



PROJECT MANUAL

GARDI
CONCOURSE B
NORTHWEST

CONTRACT NO. 201842636



CSI Fueling Specifications

VOLUME IV

TECHNICAL SPECIFICATIONS

RAMP - FUEL

ISSUED FOR BID
REVISION NO. 00

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CITY & COUNTY OF DENVER
DEPARTMENT OF AVIATION

VOLUME IV – RAMP

TECHNICAL SPECIFICATIONS – FUEL

SPEC	DESCRIPTION
260100	General Electrical Requirements
260526	Grounding and Bonding for Electrical Systems
260543	Underground Ducts and Raceways for Electrical Systems
260544	Sleeves and Sleeve Seals for Electrical Raceways and Cabling
260553	Identification for Electrical Systems
284318	Emergency Fuel Shut-Off System
335201	Basic Aviation Fueling Requirements
335205	Basic Mechanical Materials and Methods
335221	Aviation Fueling Coatings and Corrosion Protection
335233	Aviation Fueling Welding
335243	Aviation Fueling System Piping, Valves, and Fittings
335243.19	Aviation Fuel Grounding
335245	Aviation Fueling System Equipment
335247	Aviation Fueling System Inspection, Cleaning, Flushing, and Testing
335253	Aviation Fueling Identification
404642	Cathodic Process Corrosion Protection

END OF SECTION

SECTION 260100 GENERAL ELECTRICAL REQUIREMENTS

PART 1 - GENERAL

1.1 SUMMARY

- A. Certain labor, materials, and equipment may be furnished under other Sections of these specifications, by utility Companies or by the Owner. When this is the case, the extent, source and description of these items will be as indicated on the drawings or as described in the specifications.
- B. Where a panel is installed, at least 25% of panel capacity, including main panel capacity, shall remain as spare capacity after project completion.
- C. Where existing panels are used for additional work, when six (6) or less spaces remain a new panel shall be installed.
- D. All electrical/electronic circuits, including audio, video and fire alarm systems, shall be in an approved raceway system. No "wild circuits" will be accepted.
- E. The Designer of Record shall not design or specify and the Contractor shall not install rigid metal conduit, electrical metallic tubing, flexible steel conduit, liquid-tight flexible steel conduit, non-metallic rigid conduit or innerduct in any horizontal or vertical concrete wall or slab structures or portions thereof, e.g., cast-in-place concrete floor slab on steel decking; cast-in-place concrete slabs integral with concrete structural support systems; prestressed concrete slabs; post-tensioned concrete slabs; precast concrete construction with or without field applied or plant fabricated concrete topping slabs, slabs on grade, foundation walls or in concrete cast-in-place walls, etc.

1.2 RELATED DOCUMENTS

- A. Drawings, General and Special Conditions, Division 1 - General Requirements and other applicable technical specifications apply to work of this Section.

1.3 RELATED SECTIONS

- A. General Electrical Requirements specifically applicable to all Division 26 Sections, in addition to Division 1 - General Requirements, and Division .
- B. All electrical/electronic circuits and equipment from any other Division shall meet the requirements of Division 16.
- C. Description: Work shall consist of furnishing all labor, equipment, supplies, and materials, unless otherwise specified, necessary for the installation of complete electrical systems as required by the specifications and as shown on the drawings, subject to the terms and conditions of the contract. The Work shall also include the completion of those details of electrical work not mentioned or shown which are necessary for the successful operation of all electrical systems.

- D. Temporary Power: See Division 1 for construction power constraints.

1.4 REFERENCE STANDARDS

- A. Comply with the requirements of the reference standards noted herein, except where more stringent requirements are listed herein or otherwise required by the Contract Documents.
- B. Latest editions of the following:
1. ANSI/NFPA 70 - National Electrical Code (as adopted and amended by the Denver Building Code).
 2. Uniform Fire Code (as amended by the Denver Fire Department).
 3. ANSI/IEEE C2 - National Electrical Safety Code.
 4. OSHA - Occupational Safety and Health Administration, as Amended
 5. Underwriter's Laboratory (UL)
 6. National Fire Protection Association (NFPA)
 7. Other references as listed elsewhere in these specifications.
 8. IEEE standard 519- recommended practices and requirement for harmonic control in electrical power systems.

1.5 DEFINITIONS

- A. "Furnish" or "Provide": To supply, install and connect complete and ready for safe and regular operation of particular work unless specifically otherwise noted.
- B. "Install": To erect, mount and connect complete with related accessories.
- C. "Supply": To purchase, procure, acquire and deliver complete with related accessories.
- D. "Work": Labor, materials, equipment, apparatus, controls, accessories, and other items required for proper and complete installation.
- E. "Wiring": Raceway, fittings, wire, boxes and related items.
- F. "Concealed": Embedded in masonry, concrete or other construction, installed in furred spaces, within double partitions or hung ceilings, in trenches, in crawl spaces, or in enclosures.
- G. "Or Equal. Or Approved Equal": Refers to products that, in the opinion of the DEN Project Manager, are similar in all respect to products specified by proprietary brand name. (Refer to Section 01630 for procedures for submittal of proposed substitutions.)
- H. "Exposed": Not installed underground or "concealed" as defined above.
- I. "Indicated," "Shown" or "Noted": As indicated, shown or noted on drawings or specifications.

- J. "Similar" or "Equal": Same in materials, weight, size, design, construction, capacity, performance, and efficiency of specified product.
- K. "Reviewed," "Satisfactory," "Accepted," or "Directed": As reviewed, satisfactory, accepted, or directed by or to Project Manager.
- L. "Related Work" includes all "Work" required for a complete working system.
- M. "Equipment": A general term including material, fittings, devices, appliances, fixtures, apparatus, and the like used as a part of, or in connection with, an electrical installation.
- N. "Busbar": A rigid metallic conductor, lug or bar used to make a common connection between more than one circuit. (Includes all termination assemblies.)
- O. "Shall": Mandatory requirements of this specification are characterized by the use of the word "shall".
- P. "DEN Project Manager" or "Project Manager": Refers to individual authorized to make decisions on the behalf of the City and County of Denver, and are used interchangeably in these specifications.
- Q. "ROCIP": Rolling Owner Controlled Insurance Program arranged by City and County of Denver to ensure pro-active safety process are used. Includes ROCIP Safety Manual.
- R. Refer to Article 100 of the currently adopted National Electrical Code for other definitions as applicable to this project.

1.6 WORK SEQUENCE

- A. Construct Work in sequence under provisions of Division 1 where applicable.

1.7 DRAWINGS AND SPECIFICATIONS

- A. The drawings indicate the general arrangement of circuits, outlets, panelboards and other work. Information shown on the drawings is schematic; however, re-circuiting will not be permitted without specific acceptance. In cases of conflict between specifications and drawings, the specification shall have precedence. Data presented on the drawings is as accurate as planning can determine, but accuracy is not guaranteed and field verification of all dimensions, locations, levels, etc., to suit field conditions is required. Review all of the contract documents and adjust all work to conform to all conditions shown therein.
- B. Prior to submitting a bid, a site visit is required to ascertain all conditions affecting the proposed installation and to adjust all work accordingly. Costs for providing for these adjustments, including response to site constraints, shall be itemized and listed in the bid proposal.
- C. Discrepancies between different plans, between plans and specifications, between specifications, or regulations and codes governing this installation shall be brought to the attention of the Project Manager in writing 72 hours before the date of bid opening.

In the event such discrepancies exist, and the Project Manager is not so notified, the adjudication of responsibility shall be solely at the discretion of the Project Manager.

1.8 COORDINATION

- A. Prior to fabrication or installation of any electrical work, participate in detailed coordination planning meetings with all other building utilities system trades, under the direction of the General Contractor, so as to completely establish routings, elevations, space requirements, and coordination of access, layout, and suspension requirements in relationship to the building structure and the work of all other trades.
- B. Any electrical work penetrating concrete walls or floors shall require saw cutting and/or core drilling and shall require approval by the Project Manager. The contractor shall submit shop drawings of any saw cutting or core drilling to the Project Manager prior to performing the work. Refer to Section 01410 - Cutting and Patching. Reference 3.02 C for additional information.
- C. Any power outages necessary to install or test electrical systems and/or equipment shall be coordinated with Denver International Airport Maintenance/Engineering A written shutdown request form shall be submitted to and approved by the Project Manager two weeks prior to the shutdown.

1.9 COORDINATION DRAWING

- A. Where the Contractor modifies the design, through selection of equipment differing from that shown, coordination drawings shall be provided by the Contractor in accordance with Division 1 to a scale of 1/4"=1'0" or larger for equipment rooms, details, congested areas and sections; other plans at a scale of 1/8"=1'0". These drawings are to detail major elements, components, and systems of electrical equipment and materials in relationship with other systems, installations, and building components. The Contractor shall indicate locations where space is limited for installation and access and where sequencing and coordination of installations are of importance to the efficient flow of the Work, including (but not necessarily limited to) the following:
 - 1. Indicate the proposed locations of raceway systems, equipment, and materials. Include the following:
 - a. Clearances for servicing equipment, including space for equipment disassembly required for periodic maintenance.
 - b. Exterior wall and foundation penetrations.
 - c. Fire-rated wall and floor penetrations.
 - d. Equipment connections and support details.
 - e. Sizes and location of required concrete pads and bases.
 - f. Support details.
 - 2. Indicate scheduling, sequencing, movement, and positioning of large equipment into the building during construction.
 - 3. Floor plans, elevations, and appropriate details are required to indicate penetrations in floors, walls, and ceilings and their relationship to other penetrations and installations.

1.10 SUBMITTALS (REFER TO SECTIONS 01300 AND 01340)

- A. Submit shop drawings, coordination drawings and product data in accordance with provisions of Division 1. Submit all required information under a given specification section together. Do not split out submittals under the same specification section.
- B. Prior to submission, shop drawings, material lists and catalog cut sheets or manufacturer's printed data shall be thoroughly checked for compliance with contract requirements, compatibility with equipment being furnished by the Contractor or Owner, accuracy of dimensions, coordination with work of other trades, and conformance with sound and safe practice as to erection of installation. Each submittal shall bear Contractor's signed statement evidencing such checking.
- C. Clearly mark each shop drawing as follows for purposes of identification:
 - 1. Shop Drawing
 - 2. Equipment Identification Used on Contract Drawings
 - 3. Date
 - 4. Name of Project
 - 5. Branch of Work
 - 6. Project Manager's Name
 - 7. Contractor's Name
- D. Clearly mark printed material, catalog cut sheets, pamphlets or specification sheets, and shop drawings with the same designation shown on the contract document schedules.
- E. Contractor agrees that submittals processed by the Project Manager are not change orders; that the purpose of submittals is to demonstrate to the Project Manager that the Contractor understands the design concept; and that the Contractor demonstrates this understanding by indicating which equipment and material he intends to furnish and install and by detailing the installation methods he intends to use.
- F. Contractor shall be responsible for dimensions (which he shall confirm and correlate at the job site), fabrication processes and techniques of construction, and coordination of his work with that of other trades. The Contractor shall check and verify all measurements and review shop drawings before submitting them. If any deviations from the specified requirements for any item of material or equipment exist, such deviation shall be expressly stated in writing and incorporated with the submittal.
- G. Maintain one copy of accepted shop drawings at the project field office until completion of the project, and make this copy available, upon request, to representatives of the Project Manager and Owner.
- H. No equipment or materials shall be installed or stored at the jobsite until submittals for such equipment or materials have been given review action by the Project Manager accepting their use.
- I. Shop drawings and manufacturer's published data shall be submitted for all equipment required for this project.

1.11 RECORD DOCUMENTS

- A. Maintain a contract set of electrical drawings and specifications at the site. Neatly mark all changes, discoveries and deviations from the original drawings. Use a reproducible color that contrasts with the prints. This shall be a separate set of drawings, not used for construction purposes, and shall be updated daily as the job progresses and shall be made available for inspection by the Project Manager at all times. Upon completion of the contract, this set of record drawings shall be delivered to the Project Manager. Follow DEN CADD standards, to be furnished to the successful bidder. Record documents to be provided by the Contractor shall clearly and accurately show the following:
1. Provide horizontal and vertical dimensions for all raceway systems, size and location, for both exterior and interior; locations of control devices; distribution and branch electrical circuitry; and fuse and circuit breaker size and arrangements.
 2. Equipment locations (exposed and concealed), dimensioned from prominent building lines.
 3. Approved substitutions, Contract Modifications, and actual equipment and materials installed.

1.12 REGULATORY REQUIREMENTS

- A. Obtain and pay for all permits, plan review, and inspections from authority having jurisdiction.
- B. The drawings and specifications take precedence when they are more stringent than codes, statutes, or ordinances in effect. Applicable codes, ordinances, standards and statutes take precedence when they are more stringent than the drawings and specifications.

1.13 ENVIRONMENTAL CONDITIONS

- A. The equipment shall be designed and constructed to operate successfully at the rated values under the following environmental conditions:
1. Location (Indoors/Outdoors)
 2. Altitude (5,500 feet above sea level)
 3. Temperature range -30°F to 120°F

PART 2 - PRODUCTS

2.1 MATERIALS AND EQUIPMENT

- A. Materials and Equipment: Acceptable to the authority having jurisdiction as suitable for the use intended, except where more stringent requirements are indicated by the Contract Documents.

- B. All equipment and materials installed shall be new, unless otherwise specified.
- C. Defective or damaged materials shall be replaced or repaired, prior to final acceptance, in a manner acceptable to the Project Manager or Owner and at no additional cost to the Owner.
- D. All electrical "equipment" and assemblies shall be acceptable for installation only if labeled and listed by a nationally recognized testing laboratory, such as UL or an equivalent..
- E. All major equipment components shall have the manufacturer's name, address, model number, and serial number permanently attached in a conspicuous location.

2.2 STORAGE AND PROTECTION

- A. Store products in accordance with manufacturer's instructions, with seals and labels intact and legible. Store sensitive products in weather-tight enclosures; maintain within temperature and humidity ranges required by manufacturer's instructions.
- B. For exterior storage of fabricated products, place on sloped supports above ground. Cover products subject to deterioration with impervious sheet covering and provide ventilation to avoid condensation.
- C. Arrange storage to provide access for inspection. Periodically inspect to assure products are undamaged and are maintained under required conditions.

2.3 PRODUCT OPTIONS

- A. Products Specified by Reference Standards or by Description Only: Any product meeting those standards.
- B. Products Specified by Naming One or More Manufacturers with a Provision for Substitutions: Submit a request for substitution for any manufacturer not specifically named with supporting documentation.

2.4 PRODUCTS LIST

- A. Within 15 days after date of Notice to Proceed, submit complete list of major products required for submittal under these specifications, with name of manufacturer, trade name, and model number of each product.

2.5 SUBSTITUTIONS

- A. Refer to DIVISION 1 - GENERAL REQUIREMENTS, Section 01630 Substitutions.

2.6 GUARANTEE

- A. The entire electrical system installed under this Contract shall be left in proper working order. Replace, at no additional cost to the Owner, any work, materials, or equipment which evidences defects in design, construction, or workmanship within two years, or any longer period specifically noted elsewhere in these specifications, from date of final acceptance.

PART 3 - EXECUTION

3.1 WORKMANSHIP

- A. Only quality workmanship will be accepted. Poor workmanship, improper layout of work and lack of coordination of work, as determined by the Project Manager, is not acceptable and shall be corrected at the contractors cost.
- B. Contractor shall include no more than one apprentice per Journeyman Electrician. Apprentices shall be under the direct supervision of a licensed electrician at all times.
- C. Any changes or deviations from the drawings and specifications must be accepted in writing by the Project Manager. All errors in installation shall be corrected at the expense of the Contractor. All specialties shall be installed as detailed on the drawings. Where details or specific installation requirements are not provided, manufacturer's recommendations shall be followed.
- D. Upon completion of work, all equipment and materials shall be installed complete, thoroughly tested, checked, correctly adjusted, and left ready for intended use or operation. All work shall be thoroughly cleaned and all residues shall be removed from surfaces. Exterior surfaces of all material and equipment shall be left in a perfect, unblemished condition.
- E. Contractor shall provide a complete installation, including all required labor, material, cartage, testing, insurance, permits, and taxes.

3.2 CHASES, OPENINGS, CUTTING AND PATCHING

- A. Carefully lay out all work in advance so as to eliminate where possible, cutting, channeling, chasing, or drilling of floors, walls, partitions, ceilings and roofs. Any damage to the building, structure, piping, ducts, equipment or any defaced finish shall be repaired by skilled mechanics of the trades involved at no additional cost to the Owner and to the satisfaction of the DEN Project Manager. Any necessary cutting, channeling, drilling or welding as required for the proper support, concealment, installation or anchoring of raceways, outlets, or other electrical equipment shall be performed in a careful manner, and shall be pre-approved by the Project Manager.
- B. All openings made in fire-rated walls, floors, or ceilings shall be sealed and made tight in a manner to conform to the fire rating for the barrier penetrated. Reference specification section 07841 for additional information.
- C. All penetrations required through completed concrete construction shall be core drilled at minimum size required. All penetrations in concrete require an x-ray or ground penetrating radar to determine if the location is clear of reinforcing steel and

embedded systems. Precautions shall be taken when drilling to prevent damage to structural concrete.

3.3 ELECTRICAL INSTALLATIONS

- A. Coordinate electrical systems, equipment, and material installation with other building components. If the Contractor furnishes equipment of a different size, the Contractor shall furnish and install the proper fuses, circuit breaker, disconnect switch, wire and conduit required for the equipment furnished, at no additional cost to the Owner, and as deemed acceptable by the DEN Project Manager.

3.4 PROGRESS OF WORK

- A. Order the progress of electrical work to conform to the progress of the work of the other trades. Complete the entire installation as soon as the condition of the sites will permit. Any cost resulting from defective or ill-timed work performed under this Division shall be borne by the Contractor.

3.5 ELECTRICAL COMPLETION

- A. Indoctrination of Operating and Maintenance Personnel: Furnish the services of a qualified representative of the supplier of each item or system itemized below who shall instruct specific personnel, as designated by the Owner, in the operation and maintenance of that item or system.
 - 1. Instruction shall be given when the particular system is complete, shall be of the number of hours indicated, and at the time requested by the Owner. A representative of the Contractor shall be present for all demonstrations.

Systems	Hours Of Instruction
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- B. Operating and Maintenance Manuals and Parts Lists: Deliver three complete operating & maintenance manuals and parts lists in three ring binders to the Owner at the time of the above required indoctrination. The information shall be provided on the manufacturer's original data sheets. Fully explain the contents of the manuals as part of required indoctrination and instruct the Owner's personnel in the correct procedure in obtaining service, both during and after the guarantee period.
 - 1. The operating and maintenance manuals and parts lists shall give complete information as to whom the Owner shall contact for service and parts. Include address and phone number. Furnish evidence that an authorized service organization regularly carries a complete stock of repair parts for these items (or systems), and that the organization is available for service. Service shall be furnished within 24 hours after requested.
- C. Operating and Acceptance Tests: Provide all labor, instruments, and equipment for the performance of tests as specified below and elsewhere in these specifications for all

applicable equipment furnished and installed as part of this contracts. Submit three copies of test reports to the Project Manager for his approval.

- D. Clean Up: Remove all materials, scrap, etc., relative to the electrical installation, and leave the premises and all equipment, lamps, fixtures, etc. in a clean, orderly condition. Clean all electrical equipment, such as switchboards, panel boards, luminaries etc. of construction dirt, dust, etc. and touch-up or repaint all scratches, blemishes, rust spots etc. to its original condition. Any costs to the Owner for clean-up of the site will be charged against the Contractor.
- E. Acceptance Demonstration: Upon completion of the work, at a time to be designated by the Project Manager, the Contractor shall demonstrate for the Owner the operation of the entire installation, including all systems provided or modified under this contract.
- F. Final Acceptance by the Owner will not occur until all operating instructions are received and Owner's personnel have been thoroughly indoctrinated in the maintenance and operation of all equipment.

PART 4 - MEASUREMENT

4.1 METHOD OF MEASUREMENT

- A. No separate measurement shall be made for work under this Section.

PART 5 - PAYMENT

5.1 PAYMENT

- A. No separate payment will be made for work under this section. The cost of the work described in this section shall be included in the applicable unit price item, work order or lump sum bid item.

END OF SECTION 260100

SECTION 260526 GROUNDING AND BONDING FOR ELECTRICAL SYSTEMS

PART 1 - GENERAL

1.1 SUMMARY

- A. Power system grounding.
- B. Communication system grounding.
- C. Electrical equipment and raceway grounding and bonding.
- D. Perimeter ground loop.

1.2 RELATED DOCUMENTS

- A. Drawings, General and Special Conditions, Division 1 - General Requirements and other applicable technical specifications apply to work of this Section.

1.3 RELATED SECTIONS

- A. With the requirements of the reference standards noted herein, except where more stringent requirements are listed herein or otherwise required by the Contract Documents.
- B. NFPA Compliance: NFPA 70 "National Electrical Code (NEC)," as adopted and amended by the Denver Building Code, Chapter 10.
- C. UL Compliance: Applicable requirements of UL Standards Nos. 467 "Electrical Grounding and Bonding Equipment," and 869, "Electrical Service Equipment," pertaining to grounding and bonding of systems, circuits and equipment. In addition, require compliance with UL Std 486A, "Wire Connectors." Grounding and bonding products shall be UL-listed and labeled for the use.
- D. IEEE Compliance: Applicable requirements and recommended installation practices of IEEE Standards 80, 81, 141 and 142 pertaining to grounding and bonding of systems, circuits and equipment.

1.4 SYSTEM DESCRIPTION

- A. Ground the electrical service system neutral at service entrance equipment to the metallic water pipe service on building side only and to supplementary grounding electrodes, as required by the contract documents and as required by the NEC.
- B. External (underground) metal pipes, water, gas, fuel, drain/sewer etc., are not available for electrical grounding. This is due to extensive cathodic protection and isolation joints of all underground metal pipes at DEN. These systems shall be bonded to the grounding system on the building side only.
- C. Ground each separately derived system neutral to nearest referenced ground plate in the electrical room.

- D. Provide communications system with a # 6 copper grounding conductor at point of service entrance and connect to nearest referenced ground plate.
- E. Bond together at a service and at a separately derived systems; neutral conductor, equipment enclosures, all non-current carrying metal parts of electrical equipment, metal raceway systems, grounding conductor in raceways and cables, and grounding electrode connector.
- F. Provide a 2/0 minimum building perimeter-grounding conductor buried thirty inches (30") below finished grade thirty-six inches (36") from foundation. Install a 3/4" x 10' copper clad ground rod at each corner, each change of direction and at intervals not to exceed one hundred feet (100').
- G. Provide a minimum of three inch by twelve inch by one-quarter inch (3" x 12" x 1/4") copper ground bar in the electrical room for connecting the grounding systems.
- H. An insulated equipment ground conductor shall be installed continuous from the main switchgear or service entrance to all branch panelboards, motor control centers, transformers and all motors. This conductor shall be bonded to the conduit and metal enclosures that it passes through utilizing bonding bushings and terminal devices.

1.5 SUBMITTALS (REFER TO SECTIONS 01300 AND 01340)

- A. Submit shop drawings under provisions of Section 16010.
- B. Indicate layout of ground ring, location of system grounding electrode connections, and routing of grounding electrode conductors.
- C. Submit all field test reports.

PART 2 - PRODUCTS

2.1 MATERIALS

- A. Ground Rods: Copper-clad steel, 3/4-inch diameter, and minimum length of 10 feet; in manholes ground rods shall be stainless steel 3/4-inch diameter and a minimum length of 10 feet.
- B. Grounding Connection Accessories:
 - 1. Electrical insulating tape, heat-shrinkable insulating tubing, welding materials, bonding straps, as recommended by accessories manufacturers for type of service required.
- C. Exothermic welded connections are required where grounding conductors connect to underground grounding conductors and to underground grounding electrodes, and for bonding to steel. All underground connections shall be exothermic welded.
- D. All ground wires shall be copper except where stainless steel is specified for manholes, sized according to the NEC or as shown on the drawings which ever is larger.

PART 3 - EXECUTION

3.1 INSTALLATION

- A. Provide a separate, insulated, equipment-grounding conductor in all branch circuit conduits.
- B. Supplementary Grounding Electrode: Use grounding mats, where indicated, or driven ground rods. Install ground rods in suitable recessed well; fill with gravel after connection is made.
- C. Provide a No. 6 AWG and ground plate to each Communications Room or board. Connect to nearest Electrical Room ground plate.
- D. Provide isolated and insulated ground conductors for all microprocessor and data processing equipment.
- E. Tighten grounding and bonding connectors and terminals, including screws and bolts, in accordance with manufacturer's published torque tightening values for connectors and bolts. Where manufacturer's torquing requirements are not indicated, connections are to be tightened to comply with tightening torque values specified in UL 486A to assure permanent and effective grounding.
- F. Provide code-sized ground cable bonding jumpers, installed with ground clamps, across all conduit expansion couplings and fittings, including flexible steel conduit used as expansion fittings.
- G. Provide a corrosion-resistant finish to field connections, buried metallic bonding products, and where factory applied protective coatings have been destroyed.
- H. All continuous runs of cable tray and all isolated sections of cable tray shall be bonded and grounded.
- I. Provide an equipment-grounding conductor in all conduits.
- J. A non-continuous metallic raceway enclosing the service grounding electrode conductor or the separately derived system grounding electrode conductor shall be bonded at each end of the conduit to the grounding electrode conductor. If bonding jumpers are used they shall be sized per N.E.C. table 250-66.
- K. An earth electrode system shall be buried a minimum depth of two and a half feet. A # 2/0 bare copper ground wire, or if larger as sized on the drawings shall be run between ground rods.
- L. All receptacles and switches shall be provided with ground jumper from outlet box to ground terminal of the device. Exception isolated ground receptacles.
- M. Provide parallel equipment bonding jumper for parallel conduit feeders.
- N. Provide bonding jumpers around all concentric or eccentric knockouts.
- O. Include a bare # 2 copper ground conductor in all duct banks.

3.2 FIELD QUALITY CONTROL

- A. Test the ground resistance to earth of each ground rod prior to connection to the system. Where test show resistance to ground is over 5 OHMS, report to DEN Project Manager locations and values. Submit test results to the DEN Project Manager.
- B. Upon completion of installation of electrical grounding system, test ground resistance to earth in accordance with ANSI / IEEE 81 Submit test results to the DEN Project Manager.

PART 4 - MEASUREMENT

4.1 METHOD OF MEASUREMENT

- A. No separate measurement shall be made for work under this Section.

PART 5 - PAYMENT

5.1 PAYMENT

- A. No separate payment will be made for work under this section. The cost of the work described in this section shall be included in the applicable unit price item, work order or lump sum bid item.

END OF SECTION 260526

***NOTE SEE SUPPLEMENT AT THE END OF THIS APPENDIX FOR A
REPORT: "LIGHTNING, GROUNDING, AND CATHODIC PROTECTION STUDY"**

SECTION 260543 UNDERGROUND DUCTS AND RACEWAYS FOR ELECTRICAL SYSTEMS

PART 1 – GENERAL

1.1 SUMMARY

- A. Provide conduit and duct bank as required per the drawings and specifications.
- B. Provide pre-fabricated electrical junction pits as required per the drawings and specifications.

1.2 RELATED DOCUMENTS

- A. Drawings, General and Special Conditions, Division 1 - General Requirements and other applicable technical specifications apply to work of this Section.

1.3 RELATED SECTIONS

- A. All Division 26 Sections, in addition to Division 1 - General Requirements.
- B. Description: Work shall consist of furnishing all labor, equipment, supplies, and materials, unless otherwise specified, necessary for the installation of complete underground duct bank, electrical junction pits and conduit system as required by the specifications and as shown on the drawings, subject to the terms and conditions of the contract.

1.4 REFERENCE STANDARDS

- A. Comply with the requirements of the reference standards noted herein, except where more stringent requirements are listed herein or otherwise required by the Contract Documents.
- B. Latest editions of the following:
 - 1. ANSI/NFPA 70 - National Electrical Code (as adopted and amended by the Denver Building Code).
 - 2. ANSI/IEEE C2 - National Electrical Safety Code.
 - 3. OSHA - Occupational Safety and Health Administration, as Amended
 - 4. Other Standards as listed elsewhere in the contract documents.

1.5 DRAWINGS AND SPECIFICATIONS

- A. The drawings indicate the general arrangement of underground conduit and duct banks, locations of manholes, hand holes and other work. Drawings and specifications are complementary each to the other. What is called for by one shall be as binding as if called for by both. Data presented on these drawings is as accurate as can be determined. Accuracy is not guaranteed and field verification of all dimensions, locations, levels, etc., to suit field conditions is required. Review all

drawings and specifications; adjust all work to conform to all conditions shown therein.

PART 2 – PRODUCTS

2.1 MATERIALS & EQUIPMENT

- A. As called for in other Sections of the Specifications or as noted on the Drawings, the most stringent shall apply.

2.2 PRODUCTS

- A. Flow able backfill shall be 60 to 100 psi.
- B. Red concrete for encasement shall be 3,000.psi. The color shall be Davis Color “Baja Red.” Use Davis Color # 160 at a ratio of two pounds for each sack of cement in the mix or equal as determined by the DEN Project Manager.
- C. Electrical pre-fabricated junction pits:
 - 1. Cavotec Dabico Model D741WP for 75” x 41” Electric Hand Hole EHH-B15 as indicated on the drawings. Provide without optional platform grate and without optional ladder.
 - a. Furnish a completely prefabricated Pit Assembly with fiberglass liner, pit cover, and all necessary components. This will ensure the integrity and strength of the pit assembly as well as ensure that internal components are properly located.
 - b. Cover assembly shall consist of a rectangular (78” x 44”) cover that requires a maximum 35 lb. to open, and a minimum 45 lb. to close, and two spring cover castings (each 27” x 10”). Cover shall be provided with hand-holes with a minimum 1-5/8” depth, and a flush-mounted cover latch with no above-grade protrusions whether in use or not.
 - c. Cover shall have high visibility orange panels on topside and underside for safety.
 - d. When open, the cover shall provide a minimum 75” x 41” pit access.
 - e. Hinged lid shall be provided with a cast aluminum insert describing type of service, having minimum 0.125” raised lettering, and shall be abrasion/corrosion/chemical-resistant color-coded, and be affixed to the hinged lid by four no. 12 drive screws.
 - f. Pit cover shall have its own seal which shall automatically engage a sloped wall when seated in the closed position without any secondary latching motions. Seal and seal components shall be field replaceable. The seal shall be affixed without mechanical fasteners, have a minimum field life of one year, and be ozone/UV resistant.
 - g. Pit body shall be manufactured from isophthalic or terephthalic resin and chopped glass strand, 70% resin, 30% glass. Pit body shall be open bottom type and depth as indicated on the drawings.

2. Cavotec Dabico Model D38WP for 38" x 38" Electric Hand Holes EHH-14, EHH-B16, and EHH-B17 as indicated on the drawings. Provide without optional platform grate and without optional ladder.
 - a. Furnish a completely prefabricated Pit Assembly with fiberglass liner, pit cover, and all necessary components. This will ensure the integrity and strength of the pit assembly as well as ensure that internal components are properly located.
 - b. Cover assembly shall consist of a rectangular frame and rectangular hinged pit cover, that requires a maximum 35 lb. lift to open and close, and shall be provided with a hand-hole with a minimum 1-5/8" depth.
 - c. Cover shall be provided with a flush-mounted cover latch with no above-grade protrusions whether in use or not.
 - d. Cover shall have high visibility orange panels on topside and underside for safety.
 - e. When open hinged lid shall provide a minimum 38" pit access.
 - f. Hinged lid shall be provided with a cast aluminum insert describing type of service, having minimum 0.125" raised lettering, and shall be abrasion/corrosion/chemical-resistant color-coded, and be affixed to the hinged lid by four no. 12 drive screws.
 - g. Pit cover shall have its own seal which shall automatically engage a sloped wall when seated in the closed position without any secondary latching motions. Seal and seal components shall be field replaceable. The seal shall be affixed without mechanical fasteners, have a minimum field life of one year, and be ozone/UV resistant.
 - h. Pit body shall be manufactured from isophthalic or terephthalic resin and chopped glass strand, 70% resin, 30% glass. Pit body shall be open bottom type and depth as indicated on the drawings.

PART 3 - EXECUTION

3.1 TRENCHING AND BACKFILLING

- A. Verify location of existing or new utilities prior to any excavation and, if damaged by this Contractor, replace or repair as acceptable by the DEN Project Manager.
- B. All underground conduit runs outside building areas shall be encased in red concrete and a minimum of 36 - inches from top of concrete encasement to finished grade or as directed by the DEN Project Manager. A 3" wide red metallized foil core detectable warning tape shall be placed maximum of 12" below finished grade.
- C. After installation of electrical work and concrete encasement, backfill with flowable backfill to insure against the possibility of differential settling, use flowable backfill to within 8 inches of final grade or as indicated. Refer to Civil drawings for pavement section details.
- D. Perform all trenching and backfilling required for work performed under this Division. The installation shall be in accordance with the excavating and grading specifications and as herein specified.

3.2 WORKMANSHIP

- A. Only quality workmanship will be accepted. Use the NECA Standard of Installation as a minimum for installation of equipment. Poor workmanship, improper layout of work and lack of coordination of work, as determined by the Project Manager, is not acceptable and shall be corrected at the expense of the contractor.
- B. Contractor's personnel and subcontractors selected to perform the work shall be licensed, well versed and skilled in the trades involved.
- C. Contractor shall provide a complete installation, including all required labor, material, cartage, insurance, permits, and taxes.
- D. Any changes or deviations from the drawings and specifications must be accepted in writing by the Project Manager. All errors in installation shall be corrected at the expense of the Contractor.
- E. Perform all trenching and backfilling required for work performed under this Division. The installation shall be in accordance with the excavating and grading specifications and as herein specified.
- F. Upon completion of work, all equipment and materials shall be installed complete, thoroughly checked, correctly adjusted, and left ready for intended use or operation. All work shall be thoroughly cleaned and all residues shall be removed from surfaces.

3.3 CONSTRUCTION

- A. Locate all underground utilities and obstructions by non-destructive potholing before excavation. Contractor shall be responsible for all costs both direct and collateral associated with damage of existing underground utilities. The contractor is responsible for maintaining existing utilities.
- B. Underground conduits shall be Poly-vinyl Chloride (PVC) schedule 40 or greater, or Galvanized Rigid Conduit (GRC) with factory bonded 40 mil. PVC coating; as indicated on the drawings.
- C. Wipe plastic conduit and coupling clean and dry before joining. Apply full, even coat of cement to entire area that will be used in the connection. Let the joint cure for 20 minutes minimum.
- D. All elbows used with PVC conduit shall be galvanized rigid conduit (G.R.C.) and have a factory bonded PVC 40 mil. coating.
- E. A 1-inch minimum size shall be used for underground conduit.
- F. The radius of curve of any field bend shall not be less than indicated in NEC Table 2, Chapter 9. Bends shall be made so the conduit is not damaged, and the internal diameter of the conduit will not be reduced.

- G. Conduit penetrating a foundation wall shall be sleeved and continuous (without fittings) from the interior for a minimum of five feet (5') on the exterior. Conduit penetrating a footer or grade beam shall be sleeved and continuous for five feet (5') on either side of a footer or grade beam using a single ten foot piece of PVC coated GRC. Conduit penetrating a wall, footer or grade beam below grade shall be plastic coated rigid steel conduit.
- H. All underground conduits shall be mandreled with a steel mandrel. The mandrel shall not be more than 1/2-inch smaller than the inside diameter of the conduit.
- I. All empty conduit runs installed by the contractor shall have a 200- pound break-strength nylon measuring pull rope inserted in each conduit after conduit is cleaned and mandreled for the entire length.
- J. As acceptable by the DEN Project Manager, after installation of electrical work and concrete encasement, backfill with flowable backfill to insure against the possibility of differential settling, use flowable backfill to within 8 inches of final grade.
- K. When concrete is removed for underground duct runs, it shall be first saw cut full depth then removed in a workman-like manner. Slurry shall be vacuumed up as saw cutting is in operation and shall not be allowed to accumulate.

PART 4 - MEASUREMENT

4.1 METHOD OF MEASUREMENT

- A. Payment for "Remove and Replace Fueling System Handhole (EHH-B15)" shall be measured per each, for work installed in-place, completed, and approved by the DEN PM.
- B. Payment for "Remove and Replace Fueling System Handhole (EHH-B14, B16, and B17) w/4 J-Boxes" shall be measured per each, for work installed in-place, completed, and approved by the DEN PM.
- C. Payment for "Add Conduit Duct Bank for Handhole (EHH-B15)" shall be measured per each, for work installed in-place, completed, and approved by the DEN PM. Conduit Duct Bank shall be measured from the center of handhole, or riser, and shall be measured to the nearest foot.
- D. Payment for "Add Conduit Duct Bank for Valve Pits (JVP-B9, B10, B11)" shall be measured per each, for work installed in-place, completed, and approved by the DEN PM.

PART 5 - PAYMENT

5.1 METHOD OF PAYMENT

- A. Payment for "Remove and Replace Fueling System Handhole (EHH-B15)" will be made at the contract unit price per each for work installed in-place, completed, and approved by the DEN PM. This price shall be full compensation for furnishing all materials and installation of these materials, and for all labor, equipment, tools, and incidentals necessary to complete the item.
- B. Payment for "Remove and Replace Fueling System Handhole (EHH-B14, B16 and B17) w/4 J-Boxes" will be made at the contract unit price per each for work installed in-place, completed, and approved by the DEN PM. This price shall be full compensation for furnishing all materials and installation of these materials, and for all labor, equipment, tools, and incidentals necessary to complete the item.
- C. Payment for "Add Conduit Duct Bank for Handhole (EHH-B15)" will be made at the contract unit price per each for work installed in-place, completed, and approved by the DEN PM. This price shall be full compensation for furnishing all materials and installation of these materials, and for all labor, equipment, tools, and incidentals necessary to complete the item.
- D. Payment for "Add Conduit Duct Bank for Valve Pits (JVP-B9, B10, B11)" will be made at the contract unit price per each for work installed in-place, completed, and approved by the DEN PM. This price shall be full compensation for furnishing all materials and installation of these materials, and for all labor, equipment, tools, and incidentals necessary to complete the item.
- E. Payment for "Add Conduit Duct Bank between EHH-B17 and JVP-B9" will be made at the contract unit price per each for work installed in-place, completed, and approved by the DEN PM. This price shall be full compensation for furnishing all materials and installation of these materials, and for all labor, equipment, tools, and incidentals necessary to complete the item.
- F. Payment for "Add Conduit Duct Bank between JVP-B9 and EHH-B16" will be made at the contract unit price per each for work installed in-place, completed, and approved by the DEN PM. This price shall be full compensation for furnishing all materials and installation of these materials, and for all labor, equipment, tools, and incidentals necessary to complete the item.
- G. Payment for "Add Conduit Duct Bank between EHH-B16 and JVP-B10" will be made at the contract unit price per each for work installed in-place, completed, and approved by the DEN PM. This price shall be full compensation for furnishing all materials and installation of these materials, and for all labor, equipment, tools, and incidentals necessary to complete the item.
- H. Payment for "Add Conduit Duct Bank between JVP-B10 and EHH-B15" will be made at the contract unit price per each for work installed in-place, completed, and approved by the DEN PM. This price shall be full compensation for furnishing all materials and installation of these materials, and for all labor, equipment, tools, and incidentals necessary to complete the item.

- I. Payment for “Add Conduit Duct Bank between EHH-B15 and EHH-B14” will be made at the contract unit price per each for work installed in-place, completed, and approved by the DEN PM. This price shall be full compensation for furnishing all materials and installation of these materials, and for all labor, equipment, tools, and incidentals necessary to complete the item.
- J. Payment for “Add Conduit Duct Bank between EHH-B14 and JVP-B11” will be made at the contract unit price per each for work installed in-place, completed, and approved by the DEN PM. This price shall be full compensation for furnishing all materials and installation of these materials, and for all labor, equipment, tools, and incidentals necessary to complete the item.
- K. Payment for “Replace Junction Boxes in EHH-B14” will be made at the contract unit price per each for work installed in-place, completed, and approved by the DEN PM. This price shall be full compensation for furnishing all materials and installation of these materials, and for all labor, equipment, tools, and incidentals necessary to complete the item.
- L. Payment for “Replace Junction Boxes in EHH-B15” will be made at the contract unit price per each for work installed in-place, completed, and approved by the DEN PM. This price shall be full compensation for furnishing all materials and installation of these materials, and for all labor, equipment, tools, and incidentals necessary to complete the item.
- M. Payment for “Replace Junction Boxes in EHH-B16” will be made at the contract unit price per each for work installed in-place, completed, and approved by the DEN PM. This price shall be full compensation for furnishing all materials and installation of these materials, and for all labor, equipment, tools, and incidentals necessary to complete the item.
- N. Payment for “Replace Junction Boxes in EHH-B17” will be made at the contract unit price per each for work installed in-place, completed, and approved by the DEN PM. This price shall be full compensation for furnishing all materials and installation of these materials, and for all labor, equipment, tools, and incidentals necessary to complete the item.

Payment will be made under:

Item 260543-1	Remove and Replace Fueling System Handhole (EHH-B15) - per each
Item 260543-2	Remove and Replace Fueling System Handholes (EHH-B14, 16, and 17) w/4 J-Boxes – per each
Item 260543-3	Add Conduit Duct Bank for Handhole (EHH-B15) – per each
Item 260543-4	Add Conduit Duct Bank for Valve Pits (JVP-B9, B10, B11) – per each
Item 260543-5	Add Conduit Duct Bank between EHH-B17 and JVP-B9 – per each

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|----------------|--|
| Item 260543-6 | Add Conduit Duct Bank between JVP-B9 and EHH-B16 – per each |
| Item 260543-7 | Add Conduit Duct Bank between EHH-B16 and JVP-B10 – per each |
| Item 260543-8 | Add Conduit Duct Bank between JVP-B10 and EHH-B15 – per each |
| Item 260543-9 | Add Conduit Duct Bank between EHH-B15 and EHH-B14 – per each |
| Item 260543-10 | Add Conduit Duct Bank between EHH-B14 and JVP-B11 – per each |
| Item 260543-11 | Replace Junction Boxes in EHH-B14 – per each |
| Item 260543-12 | Replace Junction Boxes in EHH-B15 – per each |
| Item 260543-13 | Replace Junction Boxes in EHH-B16 – per each |
| Item 260543-14 | Replace Junction Boxes in EHH-B17 – per each |

END OF SECTION 260543

SECTION 260544 SLEEVES AND SLEEVE SEALS FOR ELECTRICAL RACEWAYS AND CABLING

PART 1 - GENERAL

1.1 SUMMARY

- A. Raceway, cable tray and equipment supports.
- B. Fastening hardware.
- C. Wall and floor seals.

1.2 RELATED DOCUMENTS

- A. Drawings, General and Special Conditions, Division 1 - General Requirements and other applicable technical specifications apply to work of this Section.

1.3 RELATED SECTIONS

- A. Refer to Section 260100 for coordination requirements.
- B. Division 26 - All Sections.

1.4 REFERENCE STANDARDS

- A. Comply with the requirements of the reference standards noted herein, except where more stringent requirements are listed herein or otherwise required by the Contract Documents.
- B. NFPA - 70: National Electrical Code.

1.5 QUALITY CONTROL

- A. Support systems shall be safe and adequate for weight of equipment and conduit, including wiring, that they carry.

PART 2 - PRODUCTS

2.1 MATERIAL

- A. Support Channel: Hot dipped galvanized for damp or wet locations, dry locations only painted steel.
- B. Hardware: Corrosion-resistant steel

PART 3 - EXECUTION

3.1 INSTALLATION

- A. Fasten hanger rods, conduit clamps, and outlet and junction boxes to building structure using precast insert system, expansion anchors, preset inserts, or beam clamps, and caddy type fasteners.
- B. Use toggle bolts or hollow wall fasteners in hollow masonry, plaster, or gypsum board partitions and walls; expansion anchors or preset inserts in solid masonry walls; self-drilling anchors or expansion anchors on concrete surfaces; sheet metal screws in sheet metal studs; and wood screws in wood construction.
- C. Do not fasten supports to piping, ductwork, mechanical equipment, cable tray or conduit.
- D. Do not drill structural steel members.
- E. Fabricate supports from structural steel or steel channel, rigidly welded or bolted to present a neat appearance. Use hexagon head bolts with spring lock washers under all nuts.
- F. Install all freestanding electrical equipment on a 4" nominal concrete housekeeping pad.
- G. Install surface-mounted cabinets and panel boards with minimum of four anchors.
- H. Bridge studs top and bottom with channels to support flush-mounted cabinets and panel boards in stud walls.
- I. Where conduit penetrates fire-rated walls, concrete and/or masonry walls and floors, seal opening around conduit with a product listed for the purpose.
- J. Where conduit penetrates waterproofed floors or exterior walls subject to entry of moisture, seal annular space around conduit with a product UL listed for the purpose.
- K. Route conduit through roof openings provided for piping and ductwork where possible; otherwise, route through roof jack with sealant approved by the roofing manufacturer.
- L. Suspended conduit or box supports shall not be less than 1/4" diameter steel rod. Rod used as pedestal support is not acceptable. The contractor shall not use tie wire or wire of any type to support conduits, junction boxes or pull boxes.
- M. No more than five (5) 1/2" conduits, three (3) 3/4" conduits or two (2) 1" conduits shall be supported on a single 1/4" diameter steel rod.
- N. All conduits shall be supported by approved hangers. Supports installed and used by other trades such as duct hangers, pipe hangers, ceiling hangers, etc. shall not be used for conduit support. No conduit shall be hung from air handling duct of any type.

- O. Cable tray and cable tray supports shall not be used to support conduits or other equipment. Cable tray and cable tray supports "shall stand alone."
- P. All light fixtures shall be independently supported at opposite corners from structure, or from trapeze supported from structure by the electrical contractor.
- Q. Wall-mounted fixtures shall be supported from building structure with backing support as approved by the Project Manager to prevent any damage to the wall.
- R. Use vibration isolation pads for vibrating equipment such as transformers.
- S. Plastic or fiber anchors are prohibited.
- T. Anchoring deeper than 1-1/2" in overhead cast in place, pre-tensioned or post-tensioned concrete is prohibited unless x-ray or ground penetrating radar study are performed and approved by the DEN Project Manager.

PART 4 - MEASUREMENT

4.1 METHOD OF MEASUREMENT

- A. No separate measurement shall be made for work under this Section.

PART 5 - PAYMENT

5.1 PAYMENT

- A. No separate payment will be made for work under this section. The cost of the work described in this section shall be included in the applicable unit price item, work order or lump sum bid item.

END OF SECTION 260544

SECTION 260553 IDENTIFICATION FOR ELECTRICAL SYSTEMS

PART 1 - GENERAL

1.1 SUMMARY

- A. Underground warning tape.
- B. Electrical power, control, signal, security, data, fiber optic, and communication conductors and raceways.
- C. Operational instructions and warnings.
- D. Danger signs.
- E. Equipment/system identification signs.

1.2 RELATED DOCUMENTS

- A. Drawings, General and Special Conditions, Division 1 - General Requirements and other applicable technical specifications apply to work of this Section.

1.3 RELATED SECTIONS

- A. Division 26 - All Sections

1.4 REFERENCE STANDARDS

- A. Comply with the requirements of the reference standards noted herein, except where more stringent requirements are listed herein or otherwise required by the Contract Documents.

1.5 QUALITY ASSURANCE

- A. Comply with "OSHA or ROCIP, whichever is more stringent" sign standards for danger, caution, warning, etc.

1.6 SUBMITTALS (REFER TO SECTIONS 01300 AND 01340)

- A. Submit product data under provisions of Division 1.
- B. Include schedule for all specified applications of electrical identification.

PART 2 - PRODUCTS

2.1 ELECTRICAL IDENTIFICATION MATERIALS

General: The manufacturer's standard products of categories and types required are to be used for each application.

- A. Underground Type Plastic Detectable Line Marker:
 - 1. Manufacturer's standard permanent red, continuous-printed plastic tape with a metalized foil core, intended for direct-burial service; not less than 3 inches wide x 4 mils thick. Printing is required on tape that most accurately indicates type of service.
- B. Wire and Cable Marker:
 - 1. For wire/cables smaller than No. 2/0 use manufacturer's standard vinyl-cloth self-adhesive cable/conductor markers of wrap-around type, either pre-numbered plastic coated type, or write-on type with clear plastic self-adhesive cover flap are to be used and numbered to show circuit identification.
 - 2. For cables No. 4 AWG and larger heat shrink sleeving is to be used for phase color coding.
- C. Plasticized Tags:
 - 1. Manufacturer's standard preprinted or partially preprinted accident-prevention and operational tags, on plasticized card stock with matte finish suitable for writing, approximately 3-1/4-inch x 5-5/8-inch, with brass grommets and wire fasteners, and with appropriate preprinted wording including large-size primary wording, e.g., DANGER, CAUTION, DO NOT OPERATE.
- D. Baked Enamel Danger Signs:
 - 1. Manufacturer's standard "EMERGENCY FUEL SHUTOFF PUSH " signs of baked enamel finish on 20-gauge steel; of standard red, black and white graphics; 14-inch x 10-inch size; with recognized standard explanation wording, e.g., XXXX VOLTS, KEEP AWAY, BURIED CABLE, DO NOT TOUCH SWITCH, etc.
- E. Engraved Plastic-Nameplates:
 - 1. All electrical equipment shall be identified unless stated otherwise. Nameplate shall be laminated phenolic black letters on a white background. . Nameplates shall be attached with a minimum of two stainless steel machine screws. Embossed plastic adhesive (dymo) tape will not be accepted for nameplates.
 - 2. Thickness: 1/16", for units up to 20 square inches or 8 inches in length, 1/8 inch for larger units.

F. Printed Flexible Adhesive Label:

1. EFSO push stations: Shall have a 4 inch X 2 inch black with 3/8" white letters labeled "FUEL SHUTOFF" and station name.
2. Flexible Adhesive Labels shall only be used on EFSO push station covers. Attach this label on inside of transparent cover.

Lettering and Graphics:

1. Numbers, lettering and wording as required or as recommended by manufacturer or as required for proper identification and operation/maintenance of electrical systems and equipment shall be used. Gothic letters shall be provided.

PART 3 - EXECUTION

3.1 APPLICATION AND INSTALLATION

A. General Installation Requirements:

1. Laminated plastic nameplates shall be fastened with two machine screws.

B. Underground Conduit and Duct bank Identification:

1. During back-filling/top-soiling of each exterior underground conduit and ductbank, a continuous underground red detectable type line marker, located directly over conduit or duct bank at a maximum of 12 inches below finished grade or 4 inches below paving, shall be provided.

C. Cable/Conductor Identification:

1. The application of cable/conductor identification, with circuit number, on each wire / cable in each box/enclosure/cabinet is required. The identification shall match the marking system used in panel boards, shop drawings, and contract documents.

D. Operational Identification and Warnings:

1. Wherever required to ensure safe and efficient operation and maintenance of electrical systems, and electrically connected mechanical systems and general systems and equipment, including prevention of misuse of electrical facilities by unauthorized personnel, self-adhesive plastic signs or similar equivalent identification, instruction or warnings on switches, outlets and other controls, devices and covers of electrical enclosures shall be provided. Where detailed instructions or explanations are needed, provide plasticized tags with clearly written messages adequate for intended purposes.

E. Danger Signs:

1. Critical Switches/Controls: Danger signs shall be provided on switches and similar controls, regardless of whether concealed or locked up, where untimely or inadvertent operation could result in danger to persons, or damage to equipment, or damage to or loss of property.

2. The installation of signs are required at locations indicated or, where not otherwise indicated, at location for best convenience of viewing without interference with operation and maintenance of equipment. The sign shall be secured to the substrate with fasteners, except use adhesive where fasteners should not or cannot penetrate substrate.

F. Equipment Designation (See Next Page)

PART 4 - MEASUREMENT

4.1 METHOD OF MEASUREMENT

- A. No separate measurement shall be made for work under this Section.

PART 5 - PAYMENT

5.1 PAYMENT

- A. No separate payment will be made for work under this section. The cost of the work described in this section shall be included in the applicable unit price item, work order or lump sum bid item.

END OF SECTION 260553

ITEM-284318 EMERGENCY FUEL SHUT-OFF SYSTEM

PART 1 – GENERAL

1.1 SUMMARY

- A. Emergency Fuel Shut-Off (EFSO) System.
- B. EFSO system shall be provided by the Contractor in accordance with National Fire Protection Association Standard for Aircraft Fuel Servicing NFPA No. 407, latest edition.
- C. The additions to the existing system shall be completely installed, connected, tested, adjusted, free of short circuits and unintentional grounds, properly maintained until final acceptance, and left in proper operating and usable condition. The Owner's designated personnel shall be instructed regarding operation and maintenance of the systems provided under these Specifications.

1.2 RELATED DOCUMENTS

- A. Drawings, General and Special Conditions, Division 1 - General Requirements and other applicable technical specifications apply to work of this Section.

1.3 RELATED SECTIONS

- A. Section 335243 - Aviation Fueling System Piping, Valves, and Fittings
- B. Section 260100 - General Electrical Requirements
- C. Section 260543 – Underground Ducts and Raceways for Electrical Systems
- D. Section 260544 – Sleeves and Sleeve Seals for Electrical Raceways and Cabling
- E. Section 260553 - Identification for Electrical Systems
- F. Section 260526 - Grounding and Bonding for Electrical Systems

1.4 REFERENCE STANDARDS

- A. Comply with the requirements of the reference standards noted herein, except where more stringent requirements are listed herein or otherwise required by the Contract Documents.
- B. National Fire Protection Association (NFPA)
 - NFPA 70 National Electric Code
 - NFPA 407 Standard for Aircraft Fueling Servicing

1.5 SUBMITTALS

- A. Include manufacturer's published data or certified laboratory test data indicating that products meet the specified requirements.
- B. Submit shop drawings for all panels required under this Section. Include configuration, layout, input/output wiring diagrams and mounting information.
- C. Provide operating and maintenance manuals in conformity with Section 260100 requirements; to include spare parts list, maintenance instructions, operating instructions and wiring diagrams.

1.6 RECORD DOCUMENTS

- A. Maintain a contract set of electrical drawings and specifications at the site. Neatly mark all changes, discoveries and deviations from the original drawings. Use a reproducible color that contrasts with the prints. This shall be a separate set of drawings, not used for construction purposes, and shall be updated daily as the job progresses and shall be made available for inspection by the Project Manager at all times. Upon completion of the contract, this set of record drawings shall be delivered to the Project Manager. Follow DEN CADD standards, to be furnished to the successful bidder. Record documents to be provided by the Contractor shall clearly and accurately show the following:
 - 1. Provide horizontal and vertical dimensions for all raceway systems, size and location, for both exterior and interior; locations of control devices; distribution and branch electrical circuitry; and fuse and circuit breaker size and arrangements.
 - 2. Equipment locations (exposed and concealed), dimensioned from prominent building lines.
 - 3. Approved substitutions, Contract Modifications, and actual equipment and materials installed.

1.7 - WARRANTY

- A. The system shall be warranted for a period of not less than one year from the Date of Final Acceptance of the system. This warranty service shall include parts and labor service for equipment supplied under this specification.

1.8 OPERATING AND MAINTENANCE DEMONSTRATIONS

- A. Product manufacturer's factory trained representative(s) shall provide instructions and demonstrations for Owner's personnel.

PART 2 – PRODUCTS

2.1 ACCEPTABLE MANUFACTURERS

- A. Manufacturers:
 1. Safety Technology International
 2. Simplex Time Recorder Co.
 3. No substitutions permitted

2.2 GENERAL SYSTEM COMPONENTS

- A. General Description: The EFSO System shall consist of U.L. listed and labeled solid state, multiplex fire alarm components. The EFSO System shall be designed such that each one half of concourse shall have an independent system, which will communicate with a Central Processing Unit (CPU) and systems at the other concourses to form an integrated composite system. Major components of the system consist of EFSO manual push/pull stations located near each aircraft fueling point; EFSO control multiplexer panels located in each one half of the concourses; and status command centers located in the Concourse Center Cores, Airport Fire Station, Fuel Farm, and the Airport Operations Center. Signals generated by the activation of an EFSO pull station shall be transmitted to the CPU by way of the multiplexer control panel mounted in concourses. Signals generated by the CPU to initiate closure of the fuel isolation valves shall be transmitted by way of receivers mounted in the multiplexer panels. Signals generated by supervisory devices in the isolation valve pits shall be transmitted to the CPU by way of multiplexers. Each supervised device (push/pull station, limit switch, valve control points, etc.) shall be individually monitored and annunciated.
- B. Existing Central Processing Unit (CPU): The existing Central Processing Unit is a Simplex 2120 system. The power shall be supplied from the nearest 120 V power panel, and have 90-minute battery back-up. The CPU shall

communicate with the Concourse Multiplexer Panels via airport fiber optic cable. Contacts shall be provided to energize valve position lights on the fuels control panel. In addition, provide normally open and normally closed contacts for tank farm pump shut down.

- C. Existing Concourse Multiplexer Panels: The existing Concourse Multiplexer Panels are Simplex 2120 Series communicating device transponders. They shall be capable of independent control at each concourse, as well as receiving input and sending event notification to the CPU. The multiplexers shall include remote input/output devices to provide input from pull stations and the fuel isolation valve pits, and output to the fuel isolation valve pits. The remote input/output panels shall also provide remote annunciation of system events. Each multiplexer shall have a system reset pushbutton. Power supply shall be from an uninterruptible power unit.
- D. Existing Graphic Display: The existing Graphic Display is a computer-based monitor, compatible with the Simplex 2120 System. The graphic display shall annunciate all information presented on each other panel, including alarms and silence switches. The graphic display shall have 24-hour battery back-up.
- E. New EFSO Manual Push Stations: Push stations shall be single action, maintained with one normally closed (N.C.) contacts, and two pair normally open (N.O.) contacts. Pull stations shall be provided complete with weather-proof steel back box for surface mounting, and weatherproof polycarbonate protective shield. The new EFSO Manual push Station shall be Safety Technology International Type SS-2272 with a yellow body and a red button, or approved equal.
- F. Existing EFSO Manual Pull Stations: Pull stations are single action, maintained with one normally closed (N.C.) contacts, and two pair normally open (N.O.) contacts. Pull stations have been provided complete with weather-proof steel back box for surface mounting, and weatherproof Lexan protective shield. The existing EFSO Manual Station shall be Simplex Type 2099-9102, or approved equal.
- G. Existing Annunciator Panel: The existing Annunciator Panel shall be Simplex Type Status Command Center. Annunciator Panel shall be connected to the fiber optic loop and located as indicated on the drawings. Annunciator Panels shall indicate all EFSO events.
- H. Existing Zone adapter modules (ZAMS): All ZAMS located in valve pits shall be installed in a common explosion proof 4X enclosure. All wiring shall be terminated at terminal block for external connections. Each enclosure shall contain a Hi-Heat Industries Inc., No. H10050C1 Thermostat controlled heater. The existing zone adaptor modules are Simplex Type ZAM, or approved equal.

- I. The EFSO station shall have a blue annunciation lamp powered from 120vAC. The light shall be provided with a weatherproof mounting fixture, and shall be Crouse-Hinds Type VXHBF25GP, or approved equal.
- J. The EFSO station shall contain an internal solid-state flasher to operate the annunciation lamp. The flasher shall be Type SSACFS123, or approved equal.
- K. All multiplexer panels shall have RS232 interface connections.
- L. All external connections to system control panels shall have lightning/surge arrestors at first point of entry into buildings.

PART 3 – EXECUTION

3.1 GENERAL EFSO SYSTEM OPERATION

- A. Provide a manual EFSO push station mounted on the exterior wall of the concourses or on exterior columns, as indicated on the drawings. The actuation of any EFSO manual push station shall cause the following to occur.
 - 1. Sound an audible signal and flash the "GENERAL ALARM" at the concourse multiplexer, CPU, and the Graphic Display.
 - 2. Initiate a command signal to automatically close the fuel isolation valves on either side of the manual EFSO pull station.
 - 3. Flash blue light mounted adjacent to activated pull station.
 - 4. "Light the "Valve Closed" annunciation light when a valve completes its closing process. Signal shall be from valve limit switches.
 - 5. Extinguish the "Valve Open" annunciation light when the valve has closed. Signal shall be from valve limit switches.
 - 6. Failure of a valve to close after receiving a primary close command shall cause an audible alarm to sound after an adjustable 0-15 second time delay, and shall generate a secondary alarm signal and initiate a command signal to automatically close the next upstream isolation valve.
 - 7. Provision for silencing audible signals shall be provided at each panel. Silencing the audible signal shall not prevent the re-sounding of the signal in the event of subsequent alarms. All indicator lights shall remain as described herein until the actuated station is reset. Acknowledging the alarm or trouble condition (silencing the audible signal) at any one panel shall acknowledge and silence audible signals at all panels. Silencing the audible alarm shall light the "ALARM SILENCED" led on the panel, to remain illuminated until the system is reset.

- B. The resetting of an actuated EFSO station shall cause the following to occur:
 - 1. The alarmed station's annunciation lights shall be extinguished.
 - 2. The EFSO station's flashing light shall revert to its normal light condition.
 - 3. No change shall occur in the valve position light until the valve has been manually returned to the open position.
 - 4. The audible signal shall resound to indicate the valve has changed position when the valve is reopened.

- C. The system shall provide for the monitoring of each of the multiplexers. Loss of function in any multiplexer, or loss of communication between central processing unit and multiplexer, shall cause the following to occur:
 - 1. The audible alarm shall sound.
 - 2. The "Panel Malfunction" light shall flash on the graphic display identifying the multiplexer.
 - 3. Silencing the audible alarm shall be as previously described.
 - 4. The LED shall flash until the signal is acknowledged, then remain steady state on until the malfunction is corrected.

- D. The graphic display shall annunciate high liquid level in valve pit as a trouble condition, which shall cause the following to occur:
 - 1. The audible alarm shall sound and "High Water" LED (Amber) shall flash indicating the affected pit.
 - 2. Silencing the audible alarm shall be as previously described.

3.2 INSTALLATION

- A. The arrangement and location of devices and components and the interconnecting wiring therefore shall be furnished, installed, tested, and be complete and operable in all respects. All interconnecting wiring shall be copper and of ample capacity for proper operation of the system. Wiring shall be installed in a raceway system.

- B. Communications between multiplexer panels, CPU, and status command center will be dedicated fiber optics channels. The Contractor shall coordinate the provisions of the dedicated fiber optics cable installed under another contract and provide the necessary conversion equipment to connect to the fiber optics.

- C. The manufacturer's authorized representative shall provide supervision of the final system panel connections, perform a complete functional test of the system and submit a written report to the Contractor attesting to the proper operation of the system.

- D. Upon completion of the installation, the Contractor shall provide a signed statement attesting that all system equipment was installed in accordance with these specifications and directions provided to the Contractor by the manufacturer.
- E. The system supplier shall furnish all required end of line-of-line relays, and coordinate their location and installation.

PART 4 - MEASUREMENT

4.1 METHOD OF MEASUREMENT

- A. Payment for "(EFSO) station to be relocated" (B25 & B27) shall be measured per each, for work installed in-place, completed, and approved by the DEN PM.
- B. Payment for "Replace Pull switch with Pushbutton" (B15, B17, B19, B21, B23, B29, B31, B33, B35 & B37) shall be measured per each, for work installed in-place, completed, and approved by the DEN PM.

PART 5 - PAYMENT

5.1 PAYMENT

- A. Payment for "(EFSO) station to be relocated" (B25 & B27) will be made at the contract unit price per each for work installed in-place, completed, and approved by the DEN PM. This price shall be full compensation for furnishing all materials and installation of these materials, and for all labor, equipment, tools, and incidentals necessary to complete the item.
- B. Payment for "Replace Pull switch with Pushbutton" (B15, B17, B19, B21, B23, B29, B31, B33, B35 & B37) will be made at the contract unit price per each for work installed in-place, completed, and approved by the DEN PM. This price shall be full compensation for furnishing all materials and installation of these materials, and for all labor, equipment, tools, and incidentals necessary to complete the item.

Payment will be made under:

Item 284318-1 (EFSO) station to be relocated (B25 & B27) - per each

Item 284318-2 Replace Pull switch with Pushbutton (B15, B17, B19, B21, B23, B29, B31, B33, B35 & B37) – per each

END OF SECTION 284318

SECTION 335201 BASIC AVIATION REQUIREMENTS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

- A. The General Conditions, Supplementary Conditions and Division 1, General Requirements apply to this Section, Section 15050 - Basic Mechanical Materials and Methods and Contractor shall review and adhere to all requirements of these Documents.

1.2 WORK INCLUDED

- A. Basic requirements common to the work in general of Division 15 and other Divisions and Sections of the Specification where referenced.
- B. Provide, unless specified otherwise, all labor, materials and equipment necessary for completely finished and operational mechanical systems described and specified under other Sections of this Division 15.
- C. Provide all minor incidental items such as offsets, fittings, and accessories required as part of the work even though not specified or indicated.
- D. Inspection: Inspect work preceding or interfacing with work of Division 15 and report any known or observed defects that affect the Work to the General Contractor. Do not proceed with the work until defects are corrected.

1.3 REFERENCES

- A. General.
 - 1. For products or workmanship specified by association, trade, or Federal Standards, comply with requirements of the standard, except when more rigid requirements are specified or are required by applicable Codes.
 - 2. The date of the standard is that in effect as the date of the Contract Documents, except when a specific date is specified.
 - 3. When required by individual Specifications Section by means of reference for cleaning or installation requirements, etc.; obtain a copy of the standard. Maintain the copy at job site during work until substantial completion. Copy may be in electronic format.
 - 4. Schedule of Referenced Organizations: The following is a list of the acronyms of organizations referenced in these Specifications:

Acronym	Organization
AABC	Associated Air Balance Council
ABMA	American Bearing Manufacturers Association
ACGIH	American Conference of Governmental Industrial Hygienists
ACI	American Concrete Institute
ADA	Americans with Disabilities Act
ASA	American National Standards on Acoustics and Vibrations
ADC	Air Diffusion Council
ASME	American Society of Mechanical Engineers
ASTM	American Society for Testing of Materials
AMCA	Air Movement and Control Association
AGA	American Gas Association
ANSI	American National Standards Institute
API	American Petroleum Institute
ASHRAE	American Society of Heating, Refrigerating and Air Conditioning Engineers
ASME	American Society of Mechanical Engineers
ARI	American Refrigerants Institute
ATA	Air Transport Association of America
AWS	American Welding Society
AWWA	American Water Works Association
EPA	Environmental Protective Agency
ETL	Electrical Testing Laboratories
CISPI	Cast Iron Soil Pipe Institute
CTI	Cooling Tower Institute
FM	Factory Mutual Insurance Association
HI	Hydronics Institute
IBC	International Building Code
IFC	International Fire Code
ISA	Instrument Society of America
MSS	Manufacturers Standardization Society of the Valve and Fittings Industry
NACE	National Association of Corrosion Engineers
NAPCA	National Association of Pipe Coating Applicators
NEMA	National Electrical Manufacturers Association
NEBB	National Environmental Balancing Bureau
NFPA	National Fire Protection Association
NIST	National Institute of Science and Technology
NSF	National Sanitation Foundation.
SMACNA	Sheet Metal and Air Conditioning Contractor's National Association
SSPC	The Society for Protective Coatings
STI	Steel Tank Institute
UL	Underwriters' Laboratories
WH	Warnock Hersey

1.4 DEFINITIONS

- A. Conform to Division 1: These Specifications are of abbreviated, simplified or streamlined type and include incomplete sentences. Singular words will be interpreted as plural and plural words will be interpreted as singular where applicable and where full context of the Contract Documents so indicates.
- B. The following words are re-defined and/or elaborated on for the context of Division 15 work:
1. Furnish: Except as otherwise defined in greater detail, term "furnish" is used to mean supply and deliver to Project site, ready for unloading, unpacking, assembly, installation, etc., as applicable in each instance.
 2. Install: Except as otherwise defined in greater detail, term "install" is used to describe operations at Project site including unloading, unpacking, assembly, erection, placing, anchoring, applying, working to dimension, finishing, curing, protecting, cleaning and similar operations, as applicable in each instance.
 3. Provide: Except as otherwise defined in greater detail, term "provide" means furnish and install, complete and ready for intended use, as applicable in each instance.
 4. General Contractor: The term "General Contractor" used in Division 15 and elsewhere in the Contract Documents means the party with whom the Owner has executed the Owner-Contractor Agreement.
 5. "DEN Project Manager" or "Project Manager": Refers to individual authorized to make decisions on the behalf of the City and County of Denver, and are used interchangeably in these specifications.
 6. "ROCIP": Rolling Owner Controlled Insurance Program arranged by City and County of Denver to ensure pro-active safety process are used. Includes ROCIP Safety Manual.

1.5 QUALITY CONTROL

- A. Conform to Division 1. Materials and apparatus required for the work to be new and of first-class quality; to be furnished, delivered, erected, connected and finished in every detail; and to be so selected and arranged so as to fit properly into the building spaces and also provide the manufacturer's recommended maintenance clearance. Where no specific kind or quality of material is given, a first-class standard article shall be furnished.
- B. Unless otherwise specifically indicated, equipment and materials to be installed in accordance with the recommendations of the Manufacturer. This includes the performance of tests as recommended by the Manufacturer.

1.6 REGULATORY REQUIREMENTS

- A. Comply with latest editions of all applicable Codes, Standards, Ordinances and Regulations in effect as of the date of the Contract Documents adopted by the City

and County of Denver (CCD), Building Department (BD), and Fire Department (FD), including but not necessarily limited to the following:

1. National Electrical Code NFPA-70.
 2. NFPA.
 3. Underwriters Laboratories.
- B. Refer to other Division 15 Specification Sections for additional code requirements and standards that are applicable to the work.
- C. If discrepancies occur between the Contract Documents and any applicable Codes, Guidelines, Ordinances, Acts, or Standards, the most stringent requirements shall apply.
- D. Where hourly fire ratings are indicated or required, provide components and assemblies meeting requirements of the American Insurance Association, Factory Mutual Insurance Association and listed by Underwriters Laboratories, Inc.

1.7 PRODUCT OPTIONS AND SUBSTITUTIONS

- A. Refer to DIVISION 1 - GENERAL REQUIREMENTS, Section 01630 Substitutions.
- B. Some materials and equipment are specified by Manufacturer and catalog numbers. The Manufacturer and catalog numbers are used to establish a degree of quality and style for such equipment and material.
- C. When alternate or substitute materials and equipment are used, Contractor shall be responsible for space requirements, configurations, performance, changes in bases, supports, structural members and openings in structure, electrical changes and other apparatus and trades that may be affected by their use.
- D. When providing a product and/or service under the qualification of "acceptable equal," Contractor shall be entirely responsible for additional costs incurred due to modifications to the civil, Architectural, structural, mechanical, and electrical design that may be required to accommodate the "acceptable equal."
- E. Substitute materials and equipment are only allowed to be provided from the Manufacturers listed as approved.

1.8 SHOP DRAWINGS AND PRODUCT DATA

- A. General: Comply with the General Conditions of the Contract and with Division 1 - General Requirements.
1. All documents shall be submitted in electronic format. Each submittal shall be in a single security free PDF document. PDF documents shall be compatible with Adobe Acrobat 8.0 or newer. All as-built documents shall be submitted in AutoCAD 2007 or newer format and PDF plot files of the project.

1.9 CONTRACT RECORD DOCUMENTS

- A. General: Comply with the General Conditions of the Contract and with Division 1 - General Requirements,

1.10 OPERATING AND MAINTENANCE DATA

- A. Division 15 Contractor shall submit one (1) CD-ROM containing a single searchable PDF file of the entire maintenance manual to the DEN Project Manager, General Contractor for their approval.
- B. The manual shall have:
1. Alphabetical list of all system components including the name, address, and 24-hour phone number of the company responsible for servicing each item during the first year's operation.
 2. Operating instructions for complete system, including emergency procedures for fire or failure of major equipment and procedures for normal starting/operating/shutdown and long-term shutdown.
 3. Maintenance instructions, including valves, valve tag and other identified equipment lists, proper lubricants and lubricating instructions for each piece of equipment and necessary cleaning/replacing/adjusting schedules.
 4. Manufacturer's data on each piece of equipment, including:
 - a. Installation instructions.
 - b. Drawings and specifications (approved shop drawings).
 - c. Parts lists.
 - d. Complete wiring and temperature control diagrams (approved shop drawings).
 5. Each piece identified on any schedule shall be bookmarked in the electronic file by its scheduled tag ID (IE: AHU-1)
- C. In addition to the maintenance manual, and keyed to it, the equipment shall be identified and tagged as specified elsewhere. Insert a copy.
1. Identify all starters, disconnect switches, and manually operated controls, except integral equipment switches with permanently applied, legible markers corresponding to operating instructions in the "Maintenance Manual".
 2. Tag all manual operating valves with 1-1/2" diameter brass tags attached with chains. Tags are to be sequence numbered with legible metal stamps.
 3. Provide a typed tag list or schedule mounted under glass in the room designated by DEN Project Manager stating number, location, and function of each tagged item. Insert a copy of tag list in each "Maintenance Manual".
- D. Division 15 Contractor shall be responsible for scheduling instructional meetings for maintenance personnel on the proper operation and maintenance of all mechanical systems, using the maintenance manual as a guide. These meetings must be scheduled through the Project Manager, and General Contractor far enough in advance so that all personnel can be notified.

- E. Division 15 Contractor shall provide proof of performance certification of all Mechanical Equipment and Systems to demonstrate that all Mechanical Equipment and Systems are operating to the intent of the design.

1.11 FINAL OBSERVATION

- A. Comply with the requirements of Division 1 and the following.
- B. Prior to the request for final observation, all Work under the contract shall be completed, all systems shall be in proper working order and placed in operation (System Startup of 48 hours).
- C. All equipment shall be cleaned, including but not limited to, plumbing fixtures. All debris and construction materials shall be removed from the DEN property to a suitable landfill off-airport.
- D. At the request of the Project Manager, a representative of the Contractor who is thoroughly familiar with the Project and operation of the various systems shall be present during the final observation to demonstrate proper operation of the equipment and controls. If requested by the Project Manager, the Contractor shall have representatives from his subcontractors present to assist during final observation.

1.12 PROJECT CONDITIONS

- A. Accessibility.
 - 1. Division 15 Contractor shall locate all equipment, which must be serviced, operated, or maintained in fully accessible positions. Such equipment shall include (but not be limited to) valves and drain points, if required. Minor deviations from Drawings may be allowed to provide for better accessibility. Any changes shall be approved by the Project Manager prior to making the change.
 - 2. Provide concrete and metal work required for work of this Division where not specifically called for under other Sections.
- B. Fabrication.
 - 1. Before any piping is fabricated and before running and/or fabricating any lines of piping the Contractor shall assure himself that they can be run as contemplated in cooperation with Contractors of other Divisions of the Work and the physical constraints of existing conditions and new Structural and Architectural Work.
- C. Scaffolding, Rigging and Hoisting.
 - 1. Provide all scaffolding, rigging, hoisting and services necessary for erection and delivery into the premises of any equipment and apparatus furnished; remove same from premises when no longer required. Conform to the more stringent of OSHA or ROCIP requirements and standards.

1.13 COORDINATION

- A. General: Coordinate and order the progress of mechanical work to conform to the progress of the work of the other trades. Complete the entire installation as soon as the condition of the building will permit.
- B. Coordination with Electrical Work: Comply with Division 16.
- C. Existing System Interruptions: Comply with Division 1.
- D. Drawings and Specifications: The Mechanical Drawings indicate the general design and arrangement of lines, equipment, systems, etc. Information shown is diagrammatic in character and does not necessarily indicate every required offset, fitting, etc. Do not scale the Drawings for dimensions. Take dimensions, measurements, locations, levels, etc., from the Civil Drawings and equipment to be furnished.
- E. Discrepancies: Examine Drawings and Specifications for other parts of the work, and if any discrepancies occur between the plans for the work of this Division and the plans for the work of others, report such discrepancies to the Project Manager and obtain written instructions for any changes necessary.
- F. Order of Precedence: The precedence of mechanical construction documents are as Specified in Article 4 of the General Conditions.

1.14 START-UP PROCEDURES

- A. Ensure that all control systems, including emergency shutoff systems, are fully operational in automatic mode.
- B. If systems are not to continue in use following the start-up procedures, steps should be taken to ensure against accidental operation or operation by unauthorized personnel. Contractor shall follow OSHA Standards for lockout/tag out procedures to secure equipment not yet placed in operation.
- C. Factory personnel shall be notified as appropriate to start systems requiring their services.
- D. Notify the DEN Project Manager in writing a minimum of 48 hours prior to start-up of all major mechanical equipment and systems.
- E. Should there be any equipment found which had not been properly started up, it will be the responsibility of the Contractor to arrange for the appropriate personnel to start up the equipment at his expense and at a time as scheduled by the DEN Project Manager.

1.15 SCHEDULE OF TESTING

- A. Provide testing in accordance with the General Conditions of the Contract.

- B. A schedule of testing shall be drawn up by the Division 15 Contractor in such a manner that it will show areas tested, test pressure, length of test, date, time and signature of testing personnel.
- C. Notify the DEN Project Manager, DEN Mechanical Inspector and DEN Mechanical Engineer in writing a minimum of 72 hours prior to testing of any mechanical equipment and systems.
- D. All testing must be performed in the presence Project Manager and or his designated representative; his signature for verification of the test must appear on the schedule.
- E. All testing must be performed in accord with the procedures set forth in Division 15 and other Sections of the Specifications where referenced. At completion of testing, the test reports shall be then submitted in triplicate to the Project Manager.
- F. Make all specified tests on piping and related systems as necessary.
- G. Complete all tests required by Code Authorities, such as health codes, building codes, and safety codes.

1.16 CLEANING AND FINISHING

- A. Provide cleaning in accordance with the General Requirements of the Contract
- B. Cleaning shall include but not be limited to removing grease, dirt, dust, stains, labels, fingerprints and other foreign materials from sight-exposed piping, equipment, and other such items installed under Division 15 of the work.
- C. Clean Aviation Fueling System piping and components in accordance with Section 15179 – Aviation Fueling System Inspection, Cleaning, Flushing and Testing.

1.17 WARRANTIES

- A. Conform to Division 1: Provide a written warranty covering the entire mechanical work to be free from defective materials, equipment and workmanship for a period of two years after date of acceptance. During this period provide labor and materials as required to repair or provide labor and materials required to repair or replace defects. Provide certificates for such items of equipment, which have or are specified to have warranties in excess of one year.

PART 2 - MEASUREMENT

2.1 METHOD OF MEASUREMENT

- A. No separate measurement shall be made for work under this Section.

PART 3 – PAYMENT

3.1 METHOD OF PAYMENT

- A. No separate payment will be made for work under this section. The cost of the work described in this section shall be included in the applicable unit price item, work order or lump sum bid item.

END OF SECTION 15010

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SECTION 335205 BASIC AVIATION FUELING MATERIALS AND METHODS

PART 1 - GENERAL

1.1 SUMMARY

- A. This Section includes the following basic mechanical materials and methods to complement other Division 15 Sections.
 - 1. Piping materials and installation instructions common to most piping systems.
 - 2. Dielectric fittings.
 - 3. Mechanical sleeve seals.
 - 4. Sleeves.
 - 5. Flowable backfill for underground piping.
 - 6. Installation requirements common to equipment specification Sections.
 - 7. Mechanical demolition.
- B. Pipe and pipe fitting materials are specified in piping system Sections.

1.2 RELATED SECTIONS

- A. Drawings and general provisions of Contract, including General and the Supplementary Conditions and Division 1 Specification Sections, apply to this Section.
- B. Section 15010 – Basic Mechanical Requirements
- C. Division 2 - Trenching and Backfilling
- D. Section 05999 - Welding

1.3 DEFINITIONS

- A. Pipe, pipe fittings, and piping include tube, tube fittings, and tubing.
- B. Finished Spaces: Spaces other than mechanical and electrical equipment rooms, furred spaces, pipe and duct shafts, unheated spaces immediately below the roof, spaces above ceilings, unexcavated spaces, crawl spaces, and tunnels.
- C. Exposed Interior Installations: Exposed to view indoors. Examples include finished occupied spaces and mechanical equipment rooms.
- D. Exposed Exterior Installations: Exposed to view outdoors, or subject to outdoor ambient temperatures and weather conditions. Examples include rooftop locations.

- E. Concealed Interior Installations: Concealed from view and protected from physical contact by building occupants. Examples include above ceilings and in duct shafts.
- F. Concealed Exterior Installations: Concealed from view and protected from weather conditions and physical contact by building occupants, but subject to outdoor ambient temperatures. Examples include installations within unheated shelters.

1.4 SUBMITTALS

- A. General: Submit the following according to the Conditions of the Contract and Division 1 Specification Sections.
- B. Prepare coordination drawings according to Division 1 Section "Submittals" to a 1/4 inch equals 1 foot scale or larger. Detail major elements, components, and systems of mechanical equipment and materials in relationship with other systems, installations, and building components. Show space requirements for installation and access. Show where sequence and coordination of installations are important to the efficient flow of the Work. Include the following:
 - 1. Clearances for servicing and maintaining equipment, including space for equipment disassembly required for periodic maintenance.
- C. Welder certificates signed by Contractor certifying that welders comply with requirements specified under the Quality Assurance Article.
- D. Floor x-rays and/or ground penetrating radar reports.
- E. "As Built" Plans drawings shall be submitted in the latest version of AutoCAD (dwg) and the latest version of Adobe Acrobat (pdf). Adobe Acrobat files shall not contain security. Other file formats will not be accepted.
- F. Contractor shall submit fully dimensioned spool drawings for all welded piping work. Drawings shall indicate all weld types, sizes and materials to be used. The spool drawing size shall match the full size contract documents of either 24x36 or 34x44. Spool drawings shall be submitted in the latest version of AutoCAD (dwg) and the latest version of Adobe Acrobat (pdf). Adobe Acrobat files shall not contain security. Other file formats will not be accepted.
- G. Field Test Reports: Written reports of each pressure tests specified in Division 15 Sections. Include the following:
 - 1. Test procedures used.
 - 2. Test results that comply with requirements.
 - 3. Failed test results and corrective action taken to achieve requirements.

1.5 QUALITY CONTROL

- A. Equipment Selection: Equipment of greater or larger power, dimensions, capacities, and ratings may be furnished provided such proposed equipment is

approved in writing by the DEN Project Manager and connecting mechanical and electrical services, circuit breakers, conduit, motors, bases, and equipment spaces are increased. No additional costs will be approved for these increases, if larger equipment is approved. If minimum energy ratings or efficiencies of the equipment are specified, the equipment must meet the design requirements and commissioning requirements.

B. Electronic Equipment Compliance:

1. Contractor warrants that all equipment, devices, items, systems, software, hardware, or firmware provided shall properly, appropriately, and consistently function and accurately process date and time data (including without limitation: calculating, comparing, and sequencing). This warranty supersedes anything in the Specifications or other Contract Documents which might be construed inconsistently. This warranty is applicable whether the equipment, device, item, system, software, hardware, or firmware is specified with or without reference to a manufacturer's name, make, or model number.

- C. Unless specified otherwise, all materials and equipment shall be of domestic (USA) manufacture and shall be of the best quality used for the purpose in commercial practice.

1.6 DELIVERY, STORAGE, AND HANDLING

- A. Deliver pipes and tubes with factory-applied end-caps. Maintain end-caps through shipping, storage, and handling to prevent pipe-end damage and prevent entrance of dirt, debris, and moisture.
- B. Protect stored pipes and tubes from moisture and dirt. Elevate above grade. When stored inside, do not exceed structural capacity of the floor.
- C. Store plastic pipes protected from direct sunlight. Support to prevent sagging and bending.
- D. Protect flanges, fittings, and piping specialties from moisture and dirt.

1.7 SEQUENCING AND SCHEDULING

- A. Coordinate mechanical equipment installation with other project scope activity.
- B. Coordinate the installation of required supporting devices.
- C. Sequence, coordinate, and integrate installations of mechanical materials and equipment for efficient flow of the Work.
- D. Coordinate connection of electrical services, and accessories.

PART 2 – PRODUCTS

2.1 PIPE AND PIPE FITTINGS

- A. Refer to individual piping system specification Sections for pipe and fitting materials and joining methods.
- B. Pipe Threads: ASME B1.20.1 for factory-threaded pipe and pipe fittings.

2.2 JOINING MATERIALS

- A. Refer to individual piping system specification Sections in Division 15 for special joining materials not listed below.
- B. Grooved Mechanical Couplings: Not applicable to this project.
- C. Pipe Flange Gasket Materials: Suitable for the chemical and thermal conditions of the piping system contents.
 - 1. ASME B16.21, nonmetallic, flat, asbestos-free, 1/8-inch maximum thickness, except where thickness or specific material is indicated.
 - a. Full-Face Type: For flat-face, Class 125 cast-iron and cast-bronze flanges.
 - b. Narrow-Face Type: For raised-face, Class 250 cast-iron and steel flanges.
- D. Solder Filler Metal: ASTM B 32.
 - 1. Alloy Sn95 or Alloy Sn94: Tin (approximately 95 percent) and silver (approximately 5 percent) – Not industry standard, usually 5% antimony.
- E. Brazing Filler Metals: AWS A5.8.
 - 1. BCuP Series: Copper-phosphorus alloys.
 - 2. BAg1: Silver alloy.
- F. Welding Filler Metals: Comply with AWS D10.12 for welding materials appropriate for wall thickness and chemical analysis of steel pipe being welded. All welding rod is to be kept in a operable rod oven at all times.

2.3 PIPING SPECIALTIES

- A. Dielectric Fittings: Assembly or fitting having insulating material isolating joined dissimilar metals to prevent galvanic action and stop corrosion.
 - 1. Description: Combination of copper alloy and ferrous; threaded, solder, plain, and weld neck end types and matching piping system materials.
 - 2. Insulating Material: Suitable for system fluid, pressure, and temperature.
 - 3. Dielectric Waterway Fittings: Dielectric fittings designed to effectively separate dissimilar metals exposed to water or other electrolytes, conforming to NSF and ASTM F492 standards for continuous use at temperatures up to 225 degrees F and pressures up to 300 psi. Fittings to have electro-zinc-plated steel casings

providing for maintained exterior electrical continuity, threaded or flanged ends as applicable, and inert linings.

4. Dielectric Flanges: Factory-fabricated, companion-flange assembly for 150- or 300-psig minimum pressure to suit system pressures.
5. Dielectric-Flange Insulation Kits: Field-assembled, companion-flange assembly, full-face or ring type. Components include neoprene or phenolic gasket, phenolic or polyethylene bolt sleeves, phenolic washers, and steel backing washers.
 - a. Provide separate companion flanges and steel bolts and nuts for 150- or 300-psig minimum working pressure to suit system pressures.

2.4 MECHANICAL SLEEVE SEALS

- A. Description: Modular sealing element unit, designed for field assembly, to fill annular space between pipe and sleeve.
 1. Manufacturers:
 - a. Metraflex Co.
 - b. Pipeline Seal and Insulator, Inc.
 - c. PSI-Thunderline/Link-Seal.
 - d. Substitutions: Under provisions of Section 15010.
 2. Sealing Elements: EPDM interlocking links shaped to fit surface of pipe. Include type and number required for pipe material and size of pipe.
 3. Pressure Plates: Carbon steel. Include two for each sealing element.
 4. Connecting Bolts and Nuts: Carbon steel with corrosion-resistant coating of length required to secure pressure plates to sealing elements. Include one for each sealing element.

2.5 GROUT

- A. Nonshrink, Nonmetallic Grout: ASTM C 1107, Grade B.
 1. Characteristics: Post-hardening, volume-adjusting, dry, hydraulic-cement grout, nonstaining, noncorrosive, nongaseous, and recommended for interior and exterior applications.
 2. Design Mix: 5000-psi, 28-day compressive strength.
 3. Packaging: Premixed and factory-packaged.

2.6 BACKFILL

- A. Flowable Backfill: Designed in accordance with ASTM C 94 and ASTM D 4832.
 1. Refer to Division 2 and Division 3 sections for material and installation requirements.
 2. Minimum Requirements:
 - a. Compressive Strength: 50-100 psi
 - b. Slump: 6-8 inches.

3. Required for all piping installed below concrete slabs, apron paving and roadways.

PART 3 - EXECUTION

3.1 PIPING SYSTEMS - COMMON REQUIREMENTS

- A. General: Install piping as described below, except where system Sections specify otherwise. Individual piping system specification Sections in Division 15 specify piping installation requirements unique to the piping system.
- B. General Locations and Arrangements: Drawings indicate general location and arrangement of piping systems. Indicated locations and arrangements were used to size pipe and calculate friction loss, expansion, pump sizing, and other design considerations. Install piping as indicated, except where deviations to layout are approved on coordination drawings.
- C. Install piping at indicated slope.
- D. Install piping free of sags and bends.
- E. Install piping plumb and at right angles and plumb or parallel to building walls. Diagonal runs are prohibited, except where indicated.
- F. Install piping tight to slabs, beams, joists, columns, walls, and other building elements.
- G. Install fittings for changes in direction and branch connections.
- H. Install couplings according to manufacturer's printed instructions.
- I. Piping Joint Construction: Join pipe and fittings as follows and as specifically required in individual piping system Sections.
 1. Ream ends of pipes and tubes and remove burrs. Bevel plain ends of steel pipe.
 2. Remove scale, slag, dirt, rust, and debris from inside and outside of pipe and fittings before assembly.
 3. Threaded Joints: Thread pipe with tapered pipe threads according to ASME B1.20.1. Cut threads full and clean using sharp dies. Ream threaded pipe ends to remove burrs and restore full inside diameter. Join pipe fittings and valves as follows:
 - a. Note the internal length of threads in fittings or valve ends, and proximity of internal seat or wall, to determine how far pipe should be threaded into joint.
 - b. Apply appropriate tape or thread compound to external pipe threads (except where dry seal threading is specified).
 - c. Align threads at point of assembly.

- d. Tighten joint with wrench. Apply wrench to valve end into which pipe is being threaded.
 - e. Damaged Threads: Do not use pipe or pipe fittings having threads that are corroded or damaged. Do not use pipe sections that have cracked or open welds.
- J. Piping below apron, concrete slabs or paving shall be encased in flowable backfill. Refer to Division 2 and Division 3 sections for material and installation requirements.

3.2 EQUIPMENT INSTALLATION - COMMON REQUIREMENTS

- A. Install equipment according to approved submittal data. Portions of the Work are shown only in diagrammatic form. Refer conflicts to the Project Manager.
- B. Install mechanical equipment to facilitate servicing, maintenance, and repair or replacement of equipment components. Connect equipment for ease of disconnecting, with minimum of interference with other installations.
- C. Install equipment giving right-of-way to piping systems installed at a required slope.
- D. Install equipment allowing for usage during operation of surrounding equipment at all portions of operations. In no instance shall an appurtenance block operation of any equipment (Example: A valve handle open position shall not block access to a PT plug).

3.3 PAINTING AND FINISHING

- A. Refer to Division 9 Section "Painting" for field painting requirements. Paint color schedule shall conform to ASME A13.1-1996, "Scheme for the Identification of Piping Systems."
- B. Damage and Touch Up: Repair marred and damaged factory-painted finishes with materials and procedures to match original factory finish.

3.4 WELDING

- A. Qualify welding processes and operators for structural steel according to AWS D1.1 Structural Welding Code - Steel. See Division 5 for additional requirements.
- B. All welding shall be inspected in process by a contractor provided, Certified, Independent Testing Agency by an AWS certified welding inspector.
- C. Qualify welding processes and operators for piping according to ASME Boiler and Pressure Vessel Code, Section IX, Welding and Brazing Qualifications.
 - 1. Comply with provisions of ASME B31 Series "Code for Pressure Piping."
 - 2. Certify that each welder has passed AWS qualification tests for the welding processes involved and that certification is current.

3.5 ERECTION OF METAL SUPPORTS AND ANCHORAGE

- A. Cut, fit, and place miscellaneous metal supports accurately in location, alignment, and elevation to support and anchor mechanical materials and equipment.
- B. Field Welding: Comply with AWS D1.1 Structural Welding Code - Steel, as referenced in Part 1.

3.6 DEMOLITION

- A. Refer to DIVISION 1 for general demolition requirements and procedures.
- B. Where pipe, ductwork, insulation, or equipment to remain is damaged or disturbed, remove damaged portions and install new products of equal capacity and quality.
- C. Temporary Disconnection: Remove, store, clean, reinstall, reconnect, and make operational equipment indicated for relocation.
- D. Disconnect, demolish, and remove mechanical systems, equipment, and components indicated to be removed.
 - 1. Piping to Be Removed: Remove portion of piping and associated supports indicated to be removed, provide a shutoff valve with plug or cap in pressurized systems and cap or plug remaining piping with same or compatible piping material. No piping shall be abandoned in place. Repair insulation.
 - 2. Piping to Be Abandoned in Place: Drain piping and cap or plug piping with same or compatible piping material.
 - 3. Equipment to Be Removed: Disconnect and cap services and remove equipment.
 - 4. Equipment to Be Removed and Reinstalled: Disconnect and cap services and remove, clean, and store equipment; when appropriate, reinstall, reconnect, and make equipment operational.
 - 5. Equipment to Be Removed and Salvaged: Disconnect and cap services and remove equipment and deliver to Owner.
 - 6. If pipe, insulation, or equipment to remain is damaged in appearance or is unserviceable, remove damaged or unserviceable portions and replace with new products of equal capacity and quality.

3.7 GROUTING

- A. Mix and install grout for mechanical equipment base bearing surfaces, pump and other equipment base plates, and anchors.
- B. Clean surfaces that will come into contact with grout.
- C. Provide forms as required for placement of grout.
- D. Avoid air entrapment during placement of grout.
- E. Place grout, completely filling equipment bases.

- F. Place grout on concrete bases and provide smooth bearing surface for equipment.
- G. Place grout around anchors.
- H. Cure placed grout.

3.8 ELECTRIC WIRING

- A. Furnish equipment requiring electrical connections to operate properly and deliver full capacity at electrical service available.
- B. All control wiring to be in accordance with Manufacturer's recommendations; all wiring shall be color coded to facilitate checking.
- C. Unless otherwise indicated, all mechanical equipment motors and controls shall be furnished, set in place, and wired in accordance with the schedule contained herein. Contractor should note that the intent of this electric wiring schedule is to have the Division 15 Contractor responsible for coordinating all control wiring as outlined, whether or not specifically called for by the Mechanical or Electrical Drawings and Specifications. Comply with the applicable requirements of Division 16 for electrical work of this Division 15, which is not otherwise specified. No extras will be allowed for Contractor's failure to provide for these required items. The Division 15 Contractor shall refer to the Division 16 Specifications and plans for all power and control wiring and shall advise the Project Manager of any discrepancies prior to bidding.

Table 3.11-1

Item	Furnished By	Set By	Power Wiring	Control Wiring
Equipment Motors	15	15	16	15
Fused and Unfused Disconnect Switches, Thermal Overloads and Heaters	16	16	16	---
Control Relays and Transformers (See Note 1)	15	15	16	15
Pushbutton Stations Pilot Lights, Manual Switches, not carrying Load Currents	15	15	16	15
Thermostats, line voltage control components	15	15	---	15
Temperature Control Systems	15	15	16	15

NOTES:

- a. * 15 = Mechanical Contractor Under Division 15 of the Work
- b. * 16 = Electrical Contractor Under Division 16 of the Work
- c. Control wiring is any voltage required to accomplish sequence specified. Contractor listed is responsible.
- d. Control relays and control transformers shall be furnished under Division 15 except where furnishing such items are specifically required under Division 16 Specifications and/or Drawings.

PART 4 - MEASUREMENT

4.1 METHOD OF MEASUREMENT

- A. No separate measurement shall be made for work under this Section.

PART 5 - PAYMENT

5.1 METHOD OF PAYMENT

- A. No separate payment will be made for work under this section. The cost of the work described in this section shall be included in the applicable unit price item, work order or lump sum bid item.

END OF SECTION 15050

SECTION 335221 AVIATION FUELING COATINGS AND CORROSION PROTECTION

PART 1 - GENERAL

1.1 SUMMARY

- A. Field and shop applied corrosion protective coatings for fuel systems piping, valves, fittings, flanges, equipment and all related materials to be installed underground.
- B. Internal coatings for fuel system pipe and fittings.

1.2 RELATED DOCUMENTS

- A. Drawings, general and special conditions, Division 1 - General Requirements and other applicable technical specifications apply to work of this Section.

1.3 RELATED SECTIONS

- A. Section 09900 - Painting.
- B. Section 15010 - Basic Mechanical Requirements.
- C. Section 15170 - Aviation Fueling System Piping, Manual Valves, and Fittings.
- D. Section 16642 - Cathodic Protection.

1.4 REFERENCED STANDARDS

- A. Materials and workmanship shall conform to the latest issue of all industry standards, publications, or regulations referenced in this section and with the following references as applicable. Refer to Section 15010 for listing of issuing organizations or agencies.
- B. Applicable Standards:
 - 1. American Water Works Association (AWWA)
 - a. AWWA C-210 - Liquid Epoxy Coating Systems for the Interior and Exterior of Steel Water Pipelines.
 - b. AWWA C-213 - Fusion Bonded Epoxy Coating for the Interior and Exterior of Steel Water Pipelines.
 - 2. International Fire Code (IFC) with the Denver Amendments
 - 3. International Building Code (IBC) with the Denver Amendments
 - 4. National Association of Corrosion Engineers
 - a. NAPCA 12-78-83 - Application Specifications for Mill Applied Fusion Bonded Epoxy Coatings.
 - 5. National Bureau of Standards (NBS)
 - a. Certified Coating Thickness Calibration Standards.

6. U.S. Government Specification
 - a. MIL-C-4556-E - Coating Kit, Epoxy for Interior, Steel Fuel Tanks
7. Steel Structures Painting Council (SSPC)
 - a. SSPC-SP5 - White Metal Blast Cleaning
 - b. SSPC-SP10 - Near-White Metal Blast Cleaning

1.5 SUBMITTALS

- A. Shop Drawings shall be submitted in accordance with Division 1 - General Requirements.
- B. Submit manufacturer's product data and application instructions for all coatings and linings.
- C. "As Built" Plans shall be provided in the same format and manner as described above. Each set shall be equipped with a plan holder equal to "Stacor Plan Clamps" for the appropriate size drawing.

1.6 EXTENT OF WORK

- A. All fuel pipe and fittings to be partially or completely buried shall be externally factory coated.
- B. Field welded joints in referenced piping systems and underground structures shall be coated and wrapped in accordance with "Field Procedures".
- C. All internal surfaces of fuel supply, transfer, drain, and vent piping and fittings 2-1/2 inches and larger shall be internally epoxy coated. Pipes and fittings smaller than 2-1/2 inches need not be internally coated.
- D. External painting of all piping, equipment, valves, fittings, flanges, tanks, gauge connections, structural and miscellaneous steel and other appurtenances aboveground and in pits is specified in Division 1.

1.7 MAINTENANCE MATERIALS

- A. Leave on premises, where directed by the DEN Project Manager, not less than one unopened gallon of each field-applied paint product, color used and product MSDS sheets.
- B. Containers shall be tightly sealed and clearly labeled for identification.

PART 2 - PRODUCTS

2.1 SHOP-APPLIED EXTERNAL PROTECTIVE PIPE COATING

- A. All fuel pipe and fittings to be installed underground or in pits, shall have an external coating system applied either in the pipe manufacturer's shop or in the mill of an approved custom applicator.
- B. Coating system shall meet the following specifications:

1. Surface preparation, material, application, testing, inspection, handling, storage and field installation shall be in accordance with the applicable requirements of AWWA C213, Fusion Bonded Epoxy Coating.
 2. Coatings shall be applied in accordance with NAPCA Bulletin 12-78-83. Application Specifications Mill Applied Fusion Bonded Epoxy Coatings.
 3. Surfaces shall be sandblasted in accordance with Steel Structures Painting Council Surface Preparation Specification No. 10, "near-white" metal blast.
 4. Sandblasting shall be coordinated with coating application, which shall be applied as soon as possible after blasting. If blasted surface remains uncoated overnight, it shall be reblasted.
 5. Care shall be taken to prevent grease, oil, or other organic matter from contacting the blasted surface prior to application of the prime coat.
 6. All burrs and rough protrusions on the outer surface of the pipe shall be ground smooth prior to coating.
 7. Apply coating to produce a uniform dry film thickness of 15-25 mils.
 8. Dry film thickness shall be spot checked at random on ten percent of the coated surfaces. If film thickness is not found to be uniform and to specification, the Contractor shall apply additional coats at no cost to the Owner until the specified film thickness has been obtained. Dry film thickness shall be checked by the Contractor at his expense.
 9. Provide a 3 inch cut-back from each end.
- C. The coating shall be holiday tested in the shop prior to shipment. Surfaces shall be checked for freedom from defects using a low-pulse electronic holiday detector at 125 volts per mil of coating thickness.
- D. The Contractor shall secure the services of an independent testing and inspection laboratory to witness the coating application and testing and to certify that the pipe and fittings were prepared, cleaned, and coated using methods and materials conforming with these specifications.
- E. Contractor shall perform final holiday test of all coatings prior to backfilling in accordance with the requirements of Section 15179 requirements.

2.2 SHOP-APPLIED INTERNAL EPOXY LINING (COATING) FOR PIPING

- A. All fuel supply, transfer, drain, and vent piping and pipe fittings 2-1/2 inches and larger in size shall be internally coated in the manufacturer's shop or in the mill of an approved internal epoxy applicator with a two coat high solids amine-cured epoxy system in accordance with Military Specification MIL-C-4556E and the following specifications. All materials used shall be lead-free, and shall not contain not more than VOC component quantities permitted by local regulatory authorities, as applied (in thinned state) unless noted otherwise.
1. Remove all grease or oil by thorough cleaning using an oil-free solvent.
 2. Sandblast inside of pipe to "near-white" metal, confirming with Steel Structures Painting Council Surface Preparation Specification No. 10. No rust preventative coating material or other temporary coating shall be applied after sandblasting and before application of the internal epoxy coating. Care shall

- be taken to prevent grease, oil, or other organic matter from contacting the blasted surface prior to application of the prime coat. Blasting shall be coordinated with primer application, which shall be applied as soon as possible after blasting. If the blasted surface remains uncoated overnight, it shall be reblasted.
3. The ends of the pipe and fittings shall have the paint wiped back 2-inches with cloth or other approved absorbent material. Masking the ends will not be acceptable as a thin film of paint is desired to prevent rust until installation of the material.
 4. Apply one coat polyamide cured orange two-component epoxy resin primer. The thickness of the cured primer shall be not less than 3 mils, but shall not exceed 6 mils.
 5. The prime coat shall be allowed to cure in accordance with manufacturer's recommendation for immersion service
 6. Apply one coat of polyamide-cured off-white two-component epoxy resin protective top coating. The cured thickness of the top coat shall be not less than 3 mils, but shall not exceed 6 mils.
 7. After the top coat has been cured in accordance with manufacturer's recommendation for immersion service, the internal epoxy lining shall be tested electrically using an approved holiday detector and shall be free of missed spots, pinholes or holidays. Apply additional primer and finished coats to areas requiring touch-up.
 8. Dry film thickness shall be spot checked at random on ten percent of the coated surfaces. If film thickness is not found to be uniform and to specification, the Contractor shall be required to apply additional coats at no cost to the Owner until the specified film thickness has been obtained. Dry film thickness is to be checked by the Contractor at his expense.
 9. If, in the opinion of the DEN Project Manager, the coatings show ridges, waves, runs or holidays indicating uneven coverage or improper application, the Contractor shall be required to remove and reapply the coating at no cost to the Owner.
 10. Prior to shipping to the project site, the ends of the pipe shall be capped using suitable plastic caps secured with a double wrap of 2-inch wide pressure sensitive tape.
- B. All applications shall be in accordance with the manufacturer's published instructions.
- C. The Contractor shall secure the services of an independent testing and inspection laboratory to witness the lining application and testing and to certify that the pipe and fittings were prepared, cleaned and lined using methods and materials conforming with these specifications.
- D. The coating system shall be Amercoat 240 manufactured by Ameron Protective Coatings Division, Diamond Vogel's Amerlock 400 FD or approved equal.

2.3 FIELD APPLIED POLYUREA HYDRANT PIT COATING

- A. Bare Fiberglass Hydrant Pits: Following completion of the installation of the hydrant

pits, and prior to starting flushing operations, coat the inside of the hydrant pits with a gray, two-component spray-on polyuria coating meeting NACE 6A198 definition for a polyuria coating. BASF Elastocoat C06430, Sherwin Williams EnviroLastic AR425, or approved equal.

1. Clean the inside of the hydrant pit, including piping and fittings with bio-degradable cleaner/degreaser.
2. Cover pipe, valves and blind flange to prevent coating during the application process.
3. Surfaces must be dry application of the coating system.
4. Apply coating following the manufacturers recommendations. The thickness of the cured primer shall be not less than 0.5 mm.
5. When dry, inspect application and re-coat as required to provide full coverage.
6. Remove the protective covering from piping and valves.

B. Factory Gel-coated Fiberglass Hydrant Pits; No additional coatings required.

2.4 FIELD-APPLIED EXTERNAL PROTECTIVE COATING AND PROCEDURE

A. All field welds of fuel piping, including fittings and areas of thermit welding and where the shop coat has been damaged, valves and equipment in pits, shall receive a field-applied external protective coating using a two part liquid epoxy coating system in accordance with AWWA C-210.

1. Sandblast surfaces to "near-white" metal, conforming with Steel Structures Painting Council Surface Preparation Specification No. 10. No rust preventative coating material or other temporary coating shall be applied after sandblasting and before application of the epoxy coating. Care shall be taken to prevent grease, oil or other organic matter from contacting the blasted surface prior to application of the prime coat. Blasting shall be coordinated with primer application, which shall be applied as soon as possible after blasting. If the blasted surface remains uncoated overnight, it shall be reblasted.
2. Grind smooth all burrs and sharp protrusions.
3. Surfaces must be dry before application of coating system.
4. Apply primer following manufacturer's recommendations. The thickness of the cured primer shall be not less than 1.5 mils.
5. Apply finish coat(s) of epoxy top coating in accordance with manufacturer's recommendations. The cured thickness of the total system shall be not less than 15 mils, but shall not exceed 25 mils.
6. After the top coat has been cured in accordance with manufacturer's recommendation, the epoxy coating shall be tested electrically using an approved holiday detector and shall be free of missed spots, pinholes or holidays. Apply additional primer and finished coats to areas requiring touch-up.
7. Coatings for piping to be pressure tested shall be applied after testing and acceptance.
8. Application, testing, and inspection shall be in accordance with AWWA C210.

9. Leave welds uncovered until after testing and acceptance.
- B. Alternatives for Joint and Fitting Wrapping and Coating:
 1. Thermofit pipe sleeves; Tapecoat CSS 1100 primer and CSS wrap around sleeve, or approved equal. Sleeve length shall overlap pipe coating four inches minimum on each side of joint.
 2. Hot-applied tape; Tapecoat 20 with TC primecoat, or approved equal. Provide a two-layered, half-lapped, spiral wrap.
- C. Do not coat manufacture's name tags, identification tags, instruction tag(s) or control mechanisms.
- D. Holiday test all coatings prior to backfilling in accordance with the applicable requirements of Specifications Section 15179 requirements.

PART 3 - EXECUTION

3.1 COATING REPAIRS

- A. Repair all damages to pipe coating systems on pipe and fittings before the piping is holiday tested.
- B. Repair all cuts, breaks, voids, bruised or scarred spots, and any other damage caused prior to delivery, or resulting from handling or installation of the pipe and fittings, or from any cause whatsoever.
- C. Repair the coating where welds are made and where the coating is damaged or broken by the installation of instrumentation or other accessories or appurtenances.
- D. Perform all repairs in accordance with the requirements specified hereinbefore under "Field-Applied External Protective Coating and Procedure".
- E. Repairs to shop-applied coating shall be such as to provide a thickness equal to or greater than the factory applied coating.

3.2 CERTIFICATION

- A. A log of mill procedure and quality control tests shall be kept daily by the coating, lining and wrapping applicator(s) and a certified copy of this log(s) shall be submitted to the DEN Project Manager with each delivery of pipe and equipment.

PART 4 - MEASUREMENT

4.1 METHOD OF MEASUREMENT

- A. No separate measurement shall be made for work under this Section.

PART 5 - PAYMENT

5.1 PAYMENT

- A. No separate payment will be made for work under this section. The cost of the work described in this section shall be included in the applicable unit price item, work order or lump sum bid item.

END OF SECTION 15055

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SECTION 335233 AVIATION FUELING WELDING

PART 1 -GENERAL

1.1 SUMMARY

- A. Welding is that work defined in American Welding Society (AWS) "Standard Welding Terms and Definitions - AWS A2.4" and as otherwise shown on drawings.
 - 1. All welding on this project shall comply with requirement of specification, Section 05999 "Welding", and other documents such as but not limited to drawings. If there is a conflict between Project Drawings, codes, and specifications, the more stringent shall apply.
- B. Extent of welding work is shown on drawings, including schedules, notes and details to show size and location of welds. Welding Symbols shall be in accordance with AWS/A2.4-Standard Symbols for Welding, Brazing, and Nondestructive Examination.
- C. Nothing stated in this Section shall be interpreted as diminishing or eliminating requirements stated in other Sections.

1.2 RELATED DOCUMENTS

- A. Drawings, General and Special conditions, general requirements and other applicable Technical Specifications apply to work of this Section.
- B. IEEE-1992. Only welding machines that have been tested and comply with harmonic distortion requirements of IEEE-1992 shall be allowed to operate off of DEN electrical power system.

1.3 RELATED SECTIONS

- A. Division 15 sections.

1.4 REFERENCE STANDARDS

- A. Welding shall comply with the requirements of the reference standards noted herein, except where more stringent requirements are listed herein or otherwise required by the Contract Documents.
 - 1. AISC - American Institute of Steel Construction
 - 2. AWS - American Welding Society
 - 3. API - American Petroleum Institute
 - 4. AWWA - American Water Works Association
 - 5. ASME - American Society of Mechanical Engineers.
 - 6. ASTM - American Society for Testing and Materials

7. ASNT - American Society for Nondestructive Testing

1.5 SUBMITTALS

- A. Product Data: Submit producers or manufacturer's specifications and installation instructions for all products, including, but not limited to those listed below. Include laboratory test reports and other data to show compliance with specifications (including specified standards).
 - 1. Welding Electrodes: Submit manufactures specifications, to include recommended parameters and technique, for each electrode to be used on this project.
- B. Submit shop drawings as specified under Section 01300 for all work specified herein, including complete details and schedules for fabrication and assembly of members, procedures and diagrams. Shop drawings shall indicate how each and every component shall be welded. If another company manufactures a component to be welded to another part(s) or piece(s) to form a larger assembly, then the shop drawings shall include that manufacturer's recommended welding procedures for that component. Design construction drawings shall not be re-used as bases for submitted shop drawings. Shop drawings, which use reproductions of design plans or details, will not be reviewed. Drawings shall be submitted in complete units. Do not submit partial sets.
- C. Shop drawings shall clearly indicate profiles, sizes and locations of structural members, connections, attachments, anchorage's, framed openings, size and type of fasteners, and clearances. Indicate welded connections using standard AWS welding symbols, per AWS A2.4. Clearly indicate net weld lengths and sizes, root openings, bevel angles and other information required to satisfactorily complete welding operations.
- D. Contractor shall submit fully dimensioned Isometric drawings (spool drawings) for all welded piping work. Drawings shall indicate all weld types, sizes and materials to be used. The spool drawing size shall match the full size contract documents of either 24x36 or 34x44. Spool drawings shall be submitted in either the latest version of AutoCAD (dwg) or the latest version of Adobe Acrobat (pdf). Adobe Acrobat files shall not contain security. Other file formats will not be accepted.
- E. Calculations required in other Sections shall show all pertinent members and pieces. Calculations shall be submitted prior to, or with, relevant shop drawing submittals. It is contractor's responsibility to insure that field construction uses connection design as submitted and reviewed.
- F. Test Reports: Submit copies of all test reports conducted on shop and field welded connections. Include data on type(s) of tests conducted and test results. Reports must be sequentially numbered and submitted to the DEN Project Manager within 48 hours of completion.
- G. Individual Welder Qualifications: Submit Welding Performance Qualification Records (WPQR) for all welders, shop and field, prior to any welding per

Specification Paragraph 05999 1.06 B.

- H. Procedures: Submit Welding Procedure Specifications for all shop and field welding prior to any welding per Specification Paragraph 05999 1.06 B

1.6 QUALITY REQUIREMENTS

- A. Codes and Standards: Comply with provisions of following, as applicable
 - 1. AISC American Institute of Steel Construction
 - a. AISC "Code of Standard Practice for Steel Buildings and Bridges", 1986.
 - b. AISC "Specifications for the Design, Fabrication, and Erection of Structural Steel for Buildings", including "Commentary" and Supplements thereto as issued.
 - 2. American Welding Society (AWS) D1.1 "Structural Welding Code Steel" and all other applicable A.W.S codes (latest editions).
 - 3. ASTM A 6 "General Requirements for Delivery of Rolled Steel Plates, Shapes, Sheet Piling and Bars for Structural Use".
 - 4. All welding shall be performed in accordance with the latest addition of applicable AWS, API, ASME code and ASTM Standards.
- B. Qualifications for Welding Work
 - 1. All Welders shall have been qualified through welding tests in accordance with applicable AWS code per Specification paragraph 05999 1.04 A within one year prior to welding taking place. Evidence of qualification shall be through Welding Performance Qualification Records (WPQR).
 - 2. All welder qualifications test shall be or shall have been administered and witnessed by an Independent Testing Agency (ITA), AWS Certified Welding Inspector, (CWI).
 - 3. If recertification of welders is required, delay costs and retesting costs shall be borne by the Contractor.
 - 4. Welding that is to take place at each and every type of joint shall be per approved AWS procedure for that type of joint. Evidence of intended procedure shall be through written Welding Procedure Specifications.
 - 5. Any welding done without submission to and approval by the DEN Project Manager of Welding Performance Qualification Records of the individual welder(s) doing the welding and Procedure Specifications for the actual welding shall be considered defective and subject to the provisions of Title 17 of the General Conditions.
 - 6. All WPS and WPQR qualification testing shall be in accordance with this specification and the applicable welding code requirements.
- C. The Contractor shall periodically review each welders work quality and take any steps required to insure high quality work. This is in addition to Quality Control requirements.

- D. Fabricator Qualifications: Minimum of three years of experience specializing in fabrication for similar projects.
- E. Design of Members and Connections: Details shown are typical; similar details apply to similar conditions, unless otherwise indicated. Verify dimensions at site whenever possible without causing delay in the work.
 - 1. Promptly notify DEN Project Manager whenever design of members and connections for any portion of structure are not clearly indicated.
- F. Welding and materials shall be inspected and tested by an Independent Testing Agency furnished and paid for by the Contractor. The Independent Testing Agency will have authority to reject weldments and materials. Such rejection may be based on visual inspection where, in the Inspector's opinion, the weldment or material would not pass more detailed investigation. Reference Specification Section 05999 4.01 for inspection and testing requirements. DEN's Quality Assurance Inspector(s), per the provisions of General Conditions Title 17, will also inspect welding and materials. Inspections by either the Independent Testing Agency or DEN's Quality Assurance Inspector may take place in the mill, shop and field.
 - 1. Promptly remove and replace materials or fabricated components that do not comply with requirements as set forth in the Contract Documents.

PART 2 - PRODUCTS

2.1 MATERIALS

- A. Electrodes for Welding: Comply with AWS Code. Use E70 grade minimum unless otherwise approved. Store all electrodes and welding materials inside and protect from moisture, corrosion, and any other damage. Damaged electrodes shall not be used.

2.2 FABRICATION

- A. Shop Fabrication and Assembly: Fabricate and assemble components in shop to greatest extent possible.
 - 1. Properly mark and match-mark materials for field assembly. Fabricate for delivery sequence which will expedite erection and minimize field handling of materials.
 - 2. Where finishing is required, complete assembly, including welding of units, before start of finishing operations. Provide finish surfaces of members exposed in final structure free of markings, burrs, and other defects.
- B. Holes for Other Work: Provide holes required for securing other work to components, and for passage of other work through components, as shown on final shop drawings.
 - 1. Provide threaded nuts welded to framing, and other specialty items as indicated to receive other work.

2. Cut, drill, or punch holes perpendicular to metal surfaces. The DEN Project Manager shall approve any enlarging of holes by flame cutting
- C. Contractor will notify DEN Project Manager or his representative at least 48 hours prior to any commencing fabrication. Notification to include starting date and duration of work.

2.3 SHOP CLEANING AND PAINTING

- A. Components to be painted are as shown on the drawings.
 1. Do not paint surfaces, which are to be welded.
 2. Do not paint over welded joints until after Independent Testing Agency and DEN Quality Assurance Inspector have approved them.

PART 3 - EXECUTION

3.1 ERECTION

- A. Do not enlarge misaligned or undersized holes in members by burning or by use of drift pins, except in secondary bracing members. Ream holes that must be enlarged to admit bolts.
- B. Gas Cutting: Do not use gas cutting torches in field for correcting fabrication errors in primary structural framing. Cutting will be permitted only on secondary members, which are not under stress, as acceptable to DEN Project Manager. Finish gas-cut sections equal to a sheared appearance when permitted.
- C. Touch-Up Painting: Immediately after erection, clean field welds, bolted connections, and abraded areas of shop paint. Once Independent Testing Agency and DEN Quality Assurance Inspector have approved welds, apply paint to exposed areas using same material as used for shop painting.
- D. No welding machines are to be operated off of DEN power until such machines have been tested for harmonic distortion per IEEE-1992 and approved by DEN Project Manager.
- E. Contractor will notify DEN Project Manager or his representative at least 48 hours prior to any inspections to be performed by ITA.

PART 4 - TESTING AND INSPECTION

4.1 INDEPENDENT TESTING AGENCY (ITA)

- A. See Division 1 for Independent Testing Agency requirements.
- B. The General Contractor shall provide the ITA for all subcontractors. Subcontractors shall not contract with a separate ITA.
- C. Contractor will engage an Independent Testing Agency to inspect welded

connections and to perform tests and prepare test reports. The Contractor's Quality Control Inspector will coordinate the inspections and tests performed by the testing lab inspectors and testing personnel.

1. The Contractor's Independent Testing Agency and DEN Project Manager's staff shall conduct and interpret tests and state in each report whether test specimens comply with requirements, and specifically state any deviations therefrom. All reports shall be delivered to the Project Manager. Results not complying with requirements are to be brought to the Project Manager's attention within 24 hours of discovery. All reports shall be sequentially numbered.
 2. Provide access for Independent Testing Agency to places where work is being fabricated or produced so that required inspection and testing can be accomplished.
 3. The Independent Testing Agency shall inspect work at the plant before shipment; however, DEN Project Manager reserves the right, at any time before final acceptance, to reject material not complying with specified requirements.
 - a. Inspections and tests conducted by the ITA or DEN shall not in any way relieve the Contractor of his responsibility and obligation to meet all specifications and referenced standards. Employment of the ITA does not relieve the Contractor of providing the required Quality Control Program.
 4. Welding Inspection Personnel Qualifications: All visual welding inspections shall be performed by AWS Certified Welding Inspectors CWI, qualified in accordance with AWS QC1. Inspectors qualified in accordance with the most current edition of the American Society for Nondestructive Testing Recommended Practice No. SNT-TC 1A, shall perform all non-destructive inspections other than visual inspections
 5. Independent Testing Agency Inspectors working for the Contractor shall identify with a distinguishing mark all parts and joints they have inspected and accepted. Marks to be visible from at least 50 feet. DEN Project Manager and the Quality Control Inspectors shall mutually agree upon identifying marks.
 6. Independent Testing Agency welding inspector shall be on job site however much time it takes to guaranty that all requirements of Project Specifications and codes are being met and provide written reports showing specific requirements have been met. Shop inspections by ITA welding inspector shall be performed in such a manner as to guaranty that all provisions of Project Specifications and codes are being met and provide written reports showing specific requirements have been met.
- D. The Contractor shall furnish such facilities and provide such assistance as may be required for carrying out the inspection prescribed herein. He shall notify the Independent Testing Agency and the DEN Project Manager at least two weeks in advance of the start of any qualification testing for welding.

- E. The Testing Agency's Inspector will perform his duties in such a way that neither fabrication nor erection is unnecessarily delayed or impeded. The Testing Agency shall notify the DEN Project Manager of any scheduled inspections at least 48 hours prior to such time. The Project Manager shall also be notified as soon as possible prior to any unscheduled inspections. In no case will the inspector recommend or prescribe the method of repair of a defect.
- F. Inspection of welding will be such as to assure that all requirements of Project Specifications AWS D1.1, and other applicable welding codes are being complied with. Reports shall show the following items as being in conformance, but not be limited to just the items shown:
 - 1. Verify that electrodes used for welding conform to the requirements Manufacturer, AWS, and other applicable Welding Codes and Standards.
 - 2. Verify that the approved Welding Procedure Specifications and the approved welding sequence are followed without deviation.
 - 3. Verify that only welding operators and welders who have been properly qualified will perform the welding. The inspection agency will witness such qualification testing of welding operations and welders, as may be required. Reference Specification Section 05999 1.06 B for Welder Qualification and Welding Procedure requirements.
 - 4. Verify that the fit up, joint preparation, size, contour, extent of reinforcement, and length and location of welds conform to specified requirements such as but not limited to applicable welding codes, Welding Procedure Specifications, and drawings.
 - 5. Review Mill Test Reports of material for compliance with Project Specifications, all applicable Codes, and Drawings.
 - 6. ITA inspection reports shall list all inspected, nonconforming, repaired, and accepted welds.
- G. DEN Project Manager shall be informed at least 48 hours prior to shop and field welding so random inspections can be performed as stipulated in these specifications and General Conditions, TITLE 17.
- H. All welders shall mark their welds with identifying marks. Contractor shall furnish DEN Project Manager with list of welders and their marks. List shall be updated each time a welder is added or subtracted.

4.2 DIVISION 15 BASIC MECHANICAL MATERIALS AND METHODS

- A. All welding in Division 15 Mechanical shall comply with the applicable AWS, ASME, AWWA, and API codes, latest editions.
- B. All shop and field welds will be inspected per these specifications and applicable code for work being performed.
- C. All welds shall be 100% visually inspected by ITA supplied by Contractor. Additional testing shall be as required by other parts of 05999, applicable codes,

DEN Project Manager and Designer of Record.

1. Fuel Piping: ASME B31.3
 - a. 100% visual inspection per acceptance criteria of ASME B31.3.
 - b. All other requirements of ASME B31.3 as required for the application.

- D. Forged fittings, for branch connections and etc. shall be welded in accordance with this specification, ASME B31.1, and manufacturer's recommendations. In the event of a conflict, the more stringent shall apply.
 1. Fittings shall be full penetration welded.
 2. Inside of fitting shall be inspected for full penetration. This shall be done prior to any welding on inside if so required. If weld is required on inside of full penetration joint, it shall be ground or back gouged to sound base metal.

PART 5 - MEASUREMENT

5.1 METHOD OF MEASUREMENT

- A. No separate measurement shall be made for work under this Section.

PART 6 - PAYMENT

6.2 METHOD OF PAYMENT

- A. No separate payment will be made for work under this Section. The cost of the work described in this Section shall be included in the Lump Sum Contract price.

END OF SECTION 05999

SECTION 335243 AVIATION FUELING SYSTEM PIPING, VALVES AND FITTINGS

PART 1 - GENERAL

1.1 SUMMARY

- A. This Section specifies piping, manual valves, fittings, and miscellaneous materials and appurtenances for the fueling storage and dispensing systems.

1.2 RELATED DOCUMENTS

- A. Drawings, General and Special Conditions, Division 1 - General Requirements and other applicable technical specifications apply to work of this Section.

1.3 RELATED SECTIONS

- A. Division 2 - Trenching and Backfilling
- B. Section 05999 - Welding
- C. Section 15010 - Basic Mechanical Requirements
- D. Section 15050 - Basic Mechanical Materials and Methods
- E. Section 15055 - Coatings and Corrosion Protection
- F. Section 15172 - Aviation Fueling System Equipment
- G. Section 15179 - Aviation Fueling System Inspection, Cleaning, Flushing and Testing.
- H. Section 15190 - Mechanical Identification.
- I. Applicable Division 16 Electrical sections.

1.4 REFERENCED STANDARDS

- A. Comply with the requirements of the reference standards noted herein, except where more stringent requirements are listed herein or otherwise required by the Contract Documents.
 - 1. American National Standards Institute (ANSI)
 - a. ANSI B16.9 - Factory Made Wrought Steel Buttwelding Fittings
 - b. ANSI B16.11 - Forged Steel Fittings, Socket Welding and Threaded
 - c. ANSI B31.3 - Petroleum Refinery Piping
 - 2. American Petroleum Institute (API)
 - a. API 609 - Butterfly Valves, Lug-Type and Wafer-Type
 - 3. API 1529 - Aviation Fueling Hose

4. American Society for Testing and Material (ASTM)
 - a. ASTM A-53 - Pipe, Steel, Black and Hot-Dipped, Zinc Coated, Welded and Seamless
 - b. ASTM A-105 - Forgings, Carbon Steel, for Piping Components
 - c. ASTM A-181 - Forgings, Carbon Steel, for General Purpose Piping
 - d. ASTM A-193 - Alloy-Steel and Stainless Steel Bolting Materials for High-Temperature Service
 - e. ASTM A-194 - Carbon and Alloy Steel Nuts for Bolts for High Pressure and High-Temperature Service
 - f. ASTM A-234 - Piping Fittings of Wrought Carbon Steel and Alloy Steel for Moderate and Elevated Temperatures
 - g. ASTM D-1599 - Short Time Hydraulic Failure Pressure of Plastic Pipe and Tube
 - h. ASTM D-2996 - Filament-Wound Reinforced Thermosetting Resin Pipe
 - i. ASTM D-2310 - Machine-Made Reinforced Thermosetting Resin Pipe
5. American Society of Mechanical Engineers (ASME) :
 - a. ASME - Boiler and Pressure Vessel Codes, SEC 9 - Qualification Standard for Welding and Brazing Procedures, Welders, Brazers, and Welding and Brazing Operators.
 - b. ASME B31.3 – Process Piping
 - c. ASME B31.4 – Pipeline Transportation Systems for Liquid Hydrocarbons and Other Liquids.
6. National Fire Protection Association (NFPA)
 - a. NFPA 30 - Flammable and Combustible Liquids Code
 - b. NFPA 30A - Automotive and Marine Service Station Code
 - c. NFPA 407 - Aircraft Fuel Service

1.5 SUBMITTALS

- A. Refer to Section 15010 for additional submittal requirements.
- B. Submittals shall include, but not be limited to:
 1. Piping
 2. Fittings
 3. Valves
 4. Welding Procedures and Certification
 5. Piping Mill Reports
 6. Gaskets
- C. Provide hard copy and electronic “As Built” Plans in the same format and manner as described above. Each set shall be equipped with a plan holder equal to “Stacor Plan Clamps” for the appropriate size drawings. Electronic drawings shall be submitted in the latest version of AutoCAD (dwg) AND the latest version of Adobe Acrobat (pdf). Adobe Acrobat files shall not contain security. Other file formats will not be accepted.

- D. Welders Certificate: Include welders certification of compliance with ASME SEC 9 and section 05999 - Welding
- E. Contractor shall submit fully dimensioned spool drawings for all welded piping work. Drawings shall indicate all weld types, sizes and materials to be used. The spool drawing size shall match the full size contract documents of either 24x36 or 34x44. Spool drawings shall be submitted in either the latest version of AutoCAD (dwg) or the latest version of Adobe Acrobat (pdf). Adobe Acrobat files shall not contain security. Other file formats will not be accepted.
- F. Leak Testing:
 - 1. Contractor shall submit drawings and procedures of the leak testing that will be performed to the DEN Project Manager no later than two weeks prior to testing. Contractor may not proceed with tests unless approved in writing by the DEN Project Manager and DEN Mechanical Inspector.
- G. Field Test Reports: Written reports of tests specified in Part 3 of this Section. Include the following:
 - 1. Test procedures used.
 - 2. Test results that comply with requirements.
 - 3. Failed test results and corrective action taken to achieve requirements.
- H. Fuel System Installation Contractor: The contractor that will install the fuel piping systems components and monitoring systems, installation and testing fuel hydrant pits and associated control systems, and shall have experience modifying and installing systems at DEN, or comparable facilities in the last 10 years. Provide documentation for the company and the staff, which shall consist of references for no less than 3 similar projects at DEN, or comparable facilities.

PART 2 - PRODUCTS

2.1 PIPING MATERIALS

- A. All materials and equipment provided under these specifications shall be new products of manufacturers regularly engaged in production of such equipment. All products shall conform to the applicable code or standard for its manufacturing, fabricating and installation.
- B. Certification:
 - 1. All steel pipe and fittings to be installed for aircraft fuel service, or for conveyance of waste fluids which may contain fuel, shall be tested and certified at the mill for conformance with the appropriate API or ASTM specification.
 - 2. Mill certification of piping shall be submitted to the DEN Project Manager for approval.
 - 3. Mill identification shall be stamped and clearly visible within 2 inches of the pipe or fitting end. The mill identification on the pipe shall be directly traceable to the mill certification report, in order to specifically identify each piece of pipe or fitting as being fabricated from the steel tested under the mill certification.

- C. The ends of the pipe shall be capped at the factory using suitable galvanized metal or plastic caps, secured with a double wrap of 2-inch wide pressure sensitive tape. Plastic caps shall not be used in plugging or capping pipes after installation.
- D. All exposed to view aboveground piping, including fittings, valves, supports, and system accessories shall be externally painted or coated in accordance with Section 15055. Internal epoxy lining of piping 2-1/2 inches in size or larger shall be provided for all steel piping conveying fuel in liquid or vapor form, in accordance with provisions of Section 15055.
- E. All piping, fittings and devices located within pits or vaults shall be considered to be above ground.

2.2 PIPING SPECIFICATIONS

- A. Piping Design Basis:

<u>Service</u>	<u>Design Conditions (psig ambient)</u>	<u>Test (psig)</u>
Fueling Supply	150	275
Fueling Drain	150	275
Fueling Vent	150	275

- B. Steel pipe and fittings shall be as scheduled below:

<u>Item</u>	<u>2 Inch and Smaller</u>	<u>2-1/2 Inch and Larger</u>
Pipe	ASTM A 53 Grade B, or API 5L Grade B Schedule 80, Seamless.	ASTM A 53 Grade B, or API 5L Grade B, Seamless or ERW, Schedule 40 for 2-1/2" to 10", Std. weight for 12" and above.
Joints	Socket weld. Screwed joints are not used except aboveground or in pits as required to connect to valves or equipment with threaded connections.	Butt-weld.
Flanges	150 lb. ANSI, Carbon Steel, ASTM A-181 Class 70 Socket Weld Raised Face	150 lb. ANSI, Carbon Steel, ASTM A- 181 Class 70 Weld Neck, Raised Face
Fittings	Socket weld, ANSI B16.11, Forged Steel, ASTM A 105, 3000 lb.	Butt weld, ANSI 16.9 Carbon Steel, ASTM A-234 Grade B, Wall thickness to match pipe.
Bolts, Studs, Nuts	Same as 2-1/2 Inch & Larger	Carbon steel, cadmium plated, machine bolts and studs per ASTM A 193 Grade B7. Nuts to be heavy hexagon, ASTM A 194 Grade 2H, Cadmium plated.
Gaskets	Same as 2-1/2 Inch & Larger	Spiral-wound, Flexitallic Style CG.

2.3 DRAINAGE PIPING SYSTEM

- A. General: For drainage of potentially contaminated storm water, including fuel wastes arising from possible spills at the helipad, fuel delivery truck unloading pad, and the fuel system equipment pad, provide FRP piping which shall conform to ASTM D-1599, D-2310, and D-2996 as applicable, with fittings, adhesives and curing, proof testing performance, and jointing methods in conformance with requirements specified by the piping manufacturer. Include all adapters required for connections to valves or other equipment components, and transitions to steel piping sections. Piping shall be Smith Fiberglass Red Thread II, or approved substitute.

2.4 FITTINGS

- A. Butt-weld type carbon steel, ASTM A234 Grade B, ANSI B16.9 for sizes 2-1/2 inches and larger. Wall thickness of fittings shall match wall thickness of pipe.
- B. Socket weld or screwed 3,000-pound forged steel, ASTM A 105 Grade II, conforming to ANSI B16.11 for sizes 2 inches and smaller.
- C. All elbows shall be long radius.
- D. Changes in direction of pipe, of other than 45 degrees or 90 degrees, shall be made as follows:
 - 1. With long radius weld ells cut to the proper angle and shop beveled.
 - 2. At the option of the Contractor, use long radius pipe bends. Pipe roundness shall be maintained to factory tolerance for straight pipe lengths. Submit shop drawings of all bends and bending procedures for approval.
- E. Branch Connections:
 - 1. Forged fittings may be used in lieu of butt welding tees for branch connections.
 - 2. Forged fittings shall be forged steel fabricated from materials conforming to ASTM A 105, standard weight steel, and shall conform to ANSI B16.11. Thickness shall match wall thickness of pipe.
 - 3. Forged fittings shall be butt weld insert sweepolets as manufactured by Bonney Forge and Tool Works, or butt weld vesselets as manufactured by W.F.I. International, Inc.
 - 4. Thredolets or sockolets shall only be used for gauge, vent, and instrument connections.

2.5 INSULATED FLANGE JOINTS

- A. Flanged insulating assemblies shall be used for electrostatically isolating cathodically protected pipeline from cathodically unprotected assemblies, and shall be LineBacker Type "E" as manufactured by Pipeline Seal and Insulator, Inc., or approved substitute.

- B. Insulating joint shall consist of a full face insulating gasket, insulating bolt sleeves and double quantity of insulating washers and stainless steel washers.
- C. Insulating materials shall be as follows:
 - 1. Gasket: NEMA Grade G10 retainer conforming to ASTM D 229 with Viton seal on each side of the retainer. Minimum dielectric strength shall be 500 volts per mil (VPM). Compressive strength shall be 50,000 psi. Water absorption shall be 0.05 percent (max.)
 - 2. Sleeves: Shall be 1/32-inch wall thickness, length to suit two class 150 lb. weld neck flanges, insulating gaskets and valve body thickness. Sleeve shall provide "full" insulation of studs; minimum dielectric strength shall be 500 VPM. Material shall be NEMA Grade G10.
 - 3. Insulating washers: NEMA Grade G10, 1/8-inch thick (minimum).
- D. Install insulating joints at the locations indicated on the Drawings. Where not shown on the Drawings, they shall be installed at the first flange (within the structure) nearest to the structure's wall or the first flange wherever underground piping comes aboveground.
- E. Flange assemblies shall provide a minimum resistance of one million ohms measured between each stud and both flanges when tested in the dry condition.

2.6 FLANGES

- A. Flanges shall be standard weldneck type 150 pound forged steel, ASTM A 181 Class 70, conforming to ANSI B16.5.
- B. Finish of the flange surface mating the gasket shall be phonographically serrated.
- C. Flange facings shall correspond to the equipment to which the piping is joined and shall, unless otherwise required, be standard 1/16-inch raised face flanges.
- D. Flange drilling shall match drilling on pump or equipment flanges.

2.7 GASKETS

- A. Gaskets shall be resistant to the effects of hydrocarbon fuels and manufactured of fire-resistant materials.
- B. Full face gaskets shall be used for flat face steel flanged joints.
- C. Ring gaskets shall be used for steel flanged joints with raised face flanges.
- D. Gaskets shall be spiral-wound construction with an integral 1/8 inch thick metal gauge ring.
- E. Gasket shall be constructed from metal windings and an enclosed filler to a thickness of 0.175 inch to compress to 0.125 to 0.135 inch under proper bolt torque.
- F. The metal windings shall be type 304 stainless steel.

- G. The filler shall be non-asbestos, chlorite mineral paper (Flexicarb).

2.8 BOLTS AND NUTS

- A. Machine bolts shall be cadmium-plated carbon steel, heavy hexagon, conforming to ANSI B18.2.1 and ASTM A193 Grade B7.
- B. Nuts shall be cadmium plated carbon steel, heavy hexagon conforming to ANSI B18.2.2 and ASTM A 194 Grade 2H.
- C. Cadmium plating shall be electro-deposit in accordance with ASTM B766-86, Coating type TS.
- D. Provide washers under bolt head and nuts. Washers to be cadmium plated ASTM F 436 hardened steel washers.

2.9 BUTTERFLY VALVES

- A. Butterfly valves shall be High Performance Butterfly Valves, full lug body, rated at 150 psi at 100 degrees F, and meet the following requirements:
 - 1. Valves shall be capable of providing bubble-tight shutoff against full differential pressure in either flow direction.
 - 2. Valve seat shall be fire-safe metal-to-metal secondary seal with primary elastomeric seal, conforming to API 607.
 - 3. Valves shall have retained top and bottom low friction bearings.
 - 4. Retainer rings must be recessed in the body so that the line gasket prevents any potential external leakage.
 - 5. Valves shall have internal stop to prevent disc over-travel.
 - 6. Shaft shall be one piece, through disc type or two-piece stem incorporating double offset design, which is drilled on the tangent for disc connection and which is attached to the discstops to be inherently blow-out proof in accordance with ANSI B16.34.
- B. Valves shall be suitable for mounting with valve shaft in the horizontal position with the lower half of disc opening in the same direction as normal flow, or offset one bolt hole angle to suit installation clearance.
- C. Valve flanges shall be class 150 lb. ANSI B16.5.
- D. Cap screws for installation of lug bodies shall be carbon steel, cadmium plated, heavy hexagon, conforming to ASTM A 193, Grade B7. Arrange for installation between flanges using cap screws from each side to permit removal of downstream flange.
- E. Valves six inches and smaller shall be furnished with spring loaded, squeeze trigger type handle complete with locking device.
- F. Valve components shall be manufactured of the following materials:

1. Valve body shall be fabricated from carbon steel conforming to API-609, ASTM A 105 or A 216 GR. WCB through 8 inch; ASTM A 216 GR. WCB 10 inch or larger.
 2. Disc shall be fabricated from stainless steel conforming to ASTM A 182 F316 or A 351 GR. CF8M.
 3. Shaft shall be fabricated from stainless steel alloy 17-4 PH, ASTM A 564, Type 640H 1150.
 4. Seat seal shall be stainless steel/RTFE.
 5. Shaft bearings shall be rated for fire-safe application and shall conform with requirements of API-607.
- G. Valve assembly shall be specifically designed for use with hydrocarbon fuels.
- H. Acceptable Manufactures:
1. WKM "Dynacentric"
 2. Mark Controls Corporation "Flowseal"
 3. Jamesbury "Fire-Tite Wafer-Sphere"
 4. Substitutions per 15010

2.10 PLUG VALVES - DOUBLE BLOCK AND BLEED

- A. Double Block and Bleed valves shall be General Valve Company Twin - Seal high-integrity positive shut-off valves, Series 8800, as manufactured by General Valve Company, Brookshire, Texas, or Tru-Seal as manufactured by Orbit Valve Company and meeting the following requirements:
1. Valves shall be non-lubricated, resilient seal, plug-type with a mechanical means of freeing the plug before it is rotated from the closed to the open position.
 2. Valves shall have a safety bleed/differential thermal relief system to check seal integrity of valve in the closed position and relieve internal pressure.
 3. Valves shall have position indicator flag to show the exact plug position.
- B. Valves shall have ANSI 150 pound class rating (275 psi working pressure).
- C. Valves six inches and smaller shall have handwheel operators. Valves eight inches and larger shall have gear operators. Chainwheel drives shall be provided where shown on the Drawings or where valve operator is mounted 7 feet or more above operating level. Where shown on the "N" series drawings, provide limit switches as specified in Section 15948.
- D. Valve components shall be manufactured of the following materials:
1. Valve body shall be cast carbon steel ASTM A 216-WCC Chrome plated.
 2. Valve plug shall be ductile iron ASTM A395 GR 60-40-18 Electroless Nickel Coated for valve sizes 8 inches to 12 inches, or cast carbon steel ASTM A 216-WCB Electroless Nickel Coated for larger sizes.

3. Valve bonnet and lower plate shall be carbon steel ASTM A36/A516 GR 70, or cast equivalent.
4. Valve slip seals and o-rings shall be viton.
5. Back-up ring shall be teflon.
6. Seating slips shall be ductile iron ASTM A395 GR 60-40-18 Manganese phosphate coated.

2.11 HYDRANT VALVES

- A. Hydrant pit valves shall be Model 60554X manufactured by J. C. Carter Co., Inc. Valves shall have a 6-inch, 150 lb. ANSI B16.5 inlet flange, and 4-inch API 1584 adapter outlet flange. Valve shall include optional actuator 64230.
- B. The valves shall be actuated by a compressed air operated pilot valve through a deadman control.
- C. Adapter flange shall be provided with a dust cover (without locking cams) chained or tied to the valve.
- D. Adapter poppet shall be provided with a pressure equalizing device or valve.
- E. The valves shall be provided with a 10 mesh screen, furnished by valve manufacturer.
- F. Valve closing time shall be adjustable from 2-5 seconds.
- G. Materials:
 1. Outer housing shall be epoxy coated A536, Grade 60-14-80 ductile iron.
 2. Trim shall be stainless steel and aluminum alloy.
- H. Hydrant valves shall not be installed until all tests and flushing are completed.
- I. Provide stainless steel strainer at upstream flange, conical type. Ring shall be 0.25" thick. Screen shall be 12 x 12 mesh with 0.023" diameter wire. Open area shall be 150 percent of pipe area.

2.12 WALL PENETRATION SEALS

- A. Pipe to wall penetration closures shall be modular mechanical type, made up of jet fuel resistant interlocking rubber links shaped to fill the annular area between pipe and wall opening or outer casing, and joined together with machine bolts and nuts. Seal shall be designed to fit loosely around pipe and after being positioned, expanded against the outer wall by tightening the bolts. Seal shall be electrically non-conductive. Bearing plates or washers between seal elements and bolt heads and nuts shall be electrically non-conductive.
- B. Seal assembly shall be constructed of materials resistant to aviation jet fuels.
- C. Seals shall be "Link-Seal" as manufactured by Thunderline Corp., Belleville, Michigan, or approved substitute.

- D. Sleeves through walls shall be (grouted) (cast) in place. Sleeves through pads shall be cast in place. Piping shall be installed centered in sleeve.

2.13 FLANGED INSULATION KITS

- A. Flanged insulating assemblies shall be used for full electrostatic isolation of cathodically protected pipe line from cathodically unprotected assemblies, and shall be Gasket-O-Seal Type "E" as manufactured by Pipeline Seal & Insulator, Inc (PSI), Maloney, Central or approved equal.
- B. Insulating joint shall consist of a full face thermosetting molded phenolic insulating gasket, insulating bolt sleeves and double quantity of insulating washers and stainless steel washers.
- C. Insulating materials shall be as follows:
 - 1. Gasket: Phenolic retainer conforming to ASTM D 229 with Buna-N "O" ring seal molded in a groove on each side of the retainers. 1/8-inch thick for class 150 raised face gasket. Minimum dielectric strength shall be 500 volts per mill (vpm).
 - 2. Sleeves: Shall be 1/32-inch wall thickness spiral wound mylar, length to suit two class 150 lb. weld neck flanges, insulating gaskets and valve body thickness. Sleeve shall provide "full" insulation of studs; minimum dielectric strength shall be 4000 vpm.
 - 3. Insulating washers: Grade G3HT phenolic, 1/8-inch thick (minimum), 1 per each side of flange. Dielectric strength shall be compatible with minimum insulating values of insulating sleeves and gaskets.

PART 3 - EXECUTION

3.1 CLEAN PIPING REQUIREMENTS

- A. It is extremely important to keep the interior of the piping system thoroughly clean at all times. The Contractor shall keep the interior of the piping clean of all visible dirt or foreign matter at all times and under all conditions. If, for any reason, the inside of the piping contains dirt or foreign matter, the Contractor shall rectify this condition to the DEN Project Manager's satisfaction with all necessary material, labor, and equipment for cleaning being furnished at the Contractor's expense.
- B. The pipe shall be delivered to the job site sealed. The seals are not to be removed until the pipe is installed. After each day's work, the open ends of all pipe being installed shall be closed with an expansion type weatherproof seal manufactured for this purpose.
- C. All fittings and valves shall be kept in a covered dry storage area until installation.
- D. Pipe shall not be installed in trenches containing water or mud.
- E. At openings for branches in pipe, all material which falls into the pipe must be removed before welding in the branch fittings.

3.2 HANDLING PIPE

- A. Shipping, delivering, and installing pipe and accessories shall be handled in such manner as to ensure a sound undamaged condition. Particular care shall be taken not to injure pipe coating and containment pipe when storing pipe, lowering it into trench and when backfilling.
- B. No other pipe or materials of any kind shall be placed inside a pipe or fitting after the coating has been applied.
- C. Storage rack materials shall be 6 inches in bearing width and placed not more than 6 feet apart.
- D. Do not rack pipe more than four sections in height.
- E. Protect and prevent movement of all racked pipe by use of suitable padded material between sections.
- F. All trucks handling coated pipe shall have properly padded bolsters, padded chains, and padded binders so as to not damage the coating.
- G. Pipe shall not be dropped or rolled off the truck, but shall be carefully lowered onto skids using padded mechanical equipment.
- H. Coated, wrapped, and double-contained sections of pipe must be lifted with nylon slings of approved width and shall not be dragged or pulled into position.

3.3 LAYING UNDERGROUND PIPE

- A. Lay, embed, and maintain all underground pipelines to the flow-line elevation and grades shown on the drawings or as directed by the DEN Project Manager. Pipelines shall be graded uniformly between invert elevations.
- B. Excavation, backfill and compaction shall be in accordance with Division 2. Trench backfill from not less than six inches below the bottom of the pipe to not less than six inches above the top of the pipe shall consist of bedding material as specified.
- C. The full length of each section of pipe shall rest solidly upon the bedding material.
- D. Any pipe that has the grade or joint disturbed after being laid shall be taken up and relaid.
- E. Do not lay pipe in water or when trench conditions are, in the judgment of the DEN Project Manager, unsuitable.
- F. Anchor pipe, in an approved manner, during installation to prevent flotation prior to backfilling and placing into service.
- G. When work is not in progress, securely close open ends of pipe or fittings using approved expanding type watertight plugs to prevent trench water, earth, or other foreign substance from entering the pipe or fittings.

3.4 WELDING

- A. General: Comply with welding requirements of this section and section 05999 – Welding. If the two sections have conflicting requirements, the more stringent shall apply.
- B. Welding electrodes shall be designed and made for use with the specific pipe metal to which it is applied and shall conform to the applicable AWS Specifications for welding rods and electrodes. Welding electrodes shall be suitably shielded.
- C. Welding shall be accomplished by the use of the shielded metallic arc process and shall be performed in strict accordance with the requirements of ANSI B31.3. Welding process and/or procedures that comply with any other standard will not be accepted. All welding shall be performed downhill.
- D. Not less than fifteen days prior to performing any weld, the Contractor shall submit to the DEN Project Manager for approval the welding procedure specifications (meeting the requirements of ANSI B31.3) proposed to be used on the job. The Contractor's submittal shall include, as a minimum, the following:
 1. Certified copies of the procedure qualification test records confirming that the procedures have been qualified in accordance with ANSI B31.3 and Section IX of the ASME Code.
 2. The Contractor shall submit the records in a form similar to the "Procedure Qualification Record" and shall include the information required by Section IX of the ASME Code and ANSI B31.3.
 3. Welding procedure shall be designed for the conditions of this Contract, shall be complete and specific, and shall differentiate between shop and field welding.
 4. The Contractor shall secure the services of an Independent Testing Laboratory to certify each welder. Welds shall be made and tested as required by ANSI B31.3 and Section IX of the ASME Boiler Code. The following conditions shall apply for qualification testing of each welder:
 - a. All welds shall be made in the downhill method.
 - b. All pipe groove welds shall be in test position 6G.
 - c. No backing rings shall be used.
 - d. All test welds shall be given a radiographic examination prior to the performance of bend test.
 - e. All test welds shall be given the performance bend test.
 - f. Welders failing to qualify after two unsuccessful attempts shall not be retested and shall not be permitted to perform any welds on this project.
 - g. All test results shall be submitted to the DEN Project Manager for approval.
 5. In addition to the above, each welder shall possess a currently approved certificate, meeting the requirements of these specifications, issued by an approved testing authority. Satisfactory evidence as to qualifications and certificate possession shall be presented to the DEN Project Manager for each welder employed prior to any welding being performed.

6. Costs incidental to these procedures and the welders qualification tests shall be borne by the Contractor.
- E. Identification:
1. Each welder shall identify his weld with specific code marking signifying his name and assigned number.
 2. The Contractor shall maintain an up-to-date record of the welders and the code assigned to each welder.
 3. The welder shall stamp his code on the pipe, not closer than 3" nor farther than 4" from a weld, using a "low stress" steel stamp or other approved methods that will not damage the pipe or pipe coating system.
 4. The Contractor shall indicate, on his set of plans for submittal as record plans (as-built), the location of each weld by number and the respective welder's identification code. The identification methods to be used by the Contractor shall be submitted to the DEN Project Manager along with the respective welders' qualification test records.
- F. Preparation of Pipe Ends for Butt Welding:
1. Preparing pipe ends shall be in accordance with ANSI B16.25.
 2. Shop and field bevels shall be machine cut; manual flame cutting will not be permitted.
- G. Backing rings shall not be used.
- H. All welds shall have full penetration and fusion and shall conform to ANSI B31.3, supplemented with additional requirements as specified herein or shown on the drawings.
- I. Align pipe joints with pipe clamps prior to welding. Clamps or other alignment devices shall not reduce the internal pipe diameter.
- J. Any weld or weld repair, once started, shall be continued until the weld has been completed.
- K. Defective welds shall be repaired or redone, in accordance with ANSI B31.3 at the Contractor's expense.
- L. Repairs to defective welds shall not be made prior to authorization. The DEN Project Manager will determine on the basis of the Testing Laboratory report if repairs may be made or if the entire joint must be cut out and welded again.
- M. No weld metal shall project within the piping at completion of the welding. All weld material and burrs protruding outside the pipe's outer surface shall be ground smooth.
- N. Prior to welding, each joint shall be cleaned and all rust and loose debris and contaminants removed.
- O. Any welder producing more than a total of three defective welds shall be disqualified and prohibited from performing any more welds on this Project.

3.5 RADIOGRAPHING AND MAGNETIC PARTICLE TESTING

- A. The Contractor shall employ a recognized independent testing laboratory to test, by radiography, 10 percent of all aboveground circumferential shop and field butt welds and fabricated branch connection welds. All fillet and seal welds shall be tested by magnetic particle testing method.
- B. The Contractor shall cooperate with the Testing Laboratory and shall give the DEN Project Manager and the Testing Laboratory adequate advance notice of when welds will be available for radiographing and that all the work required by the Contractor in connection with the welding prior to radiographing is properly completed.
- C. Testing Laboratory's report shall be submitted, in timely fashion, to the DEN Project Manager throughout the progress of the work, and the Contractor will be notified of any encountered deficiency.
- D. Reports of all radiographing and magnetic particle testing shall be prepared in accordance with the requirements of ANSI B31.3. The reports shall include welder's code, weld identification and description, whether the weld meets the specification requirements, the film type and size, and remarks on imperfections. All subsequent report formats shall be in accordance with the requirements of Section IX of the ASME Code.
- E. Radiograph exposure film negatives will be kept on file by the DEN Project Manager; the record for such radiograph film negative will show the date, location of tested weld (coordinate with weld location as shown on the Contractor's as-built drawings), area, film number, serial number, film combination, time, source-film distance, angulation and other pertinent information for each weld radiographed.
- F. A summary of these records along with an expert interpretation of the tests shall be prepared by the testing laboratory and submitted in a report form for each weld, to the DEN Project Manager. Interpretation of negatives shall be by a level 3 radiographic technician certified by examination by the American Society of Non-Destructive Testing.
- G. All welds shall be left exposed until all testing (radiographing, magnetic particle and pressure) is completed and welds have been accepted by the DEN Project Manager.
- H. Acceptance criteria for welds shall be in accordance with ANSI B31.3 requirements for normal cyclic conditions. Welds which do not meet the standards of acceptability will be judged unacceptable and shall be repaired or cut out and rewelded by the Contractor as directed by the DEN Project Manager at no additional cost to the Owner. Repaired and rewelded joints shall then be re-radiographed. If the same joint, after the second welding and radiographing fails again, then the section(s) of involved pipe shall be removed and replaced at no additional cost to the Owner.
- I. All costs of the original radiographing and re-radiographing of unacceptable welds and the accompanying reports and interpretation shall be borne by the Contractor.

3.6 COLD CUTTING AND PLUGGING FOR UNDERGROUND PIPE

- A. Cold cutting will be required on all fuel pipelines, which require modification; with all required modification work to be performed by the Contractor. The Owner will arrange for isolating and draining sections of pipeline requiring modifications, and the Contractor shall verify that the lines are completely drained.
1. Where positive isolation cannot be ensured by existence of double block and bleed valves, other measures such as blind flanging piping in accessible valve vaults, etc. will be required. Unless otherwise indicated on the drawings, the Owner will arrange for installation of isolating measures and restoration of the piping system, following completion of the Contractor's piping modification, to normal service condition.
- B. Contractor shall submit a plan of procedure and sequence of activities to the DEN Project Manager 30 days prior to actual work. The following is a suggested sequence only; the Contractor is responsible for the means, methods, sequences, techniques, and procedures of construction and safety precautions and programs.
1. Test area around pipe with approved combustible vapor indicator to verify a flammable gas-free environment at the time of performing "hot work." Provide suitable ventilation. Obtain "hot work" permit and "gas free" certificate.
 2. Equip workers with safety glasses, hard hat and suitable clothing. Provide fresh air ventilation for all personnel.
 3. Throughout performance of work required, provide and maintain provisions for collection of any fuel spills or leakage, which might occur, along with acceptable provisions for removal and disposal of captured fuel. Include details of provisions as part of required submittal.
 4. To the maximum practicable extent, prefabricate and pre-assemble new work which is to be installed in the section of pipeline being removed, so as to minimize the duration of time requiring isolation of pipeline sections.
 5. Insure pressure is zero on the line with coolant, carefully drill a 1/4" diameter test hole in the top of the fuel line section to be removed. Gauge for liquid through the holes to verify that the pipe is drained or how much liquid fuel remains. Provide temporary plug for the test hole with "on-hand" brass screws. If liquid fuel flows out of the hole while open, notify the DEN Project Manager of need for expedited corrective action.
 6. If line is empty, provide shoring and bracing for the pipe and proceed with "machine cold cutting" the fuel line using an air operated cutter with coolant.
 7. After both ends of the fuel line section have been cut and the section is removed, swab out metal chips and immediately insert gasketed type piping plug into each open end of the remaining pipeline after first placing CO₂ "dry ice" into the open pipe ends to provide inert gas behind the pipe plugs (also known as "plumber's plugs"). Tighten the plug in order to provide a liquid and vapor tight seal from the drainage of liquid or fuel vapor from the remaining fuel line segments while pipe ends are being dressed preparatory to welding. Maintain fresh air ventilation for personnel when using CO₂.
 8. The line then being ready for the new welding work, accomplish testing for combustible gas by indicator designed for the purpose. Provide suitable

ventilation for personnel. Remove pipe plugs, placing CO2 "dry ice" into the open pipe ends to provide inert gas during welding. New assemblies to be butt-welded to ends of existing piping; no underground flanges are permitted.

9. After welding is completed and non-destructive testing and radiographic inspection is successfully completed, coordinate with DEN Project Manager for restoration of the system to normal operating status.
10. Proceed with hydrostatic testing, coating of pipe joints, and holiday testing as required.

3.7 LEAK TESTING

- A. Provide temporary equipment for testing, including pump and gages. Test piping system before insulation is installed, wherever feasible, and remove control devices before testing. Subject entire piping systems to leak tests, either as a whole, or in sections; but leave no part untested.
- B. Test gauges shall have a range that provide for the test pressure to be in the middle third of the gauge scale.
- C. Contractor shall provide written notification to the DEN Project Manager/Engineer and DEN Inspector at least 48 hours before performing leak test. Perform all tests in the presence of the authorized City representative.
- D. Aviation Fueling Piping Leak Testing:
 1. Perform leak testing on all aviation fuel piping systems as required by Section 15179 – Aviation Fueling System Inspection, Cleaning, Flushing and Testing.
- E. Testing shall be witnessed by DEN Mechanical Inspector and Project Manager or Designated Representative.
- F. Repair piping systems which fail required piping test, by disassembly and reinstallation, using new materials to extent required to overcome leakage. Do not use chemicals, stop-leak compounds, mastics, or other temporary repair methods.
- G. Drain test fluid from piping systems after testing and repair work that has been completed.
- H. Prepare written report of testing procedures and result. Submit in accordance with Section 15010.

PART 4 - MEASUREMENT

4.1 METHOD OF MEASUREMENT

- A. Payment for "Remove and Eliminate Hydrant Pit Back to Main" shall be measured per each, for work installed in-place, completed, and approved by the DEN PM.
- B. Payment for "New Hydrant Valve for New Pits" shall be measured per each, for work installed in-place, completed, and approved by the DEN PM.
- C. Payment for "6-Inch Coated Jet Fuel Piping for New Hydrant Locations" shall be measured per linear foot, for work installed in-place, completed, and approved by the DEN PM.
- D. Payment for "New Jet Fuel Valve Vault Access Cover" shall be measured per each, for work installed in-place, completed, and approved by the DEN PM.

PART 5 PAYMENT

5.1 PAYMENT

- A. Payment for “Remove and Eliminate Hydrant Pit Back to Main” will be made at the contract unit price per each for work installed in-place, completed, and approved by the DEN PM. This price shall be full compensation for furnishing all materials and installation of these materials, and for all labor, equipment, tools, and incidentals necessary to complete the item.
- B. Payment for “New Hydrant Valve for New Pits” will be made at the contract unit price per each for work installed in-place, completed, and approved by the DEN PM. This price shall be full compensation for furnishing all materials and installation of these materials, and for all labor, equipment, tools, and incidentals necessary to complete the item.
- C. Payment for “6-Inch Coated Jet Fuel Piping for New Hydrant Locations” will be made at the contract unit price per linear foot for work installed in-place, completed, and approved by the DEN PM. This price shall be full compensation for furnishing all materials and installation of these materials, and for all labor, equipment, tools, and incidentals necessary to complete the item.
- D. Payment for “New Jet Fuel Valve Vault Access Cover” will be made at the contract unit price per each for work installed in-place, completed, and approved by the DEN PM. This price shall be full compensation for furnishing all materials and installation of these materials, and for all labor, equipment, tools, and incidentals necessary to complete the item.

Payment will be made under:

- Item 335243-1 Remove and Eliminate Hydrant Pit Back to Main – per each
- Item 335243-2 New Hydrant Valve for New Pits – per each
- Item 335243-3 6-Inch Coated Jet Fuel Piping for New Hydrant Locations – per linear foot
- Item 335243-4 New Jet Fuel Valve Vault Access Cover – per each

END OF SECTION 335243

SECTION 335243.19 GROUNDING

PART 1 - GENERAL

1.1 SUMMARY

- A. Power system grounding.
- B. Communication system grounding.
- C. Electrical equipment and raceway grounding and bonding.
- D. Perimeter ground loop.

1.2 RELATED DOCUMENTS

- A. Drawings, General and Special Conditions, Division 1 - General Requirements and other applicable technical specifications apply to work of this Section.

1.3 RELATED SECTIONS

- A. With the requirements of the reference standards noted herein, except where more stringent requirements are listed herein or otherwise required by the Contract Documents.
- B. NFPA Compliance: NFPA 70 "National Electrical Code (NEC)," as adopted and amended by the Denver Building Code, Chapter 10.
- C. UL Compliance: Applicable requirements of UL Standards Nos. 467 "Electrical Grounding and Bonding Equipment," and 869, "Electrical Service Equipment," pertaining to grounding and bonding of systems, circuits and equipment. In addition, require compliance with UL Std 486A, "Wire Connectors." Grounding and bonding products shall be UL-listed and labeled for the use.
- D. IEEE Compliance: Applicable requirements and recommended installation practices of IEEE Standards 80, 81, 141 and 142 pertaining to grounding and bonding of systems, circuits and equipment.

1.4 SYSTEM DESCRIPTION

- A. Ground the electrical service system neutral at service entrance equipment to the metallic water pipe service on building side only and to supplementary grounding electrodes, as required by the contract documents and as required by the NEC.
- B. External (underground) metal pipes, water, gas, fuel, drain/sewer etc., are not available for electrical grounding. This is due to extensive cathodic protection and isolation joints of all underground metal pipes at DEN. These systems shall be bonded to the grounding system on the building side only.
- C. Ground each separately derived system neutral to nearest referenced ground plate in the electrical room.

- D. Provide communications system with a # 6 copper grounding conductor at point of service entrance and connect to nearest referenced ground plate.
- E. Bond together at a service and at a separately derived systems; neutral conductor, equipment enclosures, all non-current carrying metal parts of electrical equipment, metal raceway systems, grounding conductor in raceways and cables, and grounding electrode connector.
- F. Provide a 2/0 minimum building perimeter-grounding conductor buried thirty inches (30") below finished grade thirty-six inches (36") from foundation. Install a 3/4" x 10' copper clad ground rod at each corner, each change of direction and at intervals not to exceed one hundred feet (100').
- G. Provide a minimum of three inch by twelve inch by one-quarter inch (3" x 12" x 1/4") copper ground bar in the electrical room for connecting the grounding systems.
- H. An insulated equipment ground conductor shall be installed continuous from the main switchgear or service entrance to all branch panelboards, motor control centers, transformers and all motors. This conductor shall be bonded to the conduit and metal enclosures that it passes through utilizing bonding bushings and terminal devices.

1.5 SUBMITTALS (REFER TO SECTIONS 01300 AND 01340)

- A. Submit shop drawings under provisions of Section 16010.
- B. Indicate layout of ground ring, location of system grounding electrode connections, and routing of grounding electrode conductors.
- C. Submit all field test reports.

PART 2 - PRODUCTS

2.1 MATERIALS

- A. Ground Rods: Copper-clad steel, 3/4-inch diameter, and minimum length of 10 feet; in manholes ground rods shall be stainless steel 3/4-inch diameter and a minimum length of 10 feet.
- B. Grounding Connection Accessories:
 - 1. Electrical insulating tape, heat-shrinkable insulating tubing, welding materials, bonding straps, as recommended by accessories manufacturers for type of service required.
- C. Exothermic welded connections are required where grounding conductors connect to underground grounding conductors and to underground grounding electrodes, and for bonding to steel. All underground connections shall be exothermic welded.
- D. All ground wires shall be copper except where stainless steel is specified for manholes, sized according to the NEC or as shown on the drawings which ever is larger.

PART 3 - EXECUTION

3.1 INSTALLATION

- A. Provide a separate, insulated, equipment-grounding conductor in all branch circuit conduits.
- B. Supplementary Grounding Electrode: Use grounding mats, where indicated, or driven ground rods. Install ground rods in suitable recessed well; fill with gravel after connection is made.
- C. Provide a No. 6 AWG and ground plate to each Communications Room or board. Connect to nearest Electrical Room ground plate.
- D. Provide isolated and insulated ground conductors for all microprocessor and data processing equipment.
- E. Tighten grounding and bonding connectors and terminals, including screws and bolts, in accordance with manufacturer's published torque tightening values for connectors and bolts. Where manufacturer's torquing requirements are not indicated, connections are to be tightened to comply with tightening torque values specified in UL 486A to assure permanent and effective grounding.
- F. Provide code-sized ground cable bonding jumpers, installed with ground clamps, across all conduit expansion couplings and fittings, including flexible steel conduit used as expansion fittings.
- G. Provide a corrosion-resistant finish to field connections, buried metallic bonding products, and where factory applied protective coatings have been destroyed.
- H. All continuous runs of cable tray and all isolated sections of cable tray shall be bonded and grounded.
- I. Provide an equipment-grounding conductor in all conduits.
- J. A non-continuous metallic raceway enclosing the service grounding electrode conductor or the separately derived system grounding electrode conductor shall be bonded at each end of the conduit to the grounding electrode conductor. If bonding jumpers are used they shall be sized per N.E.C. table 250-66.
- K. An earth electrode system shall be buried a minimum depth of two and a half feet. A # 2/0 bare copper ground wire, or if larger as sized on the drawings shall be run between ground rods.
- L. All receptacles and switches shall be provided with ground jumper from outlet box to ground terminal of the device. Exception isolated ground receptacles.
- M. Provide parallel equipment bonding jumper for parallel conduit feeders.
- N. Provide bonding jumpers around all concentric or eccentric knockouts.
- O. Include a bare # 2 copper ground conductor in all duct banks.

3.2 FIELD QUALITY CONTROL

- A. Test the ground resistance to earth of each ground rod prior to connection to the system. Where test show resistance to ground is over 5 OHMS, report to DEN Project Manager locations and values. Submit test results to the DEN Project Manager.
- B. Upon completion of installation of electrical grounding system, test ground resistance to earth in accordance with ANSI / IEEE 81 Submit test results to the DEN Project Manager.

PART 4 - MEASUREMENT

4.1 METHOD OF MEASUREMENT

- A. No separate measurement shall be made for work under this Section.

PART 5 - PAYMENT

5.1 PAYMENT

- A. No separate payment will be made for work under this section. The cost of the work described in this section shall be included in the applicable unit price item, work order or lump sum bid item.

END OF SECTION 16452

*NOTE SEE SUPPLEMENT AT THE END OF THIS APPENDIX FOR A
REPORT: "LIGHTNING, GROUNDING, AND CATHODIC PROTECTION STUDY"

SECTION 335245 AVIATION FUELING SYSTEM EQUIPMENT

PART 1 - GENERAL

1.1 SUMMARY

- A. This section specifies the following mechanical equipment:
 - 1. Prefabricated Pits.
 - 2. Access Covers.
 - 3. Strainers

1.2 RELATED DOCUMENTS

- A. Drawings, general and special conditions, Division 1 - general requirements and other applicable technical specifications apply to work of this section.

1.3 RELATED SECTIONS

- A. Section 15010 - Basic Mechanical Requirements.
- B. Section 15050 - Basic Mechanical Materials and Methods.
- C. Section 15055 - Coatings and Corrosion Protection
- D. Section 15170 - Aviation Fueling System, Piping, Valves and Fittings
- E. Section 15179 - Aviation Fueling System Inspection, Cleaning, Flushing and Testing
- F. Section 15190 - Mechanical Identification

1.4 REFERENCE STANDARDS

- A. Materials and workmanship shall conform to the latest issue of all industry standards, publications, or regulations referenced in this section and with the following references as applicable. Refer to Section 15010 for listing of issuing organizations or agencies.
- B. Applicable Standards:
 - 1. American Petroleum Institute (API)
 - a. API 1542 - Airport Equipment Marking for Fuel Identification
 - b. API 1581 - Specifications and Qualification Procedures for Aviation Jet Fuel Filter/Separators, Third Edition
 - c. API 421 - Management of Waste Discharges: Design and Operation of Oil-Water Separators, First Edition, January 1990
 - 2. American National Standards Institute (ANSI)

- a. ANSI B16.5 - Steel Pipe Flanges, Flanged Valves and Fittings
3. American Society of Mechanical Engineers (ASME)
 - a. ASME Boiler and Pressure Vessel Code, Section VIII
4. International Fire Code (IFC) with the Denver Amendments
5. International Building Code (IBC) with the Denver Amendmnets
6. Steel Tank Institute (STI)
 - a. STI-P3 - Steel Tank Protective Coating System
7. Underwriters' Laboratories (UL)
 - a. UL 58 - Standard for Safety, Steel Underground Tanks for Flammable and Combustible Liquids

1.5 SUBMITTALS

- A. Shop Drawings:
 1. Submit detailed shop drawings and equipment lists.
 2. Lists shall be accompanied by bulletins, plates, and schedules indicating the relative characteristics, ratings and capacities of the equipment.
 3. When standard equipment is modified to suit the conditions required, the shop drawings shall be supplemented with certification from equipment manufacturer that product meets the required specifications.
- B. Operating and Maintenance Manuals: Submit spare parts list, maintenance instructions and reviewed shop drawings in accordance with Section 15010 covering all items of equipment, and the operation of the equipment in detail.
- C. "As Built" Plans shall be provided in the same format and manner as described above. Each set shall be equipped with a plan holder equal to "Stacor Plan Clamps" for the appropriate size drawings.

PART 2 - PRODUCTS

2.1 HYDRANT PITS

- A. General: Pits shall be pre-fabricated fiberglass/steel flange pits with double-hinge aluminum frame and door.
- B. Pit Covers:
 1. Covers shall be No. A356.2 all primary metal cast aluminum per Fed. Spec. QQ-A-601F with a Mil. Spec. H-6088F T-6 heat treat, with no exceptions.
 2. Service lettering shall be abrasion/corrosion/chemical resistant, color coded, polyester powder coated.
 3. Cover access door shall have hand-holes with a minimum 1.75-inch depth and 7.5 cu. in. volume located near edge opposite of hinge side. Cover door shall have one single-motion latch lever without any above-grade protrusions whether in use or not and with a minimum 0.25 inch clearance from latching surface. Cover door and frame shall have a 35 pound

- maximum lift using non-weight bearing, free floating hinges, and a minimum 0.5 inch diameter hinge pins; providing a minimum 23.5 inch diameter clear opening to allow component access at a 4 inch maximum from cover top.
4. Cover prototype test report shall be submitted and the test shall have been conducted by an independent testing company in the following manner: Cover loading over each 200 sq. in. footprint shall result in a rating of 1,000 psi (740 psi for 11 inch O.D. cover) with a maximum full load deflection of 0.150 inch at center indicators and maximum deflection "rebound" within 0.025 inch after load release.
 5. Cover must be free of visual shrink porosity cavity areas, fillers, weldments and paint to hide them. Cover areas painted for safety or colored for information are allowed. Weight bearing mating flange surfaces of the pit and cover shall be machined flat to within 0.010 inch total indicator reading.
 6. Spare Parts - None required.
- C. Pits shall be pre-fabricated per the drawing detail dimensions, and shall be fiberglass with a galvanized steel top flange to be integrally bonded to the fiberglass in a non-bolted arrangement with a minimum overlap of 4 inches. The integral top flange shall require no extraneous corrosible material, weldments or strongbacks to support the cover.
- D. Manufacturer: Pits shall be as manufactured by CAVOTEC-DABICO, Inc. or approved equivalent. Hydrant pits shall be Model D236WPHD8SF-FHPAS-6-BF6-HS6-GL-48D. Pits are side entry type. (Substitutions: Under Provisions in Section 15010)

2.2 VAULT ACCESS COVERS

- A. Non-Counterweighted Covers:
1. General: Vault Access Covers shall be double-hinge aluminum frame and door with pre-fabricated reinforced fiberglass pit liner with a steel top flange vault access pit.
 2. Covers:
 - a. Covers shall be No. A356.2 all primary metal cast aluminum per Fed. Spec. QQ-A-601F with a Mil. Spec. H-6088F T-6 heat treat, with no exceptions.
 - b. Service lettering shall be abrasion/corrosion/chemical resistant, color coded, polyester powder coated.
 - c. Cover access door shall have hand-holes with a minimum 1.75-inch depth and 7.5 cu. in. volume located near edge opposite of hinge side. Cover door shall have one single-motion latch lever without any above-grade protrusions whether in use or not and with a minimum 0.25 inch clearance from latching surface. Cover door and frame shall have a 35 pound maximum lift using non-weight bearing, free floating hinges, and a minimum 0.5 inch diameter hinge pins; providing a minimum 23.5 inch diameter clear opening to allow component access at a 4 inch maximum from cover top.

- d. Cover prototype test report shall be submitted and the test shall have been conducted by an independent testing company in the following manner: Cover loading over each 200 sq. in. footprint shall result in a rating of 1,000 psi (740 psi for 11 inch O.D. cover) with a maximum full load deflection of 0.150 inch at center indicators and maximum deflection "rebound" within 0.025 inch after load release.
 - e. Cover must be free of visual shrink porosity cavity areas, fillers, weldments and paint to hide them. Cover areas painted for safety or colored for information are allowed. Weight bearing mating flange surfaces of the pit and cover shall be machined flat to within 0.010 inch total indicator reading.
 - f. Spare Parts - None required.
3. Pits: Shall be per the plan detail dimensions. Pit shall be one quarter inch reinforced fiberglass pit liner with a steel top flange.
 4. Manufacturer: Pits shall be as manufactured by CAVOTEC- DABICO, Inc., Model D741WP-VA-XHL1R-24D. (Substitutions: Under Provisions in Section 15010)

2.3 STRAINERS

- A. Strainers shall be ANSI Class 150, simple basket type construction of cast carbon steel, ASTM A 216 GR. WCB, with raised face flanges and bolted cover. (Substitutions: Under Provisions in Section 15010)
- B. Baskets shall be type 304 stainless steel with 1/8 inch diameter perforations and 40 mesh liner. Free area of basket shall be not less than four times the corresponding pipe size.
- C. Basket O-ring gaskets shall be Viton.
- D. Subject to meeting the requirements of the specifications, acceptable manufacturers are:
 1. Hayward Industrial Products.
 2. Mueller Steam Specialty.
 3. Substitutions: Under Provisions in Section 15010

PART 3 - EXECUTION

3.1 EQUIPMENT ELECTRICAL REQUIREMENT

- A. General: All motors and control equipment to conform to the requirements of Division 16: Electrical.
- B. Labels: All starters, pushbutton stations, switches, etc., to be marked with laminated plastic labels on their covers displaying a suitable name, number, or other legend to indicate which piece of equipment the apparatus controls or regulates.

3.2 GENERAL

- A. Installation: Install equipment and components accurately in position, true to line, level and plumb, and measured from established benchmarks or reference points. Follow manufacturer's recommended practices for equipment installation. Provide

required clearances between equipment components. Equipment, apparatus, and accessories requiring normal servicing or maintenance to be easily accessible.

- B. Anchoring: Anchor all equipment in place. Check alignment of anchor bolts before installing equipment and cleanout associated sleeves. Do not cut bolts because of misalignment. Notify DEN Project Manager of errors and obtain DEN Project Manager's acceptance before proceeding with corrections. Cut anchor bolts of excess length to the appropriate length without damage to threads. Where anchor bolts or like devices have not been installed, provide appropriate type anchors indicated for construction condition. For self drilling anchor bolts use Hilti Fastening Systems, HHS self drilling anchor or ITT Phillips Drill Division, Red Head self drilling anchor. For drop in expansion anchors, use Hilti Fastening Systems, KWIKBolt or ITT Phillips Drill Division, Red Head Wedge Anchors. Devices of lead, plastic, or wood are not acceptable.
- C. Grouting: All equipment which is anchored to a pad to be grouted in place; before setting equipment in place and before placing grout, clean surfaces to be in contact with grout, including fasteners and sleeves. Remove standing water, debris, oil, rust, coatings and other materials, which impair bond. Clean contaminated concrete by grinding or other acceptable means. Clean metal surfaces or mill scale and rust by hand or power tool methods, or other acceptable means. Provide necessary formwork for placing and retaining grout. Grout to be nonmetallic, nonshrink, fluid precision grout of a hydraulic cementitious system with graded and processed silica aggregate, Portland cement, shrinkage compensating agents, plasticizing and water reducing agents; free of aluminum powder agents, oxidizing agents and inorganic accelerators, including chlorides; proportioned, premixed and packaged at factory with only the addition of water required at the project site; grouting to meeting requirements of ASTM C 827; perform all grouting in accord with ACI, equipment manufacturer's, and grout manufacturer's published specifications and recommendations.
- D. Leveling and Aligning: Level and align all equipment in accordance with respective manufacturer's published data. Do not use anchor bolt jack nuts or wedges to support, level or align equipment. Install only flat shims for leveling equipment. Place shims to fully support equipment. Wedging is not permitted. Shims to be fabricated flat carbon steel units of surface configuration and area not less than equipment bearing surface. Shims to provide for full equipment support. Shim to have smooth surfaces and edges, free from burrs and slivers. Flame or electrode cut edges not acceptable.
- E. Threaded Fasteners and Hardware: Use appropriate type threaded fasteners and hardware for application. Material to be same type and grade required for Jet A piping system components, except as otherwise required. Provide hexagon bolt heads and nuts.
1. Bolts and Nuts: Carbon steel, ASTM A 307, Grade B, cadmium plated .0002" thick or stainless steel, ASTM A193, Grade B or ANSI T304.
 2. Standard Screws and Nuts: ANSI B18.2.
 3. Machine Screws and Nuts: ANSI B18.6.3.
 4. Plain Washers: ANSI B27.2.
 5. Beveled Washers: ANSI B27.4.
 6. Lock Washers: ANSI B18.21.1, helical spring type.

7. Threads: ANSI B1.1, Coarse Thread Series.

PART 4 - MEASUREMENT

4.1 METHOD OF MEASUREMENT

- A. Payment for “Remove and Relocate Hydrant Pit to New Location” shall be measured per each, for work installed in-place, completed, and approved by the DEN PM.
- B. Payment for “Install New Jet Fuel Hydrant Pit (JVP)” shall be measured per each, for work installed in-place, completed, and approved by the DEN PM.

PART 5 - PAYMENT

5.1 PAYMENT

- A. Payment for “Remove and Relocate Hydrant Pit to New Location” will be made at the contract unit price per each for work installed in-place, completed, and approved by the DEN PM. This price shall be full compensation for furnishing all materials and installation of these materials, and for all labor, equipment, tools, and incidentals necessary to complete the item.
- B. Payment for “Install New Jet Fuel Hydrant Pit (JVP)” will be made at the contract unit price per each for work installed in-place, completed, and approved by the DEN PM. This price shall be full compensation for furnishing all materials and installation of these materials, and for all labor, equipment, tools, and incidentals necessary to complete the item

Payment will be made under:

- Item 335245-1 Remove and Relocate Hydrant Pit to New Location – per each
- Item 335245-2 Install New Jet Fuel Hydrant Pit (JVP) – per each

END OF SECTION 335245

SECTION 335247 AVIATION FUELING SYSTEM INSPECTION, CLEANING, FLUSHING AND TESTING

PART 1 - GENERAL

1.1 SUMMARY

- A. This section includes:
 - 1. Inspection, cleaning, flushing, and testing of all fuel piping, corrosion protection coatings, and equipment performance demonstration.
 - 2. Testing of fuel piping, performed in accordance with the Chemical Plant and Petroleum Refinery Piping Code, ANSI B31.3, where applicable.

1.2 RELATED DOCUMENTS

- A. Drawings, General and Special Conditions, Division 1 - General Requirements and other applicable technical specifications apply to work of this Section.

1.3 RELATED SECTIONS

- A. Section 15010 - Basic Mechanical Requirements.
- B. Section 15055 - Coatings and Corrosion Protection.
- C. Section 15170 - Aviation Fueling System Piping, Manual Valves and Fittings.
- D. Section 15172 - Aviation Fueling System Equipment.

1.4 REFERENCE STANDARDS

- A. Comply with the requirements of the reference standards noted herein, except where more stringent requirements are listed herein or otherwise required by the Contract Documents.
 - 1. American National Standards Institute (ANSI)
 - a. ANSI B31.3 – Chemical Plant and Petroleum Refinery Piping.
 - 2. Air Transport Association
 - a. ATA 103 - Standards for Jet Fuel Quality Control at Airports
 - 3. American Society for Testing and Materials (ASTM)
 - a. ASTM D-1655 - Aviation Turbine Fuels
 - b. ASTM D-2276 - Particulate Contamination in Aviation Turbine Fuels, Tests for
 - c. D4176 - Standard Test Method for Free Water and Particulate Contamination in Distillate Fuels.
 - 4. International Building Code (IBC) with the Denver Amendments

5. International Fire Code (IFC) with the Denver Amendments
6. National Fire Protection Association (NFPA)
 - a. NFPA 30 - Flammable and Combustible Liquids Code.
 - b. NFPA 407 - Aircraft Fuel Service

1.5 SUBMITTALS

- A. Submit detailed procedures for testing methods for approval before proceeding with pipe fabrication. This includes all radiographing, pressure testing, holiday testing, and flushing.
- B. Submit examination personnel qualifications before proceeding with any testing method.
- C. Submit completed examination procedures with actual testing data (readings) and signatures of examination personnel.
- D. "As Built" Plans shall be provided in the same format and manner as described above. Each set shall be equipped with a plan holder equal to "Stacor Plan Clamps" for the appropriate size drawings.

1.6 QUALITY ASSURANCE

- A. All tests (radiographing, pressure testing, holiday testing, and flushing) shall be performed in accordance with ANSI B31.3.

PART 2 - PRODUCTS

2.1 EQUIPMENT

- A. The Contractor shall furnish all equipment required, including gauges, instruments, connections, air compressors, fuel transport trucks, pipe and hose connections, pumps, and other items specified or required.
- B. Compressors used for air testing shall have sufficient capacity to bring the system being tested up to the test pressure in approximately 20 minutes.

PART 3 - EXECUTION

3.1 TESTING PROCEDURE

- A. General:
 1. Electrically test all insulating flanges and joints.
 2. Submit detailed procedures for flushing and testing methods for approval before starting pipe installations. This includes all radiographing, pressure testing, and holiday testing.
 3. Water shall not be used for testing or flushing fuel piping.
 4. Sectionalize pipe lines as required to facilitate testing.

- B. Responsibility of Contractor:
1. Notify the proper authorities and the DEN Project Manager that items are ready for inspection and testing. Advance notice of the approximate testing time shall be given to the DEN Project Manager at least seven (7) days in advance of testing followed by not less than forty-eight (48) hours notice prior to actual time of performing any inspections and tests. Test results shall be furnished to the DEN Project Manager within forty-eight (48) hours after completion of test.
 2. Furnish all necessary equipment, materials and personnel, including pumps, compressors, gauges, and valves. Valves shall be suitable to hold test pressure for the specified time without leakage.
 3. Conduct the tests of all systems in a safe manner and correct all deficiencies.
 4. Apply the specified test pressures by means of a pump or compressor connected to the piping off highest elevation.
 5. Be fully responsible for providing qualified and experienced personnel to operate the equipment throughout the testing and flushing operations.
 6. Obtain all necessary approvals, acceptances, and permits.

3.2 INSPECTION OF COATINGS

- A. Contractor shall make a detailed inspection with a holiday tester of all pipe coating and joint coating preceding the lowering of the pipe.
- B. Holiday-tester voltage shall not be higher than the manufacturer's recommended voltage for the coating tested. Testing shall be for holidays only and not to test the dielectric strength of the coating materials.
- C. All holidays and damaged or broken places in the coating shall be repaired in a workmanlike manner at Contractor's expense.
- D. All holidays shall be patched using the methods specified for field-applied external protective pipe coating and procedure in SECTION 15055.

3.3 TESTING OF INSULATED FLANGES AND JOINTS

- A. Each insulating flange and joint assembly shall be tested with an approved ohmmeter.
- B. Ohmmeter used shall have at least 20 megohms, full-scale deflection when using the meter's highest dc resistance multiplier setting.
- C. Ohmmeter tests shall be made when flange assembly is dry using the highest multiplier setting and shall indicate infinity measured between each stud and both flanges.
- D. Each insulating flange assembly shall be field tested after installation and shall be tested not higher than the manufacturer's recommended voltage.
- E. Insulating flanges in the existing hydrant pits shall be tested by this Contract after

installation of hydrant pit valves provided by this Contract.

3.4 CLEANING

- A. After all of the new steel fuel piping has been radiographically inspected and pneumatically tested and accepted, all supply piping shall be cleaned by hand cleaning, followed by flushing with clean fuel (Jet-A).
- B. The Contractor shall furnish the necessary materials, equipment, and labor to perform a satisfactory cleaning operation.
- C. The cleaning operation shall be continued for each section of the lines until the line is determined clean by the Owner's Representative.

3.5 PNEUMATIC TESTING

- A. All fuel and piping systems shall be pressure tested with compressed air after all joints are completed, in accordance with ANSI B31.3. Sections of the system may be tested and accepted in order to expedite the work. These sections shall be tagged by the Contractor to indicate compliance with the tests.
- B. Install temporary closures or other fittings, including plugs, caps, blind flanges, etc., as necessary for the integrity of the piping system to be tested. Permanent valves and adapters shall be in place for testing.
- C. Pneumatic tests shall be made with clean dry filtered and oil free compressed air (minus 20 deg. F pressure dewpoint) or compressed nitrogen gas, and shall be made in accordance with all applicable codes particularly with regard to safety precautions and the following:
 - 1. A preliminary check at 5 psig shall be made.
 - 2. The pressure shall be increased gradually in steps, providing sufficient time to allow the piping to equalize strains during the test, and checking for leaks. Final test pressure shall be 25 psig.
 - 3. Maintain the required test pressure for at least eight (8) hours; continuously record temperature and pressure.
 - 4. Soap each joint and carefully inspect to detect leaks.
 - 5. Repair defective joints and repeat tests until approved by the DEN Project Manager.
 - 6. Pressure and temperature readings shall be taken:
 - a. Temperatures shall be representative of actual conditions.
 - b. Readings shall not be taken during times of rapid atmospheric changes. Rapid changes during test cycle will necessitate retesting.
 - c. There shall be no indication of reduction in test pressure after corrections for temperature and pressure have been made according to the relationship $T_1 P_2 = T_2 P_1$ where T and P are absolute temperatures and pressures and subscripts refer to initial and final readings.
 - d. The Contractor shall provide calibrated temperature and pressure recording instruments which are acceptable to the DEN Project Manager.

Contractor shall perform all required tests and record all data; and shall furnish the DEN Project Manager with a certified copy of the test results.

- e. Tests shall be witnessed and approved by the DEN Project Manager.

3.6 HYDROSTATIC TESTING

- A. All fueling supply piping shall be given a hydrostatic pressure test using Jet-A fuel as appropriate after the completion of all pneumatic testing. This test shall be conducted just prior to the flushing operations.
- B. Water shall not be used for hydrostatic testing.
- C. Test pressure for all hydrostatic tests shall be not less than 150 psig or 150 percent of the system operating pressure, whichever is greater. Preliminary tests shall provide for ten (10) cycles of pressurization to the test pressure, with each cycle followed by relieving pressure to not more than 25 psig. For each cycle, maintain pressure for length of time necessary to inspect for evidence of leakage.
- D. Following successful completion of preliminary tests, conduct final tests, with pressure maintained for at least two 4 hour cycles after pressure has stabilized. Pressure testing shall be performed as follows:
 - 1. Pressure shall be increased in gradual steps to the final test pressure and maintained for a 4 hour period, with continuous recording of temperature and pressure.
 - 2. Decrease pressure to 50 psig or less by venting at accessible points.
 - 3. Increase pressure again in gradual steps to the final test pressure; maintain it for another 4 hour period, continuously recording temperature and pressure.
- E. The Contractor shall provide calibrated temperature and pressure instruments and chart recorders to provide continuous temperature and pressure reading variations during the tests. Instruments shall be calibrated for temperature and pressure immediately prior to each test. Recorder charts shall be submitted to the DEN Project Manager for approval prior to final acceptance of the piping. Calibrated thermocouples may be surface applied by method approved by the DEN Project Manager.
- F. The Contractor shall observe diligent care not to spill or contaminate the test fuel. The Contractor shall be responsible for any and all required soil remediation (produced by leakage or spills) deemed necessary by the DEN Project Manager at no additional cost to the Owner.
- G. Repair any leaks detected during the preliminary cyclical tests pressure and again after first 4 hour test cycle in a manner approved by the DEN Project Manager. Retest, as described above, after all leaks have been repaired. Repeat the repair and retesting cycles until the system is acceptable to the DEN Project Manager.
- H. Equipment which is not rated by the manufacturer for the test pressure shall be removed prior to hydrostatic testing. Install temporary connections as necessary. All permanent butterfly and ball valves and equipment which are rated at the test pressure or greater shall be in place during the hydrostatic tests.

- I. Tests shall be witnessed and approved by the Owner's authorized representative. Record of the test shall be as follows:
 1. Date of test
 2. Description and identification of piping tested.
 3. Test fluid
 4. Test pressure
 5. Remarks to include such items as:
 - Leaks (type, location)
 - Repairs made on leaks
 6. Certification by Contractor and initialed acknowledgment by DEN Project Manager.
- J. The 4-hour recordings shall be made after temperature and pressure have stabilized and shall be conducted in accordance with NFPA Codes and API RP1110.
- K. For double containment systems, complete closure of containment system at joints, and backfill trenches for all piping after hydrostatic testing has been successfully completed and approved by the DEN Project Manager.

3.7 PERFORMANCE TESTING

- A. The Contractor shall subject the entire fueling system to such operating tests as required by the DEN Project Manager to demonstrate satisfactory functioning and operating performance of the entire fueling system.
- B. Tests shall include checks to determine that all control valves and switches are properly adjusted.
- C. Testing shall include the functions of the complete electrical system including the emergency shut-off electrical system.
- D. All instruments required to conduct the tests shall be furnished and operated by the Contractor using experienced and qualified personnel.
- E. Submit typed copies of test reports to the DEN Project Manager for approval.

3.8 FLUSHING

- A. General:
 1. After all of the fueling supply piping system has been radiographically inspected (for steel portions), cleaned, pressure tested, and accepted by the DEN Project Manager, the distribution system piping shall be flushed by the Contractor. Downstream of the system supply pumps, the fuel distribution piping shall be flushed with a minimum velocity of 10 feet per second.

Permanent system pumps may be used to obtain this velocity. Flushing for each system shall continue until discharged fuel is free of observable contamination.

2. At least fifteen days prior to the flushing operation the Contractor shall submit a written procedure for flushing with a list of equipment and labor to be used for the operation for approval by the DEN Project Manager.
3. Contractor shall apply all precautions to ensure safe flushing operation. Conform with fire safety needs of NFPA 30 and 101, all applicable ordinances, laws, regulations and codes of local and state authorities having jurisdiction.
4. It is the Contractor's responsibility to schedule and coordinate all personnel required for this flushing operation. The Contractor shall provide temporary pumps, tank vehicles, and labor to operate pumps and all supplementary equipment used for flushing fuel piping.
5. Contractor shall ensure that no equipment, valves, pumps, and like items are operated beyond their intended design capability or limitations.
6. All needed temporary cross connections, special fabrication, or adapters, required for flushing shall be provided by the Contractor. CAUTIONARY NOTE: The Contractor is responsible for taking into account the risk of production of electrostatic charge, at the flushing flow velocity specified, in the fuel; thus yielding possibility of fire or explosion. Refer to NFPA standards for discussion of hazards, and apply safeguards as appropriate.
7. Fuel for filling the system, for hydrostatic testing, and for flushing shall be provided by the Contractor. Upon completion and acceptance of all work, the piping system shall be left in filled condition, containing clean fuel. Any fuel remaining in the storage tanks after completion of testing shall be removed by the Contractor.
8. All general service valves and adapters shall be in place throughout the flushing procedure. Contractor shall remove control valves and metering assemblies prior to initiating flush.
9. Test samples for inspection of discharged flushing fuel cleanliness shall to be drawn immediately ahead of transport trucks provided by the Contractor to receive discharged flushing fuel.
10. Any fuel spilled shall be cleaned up and legally disposed of by the Contractor in accordance with federal, state and local regulations. Contractor shall notify DEN Project Manager and approval of spilled fuel disposal measures.
11. After flushing has been completed and approved, the Contractor shall remove all temporary cross connections, etc., and install control valves, metering elements, and other equipment as required.

B. Flushing Sequence

1. This procedure is intended as a guideline and is not necessarily all inclusive. The DEN Project Manager may vary, add to, or delete any of the following steps as are necessary to properly flush system to the cleanliness level required.
2. The truck unloading system piping shall be flushed utilizing the truck unloading pumps.

- C. Flushing into Tank Trucks:
CAUTION: All electrical and motorized equipment in area should be shut down in case of a mishap or fuel spill. For safety, all persons not involved in the flushing operation must be kept a minimum of 100 feet away from tank trucks used in the flushing operation.
1. Tank truck internal valves shall be safety wired in an open position.
 2. All quick release type couplings shall be safety wired when coupled to the bottom load receptacle and hydrant adapter.
 3. Hoses shall be secured in a manner to prevent whipping during flush. Four inch hoses shall be used to achieve flow capacities.
 4. Bond and ground truck to system piping.
 5. Start product flow slowly before reaching flushing velocity to check for leaks and system tightness.
 6. Fire extinguishers shall be kept in readily accessible locations in case of emergency.
 7. Location of test personnel:
 - a. One person per each tank truck to monitor fuel level in tank.
 - b. One person at each flushing discharge location to control fuel flow into tank truck.
 - c. One person at main pump control station to shut down pumps in emergency.
 - d. One person at nearest terminal EFSO station to shut down pumps in emergency.
 - e. One person manning fire extinguisher.
 - f. One person removed from manual tasks in command of flushing operation.
- D. Acceptance Specifications:
1. Visual - All discharged flushing fuel samples must be clear and bright. Other visual clues must be observed and acted upon accordingly; i.e., feel, color, odor, etc.
 2. Millipore Color Testing – Conduct the testing with an apparatus complying with ASTM D 2276. Once flushing is believed to be complete, perform a Millipore test on the fuel comparing the test filter to the standard color chart. If the fuel quality passes the test, flushing is complete. If the test fails, continue flushing and repeat the test.
- E. Final Acceptance:
1. The contractor shall furnish, after flushing is completed, a written report to the DEN Project Manager describing the flushing of each pipe section and the results of the Visual and Millipore tests performed in conjunction therewith.

PART 4 - MEASUREMENT

4.1 METHOD OF MEASUREMENT

- A. No separate measurement shall be made for work under this Section.

PART 5 - PAYMENT

5.1 PAYMENT

- A. No separate payment will be made for work under this section. The cost of the work described in this section shall be included in the applicable unit price item, work order or lump sum bid item.

END OF SECTION

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SECTION 335253 AVIATION FUELING IDENTIFICATION

PART 1 - GENERAL

1.1 SUMMARY

- A. Marking jet fuel and aviation gasoline piping and equipment.

1.2 RELATED SECTIONS

- A. Section 15010 - Basic Mechanical Requirements.
- B. Section 15050 - Basic Mechanical Materials and Methods.

1.3 REFERENCES

- A. Materials and workmanship shall conform to the latest issue of all industry standards, publications, or regulations referenced in this section and with the following references as applicable. Refer to Section 15010 for listing of issuing organizations or agencies.
- B. Applicable Standards:
 - 1. American Petroleum Institute (API):
 - a. API 1542 Airport Equipment Marking for Fuel Identification.
 - 2. National Fire Protection Association (NFPA):
 - a. NFPA 704 Identification of the Fire Hazards of Materials.
 - 3. American Society of Mechanical Engineers (ASME)
 - a. ASME A13.1 - Scheme for the Identification of Piping Systems.
 - 4. International Building Code (IBC) with the Denver Amendments
 - 5. International Fire Code (IFC) with the Denver Amendments

1.4 SUBMITTALS

- A. Submit list of wording, symbols, letter size, and color coding for mechanical identification.
- B. Include valve chart and schedule, including valve tag number, location, function, and valve manufacturer's name and model number.
- C. Product Data: Provide manufacturers catalog literature for each product required.
- D. "As Built" Plans shall be provided in the same format and manner as described above. Each set shall be equipped with a plan holder equal to "Stacor Plan Clamps" for the appropriate size drawings.

1.5 PROJECT RECORD DOCUMENTS

- A. Record actual locations of tagged valves.

PART 2 - PRODUCTS

2.1 ACCEPTABLE MANUFACTURERS

- A. Manufacturers:
 - 1. W.H. Brady Co.
 - 2. Panduit Corp.
 - 3. Seton Name Plate Corp.
 - 4. Marking Services, Inc.
 - 5. Substitutions: Under provisions of Section 15010.
- B. Piping identifications labeling shall be made with paint and stencil.
- C. All control valves and instrumentation shall have brass tags, 2" minimum diameter, with tag numbers and service stamped on the tag. Tags shall be securely fastened to the valves and instruments with 4-ply Monel wire meter seals. Tags shall be style 300-BL manufactured by Seton Name Plate Corp. or approved equal.

2.2 MATERIALS

- A. Color: Unless specified otherwise, conform with ASME A13.1.
- B. Plastic Nameplates: Laminated three-layer plastic with engraved black letters on light contrasting background color.
- C. Metal Tags: Brass or aluminum, with stamped letters; tag size minimum 1-1/2 inch diameter with smooth edges.
- D. Chart: Typewritten letter size list in anodized aluminum frame.
- E. Stencils: With clean cut symbols and letters of 2-1/2 inch size.
- F. Stencil Paint: In accordance with Division 9, semi-gloss enamel.
- G. Plastic Pipe Markers: Factory fabricated, flexible, semi-rigid plastic, preformed to fit around pipe or pipe covering; minimum information indicating flow direction arrow and fluid being conveyed.
- H. Underground Plastic Pipe Markers:
 - 1. Bright colored continuously printed plastic ribbon tape of not less than 6 inch wide by 4 mil thick, manufactured for direct burial service.
 - 2. For non-metallic buried piping provide printed foil type tape as manufactured by Marking Services Inc., enabling locating of runs by use of a metal detector.

PART 3 -EXECUTION

3.1 PREPARATION

- A. Degrease and clean surfaces to receive adhesive for identification materials.
- B. Prepare surfaces in accordance with Division 9 for stencil painting.

3.2 INSTALLATION

- A. Plastic Nameplates: Install with corrosive-resistant mechanical fasteners and adhesive.
- B. Metal Tags: Install with corrosive-resistant chain.
- C. Stencil Painting: Apply in accordance with Division 9.
- D. Plastic Pipe Markers: Install in accordance with manufacturer's instructions.
- E. Underground Plastic Pipe Markers: Install 6 to 8 inches below finished grade or paving, directly above buried pipe.
- F. Controls: Identify control panels and major control components outside panels with plastic nameplates. Key to control schematics.
- G. Valves Identification:
 - 1. Identify all valves, including fire protection valves, in main and branch piping located inside the building. Use tags secured with brass 'S' hooks or brass chains.
 - 2. Stamp tags with a unique prefix to identify system to which applied, followed by a number (Example: CW-1, CW-2, etc.). In general, prefix shall match system abbreviations used on drawings where applicable.
 - 3. Provide a typewritten listing of valves including: valve identification number, location, function, normal position, service, and area served. Mount list as specified and directed. Include additional copy in operation and maintenance manuals.
 - 4. Show valve tag designations on the project record document drawings, including schematic flow diagrams where included with construction documents.
 - 5. Contractor shall prepare and install where directed, in aluminum frames with clear plastic protective cover, a valve location diagram in the form of a series of flow diagrams with each automatic or manually actuated control or shut-off valve clearly identified in sequence with its individual valve tag number. Automatic control valves shall be tagged to match designations shown on the temperature control drawings, and the specified valve charts shall be installed adjacent to valve location diagrams.
- H. Piping: Identify piping, concealed or exposed, with plastic pipe markers. Tags may be used on ½" or smaller diameter non-insulated piping. Identify service, flow direction, and pressure. Install in clear view and align with axis of piping. Locate

identification not to exceed 20 feet on straight runs including risers and drops, adjacent to each valve and "T", at each side of penetration of structure or enclosure, and at each obstruction.

- I. Include signs for the following general categories of equipment:
 - 1. Main control and operating valves, including safety devices and hazardous units such as fuel outlets.
- J. Stenciled Equipment Sign Option: Stenciled signs may be provided instead of laminated-plastic equipment signs, at Installer's option, if lettering larger than 1 inch high is needed for proper identification because of distance from normal location of required identification.
- K. Install access panel markers with screws on equipment access panels.

3.3 VALVE CHART AND SCHEDULE

- A. Provide valve chart and schedule in aluminum frame with clear plastic shield. Install at location as directed.
- B. For fuel piping systems, piping identification shall conform to the following schedule:

<u>Fuel Type</u>	<u>Band Colors</u>	<u>Stenciled Legend</u>
Jet A	Black/Black Band	Jet A
Jet A-1	Black/2 Black Bands	Jet A-1
JP-4 (Jet B)	Black/3 Yellow Bands	JP-4
Avgas 115	Red/Purple Band	Avgas 115
Avgas 100	Red/Green Band	Avgas 100
Avgas 100LL	Red/Blue Band	Avgas 100LL
Avgas 80	Red/Red Band	Avgas 80

PART 4 - MEASUREMENT

4.1 METHOD OF MEASUREMENT

- A. No separate measurement shall be made for work under this Section.

PART 5 - PAYMENT

5.1 PAYMENT

- A. No separate payment will be made for work under this section. The cost of the work described in this section shall be included in the applicable unit price item, work order or lump sum bid item.

END OF SECTION 15190

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SECTION 404642 CATHODIC PROCESS CORROSION PROTECTION

PART 1 - GENERAL

1.1 SUMMARY

- A. The contractor shall furnish and install cathodic protection equipment, mounting hardware, etc., as required for complete installation as indicated in these specifications and on the drawings.

1.2 RELATED DOCUMENTS

- A. Drawings, General and Special Conditions, Division 1 - General Requirements, Section 16010, and other applicable technical specifications apply to work of this Section.

1.3 RELATED SECTIONS

- A. Division 1 - General: All Sections
- B. Division 2 – Site work: All Sections
- C. Division 16 - Electrical: All Sections

1.4 REFERENCE STANDARDS

- A. Comply with the requirements of the reference standards noted herein, except where more stringent requirements are listed herein or otherwise required by the Contract Documents.

1.5 CODES, REGULATIONS, AND STANDARDS

- A. All work shall be in strict accordance with all applicable codes including Building Code for the City and County of Denver, National Electrical Code (NEC), National Fire Protection Association (NFPA), and Life Safety Code (NFPA 101).

1.6 MATERIAL STANDARDS

- A. All material supplied shall be new and shall be equal to or exceed minimum requirements set by the following Standards:
 - 1. American National Standards Association (ANSI)
 - a. B 1.1-74: Unified Screw Threads
 - b. B 2.1-68: Pipe Threads
 - c. B16.5-77: Steel Pipe Flanges, Flanged valves and Fittings
 - d. B16.25-72: Butt welding Ends
 - e. 16.31-71: Non-Ferrous Pipe Flanges
 - f. B18.2-2: Square and Hex Nuts
 - 2. American Society for Testing and Materials (ASTM)

- a. A153-73: Zinc Coating on Iron and Steel Hardware
 - b. A194-78: Carbon and Alloy Steel Nuts
 - c. A307-76: Carbon Steel Externally and Internally Threaded Standard Fasteners
 - d. A518-74: Corrosion - Resistant High Silicon Cast Iron
 - e. C94-78: Ready-mixed Concrete
 - f. D1248-74: Polyethylene Plastic Molding and Extrusion Materials
3. U.S. Department of Transportation (DOT)
 - a. Pipeline Safety Regulations, Parts 190-195
 4. Denver Water Department (DWD)
 - a. Engineering Standards of the Board of Water
 - b. Commissioners, Chapters 9 and 10 - 1-1 -
 5. Electronic Industries Association (EIA)
 - a. RS-214: Method of Calculation of Current Rating for Hook-up Wire
 6. Federal Specifications (FS)
 - a. J-C-30A & Cable and Wire Electrical - Am-I
 - b. W-C-586B & Conduit, Outlet Boxes, Bodies and Entrance Caps Electrical - Am-I
 - c. W-F-408C & Fittings for Conduit, Metal, Rigid, EMT - Am-1 Type
 - d. HH-I-595C Insulation Tape, Electrical
 - e. WW-C-581d Conduit, Metal, Rigid
 7. Insulated Cable Engineers Association (ICEA)
 - a. S-61-402 Thermoplastic - Insulated Wires and Cables
 - b. S-66-524 Cross Linked Thermosetting Polyethylene Insulated Wires and Cables
 8. Institute for Electrical and Electronic Engineers (IEEE)
 9. National Association of Corrosion Engineers (NACE)
 - a. RP-0169-96 Recommended Practice of External Corrosion on Underground Metallic Piping Systems
 - b. RP-0193-93 Recommended Practice –External Cathodic Protection fo On-Grade Metallic Storage Tank Bottoms
 - c. RP-0285-95 Recommended Practice- Corrosion Control of Underground Storage Tank Systems by Cathodic Protection.
 - d. RP0286-86 The Electrical Isolation of Cathodically Protected Pipelines
 10. National Electrical Manufacturer's Association (NEMA)
 - a. ICS-70 Industrial Controls and Systems
 - b. MR 20-58 Cathodic Protection Units
 - c. RN 1-74 Polyvinyl-Chloride Coated Galvanized Rigid Steel Conduit
 - d. TC 2-78 Electrical Plastic Tubing and Conduit
 - e. ICS-6 Enclosures for Industrial Controls and Systems
 - f. ST-1 Specialty Transformers
 - g. AB-1 Circuit Breakers

11. National Electrical Safety Code (NESC)
12. National Fire Protection Association (NFPA)
 - a. NFPA-70 - National Electrical Code
13. Occupational Safety and Health Administration (OSHA)
 - a. OSHA-2207 Construction Industry
14. Xcel Energy (XCEL)
15. Underwriters Laboratories (UL)
 - a. 6-Rigid Metallic Conduit
 - b. 44-Rubber-Insulated Wires and Cables
 - c. 50-Electrical Cabinets and Boxes
 - d. 83/493-Thermoplastic-Insulated Wires
 - e. 467-Bonding and Grounding Equipment
 - f. 486-Wire Connectors and Soldering Lugs for Use with Copper Conductors
 - g. 510-Insulating Tape
 - h. 514-Outlet Boxes and Fittings
 - i. 354-Service-Entrance Cables
 - j. 651-Schedule 40 and 80 PVC Conduit
 - k. 1059-Electrical Terminal Blocks
 - l. 1066-L.V. AC and DC Power Circuit Breakers

1.7 CONSTRUCTION DRAWINGS

- A. The drawings are diagrammatic and indicate the general arrangement of electrical work. Locations are approximate and shall be subject to minor modifications as dictated by field conditions and as directed by DEN Project Manager.

1.8 ABBREVIATIONS

A	Ampere
AC	Alternating current
ANSI	American National Standards Association
ASTM	American Society for Testing and Materials
AWG	American Wire Gauge
AWS	American Welding Society
C	Conduit
CB/CKT	
BKR	Circuit breaker
CCD	City and County of Denver
CDOH	Colorado Division of Highways
CKT	Circuit
CE	Concrete encased
Comm	Communication
DB	Direct burial
DC	Direct current
DWG	Drawing

DISC	Disconnect
DOT	U.S. Department of Transportation
DWD	Denver Water Department
EM	Emergency
EIA	Electronic Industries Association
ELEC	Electric
EPA	Environmental Protection Agency
FAA	Federal Aviation Administration
FDR	Feeder
FS	Federal specifications
FU	Fuse
G	Generator
GND	Ground
HP	Horsepower
HV	High voltage
ICEA	Insulated Cable Engineers Association
IEEE	Institute of Electrical and Electronics Engineers
JB	Junction box
KV	Kilo volts
KVA	Kilo volt amperes
KW	Kilo watt
LV	Low voltage
MH	Manholes
MTD	Mounted
MTG HT	Mounting height
NACE	National Association of Corrosion Engineers
NC	Normally closed
NEC	National Electrical Code
NFPA	National Fire Protection Association
NEMA	National Electrical Manufacturers Association
NESC	National Electrical Safety Code
NMC	Nonmetallic conduit
OSHA	Occupational Safety and Health Administration
PB	Pull box
PNL	Panel
XCEL	Xcel Energy
RGS	Rigid galvanized steel
SW	Switch
TYP	Typical
UL	Underwriters Laboratories
V	Voltage
WP	Weatherproof

1.9 CONSTRUCTION DRAWINGS

- A. The drawings are diagrammatic and indicate the general arrangement of electrical work. Locations are approximate and shall be subject to minor modifications as dictated by field conditions and as directed by DEN Project Manager.

1.10 SUBMITTALS

- A. Product data: Including manufacturer's name and product number, electrical ratings, dimensions, mounting position, mounting method, materials, apply to this Section.
- B. Shop Drawings: Detail fabrication and installation of cathodic protection assemblies including plans, elevations, sections, component details, and attachments to other construction elements.
- C. Coordination Drawings: Include plans and sections to show cathodic protection assembly layouts and relationships between components and adjacent structural and mechanical elements. Show support locations, type of support, and weight on each support. Indicate and certify field measurements.
- D. Qualification Data: For firms and persons specified in "Quality Assurance" Article.
- E. Field Test Reports: Indicate and interpret test results for compliance with performance requirements.

1.11 QUALITY ASSURANCE

- A. The designer of the cathodic protection system shall be a personnel trained in cathodic protection sciences under a registered Professional Engineer with cathodic protection and corrosion prevention expertise or a NACE certified Corrosion Specialist. The design shall be signed by a Professional Engineer.
- B. Testing Agency Qualifications: Testing agency as a member company of the International Electrical Testing Association that is acceptable to authorities having jurisdiction.
 - 1. Testing Agency's Field Supervisor: Person currently certified by the International Electrical Testing Association or the National Institute for Certification in Engineering Technologies, to supervise on-site testing specified in Part 3.
- C. Source Limitations: Obtain enclosed cathodic protection components through one source from a single manufacturer.
- D. Enclosed Cathodic Protection Assemblies, Devices, and Accessories: Listed and labeled as defined in NFPA 70, Article 100, by a testing agency acceptable to authorities having jurisdiction.
- E. Comply with NFPA 70 for components and installation.

1.12 SEQUENCING AND SCHEDULING

- A. The cathodic protection equipment installation is to be sequenced and scheduled with other work to reduce possibility of damage and soiling of equipment during the remainder of construction period.

1.13 MAINTENANCE

- A. Furnish extra materials including 10 percent of installed cathodic protection assemblies and parts to match products installed and that are packaged with protective covering for storage and identified with labels describing contents. Deliver materials as directed by DEN Project Manager.

1.14 DELIVERY, STORAGE, AND HANDLING

- A. Deliver, store, and handle bus assemblies according to manufacturer's requirements.

1.15 PROJECT CONDITIONS

- A. Field Measurements: Verify existing dimensions by field measurements. Verify clearances and locate obstructions within manufacturing and installation tolerances of cathodic protection equipment.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

- A. Available Manufacturers: Subject to compliance with requirements and standards listed in Part 1.0.

2.2 GALVANIC OR SACRIFICIAL ANODE SYSTEM

- A. This system provides protective current to metals by electrically coupling the metal to be protected with another metal which appears higher in the electromotive force series. This sets up a galvanic coupling, because the medium in which both metals are contained acts as an electrolyte. The metal of higher potential becomes the anode, and sacrificially corrodes to protect installations such as piping or tanks which act as the cathode. The return path for current is through an electrical connection between the anode and the cathode. When sufficient current flows through the electrolyte to suppress all local action currents on the protected metal, cathodic protection is complete. This type system requires no external power supply; it uses sacrificial anodes.

2.3 CATHODIC PROTECTION CONTRACTOR RESPONSIBILITIES

- A. The function of the cathodic protection system shall include the following:
 1. Recognition of hazardous conditions prevailing at the site and the selection and specification of materials and installation practices in conformance with these standards and which will assure the safe installation and operation of the cathodic protection system.
 2. Perform a pre-engineering field survey consisting of determining or measuring the following characteristics of the electrolyte and the structures to be protected:
 - a. Collect and compile soil tests with provision for future testing, as required
 - b. Resistivity of the electrolyte.
 - c. Structure-to-electrolyte potential (if new installation, base requirement. on design calculations, field tests can only be run on existing structures).

- d. Cathodic protection current requirements.
 - e. Electrolyte characteristics such as variations and water content of soils, salinity and oxygen content of water, and maximum and minimum temperature.
 - f. Proximity of structure to be protected to other structures.
 - g. Compile characteristics of pipe coatings utilized.
 - h. Source of magnitude of stray currents including free electricity from electrical transmission lines and. strong RF fields, if any.
 - i. Locations of isolation between the protected structure and other metallic structures.
 - j. Locations of resistance bond stations (drain stations).
 - k. Electrical continuity test requirements for the metallic structures and lines that are to be protected, if available.
 - l. Locations of anode beds and rectifiers.
3. The design of cathodic protection system is for optimum economy of installation, maintenance, and operation.
 4. Compliance with specification of materials and installation practices which will assure dependable operation throughout the intended operating life of the cathodic protection system.
 5. Operation of a system is to minimize excessive protective currents or earth potential gradients, which can cause detrimental effects on pipe, coating, or neighboring buried or submerged metallic structures.
 6. Direction of cooperative investigations to determine mutually satisfactory solution(s) of interference problems.
 7. Coordinate with cathodic protection designers and installers involved in a common deep well ground bed system. to insure minimum interference currents between systems.
 8. Prepare suitable drawings to designate the over-all layout of the piping or other structures to be protected and the location of significant items of structure hardware, corrosion control test stations, electrical bonds, electrical insulators, and neighboring buried or submerged metallic structures.
 9. Layout shop drawings shall be prepared for each impressed current cathodic protection installation, showing the details and location of the components of the cathodic protection system with respect.to the protected structures and to major physical landmarks.
 10. The locations of galvanic anode installations shall be recorded on drawings or in tabular form, with appropriate notes as to anode type, weight, spacing, depth, and backfill.

2.4 CATHODIC PROTECTION SYSTEM PERFORMANCE REQUIREMENTS

- A. Provide adequate allowance for anticipated changes in current requirements with time.
- B. Placement of anodes where the possibility of disturbance or damage is minimal.

- C. The cathodic protection system shall protect all metallic surfaces presently being installed and providing for expansion capabilities for future installed items.
- D. Provide sufficient test stations to check the system's performance.

2.5 SACRIFICIAL ANODE

- A. Sacrificial anode systems may be used only where current requirements are low. Minimum negative voltage potential between structure and Cu/CuSO4 reference electrode shall be 0.85 volts.
- B. Magnesium anodes conforming to the following minimum chemical analysis, is the preferred anode material for sacrificial systems. Higher grade anodes may be utilized to reduce time between replacement.

C.Table 2.1 MINIMUM MAGNESIUM ANODES CHEMICAL ANALYSIS	
Aluminum	0.010% maximum
Manganese	0.50% to 1.30% maximum
Zinc	0
Silicon	0
Copper	0.02% maximum
Nickel	0.001% maximum
Iron	0.03% maximum
Other	0.05% each or 0.3% maximum total
Magnesium	remainder

- D. Zinc anodes conforming to the following chemical analysis may be considered only if the use of magnesium anodes is completely unworkable in areas of low soil resistivities (less than 900 ohms per square centimeter). The use of zinc anodes shall be required to be approved by the Project Manager.

E.

Table 2.2 ZINC ANODES CMEMICAM ANALYSIS	
Aluminum	0.005% maximum
Cadmium	0.003% maximum
Iron	0.0014% maximum
Lead	0.003% maximum
zinc	remainder

- F. Anodes shall be specified with the following requirements:
 1. Cast with a galvanized steel rod core silver soldered to a copper, high molecular weight polyethylene insulated (HMWPE) cable and have a net magnesium weight as required to attain a minimum 20 year life expectancy. The core weight shall not exceed 0.1 lb/ft.

- 2. Contained in a cloth sack with backfill consisting of 75 percent hydrated gypsum, 20 percent bentonite, and 5 percent sodium sulfate.
- G. The anode lead wire shall be No. 12 AWG, copper, 600 volt HMWPE insulation.
- H. Anode lead wires shall be long enough to permit installation to test station without use of underground splices.
- I. Anodes of various weights when tested shall not be allowed more than the following respective maximum current output indicated in Table 2.3 below.

J.

Weight Bare Anode	Allowable Current Output
5# Anode	0.010 Amperes
9# Anode	0.020 Amperes
17# Anode	0.045 Amperes
32# Anode	0.080 Amperes
50# Anode	0.120 Amperes

2.6 ANODE LOCATIONS

- A. Install at the locations shown on drawings for anodes and provide for symmetrical spacing to obtain uniform current distribution. Low, poorly drained areas are generally good locations for anodes and are highly desirable for efficient anode operation. Locate anodes in areas having the lowest resistance and nearest those points where corrosion has been determined to be the most severe; space anodes not closer than 4 feet from the protected structure and space a minimum of 20 feet from foreign structures. Place anodes at a depth that is below the bottom of the structure to be protected. For protection of tank interior or other structure where rod-type magnesium anodes are not practicable, zinc anodes can be mounted directly on, but separated by an insulating strip from, the surface of the steel to be protected.

2.7 RESISTOR USE

- A. In low resistivity media, where current flow must be limited, and anode output current is in excess of the required cathodic protection current, adjustable resistors must be used to limit the flow of current. The value of this resistance can be determined by applying Ohm's law.

2.8 CATHODIC PROTECTION VOLTAGE/CURRENT TEST STATIONS

- A. Install at the locations indicated on drawings for the cathodic protection test station. Test stations allow periodic checks to ensure that the system is providing the desired protection. Reference test station section for required test station locations.

2.9 CURRENT CARRYING CABLE REQUIREMENTS

- A. Where several anodes are connected to one header cable, compute the allowable voltage drop in that cable. Select the cable size in accordance with standard electrical engineering practice. Directly buried conductors should be properly insulated to prevent current leakage, and of a sufficient size to prevent mechanical damage.
- B. Cable conductor shall be copper, except resistance wire, and shall have HMWPE insulation type.
- C. All lead wire conductors shall be exothermic welded at splices and to protected surfaces, and sealed with a protective coating.
- D. All cad welded pipeline leads will include two wires to the test stations to allow for the loss of one line during the life of the installation.
- E. All other wiring shall be in compliance with Division 16.

2.10 ANODE INSTALLATION

- A. The installation of the anodes shall meet the following requirements:
 - 1. Packed anodes shall be installed completely dry and shall be lowered into holes by rope sling or by grasping the cloth gather, not by lowering with lead wire.
 - 2. Packaged galvanic anodes shall be wetted and then backfilled with compacted native soil. Where anodes and special chemical backfill are provided separately, anodes shall be centered in special backfill which would be compacted prior to backfilling with native soil. Care should be exercised so that lead wires and connections are not damaged during backfill operations. Sufficient slack should exist in lead wires to avoid strain.

2.11 BACKFILL

- A. The backfill shall be tamped calcined coke breeze material screened to provide a particle size from 1/81' to 3/811. Resistivity shall not exceed 25 ohm-cm at a moisture content of not more than 1%, with a bulk density of 46 to 50 lb/ft' and the following composition.

Table 2.5 BACKFILL COMPOSITION			
	Typical	Guaranteed Typical	Guaranteed
(a)	Fixed Carbon,	99.4	99.0 minimum percent (dry basis)
(b)	Ash,	0.3	0.5 maximum percent (dry basis)
(c)	Volatile matter,	0.3	0.5 maximum percent (dry basis)
(d)	Sulfur,	0.8	1.2 maximum percent (dry basis)
(e)	Moisture	0.02	1.0 maximum

- B. Backfill shall be vented to release the gas given off.

2.12 ANODE SHUNT JUNCTION BOXES

- A. Enclosures shall be watertight stainless steel or nonmetallic boxes complete with terminal blocks, shunts, copper jumpers, and bus bars. Shunts shall be in accordance with IEEE 316, 0.01 ohms, 8 amperes.

2.13 GENERAL CATHODIC PROTECTION SYSTEM STANDARDS

- A. Cathodic protection shall be provided for, but not limited to the following structures:
 - 1. Metallic pipelines
 - 2. Metallic underground structures, i.e., tanks, vaults, etc.
 - 3. Grounding mats, rods, et.
 - 4. Metallic structures in contact with earth.
- B. All systems protected shall be bonded, and be electrically continuous.
- C. All surfaces to be cathodically protected shall be coated in conformance to mechanical standards, referenced in Article 1.03.
- D. Stray currents will be avoided.

2.14 CABLES AND BONDS

- A. Cathodic protection cables shall be copper, in accordance with ICEA s-61-402, high molecular weight (HMW) Type CP polyethylene insulation not less than 7/64 inches (2.78 mm) thick. Insulation material shall be in accordance with ASTM D1248 Type I Class C, Grade 5. Cables shall have copper stranded conductors sized as follows:
 - 1. 2 No. 8 AWG minimum for pipe leads to test station boxes.
 - 2. 2 No. 8 AWG minimum from anodes to anode junction boxes.
 - 3. No. 2 AWG minimum for cast iron pipe mechanical joint bonds.
- B. Miscellaneous wire and cable requirements shall be as indicated in section 2, site Electrical, General.
- C. Splicing underground cables should be avoided where possible. Necessary splices be made with manufactured, UL. approved, splice kits.
- D. The DC conductors shall be run in rigid conduits of a size large enough to accommodate 1/0 cable or #8 AWG cable to the anodes to a depth of at least 18" below grade. DC conductors below 18" may be run direct buried. All conduits shall be terminated in the ground with a plastic bushing.
- E. The negative DC lead shall be connected to the protected structure by a exothermic weld connection. The connection shall be coated with a heavy coat of coal tar enamel, or equal with a plastic backfill shield installed over that.

- F. All underground pipe joints, except welded joints, shall be electrically bonded using a #2 AWG HMWPE insulated conductor, exothermic welded to each pipe section, and all component parts except bolts.

2.15 TEST STATIONS

- A. Test stations shall be provided on all protected structure at the following locations:
 - 1. Pipe lines at intervals not exceeding 1000 feet.
 - 2. Test stations will not be required within 300' of a riser pipe or any place where the pipe may be readily accessible.
 - 3. Where a carrier pipe is used under roads, railroads, etc.
 - 4. At all insulating underground joints (bond site).
 - 5. On each underground storage tank and each buried metallic process tank such as an oil-water separator or grit chamber.
 - 6. For sacrificial anodes added to the fuel system.
- B. Flush type test stations with heavy cast aluminum loading covers and collars suitable roadway installation shall be installed in all paved areas. Test station shall be Dabico Model D9-CPA-14D with Tinker-Razor Model T-3CP terminal board.
- C. Test station conductors shall be minimum #12 AWG-HMWPE insulated, color coded as required.
- D. Test stations shall be labeled with coded identification and shall be carefully located.

2.16 ELECTRICAL ISOLATION

- A. Provide electrical isolation between piping systems protected by different cathodic protection systems, at each building riser pipe, and at other points where a short-to another pipe or a foreign structure may occur. Provide electrical isolation between anchor plates, leak plates and any other structure penetration.
- B. Electrical isolation shall be provided at the first flange inside any building with the remainder of buried pipe protected. Note the DEN electrical specification which denies the use of water supply up to this flange from the exterior for use as an electrical ground.

2.17 ACCESSORIES

- A. Reference Electrodes
 - 1. The system shall be equipped with at least two references electrodes for each rectifier, either copper-copper sulfate (preferred) or silver-silver chloride designed for minimum twenty-year life. one electrode shall be installed in a location expecting minimum protection and the other in a location. expecting maximum protection.
- B. Potential Stations

1. This subject pertains to those situations where direct and uninterrupted surface contact to the soil surrounding the cathodically protected structure is not available. Examples include piping that is under concrete, piping that is below an environmental geomembrane, piping that is below coarse grade materials (such as gravel) that are not part of the electrolyte body, and above ground storage tank bottoms that have cathodic protection applied. Easy replacement of reference electrodes in the above mentioned location must be addressed in the design of the referenced electrode's installation. Elimination of the access problem for replacement through the use of test stations that allow access to native soil should be used where possible.
2. Potential stations located in areas with soil surface shall consist of a precast concrete housing, which is open at the bottom and shall be furnished with a cast iron traffic cover marked CP on the top of the cover. The station shall be filled to within 3 inches of its top with clean soil. Reference sections 02520, 02530 Airfield Geometrics and Landside Pavement Standards for any stations located in paved areas.

PART 3 - EXECUTION

3.1 INSTALLATION

- A. Install cathodic protection assemblies according to drawings, manufacturer's written installation instructions, Shop Drawings, and referenced standards.

3.2 FIELD TESTING

- A. The following requirements shall be performed by the contractor for all field-testing.

3.3 LEADS

- A. All leads shall be verified for continuity after backfill, and those found broken or otherwise defective shall be re-excavated and re-installed or repaired.

3.4 INSULATING FLANGES AND JOINTS

- A. Electrical isolation of each insulating flange or joints shall be verified. The test method and verification shall be submitted for approval.

3.5 SACRIFICIAL ANODE SYSTEM

- A. The sacrificial anode system shall be checked and shall have adequate capacity to provide a minimum pipe to soil potential of minus 0.850 V as measured against a copper/copper sulfate reference electrode positioned at grade level directly above the pipe.

3.6 POTENTIAL MEASUREMENT

- A. A complete survey of natural, or spontaneous pipe/tank to reference electrode potential measurements at all existing test stations shall be performed.

3.7 TEST RESULTS

- A. All test results shall be included as part of the final survey report.

3.8 GENERAL ANODE ACCEPTANCE TESTS

- A. Determine the resistance between the anode and the anode lead wire by immersing the anode/anode lead assembly at the center of a metal tank filled with a saturated sodium chloride solution.
- B. Impress a known current between the end of the lead wire and the filled tank.
- C. Measure the voltage between the end of the lead wire and the end of the anode opposite the lead wire end. Calculate the resistance value, to at least three significant figures, reduced to a zero length of lead wire. This value will closely approximate the anode connection resistance.

3.9 PROCEDURE FOR ACCEPTANCE OF ANODES

- A. Determine anode connection resistance as above.
- B. Reject those anodes which show open circuit.
- C. Plot the approximate anode connection resistance values. Determine the arithmetic mean of the plotted values.
- D. All anodes with connection resistance values in excess of twice the arithmetic mean shall be replaced.

3.10 STATIC POTENTIAL MEASUREMENTS

- A. A complete set of "static" potential measurements shall be obtained at the following locations:
 - 1. Fire Water Line - at all hydrant and valves.
 - 2. Fuel line - at all hydrant and valves.
 - 3. Above Ground Storage-Tanks - four (4) readings per tank with tanks greater than 10 ft diameter.
 - 4. Above Ground Storage Tanks - two (2) reading per tank with tanks less than or equal to 10 ft diameter.
 - 5. Main Pipeline Corridors - pipe-to-soil measurements, minimum of 100 ft apart.
 - 6. Anode Output - As the anodes are energized, current output shall be measured. The values obtained, date, time, and locations shall be recorded.
- B. 1. Interference Testing before final acceptance, interference tests shall be made with respect to any foreign pipelines, tanks or wells in cooperation with the owner of the foreign structure. A full report of the tests giving all details shall be made. Any methods recommended to eliminate interference shall be reported to DEN Project Manager. It is the responsibility of the new installation designer and contractor to assure the resolution to any electrical interference problems resulting from the

cathodic protection prior to system acceptance and to resolve any interferences found post construction that are deemed the result of said construction.

3.11 POST INSTALLATION REPORT

- A. A report, prepared by the design consultant and contractor, shall be issued to the DEN Project Manager, which will include all data obtained, analysis of data, record drawings, an Operations and Maintenance Manual and any further recommendations.

PART 4 - MEASUREMENT

4.1 METHOD OF MEASUREMENT

- A. Payment for “Install Cathodic Protection (CP)” shall be measured per each, for work installed in-place, completed, and approved by the DEN PM.

PART 5 - PAYMENT

5.1 PAYMENT

- A. Payment for “Install Cathodic Protection (CP)” will be made at the contract unit price per each for work installed in-place, completed, and approved by the DEN PM. This price shall be full compensation for furnishing all materials and installation of these materials, and for all labor, equipment, tools, and incidentals necessary to complete the item.

Payment will be made under:

Item 404642-1 Install Cathodic Protection (CP) – per each

END OF SECTION 404642