diameter of the pump column to the flange with the other weld. Final design of welds rests with the manufacturer, and specified welds are the minimum requirement. Parallel machine, when provided on each end of the same component, and mount parallel to a plane that is normal to pump shaft centerline. Flanges on each end of the same component must have parallel tolerance of 0.002 inch. Finish machine mating surface on flange to 125 microinch finish or better. Provide flanges with a minimum of three jacking bolts to aid in disassembly of the pump.

2.4.6.4 Flanged Joints

Design flanged joints to be air-and water-tight, without the use of preformed gaskets, against positive and negative operating pressures that will be experienced, except that permanent gasketing compound will be permitted. Provide mating flanges, unless of the male-female rabbet type, with not less than four tapered dowels equally spaced around each flange. If rabbeted fit is not used, then provide the method used to determine concentricity of connected pieces.

2.4.6.5 Nuts and Bolts

Use 300 series stainless steel for bolts used in assembling the pump and its supporting members, including anchor bolts and dowels. Use only bronze nuts and hexagonal bolts and nuts. Also use 300 series stainless steel washers.

2.4.6.6 Galvanic Protection

When dissimilar metals are used, electrically isolate dissimilar parts. Verify isolation by checking joint with an ohmmeter.

2.4.6.7 Harnessed Coupling

Provide a flexible mechanical coupling or split-sleeve type coupling that either conforms to ASTM F1476, Type II, Class 3, stainless steel (as manufactured by Teekay or Straub Couplings), ASTM F1476, Type 1 (as manufactured by Victaulic), or Dresser Couplings style 38 or approved equal, to connect the pump discharge elbow as shown on the drawings. Install a minimum of four harness bolts (sized by the pump manufacturer) at each coupling.

2.4.6.8 Wall Thimble

Provide each wall thimble with one plain end to accommodate the flexible mechanical coupling and one flanged end to mate with the flap gate and discharge piping. The plain end must match the pump discharge elbow in thickness and diameter and drill the flanged end to match, and be capable of supporting without distortion, the flap gate. Provide the seal ring on the wall thimble located so that it is centered in the wall when embedded. Fabricate the wall thimble from steel plates.

2.4.6.9 Discharge Piping

At outfall structure, provide discharge piping consisting of a transition section and a wall thimble. Provide a transition section with one plain end and one flanged end. On the plain end, match the pump discharge elbow in thickness and diameter. Arrange the wall thimble for embedment and with the flanges on each end. Mate one end with the flange on the transition section and mate the other end with the flap gate. Fabricate the discharge flange with a minimum dimension of AWWA C207, Class D, and drill to match. Provide a seal ring on the wall thimble and locate it so that it is centered in the wall when embedded. Fabricate the discharge piping from steel plate.

Install the discharge piping as indicated. Match the plain end of each discharge pipe with the pump discharge elbow in thickness and diameter and be able to allow a flexible mechanical coupling to connect it to the pump discharge elbow. Provide the discharge pipe with pipe supports or cradles as recommended by the pump manufacturer. Locate the supports between the flexible coupling and the wall, as indicated. Provide suitably-sized thrust restraints at each flexible coupling as indicated. The supports must provide support for the weight of the pipe, the water that will pass through the pipe, and any dynamic forces that may develop due to water flowing through the pipe. The discharge pipe must be non-galvanized piping of welded or seamless pipe or welded steel plate. Use steel pipe conforming to AWWA C200 with dimensional requirements as given in ASME B36.10M. Provide fittings in compliance with AWWA C208.

2.4.6.10 Flap Gate

Design the flap gate for pump discharge service with flange-frame with a resilient seat of neoprene or BUNA-N to prevent closing shock. Make the size of the flap gate the same as the discharge pipe size. Use cast iron for the body of the valve and the flap in compliance with ASTM A126. Use high-tensile bronze ASTM B584- CA 865 for the hinge arms. Design the hinge pins in double shear and of silicon bronze, ASTM B98/B98M- CA 655. Provide lubrication fittings on the hinge arms. Extend the grease lines to a convenient location for lubricating. Provide an anti-locking bar to prevent excessive rotation about the lower hinge pin. Provide a stainless steel leaf spring with rubber pad to safely limit the travel of the flap gate during pumping. Install flap gate in location shown on the drawings.

2.4.7 Impeller

Pump impeller shall be made of cast bronze and secured to the shaft by a key and thrust collars, both made of 416 stainless steel. Fabricated propellers will not be accepted.

2.4.7.1 Removal and Prior To Finishing

After removal from mold, and prior to finishing of surface imperfections, the Contracting officer will inspect castings. Fill and grind minor surface imperfections as necessary to preserve correct contour and outline of impeller and to restore surface imperfections to the same degree of finish as surrounding surfaces. Correct surface pits, depressions, projections, or overlaps showing greater than 1/16 inch variation from the general contour for that section. Castings that exhibit surface imperfections (as defined above) covering an area of more than 10 percent of blade surface will be rejected.

2.4.7.2 Balance

Balance each impeller by the two-plane balancing technique. Balance each impeller at maximum operating speed. Check the balance at 110 percent of balance speed, and make needed corrections. Amount of allowable unbalance is in accordance with grade G6.3 of ISO 1940-1. Securely fasten weights needed to obtain the required level of balance to the inside cavity of the impeller hub. In no case can portions of the impeller be removed or weights be added to the outside of the hub, vanes, or water passages. Submit balancing procedure at least four weeks prior to the date of balancing. Weigh each finished impeller and weight stamped on the bottom of the hub with weight accurate to 0.5 percent of the total weight of the impeller. Weighing and balancing will be witnessed by the Contracting Officer. Submit all impeller weights and the results of impeller balancing.

2.4.8 Shafting

2.4.8.1 Shaft

Each impeller shaft must be stainless steel and intermediate shaft(s) must be cold-rolled carbon steel. Design shafting so that shaft sections do not exceed 10 feet in length and that any necessary vertical adjustment of the impeller can be made interfering with shaft alignment. Also provide for removal of the impeller from below without disassembly of the pump above the impeller bowl. If the pump is multi-staged, design to permit the lower bowls and impeller to be easily removed for in-place inspections of upper propeller and bowl. Design shafts for two different design cases. The first uses a factor of safety of 5 based on ultimate tensile strength of the shaft material and rated horsepower of the motor. The second uses 75 percent of the yield strength of the shaft material and the locked rotor torque of the motor.

2.4.8.2 Couplings

Couple the pump and motor shafts together using rigid flanged coupling capable of transmitting the forces and torques involved. Bolt coupling halves together and maintain concentric with each other, by means of a rabbet fit, to within 0.002 inch. Retain a shaft coupling nut, if used, by fitted bolts, and comply with all tolerances specified for the coupling. Finish machine the flange and bore in one setup to insure that the flange of the coupling is true to the bore. Each flange must be perpendicular to the bore, and parallel to the opposite end and mating flanges to within 0.002 inch. Each flange must be concentric to the centerline of the shaft to within 0.002 inch. Join together pump shaft sections with sleeve-type couplings capable of taking rotation in either direction. Threads, except on fasteners, cannot be employed in construction of sleeve-type couplings. Construct couplings, including keys and fasteners, of stainless steel materials. All keys and keyseats (keyways) must meet the requirements of ASME B17.1. The finished shaft assembly must be concentric about the shaft centerline to within 0.004 inch. Shop assemble couplings and the pump shaft, and inspect for compliance with contract requirements. After inspection, matchmark parts, including fitted bolts, to their mating pieces.

2.4.8.3 Journals

Provide replaceable stainless steel one-piece journal sleeves at each guide bearing, packing gland and seal locations. Finish sleeves at all bearings and packing gland locations to at least 32 rms and finish sleeves at seal locations to 16 rms. Securely fasten sleeves to the shaft to prevent movement. Make keys and fasteners, if used, from corrosion resisting steel; fastening by adhesive or welding is not acceptable. All keys and keyseats (keyways) must meet the requirements of ASME B17.1. The surface hardness of the sleeves at the bearing and packing gland locations must be as recommended by the pump manufacturer.

2.4.8.4 Circumferential Line

Inscribe or etch a circumferential line on the shaft above the stuffing box and mount an adjustable pointer opposite this line in order to indicate a change in vertical position of shaft and to permit realignment after motor removal.

2.4.9 Shaft Enclosure

Provide a shaft enclosure to cover the intermediate shaft and coupling. It must be placed in tension or must be rigid enough to be self-supporting. Do not use external supports or bracing located in the pump water passage for support of the enclosing tube unless necessary to support intermediate bearings or indicated to be necessary or advantageous by the dynamic analysis required in paragraph DYNAMIC ANALYSIS. Consider the effect of external supports, including rubber inserts, in the dynamic analysis required in paragraph TEST, INSPECTIONS, AND VERIFICATIONS, subparagraph DYNAMIC ANALYSIS. Design each enclosure to be watertight and for easy assembly and disassembly in the field. Split each enclosure longitudinally to permit easy removal without removing or disassembling the pump shaft. Construct enclosing tubes, constructed with screw type joints and using tension in the tube to hold alignment, to prohibit the tension tube from unscrewing when the packing gland adjustments are made. On oil-lubricated pumps, fit the enclosing tube below the lowest bearing and above the oil seals with an oil/water drain line to the outside of the pump. The drain line must have a check valve outside of the pump to preclude the entrance of sump water.

2.4.10 Guide Bearings and Seals

2.4.10.1 Guide Bearings

Provide each pump with sleeve-type bearings designed for oil lubrication. Each bearing must have a bronze lining in contact with shaft journal and must be replaceable type. Arrange the bearing liner for maximum distribution of oil for lubrication of journal surface. Bearings must have a surface finish of 32 microinches rms or better to match the journal finish. Since pumped water may contain some fine sand and silt in suspension, give special attention to the design and selection of bearing parts, especially seal rings, to preclude entrance of foreign material between the bearing and journal due to differential water pressure.

Bearings must be easily removable for servicing in the field.

2.4.10.2 Oil Lubrication Shaft Seals

Pumps designed for oil lubrication must have a shaft seal system located below the upper pump shaft bearing. The seal system consists of a seal containing two lip elements. The element facing the bearing must have a stainless steel garter spring back-up and be constructed of TFE (Teflon). The secondary element faces the impeller and is constructed of TFE. Use a bullet-shaped assembly tool or other special tool over the end of the shaft or grooves in the shaft to preclude damage to the lip element during assembly. Assembly tools used are considered a special tool and must be furnished to the Government as part of special tools specified in paragraph SPECIAL TOOLS. Pumps having two stages must have seals to protect the extra bearings required by two stages of construction.

2.4.11 Bearing Heat Sensors

Fit the impeller shaft bearings with temperature-sensing elements, inserted in the bearings to within 1/8 inch of shaft. Provide these temperature-sensing elements with temperature readouts mounted on the motor instrument board. Provide a visual and audible alarm system to warn of bearing overheating. Provide temperature indicator with dual outputs that have setpoints that are separately adjustable. Support leads and protect them from water and mechanical damage. Terminate the leads outside of the pump casing in a waterproof connection head, Minco CH 339 or equal, and cap until final connections are made in the field. The connection head must be rated watertight to 25 psi. Lead protection consists of pipes fastened to the pump with brackets using bolts and nuts to permit their removal, and constructed with enough unions to be completely disassembled. Leads passing through the pump water passage in the pump must either be contained in a guide vane or be protected by Schedule 80 pipe. Make protection pipe removable if connected to the shaft-enclosing tube. Install bearing heat sensors as shown in Figure 2 at end of the section recommended by the pump manufacturer. Run leads and wiring to a junction box located on the baseplate. Provide a terminal strip in the junction box for connection of wiring to temperature readouts.

2.4.12 Thrust Bearing

Provide a thrust bearing in the motor to carry total thrust load.

2.4.13 Packing Gland

Provide grease-lubricated packing gland split longitudinally to facilitate removal or renewal. Arrange it to permit inspection, repair, removal, or replacement of packing without entering pump from below operating room floor. Provide eye bolts and tapped holes in each half of the split gland if halves weigh over 30 pounds each.

2.4.14 Siphon Breaker Valve

Provide a siphon breaker valve assembly for each of the pumps. Provide mechanical, self-actuating valves. Install each assembly at the top (summit) of the discharge pipe and must vent air from the discharge pipe when the pump is started. The assembly must also permit air to enter the discharge pipe through the siphon breaker valve to prevent reverse siphoning of water when the pump is stopped. Provide a means to operate the valve manually to stop back-siphoning through the pump in case the normal operator of the siphon breaker valve should fail. Siphon breaker valve shall be manufactured by Harris Valve. Valve models shall be as shown on the drawings.

2.5 LUBRICATION SYSTEM

Oil lubrication of shaft bearings consists of introducing oil at the top line shaft bearing and allowing oil to run down the shaft for the lubrication of the lower bearings. Oil lubrication consists of an oil reservoir mounted on the pump baseplate or pump driver at such height to permit gravity flow of oil to the highest lubrication point of the pump shaft. Construct the reservoir of transparent material to permit observation of the quantity of oil in the reservoir. The oil reservoir must have a minimum capacity of 1 quart. The reservoir must have a solenoid valve to permit oil flow whenever the pump driver is in operation. The flow rate from the oil reservoir must be adjustable from five drips per minute to constant flow. The reservoir valve must permit manual flow of oil when the pump driver is not operating for prelubrication of the shaft bearing. Construct the oil line from the oil reservoir to the pump line shaft of stainless steel tubing and support at sufficient locations to preclude vibration of tubing when the pump is operating. If the pump has a bearing located below the impeller, this bearing must be grease-lubricated. Provide a grease line with a grease fitting from this bearing to a location on top of the baseplate. Provide a grease reservoir with this bearing configuration for containing extra grease. Lubricate shaft packing by grease. Run the grease lines to a location outside of the driver pedestal and provide with a fitting for manual lubrication.

2.6 PAINTING

Perform painting in accordance with Section 09 90 00 PAINTS AND COATINGS.

2.7 TESTS, INSPECTIONS, AND VERIFICATIONS

2.7.1 Critical Speeds

The assembled pumping unit, consisting of the motor and pump must be free from critical speeds or harmful torsional vibrations at all speeds encountered within the operating range.

Before the pump and motor, furnished under Section(s) 26 29 01 ELECTRIC MOTORS, 3-PHASE VERTICAL INDUCTION TYPE are released for manufacture, the pump/motor structure must be analyzed by the pump manufacturer for harmful natural frequencies in the lateral and torsional directions. A natural frequency that occurs within 25 percent above or below normal operating speed is unacceptable. Construct a dynamic analysis model using a commercially available program such as Ansys, Cosmos/M, or equivalent, which utilize finite element methods. Incorporate effects of column pipes, cover pipes, shafts, bearings, mass concentrations, and other such features as necessary to accurately model the pump structure. Analyze the structure in the run (wet) condition and consider the effect of water mass in the column and damping effect of water in the sump (vertical units only) at highest and lowest sump water levels. Incorporate Reed critical frequency and mass elastic diagram information provided by the motor manufacturer. If the motor manufacturer cannot demonstrate to the satisfaction of the Contracting Officer (based on impact tests of similar units) that the Reed critical frequency value is accurate, the motor manufacturer must conduct a dynamic analysis using finite element methods as described to determine motor Reed critical frequency for use by the pump manufacturer. Submit the complete detailed dynamic analysis report including the following information:

a. Computer program used.

b. Schematic diagram of the model depicting nodes and elements.

c. Input data consisting of node coordinates, element types, material properties, element characteristics, element connectivities, and specified displacements.

d. Motor mass elastic and Reed critical information (or dynamic analysis, if required).

e. Analysis results, including significant natural frequencies.

f. Interpretation of results.

Impact the test motor furnished before shipment to determine actual Reed critical frequency of motor. Include results of impact tests included in motor test data to be submitted. The pump manufacturer must address any discrepancy between calculated and actual motor Reed critical frequency values to determine whether design changes are required to prevent harmful natural frequencies in the pump/motor structure. If any design changes are required, incorporate them at no cost to Government.

2.7.2 Lubricating System Tests

Test the complete lubricating system for each pumping unit, as deemed necessary by the Contracting Officer, to determine that the system meets the operational requirements specified. Test at least one valve of each size furnished with the lubrication line removed from its bearing and fitted with a pressure relief valve and pressure gage. Adjust the pressure relief valve to discharge it at the operating pressure specified and operate the system through one or more cycles as required to obtain an accurate measurement of the quantity of lubricant delivered. This must be within plus or minus 20 percent of the theoretical delivery of the respective valve. Replace, reinstall, and retest any component parts that are damaged as the result of these tests or that fail to meet the requirements of the specification.

2.7.3 Factory Test

2.7.3.1 General

Performance of each size pump to be furnished will be accepted on the basis of the factory test. Conduct this test using each size of pump or one of each size of pump produced for this contract. Perform cavitation testing in accordance with HI ANSI/HI 14.6 if no published NPSHR curves are available.

2.7.3.2 Instrumentation and Procedures

Describe each instrument in detail, giving all data applicable, such as manufacturer's name, type, model number, certified accuracy, coefficient, ratios, specific gravity of manometer fluid to be used, and smallest scale division. Provide calibration data on each of the instruments used. When necessary for clarity, include a sketch of the instrument or instrument arrangement. Include fully detailed narrative description of each proposed method of instrumentation, procedures to be used, and a sample set of computations. State the lowest equivalent static head that is obtainable with the testing when operating along the head-capacity curve of the proposed pump. Perform test procedures, except as specified, in accordance with applicable provisions of HI ANSI/HI 14.6.

2.7.3.2.1 Head Measurements

Make head measurements using either a direct reading water column, mercury-air, mercury-water, a Meriam fluid manometer, or a pressure transducer. Measure vacuums with either a mercury-air manometer, a mercury-water manometer, or a pressure transducer. Dampen fluctuations sufficiently to permit column gages or a differential pressure transducer to be read to either closest 0.01 foot of water or Meriam fluid or 0.1 inch of mercury. Use manometers as indicated by ISA RP2.1. When pressure transducers are used, check their accuracy with a manometer.

2.7.3.2.2 Capacity

Determine capacity by a calibrated venturi flowmeter or long-radius ASME flow nozzle. Do not use orifice plates. Connect the venturi or nozzle taps to the column gages equipped with dampening devices that permits differential head to be determined to either the closest 0.01 foot of water or Meriam fluid or 0.1 inch of mercury. Magnetic flowmeters and flowmeters utilizing ultrasonic flow measurements will be acceptable if calibration of flowmeter has been completed within the last 6 months.

2.7.3.2.3 Rotational Speed of Pump

Measure the rotational speed of the pump in accordance with "Method of Rotary Speed Movement" in HI ANSI/HI 14.6, except that revolution counters cannot be used. Non-contacting hand-held electronic tachometers are acceptable. The device used must permit the speed to be determined to 1 rpm.

2.7.3.2.4 Power Input

Measure power input to the pump in accordance with "Power Measurements" in HI ANSI/HI 14.6. Use a method to permit pump brake horsepower to be determined to the closest 0.5 horsepower.

2.7.3.2.5 Cavitation Tests

Use instruments suited for cavitation testing. However, do not use instruments that yield results less accurate than those obtained with the performance test.

2.7.3.3 Pump Test

Demonstrate that the proposed pump complies with the specified performance. The pump must be capable of operation without instability over the entire range of heads specified in paragraph CAPACITIES. Tolerances must be in accordance with HI requirements. Instability is defined, for this specification, as when one or more of the following conditions occur:

a. the pump has two or more flow rates at the same total head;

b. The head-capacity curve has a dip (region on curve where change in flow rate produces an abnormally low head);

c. When any point in the usable range of head-capacity curve cannot be repeated within 3 percent.

Rerun the test if this occurs. Compliance with specifications will be determined from curves required by paragraph TEST RESULTS. Test procedures, except as specified, must be in accordance with applicable provisions of HI ANSI/HI 14.6. The acceptance grade is 1U as described in HI ANSI/HI 14.6. Use water at approximately the same temperature for all tests run and record the temperature during test runs.

2.7.3.4 Test Procedure

2.7.3.4.1 Performance of The Pump

Determine the performance of the pump by a series of test points sufficient in number to develop a constant-speed curve over the range of total heads corresponding to the static and pool-to-pool heads in paragraph CAPACITIES. The performance/test range must include additional testing at total heads 2 feet higher than the total head determined in paragraph CAPACITIES. The lowest total head for testing must be, as a minimum, the total head determined from paragraph "CAPACITIES". If the test setup permits testing at lower total heads, extend the range of total heads 2 feet lower. Conduct tests using prototype total and pool-to-pool heads. Head differentials between adjacent test points cannot exceed 3 feet, but in no case may fewer than 10 points be plotted in the pumping range. If the plot of the data indicates a possibility of instability or dip in the head-versus-capacity curve, a sufficient number of additional points on either side of instability must be made to clearly define the head-capacity characteristics.

2.7.3.4.2 Sump Elevations

Conduct tests at two different sump elevations (approximately a 5 foot differential) to determine the effect of test sump geometry on the performance of the pump. Should the test results indicate that the performance is not the same in all respects for both sump conditions, take whatever corrective action is necessary to produce congruent results. The test results with this sump elevation must meet all specified conditions of capacity, head, and brake horsepower. Submit curves indicating test results.

2.7.3.4.3 Tests Results

Plot results of tests to show total head, static and pool-to-pool heads, brake horsepower and efficiency as ordinates; all plotted against pump discharge as the abscissa. Plot curves showing prototype performance to a scale that will permit reading head directly to 0.5 foot, capacity to 500 gpm, 5 cfs, efficiency to 1 percent, and power input to 50 horsepower.

2.7.3.4.4 Demonstration

Demonstrate to the Government witness that the blade templates fit the tested pump. Perform the demonstration immediately after testing is completed. Retain all templates for the tested pump, and furnish them to the Government upon request of the Contracting Officer, to permit the Government to verify geometric similarity with the manufacturer's pump. In addition to providing templates, furnish dimensioned drawings of the impeller that contain all dimensions needed to manufacture it. Stamp the tested impeller with identification marks. Provide necessary facilities and instruments needed to permit the Government to verify that pumps are in complete geometric similarity with the tested pump.

2.7.3.5 Cavitation Tests

2.7.3.5.1 Model Test

The model test must include the determination of net positive suction head required (NPSHR) at five or more points on the constant speed curve. Determine NPSHR, as a minimum, for five or more capacities corresponding to prototype capacities over the total range of specified operating conditions. If the pump has a capacity greater than that specified for the lowest and/or highest operating condition, then use these over-capacity conditions. Equally space the other test capacity points between the highest and lowest capacities.

2.7.3.5.2 NPSHR

Determine NPSHR on a constant-capacity, constant-speed basis, using arrangement Figure F.3 or F.4 as described under paragraph "Net Positive Suction Head Required Test" in HI ANSI/HI 14.6. Vary suction conditions to produce cavitation. NPSHR must be the maximum value at which any one or all of the plotted curves, head, horsepower, and efficiency depart from the constant values (point of tangency). Obtain a sufficient number of points to accurately locate the departure point.

2.7.3.5.3 Value of NPSHR

The value of NPSHR must be 3 feet less than the corresponding available net positive suction head available (NPSHA). Determine NPSHA using the temperature of the water in the model at the time the tests are run and the datum shown on Figure 3 at the end of this section. Use the water elevations specified in paragraph CAPACITIES to determine the NPSHA for the pumps.

2.7.3.5.4 Plotting Test Results

Plot the test results to the scales determined by the Contracting Officer at the time of the test. Draw curves showing static, pool-to-pool, and total head, brake horsepower, and pool-to-pool efficiency as ordinates and NPSH as the abscissa. In addition, draw curves showing NPSHR versus capacity with NPSH as the ordinate and capacity as the abscissa. Show NPSHA points on the curves.

2.7.3.5.5 Curves

Should it be considered necessary by the Contractor to take into account measurement inaccuracies when drawing the curve needed to determine NPSHR in accordance with paragraph NPSHR, use the following method. No other method is acceptable. Determine the inaccuracy for each parameter, and furnish the calculations to the Contracting Officer for approval. Using the calculated inaccuracy as the radius and the test point as the center, draw a circle for each test point. Draw two curves, one a maximum and the other a minimum, and pass through or touch each circle. The maximum curve must touch the top and the minimum curve must touch the bottom of as many circles as is practicable while maintaining smooth curves. Should the plot indicate that a test point is obviously erroneous, it may be ignored by mutual consent or the test may be rerun. Halfway between the maximum and minimum curves, draw another curve (the mean). The point at which the mean curve departs from the constant values (point of tangency) is considered to be the NPSHR of the pump for the capacity at which the test was run.

2.7.3.6 Witness Test

When the Contractor is satisfied that the tested pump performs in accordance with the requirements of the specifications and the guaranteed values, notify the Contracting Officer that the witness tests are ready to be run and furnish copies of the curves required in paragraph PUMP TEST AND CAVITATION TESTS along with a set of sample calculations with constants and conversion factors. Also, provide instrument calibration data in this report. Two weeks will be required to review this data before the Contracting Officer will be available to visit the Contractor's laboratory for witnessing the test. Should the results of the witness test reveal that the tested pump does not perform in accordance with the requirements of the specification and the guaranteed values, make such changes as are required to make it acceptable before again notifying the Contracting Officer that the witness tests are ready to be run. Immediately upon completion of each witness test, submit copies of all data taken during the test to the Contracting Officer witnessing the test. Furnish computations of test results and plotted preliminary curves to the witness.

2.7.3.7 Test Report

Submit, within 30 days of receipt of approval of the witness test, to Government digital copies of a report covering completely the test setup and performance and cavitation tests. Include, as a minimum, there following in each test report:

a. Provide a statement of the purpose of the test, the name of the project, contract number, and design conditions. Also provide where guaranteed values differ from specified values.

b. A resume of preliminary studies, if such studies were made.

c. A description of the test pump and motor, including serial numbers, if available. Information required under "b" may be included here.

d. A description of the test procedure used, including dates, test personnel, any retest events, and witness test data.

e. A list of all test instruments with model numbers and serial numbers.

f. Sample computations (complete).

g. A discussion of test results.

h. Conclusions.

i. Photographic evidence in the form of either multiple color photographs of test equipment, test setup, and representative test segments, and a digital recording on optical disc, at least 30 minutes in length, covering the same information as photographs. Label all photographic evidence with the Contract number, location, date/time, and test activity. Voice annotate the digital recording with the same information.

j. Copies of instrument calibration.

k. Copies of all recorded test data.

l. Curves required by paragraph TESTS RESULTS.

m. Curves showing the performance of the test pump.

n. Drawings of the test setup showing all pertinent dimensions and elevations and a detailed dimensioned cross section of the pump.

o. The name and credentials of the Erecting Engineer(s) who was(were) responsible for the pump testing.

2.8 BASEPLATE AND SUPPORTS

Proportion the baseplate to support the entire pump assembly, the motor and the loads (including the results of the dynamic analysis) to which it may be subjected during operation. Support and anchor is as indicated. Furnish lifting lugs or eye bolts, special slings, strongbacks, or other devices necessary to handle the pump during loading, unloading, erection, installation, and subsequent disassembly and assembly. Provide a sole plate under the baseplate. Install, level and grout the sole plate in accordance with API RP 686, Chapter 5 - Mounting Plate Grouting. Provide leveling nuts for leveling the baseplate assembly. Provide an anchor bolt layout to aid in placement of anchor bolts. Anchor bolts and embedment design shall be per ACI-350, Appendix D. Back off all leveling jacking bolts after grouting so that they do not support any of the load. The pedestal supporting the motor must contain a 1-inch lip to contain water leakage from the shaft packing. Provide a threaded drain to the sump. Seismic requirements must be in accordance with UFC 3-310-04 and Sections 13 48 00 SEISMIC PROTECTION FOR MISCELLANEOUS EQUIPMENT and 13 48 01 SEISMIC PROTECTION FOR MECHANICAL EQUIPMENT. Provide the calculations used in the design of the baseplates and the anchoring bolts to ensure that the proper forces (shear, torsion, etc.) have been considered. Calculations shall be stamped and signed by a registered California Professional Engineer. The baseplates must be structural steel plate of adequate thickness to support the weight of the pump and right angle hear or motor (as applicable) plus the maximum hydraulic thrust of the pump. Provide plates of the length and width indicated, and the thickness as determined by the pump manufacturer.

2.9 PUMP DRAINAGE

Provide drain holes for all parts of the pump to eliminate trapped water. These drain provisions must be self-draining without any requirement to enter the sump.

2.10 FACTORY ASSEMBLY

The pump must be assembled at the manufacturer's plant in a vertical position to assure proper fitting and alignment of all parts. Tolerances cannot exceed those specified or shown on the manufacturing drawings. Check rotating elements for binding. The suction bell, impeller housing, and the discharge elbow must be properly match marked and have their centerlines clearly marked on the outside of all flanges to facilitate erection and alignment in the field. Notify the Contracting Officer sufficiently in advance to permit a representative of the Contracting Officer to inspect and witness the pump assembly. Matchmark all parts disassembled for shipment.

PART 3 EXECUTION

3.1 INSTALLATION

3.1.1 Equipment

a. Install the equipment furnished under this section and related drive machinery furnished under other sections of this specification in accordance with the approved Installation and Erection Instructions Manual; no later than time of pump delivery, submit a typed or printed, and bound, and digital manual describing procedures to be followed by the erecting engineer in erecting, assembling, installing, and dry-and wet-testing the pump. To the extent necessary or desirable, coordinate and consolidate description of the pump with similar descriptions specified for the motor.

(1) The description must be a complete, orderly, step-by-step explanation of operations required, and also include such things as alignment procedures, bolt torque values, permissible blade/bowl clearances; permissible bowl out-of-roundness; permissible shaft misalignment; recommended instrument setups; recommended gages and instruments; bearing clearances; and similar details.

(2) Complement and supplement the description with drawings, sketches, photos, and similar materials to whatever extent necessary or desirable, resulting in a description that may be comprehended by an engineer or mechanic without extensive experience in erecting or installing pumps of this type.

b. The erection engineer(s), familiar with the equipment to be installed, must supervise the handling, installation, start-up and testing of the equipment as required by paragraph QUALITY ASSURANCE.

c. Submit digital copies of Operation and Maintenance Instructions Manual containing complete information on operation, lubrication, adjustment, routine and special maintenance, disassembly, repair, reassembly, and trouble diagnostics for the pump and auxiliary units. Print the operation and maintenance manual and both parts lists on good quality ANSI size A 8-1/2 by 11-inch paper, bound separately between flexible, durable covers. Drawings incorporated in manual or parts lists, may be reduced to page size provided they are clear and legible, or may be folded into the manual to page size. Photographs or catalog cuts of components may be included for identification.

3.1.2 Pipes and Joints

Install pipes and joints in accordance with AWWA M11.

3.2 FIELD TESTS

Prior to proceeding with construction of the test setup but not later than 60 days after date of notice to proceed, submit a description of the test setup and test procedure proposed. Include dimensioned drawings and cross-sectional views of the setup and pump, respectively, with location of instruments and points of their connection shown.

3.2.1 Dry Tests

Test each pumping unit, consisting of a pump and motor in the dry to determine whether it has been properly erected and connected. Conduct such test when, and as, directed by Contracting Officer. After each pumping unit has been completely assembled, including all rotating elements and the lubrication system, operate at the full rated speed for three 15-minute periods, to assure proper alignment and satisfactory operation.

a. Take vibration measurements of the assembled pumping units in both the axial and radial direction at the pump operating speed. Measure vibration as displacement in mils and do not exceed the maximum displacement (mils-peak-to-peak) shown in the "good" range of General Machinery Vibration Severity Chart. Obtain this chart from Entek IRD, 1700 Edison Drive, Cincinnati, Ohio 45150.

b. Take vibration measurements in accordance with HI 9.6.4. Vibration limits cannot exceed those recommended by HI Figure 9.6.4.2.5.16. If it is not possible to operate the pump at its best efficiency point, vibration limits may be adjusted in accordance with the requirements of the stated standard.

c. Operate each pumping unit at full-rated speed until the temperature rate of rise has stabilized for all bearings. Consider the bearings' temperature stabilized when the rate of rise does not exceed 1 degree Fahrenheit in five minutes .

d. Repeat the dry test run if it is necessary to interrupt the test before all bearing temperatures have become stable. If after a run of reasonable duration the temperature rate of rise for any bearing has not stabilized, terminate the test until the cause of overheating is determined and corrections are made. Then repeat the dry test run. Should tests reveal that there is a design deficiency or a manufacturing error in the pumping unit components, promptly correct the problem.

3.2.2 Wet Tests

Test each pump unit under load, at or near normal operating conditions, for at least 4 hours or as directed by the Contracting Officer; the test will be witnessed by the Government. Provide all supplies and equipment required to conduct the test. During the test Observe, measure and record the operation of the pumps during the test for sound, vibration and bearing temperatures. Without additional costs to the Government, make all changes and correct any errors. The Contracting Officer may waive or postpone the test if sufficient water is not available.

SYSTEM LOSS CURVE

(DESIGNER TO PROVIDE THIS

FIGURE WHEN CONTRACT

IS PREPARED)

FIGURE 1

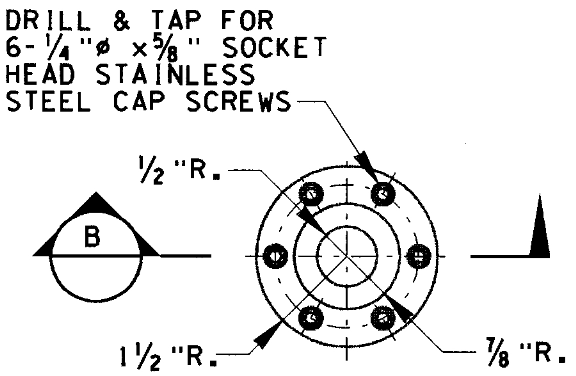
BEARING RTD INSTALLATION

FIGURE 2

AXIAL FLOW PUMP
AND
MIXED FLOW PUMP

FIGURE 3

-- End of Section --



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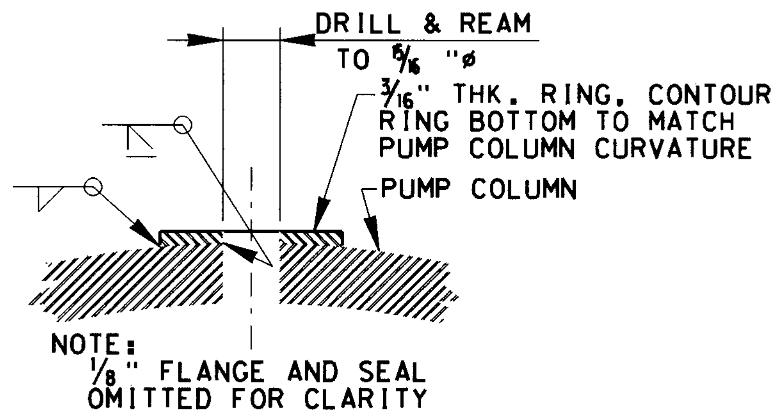

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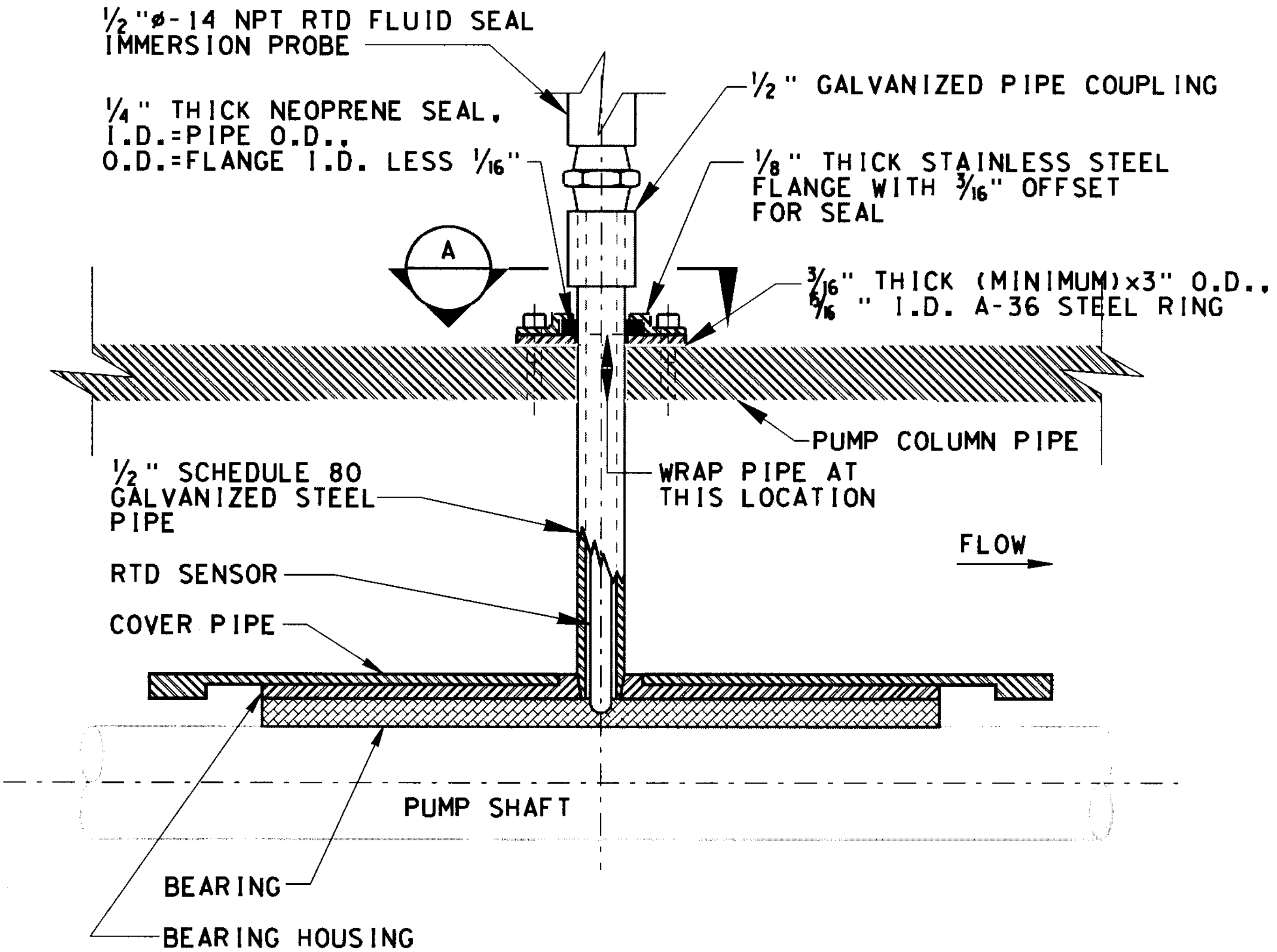
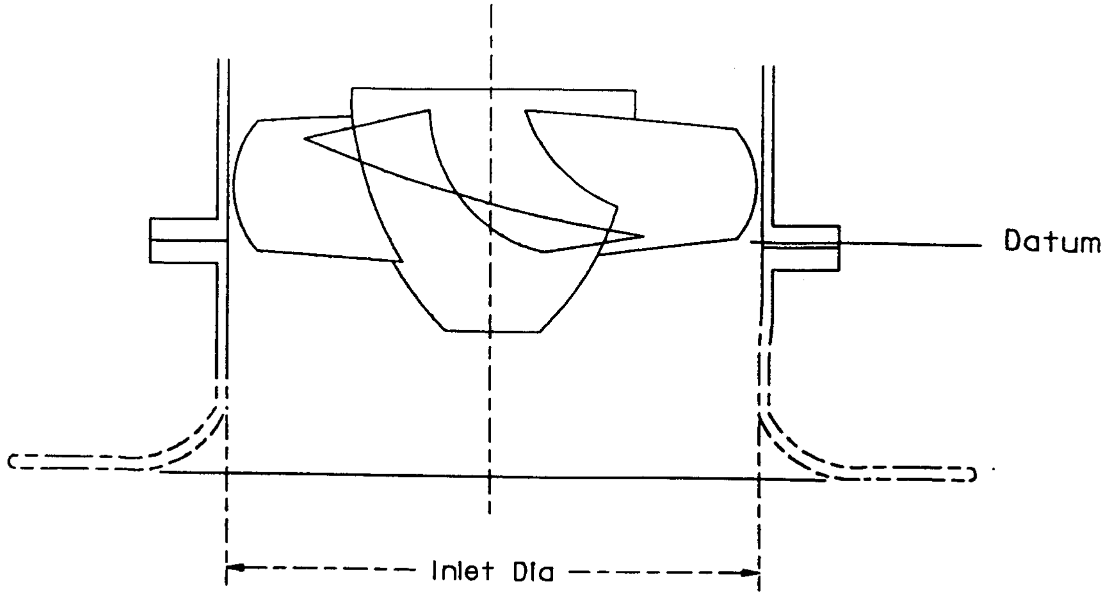
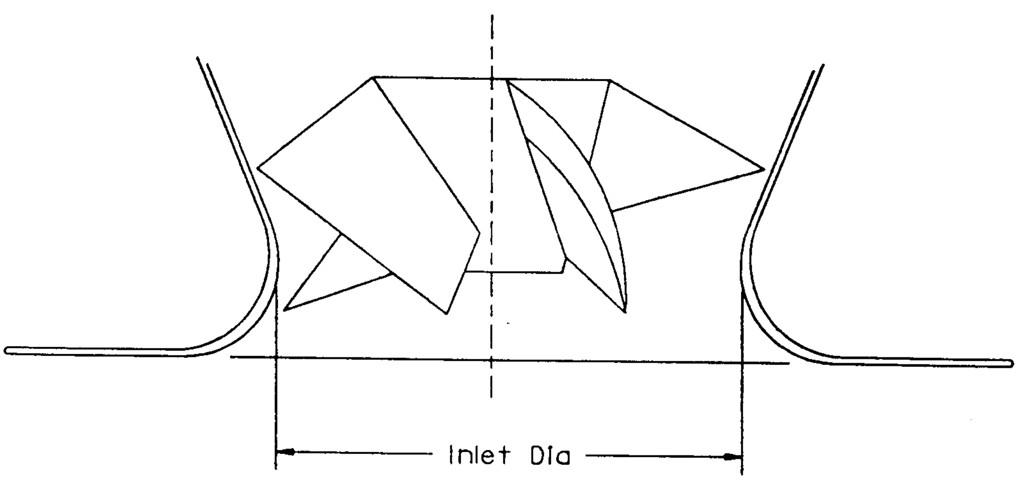


BEARING RTD INSTALLATION
SCALE: NONE

FIGURE 2



AXIAL FLOW PUMP



MIXED FLOW PUMP

FIGURE 3

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DIVISION 40 - PROCESS INTERCONNECTIONS

SECTION 40 05 13

PIPELINES, LIQUID PROCESS PIPING

10/07

-- End of Section Table of Contents --

SECTION 40 05 13

PIPELINES, LIQUID PROCESS PIPING
10/07

PART 1 GENERAL

1.1 REFERENCES

The publications listed below form a part of this specification to the extent referenced. The publications are referred to within the text by the basic designation only.

AMERICAN WATER WORKS ASSOCIATION (AWWA)

AWWA C111/A21.11	(2017) Rubber-Gasket Joints for Ductile-Iron Pressure Pipe and Fittings
AWWA C200	(2012) Steel Water Pipe - 6 In. (150 mm) and Larger
AWWA C207	(2013) Standard for Steel Pipe Flanges for Waterworks Service-Sizes 100 mm through 3600 mm 4 in. through 144 in.
AWWA C214	(2014) Tape Coating Systems for the Exterior of Steel Water Pipelines
AWWA C219	(2011) Bolted, Sleeve-Type Couplings for Plain-End Pipe
AWWA C210	(2007) Standard for Liquid Epoxy Coating Systems for the Interior and Exterior of Steel Water Pipelines
AWWA C504	(2015) Standard for Rubber-Seated Butterfly Valves
AWWA C550	(2013) Protective Interior Coatings for Valves and Hydrants

AMERICAN WELDING SOCIETY (AWS)

AWS D1.1/D1.1M	(2015; Errata 1 2015; Errata 2 2016) Structural Welding Code - Steel

ASME INTERNATIONAL (ASME)

ASME B1.20.1	(2013) Pipe Threads, General Purpose (Inch)
ASME B16.1	(2015) Gray Iron Pipe Flanges and Flanged Fittings Classes 25, 125, and 250
ASME B16.11	(2016) Forged Fittings, Socket-Welding and Threaded

ASME B16.34	(2017) Valves - Flanged, Threaded and Welding End
ASME B16.5	(2017) Pipe Flanges and Flanged Fittings NPS 1/2 Through NPS 24 Metric/Inch Standard
ASME B16.9	(2012) Standard for Factory-Made Wrought Steel Buttwelding Fittings
ASME B31.3	(2016) Process Piping
ASME B40.100	(2013) Pressure Gauges and Gauge Attachments

ASTM INTERNATIONAL (ASTM)

ASTM A126	(2004; R 2014) Standard Specification for Gray Iron Castings for Valves, Flanges, and Pipe Fittings
ASTM A181/A181M	(2014) Standard Specification for Carbon Steel Forgings, for General-Purpose Piping
ASTM A193/A193M	(2016) Standard Specification for Alloy-Steel and Stainless Steel Bolting Materials for High-Temperature Service and Other Special Purpose Applications
ASTM A194/A194M	(2017a) Standard Specification for Carbon Steel, Alloy Steel, and Stainless Steel Nuts for Bolts for High-Pressure or High-Temperature Service, or Both
ASTM A234/A234M	(2017) Standard Specification for Piping Fittings of Wrought Carbon Steel and Alloy Steel for Moderate and High Temperature Service
ASTM A283/A283M	(2013) Standard Specification for Low and Intermediate Tensile Strength Carbon Steel Plates
ASTM A351/A351M	(2016) Standard Specification for Castings, Austenitic, for Pressure-Containing Parts
ASTM A36/A36M	(2014) Standard Specification for Carbon Structural Steel
ASTM A395/A395M	(1999; R 2014) Standard Specification for Ferritic Ductile Iron Pressure-Retaining Castings for Use at Elevated Temperatures
ASTM A513/A513M	(2015) Standard Specification for Electric-Resistance-Welded Carbon and Alloy Steel Mechanical Tubing
ASTM A53/A53M	(2018) Standard Specification for Pipe, Steel, Black and Hot-Dipped, Zinc-Coated,

	Welded and Seamless
ASTM A536	(1984; R 2014) Standard Specification for Ductile Iron Castings
ASTM D1784	(2011) Standard Specification for Rigid Poly(Vinyl Chloride) (PVC) Compounds and Chlorinated Poly(Vinyl Chloride) (CPVC) Compounds
ASTM D1785	(2015; E 2018) Standard Specification for Poly(Vinyl Chloride) (PVC), Plastic Pipe, Schedules 40, 80, and 120
ASTM D2466	(2017) Standard Specification for Poly(Vinyl Chloride) (PVC) Plastic Pipe Fittings, Schedule 40
ASTM D2564	(2012) Standard Specification for Solvent Cements for Poly(Vinyl Chloride) (PVC) Plastic Piping Systems
ASTM F402	(2005; R 2012) Safe Handling of Solvent Cements, Primers, and Cleaners Used for Joining Thermoplastic Pipe and Fittings
ASTM F656	(2010) Primers for Use in Solvent Cement Joints of Poly(Vinyl Chloride) (PVC) Plastic Pipe and Fittings

MANUFACTURERS STANDARDIZATION SOCIETY OF THE VALVE AND FITTINGS INDUSTRY (MSS)

MSS SP-25	(2013) Standard Marking System for Valves, Fittings, Flanges and Unions
MSS SP-58	(1993; Reaffirmed 2010) Pipe Hangers and Supports - Materials, Design and Manufacture, Selection, Application, and Installation

NATIONAL FIRE PROTECTION ASSOCIATION (NFPA)

NFPA 704	(2017) Standard System for the Identification of the Hazards of Materials for Emergency Response

PLASTICS PIPE INSTITUTE (PPI)

PPI TR-21	(2001) Thermal Expansion and Contraction in Plastic Piping Systems

U.S. DEPARTMENT OF DEFENSE (DOD)

UFC 3-310-04	(2013; with Change 1) Seismic Design of Buildings

U.S. NATIONAL ARCHIVES AND RECORDS ADMINISTRATION (NARA)

29 CFR 1910 Occupational Safety and Health Standards

1.2 SUBMITTALS

Government approval is required for submittals with a "G" designation; submittals not having a "G" designation are for information only. When used, a designation following the "G" designation identifies the office that will review the submittal for the Government.Submit the following in accordance with Section 01 33 00 SUBMITTAL PROCEDURES:

SD-02 Shop Drawings

Materials and Equipment

SD-03 Product Data

Qualifications

Welders

Waste Water Disposal

Manufacturer's Field Services

Delivery, Storage and Handling

Materials and Equipment

Installation

Valve Schedule

SD-06 Test Reports

Pipe Leakage Tests

Hydrostatic Tests

Valve Testing

SD-07 Certificates

Plastic Piping System

1.3 QUALIFICATIONS

1.3.1 Experience

Submit a statement certifying that the Contractor has the specified experience. Contractor shall have successfully completed at least three projects of the same scope and size or larger within the last six years. Demonstrate specific experience in regard to the system installation to be performed.

1.3.2 Welders

Submit the names of all qualified welders, their identifying symbols, and the qualifying procedures for each welder including support data such as test procedures used, standards tested to, etc. The welding of pressure piping systems shall be in accordance with qualifying procedures using performance qualified welders and operators. Procedures and welders shall be qualified in accordance with Section 40 05 14 WELDING PROCESS PIPING.

1.4 DELIVERY, STORAGE, AND HANDLING

Materials delivered and placed in storage must be stored with protection from the weather, excessive humidity variation, excessive temperature variation, dirt, dust and/or other contaminants. Proper protection and care of material before, during and after installation is the Contractor's responsibility. Any material found to be damaged must be replaced at the Contractor's expense. During installation, piping must be capped to keep out dirt and other foreign matter. A Safety Data Sheet in conformance with 29 CFR 1910 Section 1200(g) must accompany each chemical delivered for use in pipe installation. At a minimum, this includes all solvents, solvent cements, glues and other materials that may contain hazardous compounds. Handling must be in accordance with ASTM F402. Storage facilities must be classified and marked in accordance with NFPA 704. Materials must be stored with protection from puncture, dirt, grease, moisture, mechanical abrasions, excessive heat, ultraviolet (UV) radiation damage, or other damage. Pipe and fittings must be handled and stored in accordance with the manufacturer's recommendation.

1.5 PROJECT/SITE CONDITIONS

1.5.1 Environmental Requirements

Buried piping at the site may be subject to corrosion from the surrounding soil. Testing and measurements shall be conducted in accordance with Section 26 42 17 CATHODIC PROTECTION SYSTEM (IMPRESSED CURRENT). Piping system design, supply and installation shall address the external corrosion conditions so indicated.

1.5.2 Existing Conditions

Verify existing piping and penetrations. Prior to ordering materials, expose all existing pipes which are to be connected to new pipelines. Verify the size, material, joint types, elevation, horizontal location, and pipe service of existing pipes, and inspect size and location of structure penetrations to verify adequacy of wall sleeves, and other openings before installing connecting pipes.

1.6 SEQUENCING AND SCHEDULING

For slab, floor, wall, and roof penetrations, keep on site pertinent wall pipes and sleeves before they are required for placement in concrete forms. Verify and coordinate the size and location of building and structure pipe penetrations before forming and placing concrete.

1.7 MAINTENANCE

1.7.1 Extra Materials

Submit the manufacturer's installation recommendations or instructions for each material or procedure to be utilized, including materials preparation. Concurrent with delivery and installation of the specified piping systems and appurtenances, spare parts for each different item of material and equipment specified that is recommended by the manufacturer to be replaced any time up to 3 years. Extra materials shall include 2 of the following spare parts for each type and size of valve: gaskets; O-ring seals; diaphragms (molded); all elastomer parts; stem packing; seat rings and seat ring pulling tool.

PART 2 PRODUCTS

2.1 SYSTEM REQUIREMENTS

This specification covers the requirements for above and below grade liquid process pipe, pipe supports, fittings, equipment and accessories.

2.1.1 Design Requirements

Support systems shall be selected and designed in accordance with MSS SP-58 within the specified spans and component requirements. The absence of pipe supports and details on the contract drawings does not relieve the Contractor of responsibility for sizing and providing supports throughout facility. The structural design, selection, fabrication and erection of piping support system components shall satisfy the seismic requirements in accordance with UFC 3-310-04 and Sections 13 48 00 SEISMIC PROTECTION FOR MISCELLANEOUS EQUIPMENT and 13 48 01 SEISMIC PROTECTION FOR MECHANICAL EQUIPMENT as indicated.

2.1.2 Performance Requirements

The pressure ratings and materials specified represent minimum acceptable standards for piping systems. The piping systems shall be suitable for the services specified and intended. Each piping system shall be coordinated to function as a unit. Flanges, valves, fittings and appurtenances shall have a pressure rating no less than that required for the system in which they are installed.

2.1.2.1 Buried Piping Systems

Piping systems shall be suitable for design conditions, considering the piping both with and without internal pressure. Consideration shall be given to all operating and service conditions both internal and external to the piping systems. Buried ferrous piping shall have cathodic protection in accordance with Section 26 42 17 CATHODIC PROTECTION SYSTEM (IMPRESSED CURRENT).

2.1.2.2 Above Grade Piping Systems

Piping systems shall be suitable for design conditions, considering the piping both with and without internal pressure, and installation factors such as insulation, support spans, and ambient temperatures. Consideration shall be given to all operating and service conditions both internal and external to the piping systems.

2.2 MATERIALS AND EQUIPMENT

Submit manufacturer's descriptive and technical literature for each piping system, including design recommendations; pressure and temperature ratings; dimensions, type, grade and strength of pipe and fittings; thermal characteristics (coefficient of expansion and thermal conductivity); and chemical resistance to each chemical and chemical mixture in the liquid stream. Provide piping materials and appurtenances as specified and as shown on the drawings, and suitable for the service intended. Piping materials, appurtenances, and equipment supplied as part of this contract shall be of equal material and ratings as the connecting pipe, new and unused except for testing equipment. Components that serve the same function and are the same size shall be identical products of the same manufacturer. The general materials to be used for the piping systems shall be in accordance with the contract drawings. Submit a list of piping systems, pressure ratings and source of supply for each piping system broken out by material, size and application as indicated on the contract drawings. A list of any special tools necessary for each piping system and appurtenances furnished for adjustment, operation, maintenance and disassembly of the system. Pipe fittings shall be compatible with the applicable pipe materials.

2.2.1 Standard Products

Provide material and equipment which are the standard products of a manufacturer regularly engaged in the manufacturing of the products and that essentially duplicate items that have been in satisfactory use for at least 2 years prior to bid opening. Submit the following: Equipment shop drawings and support system detail drawings showing piping systems and appurtenances, such as mechanical joints, valves, local indicators and hangers, including a complete list of equipment and materials. As-built drawings showing pipe anchors and guides, and layout of piping systems relative to other parts of the work including clearances for maintenance and operation. As-built piping and instrumentation diagrams (P&IDs) identifying and labeling equipment, instrumentation, valves, vents, drains, and all other inline devices; if the contract drawings contained P&IDs, the P&IDs found in the contract drawings shall be revised to reflect the constructed process system, as directed by the Contracting Officer. Nominal sizes for standardized products shall be used. Pipe, valves, fittings and appurtenances shall be supported by a service organization that is, in the opinion of the Contracting Officer, reasonably convenient to the site.

2.2.2 Identification and Tagging

Each piece of pipe shall bear the ASTM designation and all other markings required for that designation. Valves shall be marked in accordance with MSS SP-25 and shall bear an identification tag securely attached using stainless steel wire. Identification tags shall be 1.375 inch minimum diameter, made of stamped stainless steel. Indentations shall be black for reading clarity. The service, valve identification number shown on the contract drawings, the manufacturer's name, and the valve model number shall be displayed.

2.3 CARBON STEEL PIPING SYSTEM

2.3.1 Carbon Steel Pipe

2.3.1.1 General Service

Carbon steel pipe shall meet the requirements of AWWA C200 butt welded and shall be in accordance with this specification and the contract drawings. Pipe wall thickness shall be designed by the manufacturer in accordance with AWWA C200, M11, and the operating pressures for a design stress limited to 50 percent of yield. The minimum wall thickness shall be as follows:

16 - 48 IN DIA pipe: 1/4 IN.

2.3.2 Carbon Steel Joints

Carbon steel piping shall be joined by welding joints, fittings, and flanges where shown on the drawings. Dielectric fittings or isolation joints shall be provided between all dissimilar metals.

2.3.3 Carbon Steel Fittings

Fittings shall be carbon steel in accordance with ASTM A234/A234M. Where cast fittings are not available, segmental welded steel fittings, ASTM A53/A53M, Grade B, meeting the requirements of manufacturer's recommended wall thicknesses shall be fabricated.

2.3.3.1 Welding Fittings

Welding fittings shall be butt-welding. Fittings shall be welded conforming to ASME B16.9 , or ASME B16.11.

2.3.3.2 Flanged Fittings

The internal diameter bores of flanges and flanged fittings shall be the same as that of the associated pipe. The flanges shall be slip-on conforming to AWWA C207. Flange materials shall be carbon steel conforming to ASTM A283/A283M, Grade C or D and ASTM A181/A181M Grade 1. Flanges and flanged fittings shall be faced and drilled to ASME B16.5 Class 150 with a flat face. Bolting shall be alloy-steel ASTM A193/A193M hex head bolts and ASTM A194/A194M head nuts. When mating flange on valves or equipment is cast iron, ASTM A193/A193M Grade B8 Class 1 bolts and ASTM A194/A194M Grade 8 heavy hex head nuts shall be used. Bolts shall be provided with washers of the same material as the bolts. Gaskets shall meet the requirements of ASME B16.5.

2.3.4 Carbon Steel Coatings

Carbon steel piping components shall be lined and coated with corrosion resistant materials. Coating shall be in accordance with AWWA C214. Lining shall be epoxy in accordance with AWWA C210. Coatings and finishes shall be 100 percent holiday free.

2.3.5 Carbon Steel Cathodic Protection

Buried ferrous piping shall have cathodic protection as shown on the drawings.

2.4 PLASTIC PIPING SYSTEM

Submit documentation certifying that the manufacturer of each thermoplastic piping system is listed with the Plastic Pipe Institute as meeting the recipe and mixing requirements of the resin manufacturer for the resin used to manufacture each of the respective thermoplastic pipe systems.

2.4.1 PVC Pipe

PVC, ASTM D1784, minimum cell classification 12545-C, pipe shall be Schedule 80 conforming to ASTM D1785.

2.4.2 PVC Joints

The piping system shall be joined by socket-weld connections except where connecting to unions, valves, and equipment with threaded connections that may require future disassembly. Connections at those points shall be threaded and back-welded.

2.4.3 PVC Fittings

The schedule rating for the fittings shall not be less than that for the associated pipe. Fittings shall be ASTM D1784, minimum cell classification 12454, PVC conforming to the requirements of ASTM D2466, socket type.

2.4.4 PVC Solvent Cement

Socket connections shall be joined with PVC solvent cement conforming to ASTM D2564. Manufacture and viscosity shall be as recommended by the pipe and fitting manufacturer to assure compatibility. Joints shall be prepared with primers conforming to ASTM F656 prior to cementing and assembly.

2.5 ISOLATION JOINTS AND COUPLINGS

2.5.1 Dielectric Fittings

Dielectric fittings shall be provided between threaded ferrous and nonferrous metallic pipe, fittings and valves. Dielectric fittings shall prevent metal-to-metal contact of dissimilar metallic piping elements and shall be suitable for the required working pressure, temperature and corrosive application.

2.5.2 Isolation Joints

Isolation joints shall be provided between nonthreaded ferrous and nonferrous metallic pipe fittings and valves. Isolation joints shall consist of an isolation gasket of the dielectric type, isolation washers and isolation sleeves for flange bolts. Isolation gaskets shall be full faced with an outside diameter equal to the flange outside diameter. Bolt isolation sleeves shall be full length. Units shall be of a shape to prevent metal-to-metal contact of dissimilar metallic piping elements.

2.5.3 Metallic Piping Couplings

Thrust ties shall be provided where shown on the contract drawings and where required to restrain the force developed by 1.5 times the maximum allowable operating pressures specified. For metallic pipe other than ductile iron, thrust ties shall be attached with fabricated lugs. For exposed installations, zinc-plated nuts and bolts shall be used. However, high-strength, low-alloy steel, in accordance with AWWA C111/A21.11, may be substituted for use on cast iron and ductile iron couplings. For buried and submerged installations, TP304 stainless steel bolts and nuts shall be provided. Steel middle rings and followers shall be fusion bonded epoxy-lined and coated in accordance with Section 09 90 00 PAINTS AND COATINGS and pressure tested beyond yield point.

2.5.3.1 Sleeve-Type Couplings

Sleeve-type couplings shall be used for joining plain end pipe sections in a flexible manner with a diameter to properly fit the pipe in accordance with AWWA C219. A coupling shall consist of one steel middle ring, two steel followers, two elastomeric section gaskets and elliptic-neck, track-head steel bolts designed to properly compress the gaskets. For pipe sizes 2 inch and larger, the followers shall be ASTM A395/A395M, and the middle ring shall be ASTM A513/A513M with AWWA C111/A21.11 bolting. Gaskets shall be Nitrile Butadiene Rubber INBR) or Ethylene Propylene Diene Monomer (EPDM).

2.5.3.2 Flanged Coupling Adapters

Flanged coupling adapters shall be fully assembled units manufactured to meet AWWA C219 with a body of ASTM A36/A36M steel or ductile iron ASTM A536 Grade 65-45-12. The flanges shall mate with AWWA C207 Class D flanges of the same nominal size, compatible with ANSI Class 125 and 150 bolt circles. A factory applied corrosion resistant coating shall be applied. The coupling shall use styrene-butadiene rubber (SBR) or ethylene propylene diene monomer (EPDM) gaskets. Where pipe movement out of the adaptor may occur, proper anchorage of the pipe shall be provided. The coupling shall be sized to match the associated piping.

2.6 VALVES

2.6.1 General Requirements For Valves

Valves shall include operator, actuator, handwheel, extension stem, floor stand, worm and gear operator, operating nut, chain, wrench, and all other accessories required for a complete operation. The valves shall be suitable for the intended service. Renewable parts are not to be of a lower quality than those specified. Valve ends shall be compatible with adjacent piping system. An operator shall be sized to operate the associated valve for the full range of pressures and velocities. Valves will open by turning counterclockwise. Operators, actuators, and accessories shall be factory mounted.

2.6.2 Valve Schedule

Submit a list of valve materials, pressure ratings, valve operator's materials, air supply pressure, electrical service, location, source of supply, and reference identification as indicated in the contract drawings. Provide a list of any special tools necessary for each valve type and appurtenances furnished for adjustment, operation, maintenance and disassembly. Valve types are as shown on the drawings.

2.6.3 Factory Finishing

Valves shall have an epoxy lining and coating in accordance with AWWA C550 unless otherwise specified. The epoxy shall be either a two-part liquid material or a heat-activated (fusion) material except that only a heat-activated material shall apply if a valve coating is specified as "fusion" or "fusion bonded" epoxy. Exposed valves shall be finished in accordance with Section 09 90 00 PAINTS AND COATINGS.

2.6.4 Ball Valves

2.6.4.1 General Purpose Ball Valves

Ball valves, 2 inch and smaller, shall be three-part stainless steel bodies per ASTM A351/A351M CF8M and threaded, in accordance with ASME B1.20.1, full bore ports. Valves shall have reinforced polytetrafluoroethylene (RPTFE) seats and packing, stainless steel balls and hand lever operators.

Valves shall be rated for 400 psig service at 150 degrees F and shall conform to ASME B16.34.

2.6.5 Butterfly Valves

2.6.5.1 Standard Service Butterfly Valve

Butterfly valves, 2 inch and larger, shall have ASTM A126 cast iron or ASTM A536 Grade 65-45-12 ductile iron bodies, wafer styled with ASME B16.1 flanged end connections. Valves shall conform to AWWA C504 Class 125. Discs shall be contoured ASTM A536 Grade 65-45-12 ductile iron. The valve shafts shall be stainless steel with self-lubricating, corrosion-resistant sleeve type bearings. Valve seats for valves larger than 30 inch shall be field replaceable in accordance with AWWA C504. Valves shall have hand wheel operators oriented as shown on the drawings.

2.6.6 Operators

2.6.6.1 Manual Operator

The force in a manual operator shall not exceed 39.3 pound under any operating condition, including initial breakaway. The operator shall be equipped with gear reduction when force exceeds 39.3 pound. The manual operator shall be a self-locking type or shall be equipped with a self-locking device. A position indicator shall be supplied on quarter-turn valves. Worm and gear operators shall be a one-piece design with worm-gears of gear bronze material. Worm shall be hardened alloy steel with the thread ground and polished. Traveling nut type operators shall have threader steel reach rods with an internally threaded bronze or ductile iron nut.

2.6.6.1.1 Exposed Operators

Exposed operators, including operators in vaults, shall have galvanized and painted handwheels unless otherwise noted on the drawings. Lever operators are allowed on quarter-turn valves 8 inch and smaller. Cranks shall be supplied on gear type operators. If located off of the operator floor, chain wheel operator with tiebacks, extension stem, floor stands, and other accessories shall be provided to permit operation from normal operation level. Valve handles shall be capable of padlocking, and wheels shall be lockable with a chain and padlock.

2.7 DRAINS

Valved drains may not be shown on the detailed drawings for individual pipelines; their absence will not relieve the Contractor of the responsibility for providing and installing them as indicated in the piping and instrumentation diagrams to complete the piping system for the use intended.

2.7.1 Locations

Drains shall be located as indicated on the contract drawings.

2.7.2 Sizes

For pipelines 2.5 inch and larger, drains shall be 0.75 inch and equipped with ball valves.

2.8 MISCELLANEOUS PIPING COMPONENTS

2.8.1 Indicating Devices

2.8.1.1 Pressure and Vacuum Gauges

Pressure and vacuum gauges shall be stem mounted, with phenolic cases. The gauge sensors shall be Bourdon tube actuated and constructed of stainless steel. The gauges shall be equipped with TP316L stainless steel threaded 0.25 inch connections. The dials of the gauges shall be 2.5 inch in diameter with scale readings in psig and inches of mercury ranging from zero to approximately twice the anticipated process operating or equipment pressure. A slotted adjustable pointer shall be provided with accuracy to conform to ASME B40.100, Grade A.

2.8.2 Expansion Joints

Provide all structural work and equipment required to control expansion and contraction of piping. Verify that the anchors, guides, and expansion joints provided, adequately protect the piping systems.

2.9 PIPE SUPPORTS AND PENETRATIONS

Provide auxiliary steel where the support of piping systems and equipment is required between building structural elements. Light gauge and structural steel shapes shall conform to the requirements of ASTM A36/A36M. The Contractor has the option to use pre-engineered support systems of electrogalvanized steel products. However, a mixture of support system manufacturers products is not permitted.

2.9.1 Pipe Supports

Pipe supports shall conform to the requirements of MSS SP-58. Where pipe supports contact bare piping or in-line devices, provide supports of compatible material so that neither shall have a deteriorating action on the other.

2.9.2 Pipe Guides

2.9.2.1 Intermediate Guides

For piping 6 inch and smaller, a pipe clamp with an oversize pipe sleeve shall be provided for a minimum 0.16 inch clearance. For piping 8 inch and larger, U-bolts with double nuts that are manufactured for the purpose shall be used to provide a minimum 0.28 inch clearance around pipe. The stock sizes for the U-bolts are as follows: for a 8 inch pipe use a 0.625 inch U-bolt; for a 10 inch pipe, use a 3/4 inch U-bolt; for a 12 inch to 16 inch pipe, use a 0.875 inch U-bolt; and for 18 inch to 30 inch pipes use 1 inch U-bolts.

2.9.2.2 Alignment Guides

For piping, 8 inch and smaller, alignment guides shall be galvanized steel sleeve type. For piping, 10 inch and larger, alignment guides shall be galvanized steel, roller type guides.

2.9.3 Wall Penetrations

2.9.3.1 Below Grade Wall Penetrations

Below-grade wall penetrations shall be provided with hydrostatic seals designed to seal opening between pipe or conduit and a through-structure opening. Unless otherwise noted on the drawings, the seals shall be modular mechanical type consisting of interlocking synthetic rubber links shaped to continuously fill the annular space between the pipe and wall opening. Weep rings shall be used where noted on the drawings.

PART 3 EXECUTION

3.1 EXAMINATION

After becoming familiar with all details of the work, verify all dimensions in the field, and advise the Contracting Officer of any discrepancy before performing the work.

3.2 PREPARATION

3.2.1 Protection

Pipe and equipment openings shall be closed with caps or plugs during installation. Equipment shall be protected from dirt, water, and chemical or mechanical damage.

3.2.2 System Preparation

3.2.2.1 Pipe and Fittings

Pipe and fittings shall be inspected before exposed piping is installed or buried piping is lowered into the trench. Clean the ends of pipes thoroughly, remove foreign matter and dirt from inside of pipes, and keep piping clean during and after laying.

3.2.2.2 Damaged Coatings

Repair damaged coating areas in the field with material equal to the original coating, except for damaged glass-lined pipe which shall be promptly removed from the site. Do not install damaged piping materials.

3.2.2.3 Field Fabrication

Notify the Contracting Officer at least 2 weeks prior to the field fabrication of pipe or fittings and at least 3 days prior to the start of any surface preparation or coating application work. Field welding shall be performed in accordance with Section 40 05 14 WELDING PROCESS PIPING. Welding electrodes shall be provided in accordance with Table 3.1 of AWS D1.1/D1.1M as required for the applicable base metals and welding process. Fabrication of fittings shall be performed in accordance with the manufacturer's instructions.

3.3 BURIED PIPE PLACEMENT

3.3.1 Excavation and Backfilling

Earthwork shall be performed as specified in Section 31 00 00 EARTHWORK. Backfilling shall be accomplished after inspection by the Contracting

Officer. Exercise care when lowering pipe into the trench to prevent damage or twisting of the pipe.

3.3.2 Fittings

Press connections shall be made in accordance with manufacturer's installation instructions using tools approved by the manufacturer. The tubing shall be fully inserted into the fitting and then marked at the shoulder of the fitting. The fitting alignment shall be checked against the mark on the tubing to ensure the tubing is fully inserted before the joint is pressed. At valves and connections, the trench bottom shall be dug out with sufficient length, width, and depth to ensure clearance between the undisturbed trench bottom and the valves and such connections.

3.3.3 Thrust Restraint

Thrust restraint devices are generally not shown in the contract drawings; their absence will not relieve Contractor of the responsibility for providing them as required to provide complete systems for the use intended. Provide thrust blocks and ties where required, whether or not shown on the contract drawings. At a minimum, thrust restraint shall be provided at pipeline tees, plugs, caps, bends, and other locations where unbalanced forces exist.

3.3.3.1 Restrained Joints

Restrained joints shall be installed as shown on the drawings.

3.3.4 Marking Tape

Pipe marking tape shall be provided and installed in accordance with the requirements of Section 31 00 00 EARTHWORK.

3.3.5 Plastic Pipe Installation

Plastic pipe shall be cut, fabricated, and installed in strict conformance with the pipe manufacturer's recommendations. Offset loops from the trench centerline shall be as recommended by the manufacturer for the maximum temperature variation between the pipe temperature at the time of solvent welding and operating temperature. Design for installation of plastic pipe exposed to ambient conditions or in which the temperature variation of the contents is substantial shall have provisions for movement due to thermal expansion and contraction documented to be in accordance with PPI TR-21. Thrust blocking shall not be used for flexible plastic piping. The piping shall be designed and installed to withstand the compression and expansion forces imposed by the trench conditions.

3.4 CONNECTING DISSIMILAR PIPE

Flexible transition couplings, dielectric fittings and isolation joints shall be installed in accordance with the manufacturer's instructions.

3.5 EXTERNAL CORROSION PROTECTION

Protect all pipe and piping accessories from corrosion and adverse environmental conditions.

3.5.1 Underground Metallic Piping

Buried metallic piping shall be protected from corrosion using protective coatings and cathodic protection. Cathodic Protection shall be provided for metallic underground piping systems as specified in Section 26 42 17 CATHODIC PROTECTION SYSTEM (IMPRESSED CURRENT). Where dissimilar metals are joined underground, gas-tight isolation joints shall be used.

3.6 FLEXIBLE JOINTS AT CONCRETE STRUCTURES

Flexible joints shall be provided at the face of all structures, whether or not shown on the contract drawings. Rubber ring joints, mechanical joints, flexible couplings, and proprietary restrained ductile iron pipe joints shall be considered flexible joints; welded pipe joints shall not.

3.7 PENETRATIONS

Steel pipe sleeves shall be hot-dipped galvanized after fabrication for above grade applications in nonsubmerged areas. For below grade, or in submerged and damp environments, steel pipe sleeves shall be lined and coated as specified in Section 09 90 00 PAINTS AND COATINGS. Embedded metallic piping shall be isolated from concrete reinforcement using coated pipe penetrations. Coatings shall be as specified in Section 09 90 00 PAINTS AND COATINGS. Wall pipes shall be securely supported by form work to prevent contact with reinforcing steel and tie-wires. Joints shall be caulked with rubber sealant or sealed with a wall penetration seal. For existing concrete walls, rotary drilled holes may be provided in lieu of sleeves.

3.8 VALVE INSTALLATION

Flanged valve bolt holes shall be installed so as to straddle the vertical centerline of pipe. Flanged faces shall be cleaned prior to inserting the gasket and bolts, and then the nuts shall be tightened progressively and uniformly. Threaded ends shall have the threads cleaned by wire brushing or swabbing prior to installation.

3.8.1 Valve Orientation

The operating stem of a manual valve shall be installed in a vertical position when the valve is installed in horizontal runs of pipe having centerline elevations 4.5 feet or less above finished floor, unless otherwise shown on contract drawings.

3.8.1.1 Butterfly Valves

Orientation of butterfly valves shall take into account changes in pipe direction. Valve shafts shall be oriented so that unbalanced flows caused by pipe direction changes or other disturbances are equally divided to each half of the disc.

3.9 AIR RELEASE, DRAINS AND SAMPLE PORTS

Sample ports shall be provided where indicated on the contract drawings. Install specified vents at piping high points for entrapped air release and install drains in the low points of pipelines regardless of whether shown on contract drawings.

3.10 PIPING SUPPORT SYSTEMS INSTALLATION

The absence of pipe supports and details on the contract drawings shall not relieve the Contractor of responsibility for sizing and providing supports throughout plant.

3.10.1 General Support Requirements

Pipe support systems shall meet the requirements of MSS SP-58. Contractor-designed and selected support systems shall be installed in accordance with MSS SP-58, and as specified herein. Piping connections to equipment shall be supported by pipe supports and not off the equipment. Large or heavy valves, fittings, and/or equipment shall be supported independently of associated piping. Pipes shall not be supported off other pipes. Supports shall be provided at piping changes in direction or in elevation, adjacent to flexible joints and couplings, and where otherwise shown on the contract drawings. Pipe supports and hangers shall not be installed in equipment access areas or bridge crane runs. Hanging pipes shall be braced against horizontal movement by both longitudinal and lateral sway bracing. At each channel type support, every pipe shall be provided with an intermediate pipe guide, except where pipe anchors are required. Existing support systems may be used to support additional new piping only if the Contractor can demonstrate that the existing support systems are adequate for the additional loads, or if the existing systems are strengthened to support the additional loads. Pedestal type pipe supports shall be provided under base flanges adjacent to rotating equipment and where required to isolate vibration. Piping 2.5 inch in diameter and larger shall be braced for seismic forces. Lateral supports for seismic loads shall be installed at all changes in direction.

3.10.2 Support Methods

Piping support shall be provided as specified and as shown in the contract drawings. Horizontal pedestal mounted piping shall have saddle type supports.

3.11 PIPE IDENTIFICATION, PAINTING AND COLOR CODING

Color, coating, and lettering requirements for exposed piping shall be in accordance with Section 09 90 00 PAINTS AND COATINGS. A single individual band, of plastic adhesive tape or paint, designating pipe contents shall be provided with sufficient length to permit the stenciling of pipe contents in letters. Identification shall be provided at branch connections, inlets and outlets of equipment, every 19.7 feet of straight run, upstream of valves, and within 3.3 feet of entrance to or exit from wall curtains, or other similar type barrier.

3.12 FIELD QUALITY CONTROL

3.12.1 Hydrostatic Tests

3.12.1.1 Buried Piping

After the pipe is laid, the joints completed and the trench partially backfilled leaving the joints exposed for examination, the newly laid piping or any valved section of piping shall, unless otherwise specified, be subjected for 1 hour to a hydrostatic test pressure of 1.25 x the working pressure. Each valve shall be opened and closed several times during the test. Exposed pipe, joints, fittings, and valves shall be carefully examined during the partially open trench test. Joints showing visible leakage shall be replaced as necessary. Defective pipe, joints, fittings, and valves found during the pressure test shall be removed and replaced with new material, and the test repeated until the test results are satisfactory. The requirement for the joints to remain exposed for the hydrostatic tests may be waived by the Contracting Officer when one or more of the following conditions are encountered: (1) wet or unstable soil conditions in the trench; (2) compliance would require maintaining barricades and walkways around and across an open trench in a heavily used area that would require continuous surveillance to assure safe conditions; or (3) maintaining the trench in an open condition would delay completion of the Contract. The Contractor may request a waiver, setting forth in writing the reasons for the request and stating the alternative procedure proposed to comply with the hydrostatic tests. Backfill placed prior to the tests shall be placed in accordance with the requirements of Section 31 00 00 EARTHWORK.

3.12.1.1.1 Rigid Piping

For rigid piping hydrostatic testing, the maximum test pressure shall be calculated according to ASME B31.3, but shall not exceed the yield strength of the piping system. The maximum velocity during filling shall be 0.25 fps applied over full area of pipe and in accordance with the manufacturer's instructions. Test all parts of the piping system. The hydrostatic test pressure shall be maintained continuously for 30 minutes minimum and for such additional time as necessary to conduct examinations for leakage. All joints and connections shall be examined for leakage. The piping system, exclusive of possible localized instances at pump or valve packing, shall show no visual evidence of leaking. Correct visible leakage and retest. Unless otherwise directed by the Contracting Officer, the piping system shall be left full of water after leaks are repaired.

3.12.1.2 Time for Making Test

Except for joint material setting or where concrete thrust blocks necessitate a delay, underground piping jointed with rubber gaskets, mechanical or push-on joints, or couplings may be subjected to hydrostatic pressure, inspected, and tested for leakage at any time after partial completion of backfill. Tests for above ground pressure piping shall be conducted after the piping has been completely installed, including all supports, hangers, and anchors, and inspected for proper installation but prior to installation of insulation.

3.12.2 Pipe Leakage Tests

Unless approved by the Contracting Officer, leakage testing shall be conducted after the pressure tests have been satisfactorily completed. The duration of each leakage test shall be at least 2 hours, and during the test the piping shall be subjected to not less than 200 psig pressure. Leakage is defined as the quantity of the test liquid, water, that is supplied to the piping system, or any valved or approved section thereof, in order to maintain pressure within 5 psi of the specified leakage test pressure after thepiping has been filled with the test liquid and all air is expelled. No piping installation will be accepted if leakage exceeds the allowable leakage determined by the following formula:

L = Cf x N x D x P0.5		
Cf	conversion factor	0.0001351
L	allowable leakage	gallons per hour
N	number of joints in the length of piping tested	
D	nominal pipe diameter	inches
P	average test pressure during the test	psig

Should any test disclose leakage greater than that allowed, the leaks shall be located and repaired until the leakage is within the specified allowance, without additional cost.

3.12.3 Testing New to Existing Connections

New piping connected to existing pipe, existing equipment, existing treatment systems, or tanks and treatment systems furnished under other Sections shall be tested. Isolate the new piping with pipe caps, spectacle blinds, or blind flanges. The joint between new piping and existing piping shall be tested by methods that do not place the entire existing system under the test load. Proceed with the testing of new piping systems as specified herein.

3.12.4 Valve Testing

Submit copies of all field test reports within 24 hours of the completion of the test. Valves may either be tested while testing pipelines, or as a separate step. It shall be demonstrated that valves open and close smoothly with operating pressure on one side and atmospheric pressure on the other, and in both directions for two-way valve applications. Count and record the number of turns required to open and close each valve, and account for any discrepancies with manufacturer's data. Air and vacuum relief valves shall be examined as the associated pipe is being filled to verify venting and seating is fully functional. Set, verify, and record set pressures for all relief and regulating valves.

3.13 FINAL CLEANING

3.13.1 Interim Cleaning

Prevent the accumulation of weld rod, weld spatter, pipe cuttings and filings, gravel, cleaning rags, and other foreign material within piping sections during fabrication. The piping shall be examined to assure removal of these and other foreign objects prior to assembly and installation.

3.13.2 Flushing

Following assembly and testing, and prior to final acceptance, piping systems shall be flushed with water to remove accumulated construction debris and other foreign matter. The piping shall be flushed until all foreign matter is removed from the pipeline. Provide all hoses, temporary pipes, ditches, and other items as required to properly dispose of flushing water without damage to adjacent properties. The minimum flushing velocity shall be 2.5 fps. For large diameter pipe where it is impractical to flush the pipe at the minimum flushing velocity, the pipeline shall be cleaned in-place from the inside by brushing and sweeping, then flushing the pipeline at a lower velocity. Cone strainers shall be installed in the flushing connections of attached equipment and left in place until cleaning is completed. Accumulated debris shall be removed through drains, or by removing spools or valves.

3.13.3 Disinfection

Disinfection is not required for non-potable water pipeline installation.

3.14 WASTE WATER DISPOSAL

Submit the method proposed for disposal of waste water from hydrostatic tests, and all required permits, prior to performing hydrostatic tests. The water used for testing, cleaning, and flushing shall be disposed of in accordance with all applicable regulations. Disposal is solely the responsibility of the Contractor. The method proposed for disposal of waste water shall be provided to, and approved by, the Contracting Officer prior to performing any testing, cleaning, and flushing activities.

3.15 MANUFACTURER'S FIELD SERVICES

Submit a signed statement certifying that the installation is satisfactory and in accordance with the contract drawings and specifications and the manufacturer's prescribed procedures and techniques, upon completion of the project and before final acceptance. Obtain manufacturer's technical assistance for Contractor training, installation inspection, start up, and owner operating and maintenance training. Follow manufacturer's instructions for installation.

-- End of Section --

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WELDING PROCESS PIPING
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PART 1 GENERAL

1.1 REFERENCES

The publications listed below form a part of this specification to the extent referenced. The publications are referred to within the text by the basic designation only.

AMERICAN SOCIETY FOR NONDESTRUCTIVE TESTING (ASNT)

ASNT SNT-TC-1A	(2016) Recommended Practice for Personnel Qualification and Certification in Nondestructive Testing

AMERICAN WELDING SOCIETY (AWS)

AWS A2.4	(2012) Standard Symbols for Welding, Brazing and Nondestructive Examination
AWS A3.0M/A3.0	(2010) Standard Welding Terms and Definitions
AWS B2.1/B2.1M	(2014; Errata 2015) Specification for Welding Procedure and Performance Qualification
AWS QC1	(2016) Specification for AWS Certification of Welding Inspectors
AWS Z49.1	(2012) Safety in Welding and Cutting and Allied Processes

ASME INTERNATIONAL (ASME)

ASME B31.3	(2016) Process Piping
ASME BPVC SEC II-C	(2010) BPVC Section II-Materials Part C-Specifications for Welding Rods Electrodes and Filler Metals
ASME BPVC SEC IX	(2010) BPVC Section IX-Welding and Brazing Qualifications
ASME BPVC SEC V	(2010) BPVC Section V-Nondestructive Examination

1.2 DEFINITIONS AND SYMBOLS

Definitions shall be in accordance with AWS A3.0M/A3.0. Symbols shall be in accordance with AWS A2.4.

1.3 PERFORMANCE REQUIREMENTS

Quality of all joint preparation, welding, and examination is the Contractor's responsibility for. Clearly identify and record all materials used in the welding operations. The inspection and testing defined in this specification are minimum requirements. Additional inspection and testing shall be the responsibility of the Contractor when it is deemed necessary to achieve the quality required.

1.4 SUBMITTALS

Government approval is required for submittals with a "G" designation; submittals not having a "G" designation are for Contractor Quality Control approval. When used, a designation following the "G" designation identifies the office that will review the submittal for the Government. Submit the following in accordance with Section 01 33 00 SUBMITTAL PROCEDURES:

SD-02 Shop Drawings

Pressure Piping; G

SD-03 Product Data

Welding Operations

SD-07 Certificates

Qualifications

1.5 QUALIFICATIONS

Welding procedures, welders, and welding operators previously qualified by test may be accepted for the work without requalification, provided that all of the following conditions are fulfilled:

a. Copies of the welding procedures, the procedure qualification test records, and the welder and welding operator performance qualification test records are submitted and approved in accordance with paragraph SUBMITTALS.

b. Testing was performed by an approved testing laboratory or technical consultant or by the Contractor's approved quality assurance organization.

c. The welding procedures, welders, and welding operators were qualified in accordance with ASME BPVC SEC IX, or AWS B2.1/B2.1M, AR-2 level; and base materials, filler materials, electrodes, equipment, and processes conformed to the applicable requirements of this specification.

d. The requirements of paragraph "Renewal of Qualification" below are met and records showing name of employer and period of employment using the process for which qualified are submitted as evidence of conformance.

1.5.1 Welding Procedures Qualification

Record in detail and qualify the Welding Procedure Specifications for every proposed welding procedure. Qualification for each welding procedure shall conform to the requirements of ASME B31.3, and to this specification. The welding procedures shall specify end preparation for butt welds including cleaning, alignment, and root openings. Preheat, interpass temperature control, and postheat treatment of welds shall be as required by approved welding procedures, unless otherwise indicated or specified. The type of backing rings or consumable inserts, if used, shall be described and if they are to be removed, the removal process shall be described. Copies of the welding procedure specifications and procedure qualification test results for each type of welding required shall be submitted in accordance with paragraph SUBMITTALS. Approval of any procedure does not relieve the Contractor of the sole responsibility for producing acceptable welds. Welding procedures shall be identified individually and shall be referenced on the detail drawings or keyed to the contract drawings.

1.5.2 Welder and Welding Operator Performance

Each welder and welding operator assigned to work shall be qualified in accordance with ASME B31.3.

1.5.2.1 Certification

Before assigning welders or welding operators to the work, provide the Contracting Officer with their names together with certification that each individual is performance-qualified as specified. The certification shall state the type of welding and positions for which each is qualified, the code and procedure under which each is qualified, date qualified, and the firm and individual certifying the qualification tests.

1.5.2.2 Identification

Identify each particular weld with the personal number, letter, or symbol assigned to each welder or welding operator. To identify welds, written records indicating the location of welds made by each welder or welding operator shall be submitted, and each welder or welding operator shall apply the personal mark adjacent to the welds using a rubber stamp or felt-tipped marker with permanent, weatherproof ink or other methods approved by the Contracting Officer that do not deform the metal. For seam welds, identification marks shall be placed adjacent to the welds at 3 foot intervals. Identification by die stamps or electric etchers will not be allowed.

1.5.2.3 Renewal of Qualification

Requalification of a welder or welding operator is required under any of the following conditions:

a. When a welder or welding operator has not used the specific welding process for a period of 3 months; the period may be extended to 6 months if the welder or welding operator has been employed on some other welding process.

b. When a welder or welding operator has not welded with any process during a period of 3 months, all the personal qualifications shall be considered expired, including any extended by virtue of a., above.

c. There is specific reason to question the person's ability to make welds that will meet the requirements of the specifications.

d. The welder or welding operator was qualified by an employer, other than those firms performing work under this contract, and a qualification test has not been taken within the preceding 12 months.

e. Renewal of qualification for a specific welding process under conditions a., b., and d., above, needs to be made on only a single test joint or pipe of any thickness, position, or material to reestablish the welder's or welding operator's qualification for any thickness, position, or material covered under previous qualification.

1.5.3 Inspection and NDE Personnel

All inspection and NDE personnel shall be qualified in accordance with the following requirements.

1.5.3.1 Inspector Certification

Welding inspectors shall be qualified in accordance with AWS QC1.

1.5.3.2 NDE Personnel

NDE personnel shall be certified, and a written procedure for the control and administration of NDE personnel training, examination, and certification shall be established. The procedures shall be based on appropriate specific and general guidelines of training and experience recommended by ASNT SNT-TC-1A.

1.6 REGULATORY REQUIREMENTS

This section covers the welding of pressure piping systems. Submit detail drawings showing location, length, and type of welds; and indicating postweld heat treatment and NDE as required. Deviations from applicable codes, approved procedures, and approved detail drawings will not be permitted without prior written approval. Materials or components with welds made offsite will not be accepted if the welding does not conform to the requirements of this specification, unless otherwise specified. Develop procedures for welding all metals included in the work. Welding shall not be started until welding procedures, welders, and welding operators have been qualified. Qualification testing shall be performed by an approved testing laboratory, or by the Contractor if approved by the Contracting Officer. Notify the Contracting Officer at least 24 hours in advance of the time and place of the tests. When practicable, perform the qualification tests at or near the worksite. Maintain current records of the test results obtained in the welding procedure, welding operator, welder performance qualifications, and nondestructive examination (NDE) procedures readily available at the site for examination by the Contracting Officer. The procedures for making transition welds between different materials or between plates or pipes of different wall thicknesses shall be qualified. ASME B31.3 requirements for branch connections may be used in lieu of detailed designs. Unless otherwise specified, the choice of welding process shall be the responsibility of the Contractor. Safety precautions shall conform to AWS Z49.1.

1.7 DELIVERY, STORAGE, AND HANDLING

All filler metals, electrodes, fluxes, and other welding materials shall be delivered to the site in manufacturers' original packages and stored in a dry space until used. Packages shall be properly labeled and designed to give maximum protection from moisture and to insure safe handling.

1.7.1 Material Control

Materials shall be stored in a controlled access and clean, dry area that is weathertight and is maintained at a temperature recommended by the manufacturer. The materials shall not be in contact with the floor and shall be stored on wooden pallets or cribbing.

1.7.1.1 Damaged Containers

Low-hydrogen steel electrodes shall be stored in their sealed shipping container. If the seal is damaged during shipment or storage, and the damage is not immediately detected, the covered electrodes in that container shall be rebaked in accordance with the manufacturer's instructions prior to issuance or shall be discarded. If a container is damaged in storage and the damage is witnessed, the electrodes from that container shall be immediately placed in a storage oven. The storage oven temperature shall be as recommended by the manufacturer or the welding material specification.

1.7.1.2 Partial Issues

When a container of covered electrodes is opened and only a portion of the content is issued, the remaining portion shall, within 1/2 hour, be placed in a storage oven.

1.7.2 Damaged Materials

Materials which are damaged shall be discarded. Covered electrodes which are oil or water-soaked, dirty, or on which the flux has separated from the wire shall be discarded.

PART 2 PRODUCTS

2.1 MATERIALS

Provide welding materials which comply with ASME BPVC SEC II-C. Welding equipment, electrodes, welding wire, and fluxes shall be capable of producing satisfactory welds when used by a qualified welder or welding operator using qualified welding procedures.

PART 3 EXECUTION

3.1 WELDING OPERATIONS

Perform welding in accordance with qualified procedures using qualified welders and welding operators. Submit detailed procedures which define methods of compliance to contract drawings and specifications. Inspection and material procurement records. System and material testing and certification records. Written records and drawings indicating location of welds made by each welder or welding operator.

Welding shall not be done when the quality of the completed weld could be impaired by the prevailing working or weather conditions. The Contracting Officer will determine when weather or working conditions are unsuitable for welding.

3.1.1 Base Metal Preparation

Oxy-fuel cutting shall not be used on austenitic stainless steel or nonferrous materials.

3.1.2 Weld Joint Fit-Up

Parts that are to be joined by welding shall be fitted, aligned, and retained in position during the welding operation by the use of bars, jacks, clamps, or other mechanical fixtures. Welded temporary attachments shall not be used except when it is impractical to use mechanical fixtures. When temporary attachments are used, they shall be the same material as the base metal, and shall be completely removed by grinding or thermal cutting after the welding operation is completed. If thermal cutting is used, the attachment shall be cut to not less than 1/4 inch from the member and the balance removed by grinding. After the temporary attachment has been removed, the area shall be visually examined.

3.1.3 Preheat and Interpass Temperatures

Preheat temperatures shall meet the requirements specified by ASME B31.3. However, in no case shall the preheat be below 50 degrees F for ferritic steel or austenitic stainless steel, or 32 degrees F for nonferrous alloys. The maximum interpass temperatures shall not exceed 300 degrees F for austenitic stainless steels, nickel alloys, and copper alloys; and 500 degrees F for carbon steels. Preheat techniques shall be such as to ensure that the full thickness of the weld joint preparation and/or adjacent base material, at least 3 inches in all directions, is at the specified temperature. Preheating by induction or resistance methods is preferred. When flame heating is used, only a neutral flame shall be employed. Oxy-fuel heating shall not be used on austenitic stainless steel or nickel-alloy materials; however, air-fuel heating is acceptable if controlled to insure that the surface temperature does not exceed 150 degrees F. Interpass temperatures shall be checked on the surface of the component within 1 inch of the weld groove and at the starting location of the next weld pass, and for a distance of about 6 inches ahead of the weld, but not on the area to be welded.

3.1.4 Production Welding Instructions

a. Welding shall not be done when the ambient temperature is lower than 0 degree F.

b. Welding is not permitted on surfaces that are wet or covered with ice, when snow or rain is falling on the surfaces to be welded, or during periods of high winds, unless the welders and the work are properly protected.

c. Gases for purging and shielding shall be welding grade and shall have a dew point of minus 40 degrees F or lower.

d. Back purges are required for austenitic stainless steels and nonferrous alloys welded from one side and shall be set up such that the flow of gas from the inlet to the outlet orifice passes across the area to be welded. The oxygen content of the gas exiting from the purge vent shall be less than 2 percent prior to welding.

e. The purge on groove welds shall be maintained for at least three layers or 3/16 inch.

f. Removable purge dam materials shall be made of expandable or flexible plugs, such as plexiglass, plywood (which shall be dry when used), etc. Wood dams shall be kiln-dried quality. Nonremovable purge dams and purge dam adhesives shall be made of water soluble materials. Purge dams shall not be made of polyvinyl alcohol.

g. Any welding process which requires the use of external gas shielding shall not be done in a draft or wind unless the weld area is protected by a shelter. This shelter shall be of material and shape appropriate to reduce wind velocity in the vicinity of the weld to a maximum of 5 mph (440 fpm).

h. Welding of low-alloy and hardenable high-alloy steels may be interrupted provided a minimum of at least 3/8 inch thickness of weld deposit or 25 percent of the weld groove is filled, whichever is greater, and the preheat temperature is maintained during the time that welding is interrupted.

i. Tack welds to be incorporated in the final welds shall have their ends tapered by grinding or welding technique. Tack welds that are cracked or defective shall be removed and the groove shall be retacked prior to welding. Temporary tack welds shall be removed, the surface ground smooth, and visually inspected.

j. Grinding of completed welds is to be performed only to the extent required for NDE, including any inservice examination, and to provide weld reinforcement within the requirements of ASME B31.3. If the surface of the weld requires grinding, reducing the weld or base material below the minimum required thickness shall be avoided. Minimum weld external reinforcement shall be flush between external surfaces.

3.1.5 Postweld Heat Treatment

a. Postweld heat treatment shall be performed in accordance with ASME B31.3. Temperatures for local postweld heat treatment shall be measured continuously by thermocouples in contact with the weldment.

b. Postweld heat treatment of low-alloy steels, when required, shall be performed immediately upon completion of welding and prior to the temperature of the weld falling below the preheat temperature. However, postweld heat treatment may be postponed after the completion of the weld, if, immediately after the weld is completed, it is maintained at a minimum temperature of 300 degrees F or the preheat temperature, whichever is greater, for 2 hours per inch of weld thickness.

c. For low-alloy steels, the cooling rates shall be such that temper embrittlement is avoided.

3.2 EXAMINATIONS, INSPECTIONS, AND TESTS

Visual and NDE shall be performed by the Government and by the Contractor to detect surface and internal discontinuities in completed welds. The services of a qualified commercial inspection or testing laboratory or technical consultant, approved by the Contracting Officer, shall be employed by the Contractor. All tack welds, weld passes, and completed welds shall be visually inspected. When inspection and testing indicates defects in a weld joint, the weld shall be repaired by a qualified welder in accordance with paragraph CORRECTIONS AND REPAIRS.

TABLE I. MANDATORY MINIMUM NONDESTRUCTIVE EXAMINATIONS

Type Weld	Piping Service Conditions and Nondestructive Test		
	Temperatures over 750 degrees F and at all pressures	Temperatures between 350 degrees F and 750 degrees F inclusive and at pressures above 1025 psig	All others
Butt Welds (Girth and Longitudinal)	RT for NPS over 2 inches MT or PT for NPS 2 inches and less	RT for over 2 inches NPS with thickness over 3/4 inch. Visual for all sizes with thickness 3/4 inch or less.	Visual for all sizes and thicknesses
Welded Branch Conncetions (Size indicated is branch size) (See Note 7)	RT for NPS over 4 inches MT or PT for NPS 4 inches and less	RT for over 4 inches NPS with thickness over 3/4 inch. Visual for all sizes with thickness 3/4 inch or less.	Visual for all sizes and thicknesses
Fillet, Socket Attachment and Seal Welds	PT or MT for all sizes and thicknesses	Visual for all sizes and thicknesses	Visual for all sizes and thicknesses

NOTES TO TABLE I

(1) All welds must be given a visual examination in addition to type of specific nondestructive examination specified.

(2) NPS - nominal pipe size.

(3) RT - Radiographic examination; MT - magnetic particle examination; PT - liquid penetrant examination.

(4) RT of branch welds shall be performed before any nonintegral reinforcing material is applied.

(5) The thickness of butt welds is defined as the thicker of the two abutting ends after end preparation.

(6) Temperatures and pressures shown are design.

(7) In lieu of radiography of welded branch connections when required above, liquid penetrant or magnetic particle examination is acceptable and, when used, shall be performed at the lesser of one half of the weld thickness or each 1/2 inch of weld thickness and all accessible final

(8) For nondestructive examination of the pressure retaining component, refer to the standards listed in applicable code or the manufacturing specifications.

TABLE I. MANDATORY MINIMUM NONDESTRUCTIVE EXAMINATIONS	
Type Weld	Piping Service Conditions and Nondestructive Test
(9) Fillet welds not exceeding 1/4 inch throat thickness which are used for the permanent attachment of nonpressure retaining parts are exempt from the PT or MT requirements of the above table.	

3.2.1 Visual Inspection

Weld joints shall be inspected visually as follows:

3.2.1.1 Before Welding

For compliance with requirements for joint preparation, placement of backing rings or consumable inserts, alignment and fit-up, and cleanliness.

3.2.1.2 During Welding

For cracks and conformance to the qualified welding procedure.

3.2.1.3 After Welding

For cracks, contour and finish, bead reinforcement, undercutting, overlap, and size of fillet welds.

3.2.2 NDE Testing

NDE shall be in accordance with written procedures. Procedures for tests and methods shall conform to ASME BPVC SEC V. The approved procedure shall be demonstrated to the satisfaction of the Contracting Officer. In addition to the information required in ASME BPVC SEC V, the written procedures shall include the timing of the NDE in relation to the welding operations and safety precautions.

3.2.3 Inspection and Tests by the Government

The Government will perform inspection and supplemental nondestructive or destructive tests as deemed necessary. The cost of supplemental NDE will be borne by the Government. The correction and repair of defects and the reexamination of weld repairs shall be performed by the Contractor at no additional cost to the Government. Inspection and tests will be performed as required for visual inspection and NDE, except that destructive tests may be required also. When destructive tests are ordered by the Contracting Officer and performed by the Contractor, and the specimens or other supplemental examinations indicate that the materials and workmanship do not conform to the contract requirements, the cost of the tests, corrections, and repairs shall be borne by the Contractor. When the specimens or other supplemental examinations of destructive tests indicate that materials or workmanship do conform to the specification requirements, the cost of the tests and repairs will be borne by the Government. When destructive tests are made, repairs shall be made by qualified welders or welding operators using welding procedures which will develop the full strength of the members cut. Welding shall be subject to inspection and tests in the mill, shop, and field. When materials or workmanship do not conform to the specification requirements, the work may be rejected at any time before final acceptance of the system containing the weldment.

3.3 ACCEPTANCE STANDARDS

3.3.1 Visual

The following indications are unacceptable:

a. Cracks.

b. Undercut on surface which is greater than 1/32 inch deep.

c. Weld reinforcement greater than 3/16 inch.

d. Lack of fusion on surface.

e. Incomplete penetration (applies only when inside surface is readily accessible).

f. Convexity of fillet weld surface greater than 10 percent of longest leg plus 0.03 inch.

g. Concavity in groove welds.

h. Concavity in fillet welds greater than 1/16 inch.

i. Fillet weld size less than indicated or greater than 1.25 times the minimum indicated fillet leg length.

3.3.2 Ultrasonic Examination

Where discontinuities are interpreted to be cracks, lack of fusion, and incomplete penetration, they are unacceptable regardless of length. Linear-type discontinuities are unacceptable if the amplitude exceeds the reference level and discontinuities have lengths which exceed the following:

a. 1/4 inch for "t" up to 3/4 inch. Where "t", here and below, is the thickness of the weld being examined; if the weld joins two members having different thicknesses at the weld, "t" is the thinner of these two thicknesses.

b. 1/3 inch for "t" from 3/4 to 2-1/4 inch.

c. 3/4 inch for "t" over 2-1/4 inch.

3.4 CORRECTIONS AND REPAIRS

Defects shall be removed and repaired as specified in ASME B31.3 unless otherwise specified. Disqualifying defects discovered between weld passes shall be repaired before additional weld material is deposited. Wherever a defect is removed, and repair by welding is not required, the affected area shall be blended into the surrounding surface eliminating sharp notches, crevices, or corners. After defect removal is complete and before rewelding, the area shall be examined by the same test method which first revealed the defect to ensure that the defect has been eliminated. After rewelding, the repaired area shall be reexamined by the same test method originally used for that area. Any indication of a defect shall be regarded as a defect unless reevaluation by NDE or by surface conditioning shows that no disqualifying defects are present. The use of any foreign material to mask, fill in, seal, or disguise welding defects will not be permitted.

-- End of Section --