PROJECT MANUAL

FOR

NAPLES AIRPORT
FUEL FARM
IMPROVEMENTS PROJECT

OWNER:

Naples Airport Authority (NAA)

NAA TENANT PROJECT TITLE: Fuel Farm Improvements- Construction
HANSON PROJECT NUMBER: 23A0138.02
CURRIER PROJECT NUMBER: 23049

NAPLES AIRPORT AUTHORITY
NAPLES AIRPORT (APF)
160 AVIATION DRIVE NORTH
NAPLES, FL 34104

ISSUED FOR BID
ISSUE DATE
April 12, 2024

CURRIER
CURRIER & COMPANY, INC.

HANSON
TRUSTED PARTNERS. PROVEN RESULTS.

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INVITATION TO BID

NOTICE IS HEREBY GIVEN that the City of Naples Airport Authority (NAA) invites sealed bids from qualified Contractors to perform the following work, which is described in detail in the Bid Documents.

BID TITLE: FUEL FARM IMPROVEMENTS
NAPLES AIRPORT

BID OPENING LOCATION: Naples Airport
160 Aviation Drive North
2nd Floor Larson Conference Room
Naples, Florida 34104

BID SUBMITTAL DEADLINE: Wednesday, May 29, 2024 at 10:00 am ET

The City of Naples Airport Authority is seeking sealed bids for the Fuel Farm Improvements Project at Naples Airport. This project will improve capabilities of airport fueling operations to address the aging infrastructure and obsolescence, inefficient loading/unloading configuration, changes to code requirements, environmental wear and tear, and lack of resiliency in the system. These improvements include replacement of all piping, much of the electrical infrastructure along with elevation above base flood plain, upgrades to safety shut-off valves and dispensers at improved loading positions, a new operator office, new meters and controls, and an additional loading rack and tank for Sustainable Aviation Fuel (SAF). Additionally, all site work such as grading, containment, drainage features, and access road widening is included to complete this upgrade.

Instructions to Bidders, Bid Forms, Contract Documents, Plans and Specifications are available as of **Friday, April 12th, 2024,** as a download from https://flynaples.com/doing-business-with-the-authority/open-bids/, as electronic files in PDF format.

All interested prime contractors are strongly urged to attend a **Pre-bid Conference and Site Visit** scheduled for **09:00 A.M. EDT, Tuesday, April 23rd, 2024** at the Naples Airport, General Aviation Terminal, 2nd Floor Larson Conference Room, 160 Aviation Drive North, Naples, Florida 34104. Questions may be submitted until **5:00 P.M**., **Friday, May 10th, 2024** to Greg Helton at ghelton@hanson-inc.com as a Microsoft Word document. No questions will be accepted after that time. Bidders shall not contact City of Naples Airport Authority Employees, Agents, City of Naples Elected Officials, or the Engineer to discuss the project. Answers to all questions will be compiled into an addendum and posted at https://flynaples.com/doing-business-with-the-authority/open-bids/ on **Wednesday, May 15th, 2024**, **2024**. Proposers are encouraged to monitor the Naples Website for posting of Addenda up until the submittal deadline.

Prospective Bidders shall make sure that bids are mailed or delivered to the City of Naples Airport Authority, (address above) no later than the deadline specified, using the forms furnished with and conforming to the requirements of the Bid Documents. Prospective bidders shall enclose their proposal in a sealed opaque envelope addressed as follows:

City of Naples Airport Authority
Mrs. Linda Jackson Best
Senior Procurement and Contracts Manager
160 Aviation Drive North, 2nd Floor

Naples, Florida 34104 A bid bond or certified cashier's check payable to the City of Naples Airport Authority, equal to five percent (5%) of the total bid amount must be enclosed with the bid. The NAA assumes no responsibility for bids received after the bid submittal time or at any location other than that specified, no matter what the reason. Late bids will not be opened and will not be considered for award. No bidder may withdraw his bid within a period of one hundred fifty (150) days after the actual date of opening thereof.

INVITATION TO BID

All bidders are advised that the project will be funded in part by an Airport Improvement Plan grant, therefore typical Federal mandatory provisions will apply to the contract. Among these are:

Buy American
Foreign Trade Restrictions
Davis Bacon
Affirmative Action
Government-wide Debarment and Suspension
Government-wide Requirements for a Drug-free Workplace
Disadvantaged Business Enterprise

A full listing along with the text of the referenced provisions is included in the contract documents and specifications.

All Bidders must be licensed in accordance with Florida Laws. The Authority recognizes fair and open competition as a basic tenet of public procurement. Respondents doing business with the Authority are prohibited from discriminating on the basis of race, color, creed, national origin, handicap, age or sex. The NAA has a progressive Disadvantaged, Minority, and Women-Owned Business Enterprises Program in place and encourages Disadvantaged, Minority, and Women-Owned Business Enterprises to participate in its RFB process.

The City of Naples Airport Authority reserves the right to waive any formalities, technicalities, or irregularities in; or reject any or all Bids; or to re-advertise for Bids and award or refrain from awarding the Contract for the Work.

The City of Naples Airport Authority adheres to the American with Disabilities Act and will make reasonable modifications for access to Airport services, programs and activities. Please call (239) 643-0733 for further information. Requests must be made at least 48 hours in advance of the event in order to allow the NAA time to provide the requested services.

City of Naples Airport Authority, Florida
Kerry Keith, Senior Director
Airport Development and Facilities

Publish Date: 4/12/2024

Part 1 – General Contract Provisions

Section 10 Definition of Terms

When the following terms are used in these specifications, in the contract, or in any documents or other instruments pertaining to construction where these specifications govern, the intent and meaning shall be defined as follows:

Paragraph Number	Term	Definition
10-01	**AASHTO**	The American Association of State Highway and Transportation Officials.
10-02	**Access Road**	The right-of-way, the roadway and all improvements constructed thereon connecting the airport to a public roadway.
10-03	**Advertisement**	A public announcement, as required by local law, inviting bids for work to be performed and materials to be furnished.
10-04	**Airport**	Airport means an area of land or water which is used or intended to be used for the landing and takeoff of aircraft; an appurtenant area used or intended to be used for airport buildings or other airport facilities or rights of way; airport buildings and facilities located in any of these areas, and a heliport.
10-05	**Airport Improvement Program (AIP)**	A grant-in-aid program, administered by the Federal Aviation Administration (FAA).
10-06	**Air Operations Area (AOA)**	The term air operations area (AOA) shall mean any area of the airport used or intended to be used for the landing, takeoff, or surface maneuvering of aircraft. An air operation area shall include such paved or unpaved areas that are used or intended to be used for the unobstructed movement of aircraft in addition to its associated runway, taxiway, or apron.
10-07	**Apron**	Area where aircraft are parked, unloaded or loaded, fueled and/or serviced.
10-08	**ASTM International (ASTM)**	Formerly known as the American Society for Testing and Materials (ASTM).

Paragraph Number	Term	Definition
10-09	**Award**	The Owner's notice to the successful bidder of the acceptance of the submitted bid.
10-10	**Bidder**	Any individual, partnership, firm, or corporation, acting directly or through a duly authorized representative, who submits a proposal for the work contemplated.
10-11	**Building Area**	An area on the airport to be used, considered, or intended to be used for airport buildings or other airport facilities or rights-of-way together with all airport buildings and facilities located thereon.
10-12	**Calendar Day**	Every day shown on the calendar.
10-13	**Certificate of Analysis (COA)**	The COA is the manufacturer's Certificate of Compliance (COC) including all applicable test results required by the specifications.
10-14	**Certificate of Compliance (COC)**	The manufacturer's certification stating that materials or assemblies furnished fully comply with the requirements of the contract. The certificate shall be signed by the manufacturer's authorized representative.
10-15	**Change Order**	A written order to the Contractor covering changes in the plans, specifications, or proposal quantities and establishing the basis of payment and contract time adjustment, if any, for work within the scope of the contract and necessary to complete the project.
10-16	**Contract**	A written agreement between the Owner and the Contractor that establishes the obligations of the parties including but not limited to performance of work, furnishing of labor, equipment and materials and the basis of payment. The awarded contract includes but may not be limited to: Advertisement, Contract form, Proposal, Performance bond, payment bond, General provisions, certifications and representations, Technical Specifications, Plans, Supplemental Provisions, standards incorporated by reference and issued addenda.
10-17	**Contract Item (Pay Item)**	A specific unit of work for which a price is provided in the contract.

Paragraph Number	Term	Definition
10-18	**Contract Time**	The number of calendar days or working days, stated in the proposal, allowed for completion of the contract, including authorized time extensions. If a calendar date of completion is stated in the proposal, in lieu of a number of calendar or working days, the contract shall be completed by that date.
10-19	**Contractor**	The individual, partnership, firm, or corporation primarily liable for the acceptable performance of the work contracted and for the payment of all legal debts pertaining to the work who acts directly or through lawful agents or employees to complete the contract work.
10-20	**Contractors Quality Control (QC) Facilities**	The Contractor's QC facilities in accordance with the Contractor Quality Control Program (CQCP).
10-21	**Contractor Quality Control Program (CQCP)**	Details the methods and procedures that will be taken to assure that all materials and completed construction required by the contract conform to contract plans, technical specifications and other requirements, whether manufactured by the Contractor, or procured from subcontractors or vendors.
10-22	**Control Strip**	A demonstration by the Contractor that the materials, equipment, and construction processes results in a product meeting the requirements of the specification.
10-23	**Construction Safety and Phasing Plan (CSPP)**	The overall plan for safety and phasing of a construction project developed by the airport operator, or developed by the airport operator's consultant and approved by the airport operator. It is included in the invitation for bids and becomes part of the project specifications.
10-24	**Drainage System**	The system of pipes, ditches, and structures by which surface or subsurface waters are collected and conducted from the airport area.
10-25	**Engineer**	The individual, partnership, firm, or corporation duly authorized by the Owner to be responsible for engineering, inspection, and/or observation of the contract work and acting directly or through an authorized representative.
10-26	**Equipment**	All machinery, together with the necessary supplies for upkeep and maintenance; and all tools and apparatus necessary for the proper construction and acceptable completion of the work.

Paragraph Number	Term	Definition
10-27	**Extra Work**	An item of work not provided for in the awarded contract as previously modified by change order or supplemental agreement, but which is found by the Owner's Engineer or Resident Project Representative (RPR) to be necessary to complete the work within the intended scope of the contract as previously modified.
10-28	**FAA**	The Federal Aviation Administration. When used to designate a person, FAA shall mean the Administrator or their duly authorized representative.
10-29	**Federal Specifications**	The federal specifications and standards, commercial item descriptions, and supplements, amendments, and indices prepared and issued by the General Services Administration.
10-30	**Force Account**	**a.** Contract Force Account - A method of payment that addresses extra work performed by the Contractor on a time and material basis. **b.** Owner Force Account - Work performed for the project by the Owner's employees.
10-31	**Intention of Terms**	Whenever, in these specifications or on the plans, the words "directed," "required," "permitted," "ordered," "designated," "prescribed," or words of like import are used, it shall be understood that the direction, requirement, permission, order, designation, or prescription of the Engineer and/or Resident Project Representative (RPR) is intended; and similarly, the words "approved," "acceptable," "satisfactory," or words of like import, shall mean approved by, or acceptable to, or satisfactory to the Engineer and/or RPR, subject in each case to the final determination of the Owner. Any reference to a specific requirement of a numbered paragraph of the contract specifications or a cited standard shall be interpreted to include all general requirements of the entire section, specification item, or cited standard that may be pertinent to such specific reference.
10-32	**Lighting**	A system of fixtures providing or controlling the light sources used on or near the airport or within the airport buildings. The field lighting includes all luminous signals, markers, floodlights, and illuminating devices used on or near the airport or to aid in the operation of aircraft landing at, taking off from, or taxiing on the airport surface.

Paragraph Number	Term	Definition
10-33	**Major and Minor Contract Items**	A major contract item shall be any item that is listed in the proposal, the total cost of which is equal to or greater than 20% of the total amount of the award contract. All other items shall be considered minor contract items.
10-34	**Materials**	Any substance specified for use in the construction of the contract work.
10-35	**Modification of Standards (MOS)**	Any deviation from standard specifications applicable to material and construction methods in accordance with FAA Order 5300.1.
10-36	**Notice to Proceed (NTP)**	A written notice to the Contractor to begin the actual contract work on a previously agreed to date. If applicable, the Notice to Proceed shall state the date on which the contract time begins.
10-37	**Owner**	The term "Owner" shall mean the party of the first part or the contracting agency signatory to the contract. Where the term "Owner" is capitalized in this document, it shall mean airport Sponsor only. The Owner for this project is **City of Naples Airport Authority (NAA).**
10-38	**Passenger Facility Charge (PFC)**	Per 14 Code of Federal Regulations (CFR) Part 158 and 49 United States Code (USC) § 40117, a PFC is a charge imposed by a public agency on passengers enplaned at a commercial service airport it controls.
10-39	**Pavement Structure**	The combined surface course, base course(s), and subbase course(s), if any, considered as a single unit.
10-40	**Payment bond**	The approved form of security furnished by the Contractor and their own surety as a guaranty that the Contractor will pay in full all bills and accounts for materials and labor used in the construction of the work.
10-41	**Performance bond**	The approved form of security furnished by the Contractor and their own surety as a guaranty that the Contractor will complete the work in accordance with the terms of the contract.

Paragraph Number	Term	Definition
10-42	**Plans**	The official drawings or exact reproductions which show the location, character, dimensions and details of the airport and the work to be done and which are to be considered as a part of the contract, supplementary to the specifications. Plans may also be referred to as 'contract drawings.'
10-43	**Project**	The agreed scope of work for accomplishing specific airport development with respect to a particular airport.
10-44	**Proposal**	The written offer of the bidder (when submitted on the approved proposal form) to perform the contemplated work and furnish the necessary materials in accordance with the provisions of the plans and specifications.
10-45	**Proposal guaranty**	The security furnished with a proposal to guarantee that the bidder will enter into a contract if their own proposal is accepted by the Owner.
10-46	**Quality Assurance (QA)**	Owner's responsibility to assure that construction work completed complies with specifications for payment.
10-47	**Quality Control (QC)**	Contractor's responsibility to control material(s) and construction processes to complete construction in accordance with project specifications.
10-48	**Quality Assurance (QA) Inspector**	An authorized representative of the Engineer and/or Resident Project Representative (RPR) assigned to make all necessary inspections, observations, tests, and/or observation of tests of the work performed or being performed, or of the materials furnished or being furnished by the Contractor.
10-49	**Quality Assurance (QA) Laboratory**	The official quality assurance testing laboratories of the Owner or such other laboratories as may be designated by the Engineer or RPR. May also be referred to as Engineer's, Owner's, or QA Laboratory.
10-50	**Resident Project Representative (RPR)**	The individual, partnership, firm, or corporation duly authorized by the Owner to be responsible for all necessary inspections, observations, tests, and/or observations of tests of the contract work performed or being performed, or of the materials furnished or being furnished by the Contractor, and acting directly or through an authorized representative.
10-51	**Runway**	The area on the airport prepared for the landing and takeoff of aircraft.

Paragraph Number	Term	Definition
10-52	**Runway Safety Area (RSA)**	A defined surface surrounding the runway prepared or suitable for reducing the risk of damage to aircraft. See the construction safety and phasing plan (CSPP) for limits of the RSA.
10-53	**Safety Plan Compliance Document (SPCD)**	Details how the Contractor will comply with the CSPP.
10-54	**Specifications**	A part of the contract containing the written directions and requirements for completing the contract work. Standards for specifying materials or testing which are cited in the contract specifications by reference shall have the same force and effect as if included in the contract physically.
10-55	**Sponsor**	A Sponsor is defined in 49 USC § 47102(24) as a public agency that submits to the FAA for an AIP grant; or a private Owner of a public-use airport that submits to the FAA an application for an AIP grant for the airport.
10-56	**Structures**	Airport facilities such as bridges; culverts; catch basins, inlets, retaining walls, cribbing; storm and sanitary sewer lines; water lines; underdrains; electrical ducts, manholes, handholes, lighting fixtures and bases; transformers; navigational aids; buildings; vaults; and, other manmade features of the airport that may be encountered in the work and not otherwise classified herein.
10-57	**Subgrade**	The soil that forms the pavement foundation.
10-58	**Superintendent**	The Contractor's executive representative who is present on the work during progress, authorized to receive and fulfill instructions from the RPR, and who shall supervise and direct the construction.
10-59	**Supplemental Agreement**	A written agreement between the Contractor and the Owner that establishes the basis of payment and contract time adjustment, if any, for the work affected by the supplemental agreement. A supplemental agreement is required if: (1) in scope work would increase or decrease the total amount of the awarded contract by more than 25%: (2) in scope work would increase or decrease the total of any major contract item by more than 25%; (3) work that is not within the scope of the originally awarded contract; or (4) adding or deleting of a major contract item.
10-60	**Surety**	The corporation, partnership, or individual, other than the Contractor, executing payment or performance bonds that are furnished to the Owner by the Contractor.

Paragraph Number	Term	Definition
10-61	**Taxilane**	A taxiway designed for low speed movement of aircraft between aircraft parking areas and terminal areas.
10-62	**Taxiway**	The portion of the air operations area of an airport that has been designated by competent airport authority for movement of aircraft to and from the airport's runways, aircraft parking areas, and terminal areas.
10-63	**Taxiway/Taxilane Safety Area (TSA)**	A defined surface alongside the taxiway prepared or suitable for reducing the risk of damage to an aircraft. See the construction safety and phasing plan (CSPP) for limits of the TSA.
10-64	**Work**	The furnishing of all labor, materials, tools, equipment, and incidentals necessary or convenient to the Contractor's performance of all duties and obligations imposed by the contract, plans, and specifications.
10-65	**Working day**	A working day shall be any day other than a legal holiday, Saturday, or Sunday on which the normal working forces of the Contractor may proceed with regular work for at least six (6) hours toward completion of the contract. When work is suspended for causes beyond the Contractor's control, it will not be counted as a working day. Saturdays, Sundays and holidays on which the Contractor's forces engage in regular work will be considered as working days.
10-66	**Owner Defined terms**	None

END OF SECTION 10

Section 20 Proposal Requirements and Conditions

20-01 Advertisement (Notice to Bidders). Refer to Section 00 Invitation to Bid

20-02 Qualification of bidders. Each bidder shall submit evidence of competency and evidence of financial responsibility to perform the work to the Owner at the time of bid opening.

Evidence of competency, unless otherwise specified, shall consist of statements covering the bidder's past experience on similar work, and a list of equipment and a list of key personnel that would be available for the work.

Each bidder shall furnish the Owner satisfactory evidence of their financial responsibility. Evidence of financial responsibility, unless otherwise specified, shall consist of a confidential statement or report of the bidder's financial resources and liabilities as of the last calendar year or the bidder's last fiscal year. Such statements or reports shall be certified by a public accountant. At the time of submitting such financial statements or reports, the bidder shall further certify whether their financial responsibility is approximately the same as stated or reported by the public accountant. If the bidder's financial responsibility has changed, the bidder shall qualify the public accountant's statement or report to reflect the bidder's true financial condition at the time such qualified statement or report is submitted to the Owner.

Unless otherwise specified, a bidder may submit evidence that they are prequalified with the Florida Department of Transportation (FDOT). Evidence of FDOT prequalification may be submitted as evidence of financial responsibility in lieu of the certified statements or reports specified above.

20-03 Contents of proposal forms. The Owner's proposal forms state the location and description of the proposed construction; the place, date, and time of opening of the proposals; and the estimated quantities of the various items of work to be performed and materials to be furnished for which unit bid prices are asked. The proposal form states the time in which the work must be completed, and the amount of the proposal guaranty that must accompany the proposal. The Owner will accept only those Proposals properly executed on physical forms or electronic forms provided by the Owner. Bidder actions that may cause the Owner to deem a proposal irregular are given in paragraph 20-09 *Irregular proposals*.

Mobilization is limited to 10 percent of the total project cost.

20-04 Issuance of proposal forms. The Owner reserves the right to refuse to issue a proposal form to a prospective bidder if the bidder is in default for any of the following reasons:

a. Failure to comply with any prequalification regulations of the Owner, if such regulations are cited, or otherwise included, in the proposal as a requirement for bidding.

b. Failure to pay, or satisfactorily settle, all bills due for labor and materials on former contracts in force with the Owner at the time the Owner issues the proposal to a prospective bidder.

c. Documented record of Contractor default under previous contracts with the Owner.

d. Documented record of unsatisfactory work on previous contracts with the Owner.

20-05 Interpretation of estimated proposal quantities. An estimate of quantities of work to be done and materials to be furnished under these specifications is given in the proposal. It is the result of careful calculations and is believed to be correct. It is given only as a basis for comparison of proposals and the award of the contract. The Owner does not expressly, or by implication, agree that the actual quantities involved will correspond exactly therewith; nor shall the bidder plead misunderstanding or deception because of such estimates of quantities, or of the character, location, or other conditions pertaining to the work. Payment to the Contractor will be made only for the actual quantities of work performed or materials furnished in accordance with the plans and specifications. It is understood that the quantities may be increased or decreased as provided in the Section 40, paragraph 40-02, Alteration of Work and Quantities, without in any way invalidating the unit bid prices.

20-06 Examination of plans, specifications, and site. The bidder is expected to carefully examine the site of the proposed work, the proposal, plans, specifications, and contract forms. Bidders shall satisfy themselves to the character, quality, and quantities of work to be performed, materials to be furnished, and to the requirements of the proposed contract. The submission of a proposal shall be prima facie evidence that the bidder has made such examination and is satisfied to the conditions to be encountered in performing the work and the requirements of the proposed contract, plans, and specifications.

Boring logs and other records of subsurface investigations and tests are available for inspection of bidders. It is understood and agreed that such subsurface information, whether included in the plans, specifications, or otherwise made available to the bidder, was obtained and is intended for the Owner's design and estimating purposes only. Such information has been made available for the convenience of all bidders. It is further understood and agreed that each bidder is solely responsible for all assumptions, deductions, or conclusions which the bidder may make or obtain from their own examination of the boring logs and other records of subsurface investigations and tests that are furnished by the Owner.

20-07 Preparation of proposal. The bidder shall submit their proposal on the forms furnished by the Owner. All blank spaces in the proposal forms, unless explicitly stated otherwise, must be correctly filled in where indicated for each and every item for which a quantity is given. The bidder shall state the price (written in ink or typed) both in words and numerals which they propose for each pay item furnished in the proposal. In case of conflict between words and numerals, the words, unless obviously incorrect, shall govern.

The bidder shall correctly sign the proposal in ink. If the proposal is made by an individual, their name and post office address must be shown. If made by a partnership, the name and post office address of each member of the partnership must be shown. If made by a corporation, the person signing the proposal shall give the name of the state where the corporation was chartered and the name, titles, and business address of the president, secretary, and the treasurer. Anyone signing a proposal as an agent shall file evidence of their authority to do so and that the signature is binding upon the firm or corporation.

20-08 Responsive and responsible bidder. A responsive bid conforms to all significant terms and conditions contained in the Owner's invitation for bid. It is the Owner's responsibility to decide if the exceptions taken by a bidder to the solicitation are material or not and the extent of deviation it is willing to accept.

A responsible bidder has the ability to perform successfully under the terms and conditions of a proposed procurement, as defined in 2 CFR § 200.318(h). This includes such matters as Contractor integrity, compliance with public policy, record of past performance, and financial and technical resources.

20-09 Irregular proposals. Proposals shall be considered irregular for the following reasons:

a. If the proposal is on a form other than that furnished by the Owner, or if the Owner's form is altered, or if any part of the proposal form is detached.

b. If there are unauthorized additions, conditional or alternate pay items, or irregularities of any kind that make the proposal incomplete, indefinite, or otherwise ambiguous.

c. If the proposal does not contain a unit price for each pay item listed in the proposal, except in the case of authorized alternate pay items, for which the bidder is not required to furnish a unit price.

d. If the proposal contains unit prices that are obviously unbalanced.

e. If the proposal is not accompanied by the proposal guaranty specified by the Owner.

f. If the applicable Disadvantaged Business Enterprise information is incomplete.

The Owner reserves the right to reject any irregular proposal and the right to waive technicalities if such waiver is in the best interest of the Owner and conforms to local laws and ordinances pertaining to the letting of construction contracts.

20-10 Bid guarantee. Each separate proposal shall be accompanied by a bid bond, certified check, or other specified acceptable collateral, in the amount specified in the proposal form. Such bond, check, or collateral, shall be made payable to the Owner.

20-11 Delivery of proposal. Each proposal submitted shall be placed in a sealed envelope plainly marked with the project number, location of airport, and name and business address of the bidder on the outside. When sent by mail, preferably registered, the sealed proposal, marked as indicated above, should be enclosed in an additional envelope. No proposal will be considered unless received at the place specified in the advertisement or as modified by Addendum before the time specified for opening all bids. Proposals received after the bid opening time shall be returned to the bidder unopened.

20-12 Withdrawal or revision of proposals. A bidder may withdraw or revise (by withdrawal of one proposal and submission of another) a proposal provided that the bidder's request for withdrawal is received by the Owner in writing, by fax or by email before the time specified for opening bids. Revised proposals must be received at the place specified in the advertisement before the time specified for opening all bids.

20-13 Public opening of proposals. Proposals shall be opened, and read, publicly at the time and place specified in the advertisement. Bidders, their authorized agents, and other interested persons are invited to attend. Proposals that have been withdrawn (by written or telegraphic request) or received after the time specified for opening bids shall be returned to the bidder unopened.

20-14 Disqualification of bidders. A bidder shall be considered disqualified for any of the following reasons:

a. Submitting more than one proposal from the same partnership, firm, or corporation under the same or different name.

b. Evidence of collusion among bidders. Bidders participating in such collusion shall be disqualified as bidders for any future work of the Owner until any such participating bidder has been reinstated by the Owner as a qualified bidder.

c. If the bidder is considered to be in "default" for any reason specified in paragraph 20-04, *Issuance of Proposal Forms,* of this section.

20-15 Discrepancies and Omissions. A Bidder who discovers discrepancies or omissions with the project bid documents shall immediately notify the Owner's Engineer of the matter. A bidder that has doubt as to the true meaning of a project requirement may submit to the Owner's Engineer a written request for interpretation no later than seven (7) days prior to bid opening.

Any interpretation of the project bid documents by the Owner's Engineer will be by written addendum issued by the Owner. The Owner will not consider any instructions, clarifications or interpretations of the bidding documents in any manner other than written addendum.

END OF SECTION 20

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Section 30 Award and Execution of Contract

30-01 Consideration of proposals. After the proposals are publicly opened and read, they will be compared on the basis of the summation of the products obtained by multiplying the estimated quantities shown in the proposal by the unit bid prices. If a bidder's proposal contains a discrepancy between unit bid prices written in words and unit bid prices written in numbers, the unit bid price written in words shall govern.

Until the award of a contract is made, the Owner reserves the right to reject a bidder's proposal for any of the following reasons:

a. If the proposal is irregular as specified in Section 20, paragraph 20-09, *Irregular Proposals*.

b. If the bidder is disqualified for any of the reasons specified Section 20, paragraph 20-14, *Disqualification of Bidders*.

In addition, until the award of a contract is made, the Owner reserves the right to reject any or all proposals, waive technicalities, if such waiver is in the best interest of the Owner and is in conformance with applicable state and local laws or regulations pertaining to the letting of construction contracts; advertise for new proposals; or proceed with the work otherwise. All such actions shall promote the Owner's best interests.

30-02 Award of contract. The award of a contract, if it is to be awarded, shall be made within 150 calendar days of the date specified for publicly opening proposals, unless otherwise specified herein.

If the Owner elects to proceed with an award of contract, the Owner will make award to the responsible bidder whose bid, conforming with all the material terms and conditions of the bid documents, is the lowest in price.

30-03 Cancellation of award. The Owner reserves the right to cancel the award without liability to the bidder, except return of proposal guaranty, at any time before a contract has been fully executed by all parties and is approved by the Owner in accordance with paragraph 30-07 *Approval of Contract*.

30-04 Return of proposal guaranty. All proposal guaranties, except those of the two lowest bidders, will be returned immediately after the Owner has made a comparison of bids as specified in the paragraph 30-01, *Consideration of Proposals.* Proposal guaranties of the two lowest bidders will be retained by the Owner until such time as an award is made, at which time, the unsuccessful bidder's proposal guaranty will be returned. The successful bidder's proposal guaranty will be returned as soon as the Owner receives the contract bonds as specified in paragraph 30-05, *Requirements of Contract Bonds.*

30-05 Requirements of contract bonds. At the time of the execution of the contract, the successful bidder shall furnish the Owner a surety bond or bonds that have been fully executed by the bidder and the surety guaranteeing the performance of the work and the payment of all legal debts that may be incurred by reason of the Contractor's performance of the work. The surety and the form of the bond or bonds shall be acceptable to the Owner. Unless otherwise specified in this subsection, the surety bond or bonds shall be in a sum equal to the full amount of the contract.

30-06 Execution of contract. The successful bidder shall sign (execute) the necessary agreements for entering into the contract and return the signed contract to the Owner, along with the fully executed surety bond or bonds specified in paragraph 30-05, *Requirements of Contract Bonds,* of this section, within 15 calendar days from the date mailed or otherwise delivered to the successful bidder.

30-07 Approval of contract. Upon receipt of the contract and contract bond or bonds that have been executed by the successful bidder, the Owner shall complete the execution of the contract in accordance with local laws or ordinances, and return the fully executed contract to the Contractor. Delivery of the fully executed contract to the Contractor shall constitute the Owner's approval to be bound by the

successful bidder's proposal and the terms of the contract.

30-08 Failure to execute contract. Failure of the successful bidder to execute the contract and furnish an acceptable surety bond or bonds within the period specified in paragraph 30-06, *Execution of Contract,* of this section shall be just cause for cancellation of the award and forfeiture of the proposal guaranty, not as a penalty, but as liquidated damages to the Owner.

END OF SECTION 30

Section 40 Scope of Work

40-01 Intent of contract. The intent of the contract is to provide for construction and completion, in every detail, of the work described. It is further intended that the Contractor shall furnish all labor, materials, equipment, tools, transportation, and supplies required to complete the work in accordance with the plans, specifications, and terms of the contract.

40-02 Alteration of work and quantities. The Owner reserves the right to make such changes in quantities and work as may be necessary or desirable to complete, in a satisfactory manner, the original intended work. Unless otherwise specified in the Contract, the Owner's Engineer or RPR shall be and is hereby authorized to make, in writing, such in-scope alterations in the work and variation of quantities as may be necessary to complete the work, provided such action does not represent a significant change in the character of the work.

For purpose of this section, a significant change in character of work means: any change that is outside the current contract scope of work; any change (increase or decrease) in the total contract cost by more than 25%; or any change in the total cost of a major contract item by more than 25%.

Work alterations and quantity variances that do not meet the definition of significant change in character of work shall not invalidate the contract nor release the surety. Contractor agrees to accept payment for such work alterations and quantity variances in accordance with Section 90, paragraph 90-03, *Compensation for Altered Quantities*.

Should the value of altered work or quantity variance meet the criteria for significant change in character of work, such altered work and quantity variance shall be covered by a supplemental agreement. Supplemental agreements shall also require consent of the Contractor's surety and separate performance and payment bonds. If the Owner and the Contractor are unable to agree on a unit adjustment for any contract item that requires a supplemental agreement, the Owner reserves the right to terminate the contract with respect to the item and make other arrangements for its completion.

40-03 Omitted items. The Owner, the Owner's Engineer or the RPR may provide written notice to the Contractor to omit from the work any contract item that does not meet the definition of major contract item. Major contract items may be omitted by a supplemental agreement. Such omission of contract items shall not invalidate any other contract provision or requirement.

Should a contract item be omitted or otherwise ordered to be non-performed, the Contractor shall be paid for all work performed toward completion of such item prior to the date of the order to omit such item. Payment for work performed shall be in accordance with Section 90, paragraph 90-04, *Payment for Omitted Items*.

40-04 Extra work. Should acceptable completion of the contract require the Contractor to perform an item of work not provided for in the awarded contract as previously modified by change order or supplemental agreement, Owner may issue a Change Order to cover the necessary extra work. Change orders for extra work shall contain agreed unit prices for performing the change order work in accordance with the requirements specified in the order, and shall contain any adjustment to the contract time that, in the RPR's opinion, is necessary for completion of the extra work.

When determined by the RPR to be in the Owner's best interest, the RPR may order the Contractor to proceed with extra work as provided in Section 90, paragraph 90-05, *Payment for Extra Work*. Extra work that is necessary for acceptable completion of the project, but is not within the general scope of the work covered by the original contract shall be covered by a supplemental agreement as defined in Section 10, paragraph 10-59, *Supplemental Agreement*.

If extra work is essential to maintaining the project critical path, RPR may order the Contractor to commence the extra work under a Time and Material contract method. Once sufficient detail is available

to establish the level of effort necessary for the extra work, the Owner shall initiate a change order or supplemental agreement to cover the extra work.

Any claim for payment of extra work that is not covered by written agreement (change order or supplemental agreement) shall be rejected by the Owner.

40-05 Maintenance of traffic. It is the explicit intention of the contract that the safety of aircraft, as well as the Contractor's equipment and personnel, is the most important consideration. The Contractor shall maintain traffic in the manner detailed in the Construction Safety and Phasing Plan (CSPP).

a. It is understood and agreed that the Contractor shall provide for the free and unobstructed movement of aircraft in the air operations areas (AOAs) of the airport with respect to their own operations and the operations of all subcontractors as specified in Section 80, paragraph 80-04, *Limitation of Operations*. It is further understood and agreed that the Contractor shall provide for the uninterrupted operation of visual and electronic signals (including power supplies thereto) used in the guidance of aircraft while operating to, from, and upon the airport as specified in Section 70, paragraph 70-15, *Contractor's Responsibility for Utility Service and Facilities of Others*.

b. With respect to their own operations and the operations of all subcontractors, the Contractor shall provide marking, lighting, and other acceptable means of identifying personnel, equipment, vehicles, storage areas, and any work area or condition that may be hazardous to the operation of aircraft, fire-rescue equipment, or maintenance vehicles at the airport in accordance with the construction safety and phasing plan (CSPP) and the safety plan compliance document (SPCD).

c. When the contract requires the maintenance of an existing road, street, or highway during the Contractor's performance of work that is otherwise provided for in the contract, plans, and specifications, the Contractor shall keep the road, street, or highway open to all traffic and shall provide maintenance as may be required to accommodate traffic. The Contractor, at their expense, shall be responsible for the repair to equal or better than preconstruction conditions of any damage caused by the Contractor's equipment and personnel. The Contractor shall furnish, erect, and maintain barricades, warning signs, flag person, and other traffic control devices in reasonable conformity with the Manual on Uniform Traffic Control Devices (MUTCD) (http://mutcd.fhwa.dot.gov/), unless otherwise specified. The Contractor shall also construct and maintain in a safe condition any temporary connections necessary for ingress to and egress from abutting property or intersecting roads, streets or highways.

40-06 Removal of existing structures. All existing structures encountered within the established lines, grades, or grading sections shall be removed by the Contractor, unless such existing structures are otherwise specified to be relocated, adjusted up or down, salvaged, abandoned in place, reused in the work or to remain in place. The cost of removing such existing structures shall not be measured or paid for directly, but shall be included in the various contract items.

Should the Contractor encounter an existing structure (above or below ground) in the work for which the disposition is not indicated on the plans, the Resident Project Representative (RPR) shall be notified prior to disturbing such structure. The disposition of existing structures so encountered shall be immediately determined by the RPR in accordance with the provisions of the contract.

Except as provided in Section 40, paragraph 40-07, *Rights in and Use of Materials Found in the Work*, it is intended that all existing materials or structures that may be encountered (within the lines, grades, or grading sections established for completion of the work) shall be used in the work as otherwise provided for in the contract and shall remain the property of the Owner when so used in the work.

40-07 Rights in and use of materials found in the work. Should the Contractor encounter any material such as (but not restricted to) sand, stone, gravel, slag, or concrete slabs within the established lines, grades, or grading sections, the use of which is intended by the terms of the contract to be embankment, the Contractor may at their own option either:

a. Use such material in another contract item, providing such use is approved by the RPR and is in conformance with the contract specifications applicable to such use; or,

b. Remove such material from the site, upon written approval of the RPR; or

c. Use such material for the Contractor's own temporary construction on site; or,

d. Use such material as intended by the terms of the contract.

Should the Contractor wish to exercise option a., b., or c., the Contractor shall request the RPR's approval in advance of such use.

Should the RPR approve the Contractor's request to exercise option a., b., or c., the Contractor shall be paid for the excavation or removal of such material at the applicable contract price. The Contractor shall replace, at their expense, such removed or excavated material with an agreed equal volume of material that is acceptable for use in constructing embankment, backfills, or otherwise to the extent that such replacement material is needed to complete the contract work. The Contractor shall not be charged for use of such material used in the work or removed from the site.

Should the RPR approve the Contractor's exercise of option a., the Contractor shall be paid, at the applicable contract price, for furnishing and installing such material in accordance with requirements of the contract item in which the material is used.

It is understood and agreed that the Contractor shall make no claim for delays by reason of their own exercise of option a., b., or c.

The Contractor shall not excavate, remove, or otherwise disturb any material, structure, or part of a structure which is located outside the lines, grades, or grading sections established for the work, except where such excavation or removal is provided for in the contract, plans, or specifications.

40-08 Final cleanup. Upon completion of the work and before acceptance and final payment will be made, the Contractor shall remove from the site all machinery, equipment, surplus and discarded materials, rubbish, temporary structures, and stumps or portions of trees. The Contractor shall cut all brush and woods within the limits indicated and shall leave the site in a neat and presentable condition. Material cleared from the site and deposited on adjacent property will not be considered as having been disposed of satisfactorily, unless the Contractor has obtained the written permission of the property Owner.

END OF SECTION 40

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Section 50 Control of Work

50-01 Authority of the Resident Project Representative (RPR). The RPR has final authority regarding the interpretation of project specification requirements. The RPR shall determine acceptability of the quality of materials furnished, method of performance of work performed, and the manner and rate of performance of the work. The RPR does not have the authority to accept work that does not conform to specification requirements.

50-02 Conformity with plans and specifications. All work and all materials furnished shall be in reasonably close conformity with the lines, grades, grading sections, cross-sections, dimensions, material requirements, and testing requirements that are specified (including specified tolerances) in the contract, plans, or specifications.

If the RPR finds the materials furnished, work performed, or the finished product not within reasonably close conformity with the plans and specifications, but that the portion of the work affected will, in their opinion, result in a finished product having a level of safety, economy, durability, and workmanship acceptable to the Owner, the RPR will advise the Owner of their determination that the affected work be accepted and remain in place. The RPR will document the determination and recommend to the Owner a basis of acceptance that will provide for an adjustment in the contract price for the affected portion of the work. Changes in the contract price must be covered by contract change order or supplemental agreement as applicable.

If the RPR finds the materials furnished, work performed, or the finished product are not in reasonably close conformity with the plans and specifications and have resulted in an unacceptable finished product, the affected work or materials shall be removed and replaced or otherwise corrected by and at the expense of the Contractor in accordance with the RPR's written orders.

The term "reasonably close conformity" shall not be construed as waiving the Contractor's responsibility to complete the work in accordance with the contract, plans, and specifications. The term shall not be construed as waiving the RPR's responsibility to insist on strict compliance with the requirements of the contract, plans, and specifications during the Contractor's execution of the work, when, in the RPR's opinion, such compliance is essential to provide an acceptable finished portion of the work.

The term "reasonably close conformity" is also intended to provide the RPR with the authority, after consultation with the Sponsor and FAA, to use sound engineering judgment in their determinations to accept work that is not in strict conformity, but will provide a finished product equal to or better than that required by the requirements of the contract, plans and specifications.

The RPR will not be responsible for the Contractor's means, methods, techniques, sequences, or procedures of construction or the safety precautions incident thereto.

50-03 Coordination of contract, plans, and specifications. The contract, plans, specifications, and all referenced standards cited are essential parts of the contract requirements. If electronic files are provided and used on the project and there is a conflict between the electronic files and hard copy plans, the hard copy plans shall govern. A requirement occurring in one is as binding as though occurring in all. They are intended to be complementary and to describe and provide for a complete work. In case of discrepancy, calculated dimensions will govern over scaled dimensions; contract technical specifications shall govern over contract general provisions, plans, cited standards for materials or testing, and cited advisory circulars (ACs); contract general provisions shall govern over plans, cited standards for materials or testing, and cited ACs; plans shall govern over cited standards for materials or testing and cited ACs. If any paragraphs contained in the Special Provisions conflict with General Provisions or Technical Specifications, the Special Provisions shall govern.

From time to time, discrepancies within cited testing standards occur due to the timing of the change, edits, and/or replacement of the standards. If the Contractor discovers any apparent discrepancy within

standard test methods, the Contractor shall immediately ask the RPR for an interpretation and decision, and such decision shall be final.

The Contractor shall not take advantage of any apparent error or omission on the plans or specifications. In the event the Contractor discovers any apparent error or discrepancy, Contractor shall immediately notify the Owner or the designated representative in writing requesting their written interpretation and decision.

50-04 List of Special Provisions. Not Applicable.

50-05 Cooperation of Contractor. The Contractor shall be supplied with an electronic PDF of the plans and specifications. The Contractor shall have available on the construction site at all times one hardcopy each of the plans and specifications. Hard copies of plans and specifications may be obtained by the Contractor for the cost of reproduction.

The Contractor shall give constant attention to the work to facilitate the progress thereof, and shall cooperate with the RPR and their inspectors and with other Contractors in every way possible. The Contractor shall have a competent superintendent on the work at all times who is fully authorized as their agent on the work. The superintendent shall be capable of reading and thoroughly understanding the plans and specifications and shall receive and fulfill instructions from the RPR or their authorized representative.

50-06 Cooperation between Contractors. The Owner reserves the right to contract for andperform other or additional work on or near the work covered by this contract.

When separate contracts are let within the limits of any one project, each Contractor shall conduct the work not to interfere with or hinder the progress of completion of the work being performed by other Contractors. Contractors working on the same project shall cooperate with each other as directed.

Each Contractor involved shall assume all liability, financial or otherwise, in connection with their own contract and shall protect and hold harmless the Owner from any and all damages or claims that may arise because of inconvenience, delays, or loss experienced because of the presence and operations of other Contractors working within the limits of the same project.

The Contractor shall arrange their work and shall place and dispose of the materials being used to not interfere with the operations of the other Contractors within the limits of the same project. The Contractor shall join their work with that of the others in an acceptable manner and shall perform it in proper sequence to that of the others.

50-07 Construction layout and stakes. The Engineer shall establish necessary horizontal and vertical control. The establishment of Survey Control and/or reestablishment of survey control shall be by a State Licensed Land Surveyor. Contractor is responsible for preserving integrity of horizontal and vertical controls established by Engineer. In case of negligence on the part of the Contractor or their employees, resulting in the destruction of any horizontal and vertical control, the resulting costs will be deducted as a liquidated damage against the Contractor.

Prior to the start of construction, the Contractor will check all control points for horizontal and vertical accuracy and certify in writing to the RPR that the Contractor concurs with survey control established for the project. All lines, grades and measurements from control points necessary for the proper execution and control of the work on this project will be provided to the RPR. The Contractor is responsible to establish all layout required for the construction of the project.

Copies of survey notes will be provided to the RPR for each area of construction and for each placement of material as specified to allow the RPR to make periodic checks for conformance with plan grades, alignments and grade tolerances required by the applicable material specifications. Surveys will be provided to the RPR prior to commencing work items that cover or disturb the survey staking. Survey(s) and notes shall be provided in the following format(s): PDF's and/or AutoCAD.dwg.

Laser, GPS, String line, or other automatic control shall be checked with temporary control as necessary. In the case of error, on the part of the Contractor, their surveyor, employees or subcontractors, resulting in established grades, alignment or grade tolerances that do not concur with those specified or shown on the plans, the Contractor is solely responsible for correction, removal, replacement and all associated costs at no additional cost to the Owner.

No direct payment will be made, unless otherwise specified in contract documents, for this labor, materials, or other expenses. The cost shall be included in the price of the bid for the various items of the Contract.

50-08 Authority and duties of Quality Assurance (QA) inspectors. QA inspectors shall be authorized to inspect all work done and all material furnished. Such QA inspection may extend to all or any part of the work and to the preparation, fabrication, or manufacture of the materials to be used. QA inspectors are not authorized to revoke, alter, or waive any provision of the contract. QA inspectors are not authorized to issue instructions contrary to the plans and specifications or to act as foreman for the Contractor.

QA Inspectors are authorized to notify the Contractor or their representatives of any failure of the work or materials to conform to the requirements of the contract, plans, or specifications and to reject such nonconforming materials in question until such issues can be referred to the RPR for a decision.

50-09 Inspection of the work. All materials and each part or detail of the work shall be subject to inspection. The RPR shall be allowed access to all parts of the work and shall be furnished with such information and assistance by the Contractor as is required to make a complete and detailed inspection.

If the RPR requests it, the Contractor, at any time before acceptance of the work, shall remove or uncover such portions of the finished work as may be directed. After examination, the Contractor shall restore said portions of the work to the standard required by the specifications. Should the work thus exposed or examined prove acceptable, the uncovering, or removing, and the replacing of the covering or making good of the parts removed will be paid for as extra work; but should the work so exposed or examined prove unacceptable, the uncovering, or removing, and the replacing of the covering or making good of the parts removed will be at the Contractor's expense.

Provide advance written notice to the RPR of work the Contractor plans to perform each week and each day. Any work done or materials used without written notice and allowing opportunity for inspection by the RPR may be ordered removed and replaced at the Contractor's expense.

Should the contract work include relocation, adjustment, or any other modification to existing facilities, not the property of the (contract) Owner, authorized representatives of the Owners of such facilities shall have the right to inspect such work. Such inspection shall in no sense make any facility owner a party to the contract, and shall in no way interfere with the rights of the parties to this contract.

50-10 Removal of unacceptable and unauthorized work. All work that does not conform to the requirements of the contract, plans, and specifications will be considered unacceptable, unless otherwise determined acceptable by the RPR as provided in paragraph 50-02, *Conformity with Plans and Specifications*.

Unacceptable work, whether the result of poor workmanship, use of defective materials, damage through carelessness, or any other cause found to exist prior to the final acceptance of the work, shall be removed immediately and replaced in an acceptable manner in accordance with the provisions of Section 70, paragraph 70-14, *Contractor's Responsibility for Work*.

No removal work made under provision of this paragraph shall be done without lines and grades having been established by the RPR. Work done contrary to the instructions of the RPR, work done beyond the lines shown on the plans or as established by the RPR, except as herein specified, or any extra work done without authority, will be considered as unauthorized and will not be paid for under the provisions of the contract. Work so done may be ordered removed or replaced at the Contractor's expense.

Upon failure on the part of the Contractor to comply with any order of the RPR made under the provisions of this subsection, the RPR will have authority to cause unacceptable work to be remedied or removed and replaced; and unauthorized work to be removed and recover the resulting costs as a liquidated damage against the Contractor.

50-11 Load restrictions. The Contractor shall comply with all legal load restrictions in the hauling of materials on public roads beyond the limits of the work. A special permit will not relieve the Contractor of liability for damage that may result from the moving of material or equipment.

The operation of equipment of such weight or so loaded as to cause damage to structures or to any other type of construction will not be permitted. Hauling of materials over the base course or surface course under construction shall be limited as directed. No loads will be permitted on a concrete pavement, base, or structure before the expiration of the curing period. The Contractor, at their own expense, shall be responsible for the repair to equal or better than preconstruction conditions of any damage caused by the Contractor's equipment and personnel.

50-12 Maintenance during construction. The Contractor shall maintain the work during construction and until the work is accepted. Maintenance shall constitute continuous and effective work prosecuted day by day, with adequate equipment and forces so that the work is maintained in satisfactory condition at all times.

In the case of a contract for the placing of a course upon a course or subgrade previously constructed, the Contractor shall maintain the previous course or subgrade during all construction operations.

All costs of maintenance work during construction and before the project is accepted shall be included in the unit prices bid on the various contract items, and the Contractor will not be paid an additional amount for such work.

50-13 Failure to maintain the work. Should the Contractor at any time fail to maintain the work as provided in paragraph 50-12, *Maintenance during Construction*, the RPR shall immediately notify the Contractor of such noncompliance. Such notification shall specify a reasonable time within which the Contractor shall be required to remedy such unsatisfactory maintenance condition. The time specified will give due consideration to the exigency that exists.

Should the Contractor fail to respond to the RPR's notification, the Owner may suspend any work necessary for the Owner to correct such unsatisfactory maintenance condition, depending on the exigency that exists. Any maintenance cost incurred by the Owner, shall be recovered as a liquidated damage against the Contractor.

50-14 Partial acceptance. If at any time during the execution of the project the Contractor substantially completes a usable unit or portion of the work, the occupancy of which will benefit the Owner, the Contractor may request the RPR to make final inspection of that unit. If the RPR finds upon inspection that the unit has been satisfactorily completed in compliance with the contract, the RPR may accept it as being complete, and the Contractor may be relieved of further responsibility for that unit. Such partial acceptance and beneficial occupancy by the Owner shall not void or alter any provision of the contract.

50-15 Final acceptance. Upon due notice from the Contractor of presumptive completion of the entire project, the RPR and Owner will make an inspection. If all construction provided for and contemplated by the contract is found to be complete in accordance with the contract, plans, and specifications, such inspection shall constitute the final inspection. The RPR shall notify the Contractor in writing of final acceptance as of the date of the final inspection.

If, however, the inspection discloses any work, in whole or in part, as being unsatisfactory, the RPR will notify the Contractor and the Contractor shall correct the unsatisfactory work. Upon correction of the work, another inspection will be made which shall constitute the final inspection, provided the work has been satisfactorily completed. In such event, the RPR will make the final acceptance and notify the Contractor in writing of this acceptance as of the date of final inspection.

50-16 Claims for adjustment and disputes. If for any reason the Contractor deems that additional compensation is due for work or materials not clearly provided for in the contract, plans, or specifications or previously authorized as extra work, the Contractor shall notify the RPR in writing of their intention to claim such additional compensation before the Contractor begins the work on which the Contractor bases the claim. If such notification is not given or the RPR is not afforded proper opportunity by the Contractor for keeping strict account of actual cost as required, then the Contractor hereby agrees to waive any claim for such additional compensation. Such notice by the Contractor and the fact that the RPR has kept account of the cost of the work shall not in any way be construed as proving or substantiating the validity of the claim. When the work on which the claim for additional compensation is based has been completed, the Contractor shall, within 10 calendar days, submit a written claim to the RPR who will present it to the Owner for consideration in accordance with local laws or ordinances.

Nothing in this subsection shall be construed as a waiver of the Contractor's right to dispute final payment based on differences in measurements or computations.

END OF SECTION 50

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Section 60 Control of Materials

60-01 Source of supply and quality requirements. The materials used in the work shall conform to the requirements of the contract, plans, and specifications. Unless otherwise specified, such materials that are manufactured or processed shall be new (as compared to used or reprocessed).

In order to expedite the inspection and testing of materials, the Contractor shall furnish documentation to the Engineer as to the origin, composition, and manufacture of all materials to be used in the work. Documentation shall be furnished promptly after execution of the contract but, in all cases, prior to delivery of such materials.

At the Engineer's option, materials may be approved at the source of supply before delivery. If it is found after trial that sources of supply for previously approved materials do not produce specified products, the Contractor shall furnish materials from other sources.

The Contractor shall furnish airport lighting equipment that meets the requirements of the specifications; and is listed in AC 150/5345-53, *Airport Lighting Equipment Certification Program* and *Addendum*, that is in effect on the date of advertisement.

60-02 Samples, tests, and cited specifications. All materials used in the work shall be inspected, tested, and accepted by the RPR before incorporation in the work unless otherwise designated. Any work in which untested materials are used without acceptance or written permission of the RPR shall be performed at the Contractor's risk. Materials found to be unacceptable and unauthorized will not be paid for and, if directed by the RPR, shall be removed at the Contractor's expense.

Unless otherwise designated, quality assurance tests will be made by and at the expense of the Owner in accordance with the cited standard methods of ASTM, American Association of State Highway and Transportation Officials (AASHTO), federal specifications, Commercial Item Descriptions, and all other cited methods, which are current on the date of advertisement for bids.

The testing organizations performing on-site quality assurance field tests shall have copies of all referenced standards on the construction site for use by all technicians and other personnel. Unless otherwise designated, samples for quality assurance will be taken by a qualified representative of the RPR. All materials being used are subject to inspection, test, or rejection at any time prior to or during incorporation into the work. Copies of all tests will be furnished to the Contractor's representative at their request after review and approval of the RPR.

A copy of all Contractor QC test data shall be provided to the RPR daily, along with printed reports, in an approved format, on a weekly basis. After completion of the project, and prior to final payment, the Contractor shall submit a final report to the RPR showing all test data reports, plus an analysis of all results showing ranges, averages, and corrective action taken on all failing tests.

The Contractor shall employ a Quality Control (QC) testing organization to perform all Contractor required QC tests in accordance with Item C-100 Contractor Quality Control Program (CQCP).

60-03 Certification of compliance/analysis (COC/COA). The RPR may permit the use, prior to sampling and testing, of certain materials or assemblies when accompanied by manufacturer's COC stating that such materials or assemblies fully comply with the requirements of the contract. The certificate shall be signed by the manufacturer. Each lot of such materials or assemblies delivered to the work must be accompanied by a certificate of compliance in which the lot is clearly identified. The COA is the manufacturer's COC and includes all applicable test results.

Materials or assemblies used on the basis of certificates of compliance may be sampled and tested at any time and if found not to be in conformity with contract requirements will be subject to rejection whether in place or not.

The form and distribution of certificates of compliance shall be as approved by the RPR.

When a material or assembly is specified by "brand name or equal" and the Contractor elects to furnish the specified "or equal," the Contractor shall be required to furnish the manufacturer's certificate of compliance for each lot of such material or assembly delivered to the work. Such certificate of compliance shall clearly identify each lot delivered and shall certify as to:

a. Conformance to the specified performance, testing, quality or dimensional requirements; and,

b. Suitability of the material or assembly for the use intended in the contract work.

The RPR shall be the sole judge as to whether the proposed "or equal" is suitable for use in the work.

The RPR reserves the right to refuse permission for use of materials or assemblies on the basis of certificates of compliance.

60-04 Plant inspection. The RPR or their authorized representative may inspect, at its source, any specified material or assembly to be used in the work. Manufacturing plants may be inspected from time to time for the purpose of determining compliance with specified manufacturing methods or materials to be used in the work and to obtain samples required for acceptance of the material or assembly.

Should the RPR conduct plant inspections, the following conditions shall exist:

a. The RPR shall have the cooperation and assistance of the Contractor and the producer with whom the Contractor has contracted for materials.

b. The RPR shall have full entry at all reasonable times to such parts of the plant that concern the manufacture or production of the materials being furnished.

c. If required by the RPR, the Contractor shall arrange for adequate office or working space that may be reasonably needed for conducting plant inspections. Place office or working space in a convenient location with respect to the plant.

It is understood and agreed that the Owner shall have the right to retest any material that has been tested and approved at the source of supply after it has been delivered to the site. The RPR shall have the right to reject only material which, when retested, does not meet the requirements of the contract, plans, or specifications.

60-05 Engineer/ Resident Project Representative (RPR) field office. Not Used.

60-06 Storage of materials. Materials shall be stored to assure the preservation of their quality and fitness for the work. Stored materials, even though approved before storage, may again be inspected prior to their use in the work. Stored materials shall be located to facilitate their prompt inspection. The Contractor shall coordinate the storage of all materials with the RPR. Materials to be stored on airport property shall not create an obstruction to air navigation nor shall they interfere with the free and unobstructed movement of aircraft. Unless otherwise shown on the plans and/or CSPP, the storage of materials and the location of the Contractor's plant and parked equipment or vehicles shall be as directed by the RPR. Private property shall not be used for storage purposes without written permission of the Owner or lessee of such property. The Contractor shall make all arrangements and bear all expenses for the storage of materials on private property. Upon request, the Contractor shall furnish the RPR a copy of the property Owner's permission.

All storage sites on private or airport property shall be restored to their original condition by the Contractor at their expense, except as otherwise agreed to (in writing) by the Owner or lessee of the property.

60-07 Unacceptable materials. Any material or assembly that does not conform to the requirements of the contract, plans, or specifications shall be considered unacceptable and shall be rejected. The Contractor shall remove any rejected material or assembly from the site of the work, unless otherwise instructed by the RPR.

Rejected material or assembly, the defects of which have been corrected by the Contractor, shall not be returned to the site of the work until such time as the RPR has approved its use in the work.

60-08 Owner furnished materials. The Contractor shall furnish all materials required to complete the work, except those specified, if any, to be furnished by the Owner. Owner-furnished materials shall be made available to the Contractor at the location specified.

All costs of handling, transportation from the specified location to the site of work, storage, and installing Owner-furnished materials shall be included in the unit price bid for the contract item in which such Owner-furnished material is used.

After any Owner-furnished material has been delivered to the location specified, the Contractor shall be responsible for any demurrage, damage, loss, or other deficiencies that may occur during the Contractor's handling, storage, or use of such Owner-furnished material. The Owner will deduct from any monies due or to become due the Contractor any cost incurred by the Owner in making good such loss due to the Contractor's handling, storage, or use of Owner-furnished materials.

END OF SECTION 60

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Section 70 Legal Regulations and Responsibility to Public

70-01 Laws to be observed. The Contractor shall keep fully informed of all federal and state laws, all local laws, ordinances, and regulations and all orders and decrees of bodies or tribunals having any jurisdiction or authority, which in any manner affect those engaged or employed on the work, or which in any way affect the conduct of the work. The Contractor shall at all times observe and comply with all such laws, ordinances, regulations, orders, and decrees; and shall protect and indemnify the Owner and all their officers, agents, or servants against any claim or liability arising from or based on the violation of any such law, ordinance, regulation, order, or decree, whether by the Contractor or the Contractor's employees.

70-02 Permits, licenses, and taxes. The Contractor shall procure all permits and licenses, pay all charges, fees, and taxes, and give all notices necessary and incidental to the due and lawful execution of the work.

70-03 Patented devices, materials, and processes. If the Contractor is required or desires to use any design, device, material, or process covered by letters of patent or copyright, the Contractor shall provide for such use by suitable legal agreement with the Patentee or Owner. The Contractor and the surety shall indemnify and hold harmless the Owner, any third party, or political subdivision from any and all claims for infringement by reason of the use of any such patented design, device, material or process, or any trademark or copyright, and shall indemnify the Owner for any costs, expenses, and damages which it may be obliged to pay by reason of an infringement, at any time during the execution or after the completion of the work.

70-04 Restoration of surfaces disturbed by others. The Owner reserves the right to authorize the construction, reconstruction, or maintenance of any public or private utility service, FAA or National Oceanic and Atmospheric Administration (NOAA) facility, or a utility service of another government agency at any time during the progress of the work. To the extent that such construction, reconstruction, or maintenance has been coordinated with the Owner, such authorized work (by others) must be shown on the plans and indicated by the note "Authorized Work By Others"

Authorized work during this project: Potential modifications to Florida Power & Light (FPL) main distribution and transformers.

Except as listed above, the Contractor shall not permit any individual, firm, or corporation to excavate or otherwise disturb such utility services or facilities located within the limits of the work without the written permission of the RPR.

Should the Owner of public or private utility service, FAA, or NOAA facility, or a utility service of another government agency be authorized to construct, reconstruct, or maintain such utility service or facility during the progress of the work, the Contractor shall cooperate with such Owners by arranging and performing the work in this contract to facilitate such construction, reconstruction or maintenance by others whether or not such work by others is listed above. When ordered as extra work by the RPR, the Contractor shall make all necessary repairs to the work which are due to such authorized work by others, unless otherwise provided for in the contract, plans, or specifications. It is understood and agreed that the Contractor shall not be entitled to make any claim for damages due to such authorized work by others or for any delay to the work resulting from such authorized work.

70-05 Federal Participation. The United States Government is expected to reimburse the Owner for some portion of the contract costs. The contract work is subject to the inspection and approval of duly authorized representatives of the FAA Administrator. No requirement of this contract shall be construed as making the United States a party to the contract nor will any such requirement interfere, in any way, with the rights of either party to the contract.

70-06 Sanitary, health, and safety provisions. The Contractor's worksite and facilities shall comply with applicable federal, state, and local requirements for health, safety and sanitary provisions.

70-07 Public convenience and safety. The Contractor shall control their operations and those of their subcontractors and all suppliers, to assure the least inconvenience to the traveling public. Under all circumstances, safety shall be the most important consideration.

The Contractor shall maintain the free and unobstructed movement of aircraft and vehicular traffic with respect to their own operations and those of their own subcontractors and all suppliers in accordance with Section 40, paragraph 40-05, *Maintenance of Traffic,* and shall limit such operations for the convenience and safety of the traveling public as specified in Section 80, paragraph 80-04, *Limitation of Operations*.

The Contractor shall remove or control debris and rubbish resulting from its work operations at frequent intervals, and upon the order of the RPR. If the RPR determines the existence of Contractor debris in the work site represents a hazard to airport operations and the Contractor is unable to respond in a prompt and reasonable manner, the RPR reserves the right to assign the task of debris removal to a third party and recover the resulting costs as a liquidated damage against the Contractor.

70-08 Construction Safety and Phasing Plan (CSPP). The Contractor shall complete the work in accordance with the approved Construction Safety and Phasing Plan (CSPP) developed in accordance with AC 150/5370-2, Operational Safety on Airports During Construction. Where a thorough CSPP is not previously developed due to minutia within the project and/or requires contract input, the contractor shall develop written CSPP for submittal with preliminary schedule. This project requires specific operational capabilities at all times, to include but is not limited to, a minimum of two (2) loading/unloading stations shall remain functional throughout the entirety of the project. Refer to liquidated damages table for any outages conflicting with this requirement that are determined within the contractor's control by the RPR.

70-09 Use of explosives. The use of explosives is not permitted on this project.

70-10 Protection and restoration of property and landscape. The Contractor shall be responsible for the preservation of all public and private property, and shall protect carefully from disturbance or damage all land monuments and property markers until the Engineer/RPR has witnessed or otherwise referenced their location and shall not move them until directed.

The Contractor shall be responsible for all damage or injury to property of any character, during the execution of the work, resulting from any act, omission, neglect, or misconduct in manner or method of executing the work, or at any time due to defective work or materials, and said responsibility shall not be released until the project has been completed and accepted.

When or where any direct or indirect damage or injury is done to public or private property by or on account of any act, omission, neglect, or misconduct in the execution of the work, or in consequence of the non-execution thereof by the Contractor, the Contractor shall restore, at their expense, such property to a condition similar or equal to that existing before such damage or injury was done, by repairing, or otherwise restoring as may be directed, or the Contractor shall make good such damage or injury in an acceptable manner.

70-11 Responsibility for damage claims. The Contractor shall indemnify and hold harmless the Engineer/RPR and the Owner and their officers, agents, and employees from all suits, actions, or claims, of any character, brought because of any injuries or damage received or sustained by any person, persons, or property on account of the operations of the Contractor; or on account of or in consequence of any neglect in safeguarding the work; or through use of unacceptable materials in constructing the work; or because of any act or omission, neglect, or misconduct of said Contractor; or because of any claims or amounts recovered from any infringements of patent, trademark, or copyright; or from any claims or amounts arising or recovered under the "Workmen's Compensation Act," or any other law, ordinance, order, or decree. Money due the Contractor under and by virtue of their own contract considered necessary by the Owner for such purpose may be retained for the use of the Owner or, in case no money is due, their own surety may be held until such suits, actions, or claims for injuries or damages shall have

been settled and suitable evidence to that effect furnished to the Owner, except that money due the Contractor will not be withheld when the Contractor produces satisfactory evidence that he or she is adequately protected by public liability and property damage insurance.

70-12 Third party beneficiary clause. It is specifically agreed between the parties executing the contract that it is not intended by any of the provisions of any part of the contract to create for the public or any member thereof, a third-party beneficiary or to authorize anyone not a party to the contract to maintain a suit for personal injuries or property damage pursuant to the terms or provisions of the contract.

70-13 Opening sections of the work to traffic. If it is necessary for the Contractor to complete portions of the contract work for the beneficial occupancy of the Owner prior to completion of the entire contract, such "phasing" of the work must be specified below and indicated on the approved Construction Safety and Phasing Plan (CSPP) and the project plans. When so specified, the Contractor shall complete such portions of the work on or before the date specified or as otherwise specified.

Upon completion of any portion of work listed above, such portion shall be accepted by the Owner in accordance with Section 50, paragraph 50-14, *Partial Acceptance*.

No portion of the work may be opened by the Contractor until directed by the Owner in writing. Should it become necessary to open a portion of the work to traffic on a temporary or intermittent basis, such openings shall be made when, in the opinion of the RPR, such portion of the work is in an acceptable condition to support the intended traffic. Temporary or intermittent openings are considered to be inherent in the work and shall not constitute either acceptance of the portion of the work so opened or a waiver of any provision of the contract. Any damage to the portion of the work so opened that is not attributable to traffic which is permitted by the Owner shall be repaired by the Contractor at their expense.

The Contractor shall make their own estimate of the inherent difficulties involved in completing the work under the conditions herein described and shall not claim any added compensation by reason of delay or increased cost due to opening a portion of the contract work.

The Contractor must conform to safety standards contained AC 150/5370-2 and the approved CSPP.

Contractor shall refer to the plans, specifications, and the approved CSPP to identify barricade requirements, temporary and/or permanent markings, airfield lighting, guidance signs and other safety requirements prior to opening up sections of work to traffic.

70-14 Contractor's responsibility for work. Until the RPR's final written acceptance of the entire completed work, excepting only those portions of the work accepted in accordance with Section 50, paragraph 50-14, *Partial Acceptance*, the Contractor shall have the charge and care thereof and shall take every precaution against injury or damage to any part due to the action of the elements or from any other cause, whether arising from the execution or from the non-execution of the work. The Contractor shall rebuild, repair, restore, and make good all injuries or damages to any portion of the work occasioned by any of the above causes before final acceptance and shall bear the expense thereof except damage to the work due to unforeseeable causes beyond the control of and without the fault or negligence of the Contractor, including but not restricted to acts of God such as earthquake, tidal wave, tornado, hurricane or other cataclysmic phenomenon of nature, or acts of the public enemy or of government authorities.

If the work is suspended for any cause whatever, the Contractor shall be responsible for the work and shall take such precautions necessary to prevent damage to the work. The Contractor shall provide for normal drainage and shall erect necessary temporary structures, signs, or other facilities at their own expense. During such period of suspension of work, the Contractor shall properly and continuously maintain in an acceptable growing condition all living material in newly established planting, seeding, and sodding furnished under the contract, and shall take adequate precautions to protect new tree growth and other important vegetative growth against injury.

70-15 Contractor's responsibility for utility service and facilities of others. As provided in paragraph 70-04, *Restoration of Surfaces Disturbed by Others*, the Contractor shall cooperate with the owner of any public or private utility service, FAA or NOAA, or a utility service of another government agency that may be authorized by the Owner to construct, reconstruct or maintain such utility services or facilities during the progress of the work. In addition, the Contractor shall control their operations to prevent the unscheduled interruption of such utility services and facilities.

To the extent that such public or private utility services, FAA, or NOAA facilities, or utility services of another governmental agency are known to exist within the limits of the contract work, the approximate locations have not been indicated on the plans. The utility service owners are indicated as follows:

Utility Service or Facility	Contact Information	Phone Number
For Airside work contact the City of Naples Airport Authority	Kerry Keith Director of Airport Development 160 Aviation Drive North Naples, FL 34101-3568	239-673-0733 or 239-253-4137 (cell)
Sunshine One Call		811
Internet, TV and Voice/Telephone	Century Link	877-290-5458
Internet, TV and Voice/Telephone	Comcast	239-793-3577
Electrical	Florida Power & Light (FPL)	800-468-8243
Water/Sewer	Naples Water & Sewer (Public Works) Wayne McDowell	239-213-4720

It is understood and agreed that the Owner does not guarantee the accuracy or the completeness of the location information relating to existing utility services, facilities, or structures that may be shown on the plans or encountered in the work. Any inaccuracy or omission in such information shall not relieve the Contractor of the responsibility to protect such existing features from damage or unscheduled interruption of service.

It is further understood and agreed that the Contractor shall, upon execution of the contract, notify the Owners of all utility services or other facilities of their plan of operations. Such notification shall be in writing addressed to "The Person to Contact" as provided in this paragraph and paragraph 70-04, *Restoration of Surfaces Disturbed By Others*. A copy of each notification shall be given to the RPR.

In addition to the general written notification provided, it shall be the responsibility of the Contractor to keep such individual Owners advised of changes in their plan of operations that would affect such Owners.

Prior to beginning the work in the general vicinity of an existing utility service or facility, the Contractor shall again notify each such Owner of their plan of operation. If, in the Contractor's opinion, the Owner's assistance is needed to locate the utility service or facility or the presence of a representative of the Owner is desirable to observe the work, such advice should be included in the notification. Such notification shall be given by the most expeditious means to reach the utility owner's "Person to Contact" no later than two normal business days prior to the Contractor's commencement of operations in such general vicinity. The Contractor shall furnish a written summary of the notification to the RPR.

The Contractor's failure to give the two days' notice shall be cause for the Owner to suspend the Contractor's operations in the general vicinity of a utility service or facility.

Where the outside limits of an underground utility service have been located and staked on the ground, the Contractor shall be required to use hand excavation methods within 3 feet (1 m) of such outside limits at such points as may be required to ensure protection from damage due to the Contractor's operations.

Should the Contractor damage or interrupt the operation of a utility service or facility by accident or otherwise, the Contractor shall immediately notify the proper authority and the RPR and shall take all reasonable measures to prevent further damage or interruption of service. The Contractor, in such events,

shall cooperate with the utility service or facility owner and the RPR continuously until such damage has been repaired and service restored to the satisfaction of the utility or facility owner.

The Contractor shall bear all costs of damage and restoration of service to any utility service or facility due to their operations whether due to negligence or accident. The Owner reserves the right to deduct such costs from any monies due or which may become due the Contractor, or their own surety.

70-16 Furnishing rights-of-way. The Owner will be responsible for furnishing all rights-of-way upon which the work is to be constructed in advance of the Contractor's operations.

70-17 Personal liability of public officials. In carrying out any of the contract provisions or in exercising any power or authority granted by this contract, there shall be no liability upon the Engineer, RPR, their authorized representatives, or any officials of the Owner either personally or as an official of the Owner. It is understood that in such matters they act solely as agents and representatives of the Owner.

70-18 No waiver of legal rights. Upon completion of the work, the Owner will expeditiously make final inspection and notify the Contractor of final acceptance. Such final acceptance, however, shall not preclude or stop the Owner from correcting any measurement, estimate, or certificate made before or after completion of the work, nor shall the Owner be precluded or stopped from recovering from the Contractor or their surety, or both, such overpayment as may be sustained, or by failure on the part of the Contractor to fulfill their obligations under the contract. A waiver on the part of the Owner of any breach of any part of the contract shall not be held to be a waiver of any other or subsequent breach.

The Contractor, without prejudice to the terms of the contract, shall be liable to the Owner for latent defects, fraud, or such gross mistakes as may amount to fraud, or as regards the Owner's rights under any warranty or guaranty.

70-19 Environmental protection. The Contractor shall comply with all federal, state, and local laws and regulations controlling pollution of the environment. The Contractor shall take necessary precautions to prevent pollution of streams, lakes, ponds, and reservoirs with fuels, oils, asphalts, chemicals, or other harmful materials and to prevent pollution of the atmosphere from particulate and gaseous matter.

70-20 Archaeological and historical findings. Unless otherwise specified in this subsection, the Contractor is advised that the site of the work is not within any property, district, or site, and does not contain any building, structure, or object listed in the current National Register of Historic Places published by the United States Department of Interior.

Should the Contractor encounter, during their operations, any building, part of a building, structure, or object that is incongruous with its surroundings, the Contractor shall immediately cease operations in that location and notify the RPR. The RPR will immediately investigate the Contractor's finding and the Owner will direct the Contractor to either resume operations or to suspend operations as directed.

Should the Owner order suspension of the Contractor's operations in order to protect an archaeological or historical finding, or order the Contractor to perform extra work, such shall be covered by an appropriate contract change order or supplemental agreement as provided in Section 40, paragraph 40-04, *Extra Work,* and Section 90, paragraph 90-05, *Payment for Extra Work*. If appropriate, the contract change order or supplemental agreement shall include an extension of contract time in accordance with Section 80, paragraph 80-07, *Determination and Extension of Contract Time*.

70-21 Insurance Requirements. Contactor shall obtain and maintain insurance requirements as noted in the Naples Airport Authority, Sample Contract/Service Agreement.

END OF SECTION 70

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Section 80 Execution and Progress

80-01 Subletting of contract. The Owner will not recognize any subcontractor on the work. The Contractor shall at all times when work is in progress be represented either in person, by a qualified superintendent, or by other designated, qualified representative who is duly authorized to receive and execute orders of the Resident Project Representative (RPR).

The Contractor shall perform, with his organization, an amount of work equal to at least 25 percent of the total contract cost.

Should the Contractor elect to assign their contract, said assignment shall be concurred in by the surety, shall be presented for the consideration and approval of the Owner, and shall be consummated only on the written approval of the Owner.

The Contractor shall provide copies of all subcontracts to the RPR 14 days prior to being utilized on the project. As a minimum, the information shall include the following:

- Subcontractor's legal company name.
- Subcontractor's legal company address, including County name.
- Principal contact person's name, telephone and fax number.
- Complete narrative description, and dollar value of the work to be performed by the subcontractor.
- Copies of required insurance certificates in accordance with the specifications.
- Minority/ non-minority status.

80-02 Notice to proceed (NTP). The Owners notice to proceed will state the date on which contract time commences. The Contractor is expected to commence project operations within 10 days of the NTP date. The Contractor shall notify the RPR at least 24 hours in advance of the time contract operations begins. The Contractor shall not commence any actual operations prior to the date on which the notice to proceed is issued by the Owner.

80-03 Execution and progress. Unless otherwise specified, the Contractor shall submit their coordinated construction schedule showing all work activities for the RPR's review and acceptance at least 10 days prior to the start of work. The Contractor's progress schedule, once accepted by the RPR, will represent the Contractor's baseline plan to accomplish the project in accordance with the terms and conditions of the Contract. The RPR will compare actual Contractor progress against the baseline schedule to determine that status of the Contractor's performance. The Contractor shall provide sufficient materials, equipment, and labor to guarantee the completion of the project in accordance with the plans and specifications within the time set forth in the proposal.

If the Contractor falls significantly behind the submitted schedule, the Contractor shall, upon the RPR's request, submit a revised schedule for completion of the work within the contract time and modify their operations to provide such additional materials, equipment, and labor necessary to meet the revised schedule. Should the execution of the work be discontinued for any reason, the Contractor shall notify the RPR at least 24 hours in advance of resuming operations.

The Contractor shall not commence any actual construction prior to the date on which the NTP is issued by the Owner.

The project schedule shall be prepared as a network diagram in Critical Path Method (CPM), or other format, or as otherwise specified. It shall include information on the sequence of work activities, milestone

dates, and activity duration. The schedule shall show all work items identified in the project proposal for each work area and shall include the project start date and end date

The Contractor shall maintain the work schedule and provide an update and analysis of the progress schedule on a twice monthly basis, or as otherwise specified in the contract. Submission of the work schedule shall not relieve the Contractor of overall responsibility for scheduling, sequencing, and coordinating all work to comply with the requirements of the contract.

80-04 Limitation of operations. The Contractor shall control their operations and the operations of their subcontractors and all suppliers to provide for the free and unobstructed movement of aircraft in the air operations areas (AOA) of the airport, and fueling tankers around and through the area during construction.

(If applicable) When the work requires the Contractor to conduct their operations within an AOA of the airport, the work shall be coordinated with airport operations (through the RPR) at least 96 hours prior to commencement of such work. The Contractor shall not close an AOA until so authorized by the RPR and until the necessary temporary marking, signage and associated lighting is in place as provided in Section 70, paragraph 70-08, *Construction Safety and Phasing Plan (CSPP)*.

If the contract work requires the Contractor to work within an AOA of the airport on an intermittent basis (intermittent opening and closing of the AOA), the Contractor shall maintain constant communications as specified; immediately obey all instructions to vacate the AOA; and immediately obey all instructions to resume work in such AOA. Failure to maintain the specified communications or to obey instructions shall be cause for suspension of the Contractor's operations in the AOA until satisfactory conditions are provided. The areas of the AOA identified in the Construction Safety and Phasing Plan (CSPP) and as listed below, cannot be closed to operating aircraft to permit the Contractor's operations on a continuous basis and will therefore be closed to aircraft operations intermittently as follows: Refer to the Construction Safety and Phasing Plan (CSPP) for closure information.

The Contractor shall be required to conform to safety standards contained in AC 150/5370-2, Operational Safety on Airports During Construction and the approved CSPP.

80-04.1 Operational safety on airport during construction. All Contractors' operations shall be conducted in accordance with the approved project Construction Safety and Phasing Plan (CSPP) and the Safety Plan Compliance Document (SPCD) and the provisions set forth within the current version of AC 150/5370-2, Operational Safety on Airports During Construction. The CSPP included within the contract documents conveys minimum requirements for operational safety on the airport during construction activities. The Contractor shall prepare and submit a SPCD that details how it proposes to comply with the requirements presented within the developed CSPP.

The Contractor shall implement all necessary safety plan measures prior to commencement of any work activity. The Contractor shall conduct routine checks to assure compliance with the safety plan measures.

The Contractor is responsible to the Owner for the conduct of all subcontractors it employs on the project. The Contractor shall assure that all subcontractors are made aware of the requirements of the CSPP and SPCD and that they implement and maintain all necessary measures.

No deviation or modifications may be made to the approved CSPP and SPCD unless approved in writing by the Owner. The necessary coordination actions to review Contractor proposed modifications to an approved CSPP or approved SPCD can require a significant amount of time.

80-05 Character of workers, methods, and equipment. The Contractor shall, at all times, employ sufficient labor and equipment for prosecuting the work to full completion in the manner and time required by the contract, plans, and specifications.

All workers shall have sufficient skill and experience to perform properly the work assigned to them. Workers engaged in special work or skilled work shall have sufficient experience in such work and in the operation of the equipment required to perform the work satisfactorily.

Any person employed by the Contractor or by any subcontractor who violates any operational regulations or operational safety requirements and, in the opinion of the RPR, does not perform his work in a proper and skillful manner or is intemperate or disorderly shall, at the written request of the RPR, be removed immediately by the Contractor or subcontractor employing such person, and shall not be employed again in any portion of the work without approval of the RPR.

Should the Contractor fail to remove such person or persons, or fail to furnish suitable and sufficient personnel for the proper execution of the work, the RPR may suspend the work by written notice until compliance with such orders.

All equipment that is proposed to be used on the work shall be of sufficient size and in such mechanical condition as to meet requirements of the work and to produce a satisfactory quality of work. Equipment used on any portion of the work shall not cause injury to previously completed work, adjacent property, or existing airport facilities due to its use.

When the methods and equipment to be used by the Contractor in accomplishing the work are not prescribed in the contract, the Contractor is free to use any methods or equipment that will accomplish the work in conformity with the requirements of the contract, plans, and specifications.

When the contract specifies the use of certain methods and equipment, such methods and equipment shall be used unless otherwise authorized by the RPR. If the Contractor desires to use a method or type of equipment other than specified in the contract, the Contractor may request authority from the RPR to do so. The request shall be in writing and shall include a full description of the methods and equipment proposed and of the reasons for desiring to make the change. If approval is given, it will be on the condition that the Contractor will be fully responsible for producing work in conformity with contract requirements. If, after trial use of the substituted methods or equipment, the RPR determines that the work produced does not meet contract requirements, the Contractor shall discontinue the use of the substitute method or equipment and shall complete the remaining work with the specified methods and equipment. The Contractor shall remove any deficient work and replace it with work of specified quality, or take such other corrective action as the RPR may direct. No change will be made in basis of payment for the contract items involved nor in contract time as a result of authorizing a change in methods or equipment under this paragraph.

80-06 Temporary suspension of the work. The Owner shall have the authority to suspend the work wholly, or in part, for such period or periods the Owner may deem necessary, due to unsuitable weather, or other conditions considered unfavorable for the execution of the work, or for such time necessary due to the failure on the part of the Contractor to carry out orders given or perform any or all provisions of the contract.

In the event that the Contractor is ordered by the Owner, in writing, to suspend work for some unforeseen cause not otherwise provided for in the contract and over which the Contractor has no control, the Contractor may be reimbursed for actual money expended on the work during the period of shutdown. No allowance will be made for anticipated profits. The period of shutdown shall be computed from the effective date of the written order to suspend work to the effective date of the written order to resume the work. Claims for such compensation shall be filed with the RPR within the time period stated in the RPR's order to resume work. The Contractor shall submit with their own claim information substantiating the amount shown on the claim. The RPR will forward the Contractor's claim to the Owner for consideration in accordance with local laws or ordinances. No provision of this article shall be construed as entitling the Contractor to compensation for delays due to inclement weather or for any other delay provided for in the contract, plans, or specifications.

If it becomes necessary to suspend work for an indefinite period, the Contractor shall store all materials in such manner that they will not become an obstruction nor become damaged in any way. The Contractor shall take every precaution to prevent damage or deterioration of the work performed and provide for normal drainage of the work. The Contractor shall erect temporary structures where necessary to provide

for traffic on, to, or from the airport.

80-07 Determination and extension of contract time. The number of calendar days shall be stated in the proposal and contract and shall be known as the Contract Time.

If the contract time requires extension for reasons beyond the Contractor's control, it shall be adjusted as follows:

80-07.1 Contract time based on calendar days. Contract Time based on calendar days shall consist of the number of calendar days stated in the contract counting from the effective date of the Notice to Proceed and including all Saturdays, Sundays, holidays, and non-work days. All calendar days elapsing between the effective dates of the Owner's orders to suspend and resume all work, due to causes not the fault of the Contractor, shall be excluded.

At the time of final payment, the contract time shall be increased in the same proportion as the cost of the actually completed quantities bears to the cost of the originally estimated quantities in the proposal. Such increase in the contract time shall not consider either cost of work or the extension of contract time that has been covered by a change order or supplemental agreement. Charges against the contract time will cease as of the date of final acceptance.

80-08 Failure to complete on time. For each calendar day or working day, as specified in the contract, that any work remains uncompleted after the contract time (including all extensions and adjustments as provided in paragraph 80-07, *Determination and Extension of Contract Time*) the sum specified in the contract and proposal as liquidated damages (LD) will be deducted from any money due or to become due the Contractor or their own surety. Such deducted sums shall not be deducted as a penalty but shall be considered as liquidation of a reasonable portion of damages including but not limited to additional engineering services that will be incurred by the Owner should the Contractor fail to complete the work in the time provided in their contract.

Phase	**DURATION (Calendar Days)**	**LIQUIDATED DAMAGES by PHASE or COMPONENT of PHASE**
Overall Project	**540**	**$3,756 for each day past 540**
Mobilization/Procurement	**60***	**N/A**
Disruptions to access/operations	**N/A**	**$2,000 per hour for every hour of disruption**
***To be performed within the time allotted for Overall Project**		

Liquidated Damages: The schedule for completion of this project is time sensitive. To ensure the disruption to Fuel Farm operations is minimal and within the agreed upon schedule, it is understood that Liquidated Damages will be applied to the contract as identified in General Conditions Article 18, section 18.03 at $3,756 per day over the 540 calendar days allotted for the project, and $2,000 per hour for every hour fuel farm operations do not have undisruptive access to at least two fully operable fueling positions between the hours of 6:00 a.m. and 10:00 p.m. Bidders Initials: _____

80-09 Default and termination of contract. The Contractor shall be considered in default of their contract and such default will be considered as cause for the Owner to terminate the contract for any of the following reasons, if the Contractor:

a. Fails to begin the work under the contract within the time specified in the Notice to Proceed, or Fails to perform the work or fails to provide sufficient workers, equipment and/or materials to assure completion of work in accordance with the terms of the contract, or

b. Performs the work unsuitably or neglects or refuses to remove materials or to perform anew such work as may be rejected as unacceptable and unsuitable, or

c. Discontinues the execution of the work, or

d. Fails to resume work which has been discontinued within a reasonable time after notice to do so, or

e. Becomes insolvent or is declared bankrupt, or commits any act of bankruptcy or insolvency, or

f. Allows any final judgment to stand against the Contractor unsatisfied for a period of 10 days, or

g. Makes an assignment for the benefit of creditors, or

h. For any other cause whatsoever, fails to carry on the work in an acceptable manner.

Should the Owner consider the Contractor in default of the contract for any reason above, the Owner shall immediately give written notice to the Contractor and the Contractor's surety as to the reasons for considering the Contractor in default and the Owner's intentions to terminate the contract.

If the Contractor or surety, within a period of 10 days after such notice, does not proceed in accordance therewith, then the Owner will, upon written notification from the RPR of the facts of such delay, neglect, or default and the Contractor's failure to comply with such notice, have full power and authority without violating the contract, to take the execution of the work out of the hands of the Contractor. The Owner may appropriate or use any or all materials and equipment that have been mobilized for use in the work and are acceptable and may enter into an agreement for the completion of said contract according to the terms and provisions thereof, or use such other methods as in the opinion of the RPR will be required for the completion of said contract in an acceptable manner.

All costs and charges incurred by the Owner, together with the cost of completing the work under contract, will be deducted from any monies due or which may become due the Contractor. If such expense exceeds the sum which would have been payable under the contract, then the Contractor and the surety shall be liable and shall pay to the Owner the amount of such excess.

80-10 Termination for national emergencies. The Owner shall terminate the contract or portion thereof by written notice when the Contractor is prevented from proceeding with the construction contract as a direct result of an Executive Order of the President with respect to the execution of war or in the interest of national defense.

When the contract, or any portion thereof, is terminated before completion of all items of work in the contract, payment will be made for the actual number of units or items of work completed at the contract price or as mutually agreed for items of work partially completed or not started. No claims or loss of anticipated profits shall be considered.

Reimbursement for organization of the work, and other overhead expenses, (when not otherwise included in the contract) and moving equipment and materials to and from the job will be considered, the intent being that an equitable settlement will be made with the Contractor.

Acceptable materials, obtained or ordered by the Contractor for the work and that are not incorporated in the work shall, at the option of the Contractor, be purchased from the Contractor at actual cost as shown by receipted bills and actual cost records at such points of delivery as may be designated by the RPR.

Termination of the contract or a portion thereof shall neither relieve the Contractor of their responsibilities for the completed work nor shall it relieve their surety of its obligation for and concerning any just claim arising out of the work performed.

80-11 Work area, storage area and sequence of operations. The Contractor shall obtain approval from the RPR prior to beginning any work in all areas of the airport. No operating runway, taxiway, or air operations area (AOA) shall be crossed, entered, or obstructed while it is operational. The Contractor shall plan and coordinate work in accordance with the approved CSPP and SPCD.

END OF SECTION 80

Section 90 Measurement and Payment

90-01 Measurement of quantities. All work completed under the contract will be measured by the RPR, or their authorized representatives, using United States Customary Units of Measurement.

The method of measurement and computations to be used in determination of quantities of material furnished and of work performed under the contract will be those methods generally recognized as conforming to good engineering practice.

Unless otherwise specified, longitudinal measurements for area computations will be made horizontally, and no deductions will be made for individual fixtures (or leave-outs) having an area of 9 square feet (0.8 square meters) or less. Unless otherwise specified, transverse measurements for area computations will be the neat dimensions shown on the plans or ordered in writing by the RPR.

Unless otherwise specified, all contract items which are measured by the linear foot such as electrical ducts, conduits, pipe culverts, underdrains, and similar items shall be measured parallel to the base or foundation upon which such items are placed.

The term "lump sum" when used as an item of payment will mean complete payment for the work described in the contract. When a complete structure or structural unit (in effect, "lump sum" work) is specified as the unit of measurement, the unit will be construed to include all necessary fittings and accessories.

When requested by the Contractor and approved by the RPR in writing, material specified to be measured by the cubic yard (cubic meter) may be weighed, and such weights will be converted to cubic yards (cubic meters) for payment purposes. Factors for conversion from weight measurement to volume measurement will be determined by the RPR and shall be agreed to by the Contractor before such method of measurement of pay quantities is used.

Measurement and Payment Terms

Term	Description
Excavation and Embankment Volume	In computing volumes of excavation, the average end area method will be used unless otherwise specified.
Measurement and Proportion by Weight	The term "ton" will mean the short ton consisting of 2,000 pounds (907 km) avoirdupois. All materials that are measured or proportioned by weights shall be weighed on accurate, independently certified scales by competent, qualified personnel at locations designated by the RPR. If material is shipped by rail, the car weight may be accepted provided that only the actual weight of material is paid for. However, car weights will not be acceptable for material to be passed through mixing plants. Trucks used to haul material being paid for by weight shall be weighed empty daily at such times as the RPR directs, and each truck shall bear a plainly legible identification mark.

Term	Description
Measurement by Volume	Materials to be measured by volume in the hauling vehicle shall be hauled in approved vehicles and measured therein at the point of delivery. Vehicles for this purpose may be of any size or type acceptable for the materials hauled, provided that the body is of such shape that the actual contents may be readily and accurately determined. All vehicles shall be loaded to at least their water level capacity, and all loads shall be leveled when the vehicles arrive at the point of delivery.
Asphalt Material	Asphalt materials will be measured by the gallon (liter) or ton (kg). When measured by volume, such volumes will be measured at 60°F (16°C) or will be corrected to the volume at 60°F (16°C) using ASTM D1250 for asphalts. Net certified scale weights or weights based on certified volumes in the case of rail shipments will be used as a basis of measurement, subject to correction when asphalt material has been lost from the car or the distributor, wasted, or otherwise not incorporated in the work. When asphalt materials are shipped by truck or transport, net certified weights by volume, subject to correction for loss or foaming, will be used for computing quantities.
Cement	Cement will be measured by the ton (kg) or hundredweight (km).
Structure	Structures will be measured according to neat lines shown on the plans or as altered to fit field conditions.
Timber	Timber will be measured by the thousand feet board measure (MFBM) actually incorporated in the structure. Measurement will be based on nominal widths and thicknesses and the extreme length of each piece.
Plates and Sheets	The thickness of plates and galvanized sheet used in the manufacture of corrugated metal pipe, metal plate pipe culverts and arches, and metal cribbing will be specified and measured in decimal fraction of inch.
Miscellaneous Items	When standard manufactured items are specified such as fence, wire, plates, rolled shapes, pipe conduit, etc., and these items are identified by gauge, unit weight, section dimensions, etc., such identification will be considered to be nominal weights or dimensions. Unless more stringently controlled by tolerances in cited specifications, manufacturing tolerances established by the industries involved will be accepted.
Scales	Scales must be tested for accuracy and serviced before use. Scales for weighing materials which are required to be proportioned or measured and paid for by weight shall be furnished, erected, and maintained by the Contractor, or be certified permanently installed commercial scales. Platform scales shall be installed and maintained with the platform level and rigid bulkheads at each end. Scales shall be accurate within 0.5% of the correct weight throughout the range of use. The Contractor shall have the scales checked under the observation of the RPR before beginning work and at such other times as requested. The intervals shall be uniform in spacing throughout the graduated or marked length of the beam or dial and shall not exceed 0.1% of the nominal rated capacity of the

Term	Description
	scale, but not less than one pound (454 grams). The use of spring balances will not be permitted. In the event inspection reveals the scales have been "overweighing" (indicating more than correct weight) they will be immediately adjusted. All materials received subsequent to the last previous correct weighting-accuracy test will be reduced by the percentage of error in excess of 0.5%. In the event inspection reveals the scales have been under-weighing (indicating less than correct weight), they shall be immediately adjusted. No additional payment to the Contractor will be allowed for materials previously weighed and recorded. Beams, dials, platforms, and other scale equipment shall be so arranged that the operator and the RPR can safely and conveniently view them. Scale installations shall have available ten standard 50-pound (2.3 km) weights for testing the weighing equipment or suitable weights and devices for other approved equipment. All costs in connection with furnishing, installing, certifying, testing, and maintaining scales; for furnishing check weights and scale house; and for all other items specified in this subsection, for the weighing of materials for proportioning or payment, shall be included in the unit contract prices for the various items of the project.
Rental Equipment	Rental of equipment will be measured by time in hours of actual working time and necessary traveling time of the equipment within the limits of the work. Special equipment ordered in connection with extra work will be measured as agreed in the change order or supplemental agreement authorizing such work as provided in paragraph 90-05 *Payment for Extra Work*.
Pay Quantities	When the estimated quantities for a specific portion of the work are designated as the pay quantities in the contract, they shall be the final quantities for which payment for such specific portion of the work will be made, unless the dimensions of said portions of the work shown on the plans are revised by the RPR. If revised dimensions result in an increase or decrease in the quantities of such work, the final quantities for payment will be revised in the amount represented by the authorized changes in the dimensions.

90-02 Scope of payment. The Contractor shall receive and accept compensation provided for in the contract as full payment for furnishing all materials, for performing all work under the contract in a complete and acceptable manner, and for all risk, loss, damage, or expense of whatever character arising out of the nature of the work or the execution thereof, subject to the provisions of Section 70, paragraph 70-18, *No Waiver of Legal Rights*.

When the "basis of payment" subsection of a technical specification requires that the contract price (price bid) include compensation for certain work or material essential to the item, this same work or material will not also be measured for payment under any other contract item which may appear elsewhere in the contract, plans, or specifications.

90-03 Compensation for altered quantities. When the accepted quantities of work vary from the quantities in the proposal, the Contractor shall accept as payment in full, so far as contract items are concerned, payment at the original contract price for the accepted quantities of work actually completed

and accepted. No allowance, except as provided for in Section 40, paragraph 40-02, *Alteration of Work and Quantities,* will be made for any increased expense, loss of expected reimbursement, or loss of anticipated profits suffered or claimed by the Contractor which results directly from such alterations or indirectly from their own unbalanced allocation of overhead and profit among the contract items, or from any other cause.

90-04 Payment for omitted items. As specified in Section 40, paragraph 40-03, *Omitted Items,* the RPR shall have the right to omit from the work (order nonperformance) any contract item, except major contract items, in the best interest of the Owner.

Should the RPR omit or order nonperformance of a contract item or portion of such item from the work, the Contractor shall accept payment in full at the contract prices for any work actually completed and acceptable prior to the RPR's order to omit or non-perform such contract item.

Acceptable materials ordered by the Contractor or delivered on the work prior to the date of the RPR's order will be paid for at the actual cost to the Contractor and shall thereupon become the property of the Owner.

In addition to the reimbursement hereinbefore provided, the Contractor shall be reimbursed for all actual costs incurred for the purpose of performing the omitted contract item prior to the date of the RPR's order. Such additional costs incurred by the Contractor must be directly related to the deleted contract item and shall be supported by certified statements by the Contractor as to the nature the amount of such costs.

90-05 Payment for extra work. Extra work, performed in accordance with Section 40, paragraph 40-04, *Extra Work*, will be paid for at the contract prices or agreed prices specified in the change order or supplemental agreement authorizing the extra work.

90-06 Partial payments. Partial payments will be made to the Contractor at least once each month as the work progresses. Said payments will be based upon estimates, prepared by the RPR, of the value of the work performed and materials complete and in place, in accordance with the contract, plans, and specifications. Such partial payments may also include the delivered actual cost of those materials stockpiled and stored in accordance with paragraph 90-07, *Payment for Materials on Hand*. No partial payment will be made when the amount due to the Contractor since the last estimate amounts to less than five hundred dollars.

a. From the total of the amount determined to be payable on a partial payment, 5 percent of such total amount will be deducted and retained by the Owner for protection of the Owner's interests. Unless otherwise instructed by the Owner, the amount retained by the Owner will be in effect until the final payment is made except as follows:

(1) Contractor may request release of retainage on work that has been partially accepted by the Owner in accordance with Section 50-03. Contractor must provide a certified invoice to the RPR that supports the value of retainage held by the Owner for partially accepted work.

(2) In lieu of retainage, the Contractor may exercise at its option the establishment of an escrow account per paragraph 90-08.

b. The Contractor is required to pay all subcontractors for satisfactory performance of their contracts no later than 30 days after the Contractor has received a partial payment. Contractor must provide the Owner evidence of prompt and full payment of retainage held by the prime Contractor to the subcontractor within 30 days after the subcontractor's work is satisfactorily completed. A subcontractor's work is satisfactorily completed when all the tasks called for in the subcontract have been accomplished and documented as required by the Owner. When the Owner has made

an incremental acceptance of a portion of a prime contract, the work of a subcontractor covered by that acceptance is deemed to be satisfactorily completed.

c. When at least 95% of the work has been completed to the satisfaction of the RPR, the RPR shall, at the Owner's discretion and with the consent of the surety, prepare estimates of both the contract value and the cost of the remaining work to be done. The Owner may retain an amount not less than twice the contract value or estimated cost, whichever is greater, of the work remaining to be done. The remainder, less all previous payments and deductions, will then be certified for payment to the Contractor.

It is understood and agreed that the Contractor shall not be entitled to demand or receive partial payment based on quantities of work in excess of those provided in the proposal or covered by approved change orders or supplemental agreements, except when such excess quantities have been determined by the RPR to be a part of the final quantity for the item of work in question.

No partial payment shall bind the Owner to the acceptance of any materials or work in place as to quality or quantity. All partial payments are subject to correction at the time of final payment as provided in paragraph 90-09, *Acceptance and Final Payment*.

The Contractor shall deliver to the Owner a complete release of all claims for labor and material arising out of this contract before the final payment is made. If any subcontractor or supplier fails to furnish such a release in full, the Contractor may furnish a bond or other collateral satisfactory to the Owner to indemnify the Owner against any potential lien or other such claim. The bond or collateral shall include all costs, expenses, and attorney fees the Owner may be compelled to pay in discharging any such lien or claim.

90-07 Payment for materials on hand. Partial payments may be made to the extent of the delivered cost of materials to be incorporated in the work, provided that such materials meet the requirements of the contract, plans, and specifications and are delivered to acceptable sites on the airport property or at other sites in the vicinity that are acceptable to the Owner. Such delivered costs of stored or stockpiled materials may be included in the next partial payment after the following conditions are met:

a. The material has been stored or stockpiled in a manner acceptable to the RPR at or on an approved site.

b. The Contractor has furnished the RPR with acceptable evidence of the quantity and quality of such stored or stockpiled materials.

c. The Contractor has furnished the RPR with satisfactory evidence that the material and transportation costs have been paid.

d. The Contractor has furnished the Owner legal title (free of liens or encumbrances of any kind) to the material stored or stockpiled.

e. The Contractor has furnished the Owner evidence that the material stored or stockpiled is insured against loss by damage to or disappearance of such materials at any time prior to use in the work.

It is understood and agreed that the transfer of title and the Owner's payment for such stored or stockpiled materials shall in no way relieve the Contractor of their responsibility for furnishing and placing such materials in accordance with the requirements of the contract, plans, and specifications.

In no case will the amount of partial payments for materials on hand exceed the contract price for such materials or the contract price for the contract item in which the material is intended to be used.

No partial payment will be made for stored or stockpiled living or perishable plant materials.

The Contractor shall bear all costs associated with the partial payment of stored or stockpiled materials in accordance with the provisions of this paragraph.

90-08 Payment of withheld funds. At the Contractor's option, if an Owner withholds retainage in accordance with the methods described in paragraph 90-06 *Partial Payments*, the Contractor may request that the Owner deposit the retainage into an escrow account. The Owner's deposit of retainage into an escrow account is subject to the following conditions:

a. The Contractor shall bear all expenses of establishing and maintaining an escrow account and escrow agreement acceptable to the Owner.

b. The Contractor shall deposit to and maintain in such escrow only those securities or bank certificates of deposit as are acceptable to the Owner and having a value not less than the retainage that would otherwise be withheld from partial payment.

c. The Contractor shall enter into an escrow agreement satisfactory to the Owner.

d. The Contractor shall obtain the written consent of the surety to such agreement.

90-09 Acceptance and final payment. When the contract work has been accepted in accordance with the requirements of Section 50, paragraph 50-15, *Final Acceptance*, the RPR will prepare the final estimate of the items of work actually performed. The Contractor shall approve the RPR's final estimate or advise the RPR of the Contractor's objections to the final estimate which are based on disputes in measurements or computations of the final quantities to be paid under the contract as amended by change order or supplemental agreement. The Contractor and the RPR shall resolve all disputes (if any) in the measurement and computation of final quantities to be paid within 30 calendar days of the Contractor's receipt of the RPR's final estimate. If, after such 30-day period, a dispute still exists, the Contractor may approve the RPR's estimate under protest of the quantities in dispute, and such disputed quantities shall be considered by the Owner as a claim in accordance with Section 50, paragraph 50-16, *Claims for Adjustment and Disputes*.

After the Contractor has approved, or approved under protest, the RPR's final estimate, and after the RPR's receipt of the project closeout documentation required in paragraph 90-11, *Contractor Final Project Documentation*, final payment will be processed based on the entire sum, or the undisputed sum in case of approval under protest, determined to be due the Contractor less all previous payments and all amounts to be deducted under the provisions of the contract. All prior partial estimates and payments shall be subject to correction in the final estimate and payment.

If the Contractor has filed a claim for additional compensation under the provisions of Section 50, paragraph 50-16, *Claims for Adjustments and Disputes,* or under the provisions of this paragraph, such claims will be considered by the Owner in accordance with local laws or ordinances. Upon final adjudication of such claims, any additional payment determined to be due the Contractor will be paid pursuant to a supplemental final estimate.

90-10 Construction warranty.

a. In addition to any other warranties in this contract, the Contractor warrants that work performed under this contract conforms to the contract requirements and is free of any defect in equipment, material, workmanship, or design furnished, or performed by the Contractor or any subcontractor or supplier at any tier.

b. This warranty shall continue for a period of one year from the date of final acceptance of the work, except as noted. If the Owner takes possession of any part of the work before final acceptance, this warranty shall continue for a period of one year from the date the Owner takes possession. However, this will not relieve the Contractor from corrective items required by the final acceptance of the project work. Light Emitting Diode (LED) light fixtures with the exception of obstruction lighting, must be warranted by the manufacturer for a minimum of four (4) years after date of installation inclusive of all electronics.

c. The Contractor shall remedy at the Contractor's expense any failure to conform, or any defect. In addition, the Contractor shall remedy at the Contractor's expense any damage to Owner real or personal

property, when that damage is the result of the Contractor's failure to conform to contract requirements; or any defect of equipment, material, workmanship, or design furnished by the Contractor.

d. The Contractor shall restore any work damaged in fulfilling the terms and conditions of this clause. The Contractor's warranty with respect to work repaired or replaced will run for one year from the date of repair or replacement.

e. The Owner will notify the Contractor, in writing, within fourteen (14) days after the discovery of any failure, defect, or damage.

f. If the Contractor fails to remedy any failure, defect, or damage within fourteen (14) days after receipt of notice, the Owner shall have the right to replace, repair, or otherwise remedy the failure, defect, or damage at the Contractor's expense.

g. With respect to all warranties, express or implied, from subcontractors, manufacturers, or suppliers for work performed and materials furnished under this contract, the Contractor shall: (1) Obtain all warranties that would be given in normal commercial practice; (2) Require all warranties to be executed, in writing, for the benefit of the Owner, as directed by the Owner, and (3) Enforce all warranties for the benefit of the Owner.

h. This warranty shall not limit the Owner's rights with respect to latent defects, gross mistakes, or fraud.

90-11 Contractor Final Project Documentation. Approval of final payment to the Contractor is contingent upon completion and submittal of the items listed below. The final payment will not be approved until the RPR approves the Contractor's final submittal. The Contractor shall:

a. Provide two (2) copies of all manufacturer's warranties specified for materials, equipment, and installations.

b. Provide weekly payroll records (not previously received) from the general Contractor and all subcontractors.

c. Complete final cleanup in accordance with Section 40, paragraph 40-08, *Final Cleanup*.

d. Complete all punch list items identified during the Final Inspection.

e. Provide complete release of all claims for labor and material arising out of the Contract.

f. Provide a certified statement signed by the subcontractors, indicating actual amounts paid to the Disadvantaged Business Enterprise (DBE) subcontractors and/or suppliers associated with the project.

g. When applicable per state requirements, return copies of sales tax completion forms.

h. Manufacturer's certifications for all items incorporated in the work.

i. All required record drawings, as-built drawings or as-constructed drawings.

j. Project Operation and Maintenance (O&M) Manual(s).

k. Security for Construction Warranty.

l. Equipment commissioning documentation submitted, if required.

m. Consent of Surety.

n. Any test results required by the technical specifications or permit conditions.

END OF SECTION 90

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TECHNICAL SPECIFICATIONS

SECTION 03 30 00

CAST-IN-PLACE CONCRETE

PART 1 - GENERAL

1.01 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.02 SUMMARY

A. Section includes cast-in-place concrete, including formwork, reinforcement, concrete materials, mixture design, placement procedures, and finishes.

1.03 DEFINITIONS

A. Cementitious Materials: Portland cement alone or in combination with one or more of the following: blended hydraulic cement, fly ash, slag cement, other pozzolans, and silica fume; materials subject to compliance with requirements.

B. W/C Ratio: The ratio by weight of water to cementitious materials.

C. Cold Joint: A discontinuity between layers (horizontal or vertical) of concrete that occurs when one layer of concrete is allowed to harden before the remainder of the concrete is poured in what was to be a single, solid mass. The discontinuity occurs between the layers due to the inability of the freshly poured or wet concrete to intermix with and properly bind to the hardened concrete.

D. deg F: Degrees Fahrenheit.

1.04 PREINSTALLATION MEETINGS

A. Preinstallation Conference: Conduct conference at the Construction Office for the Project.

1. Before submitting design mixtures, review concrete design mixture and examine procedures for ensuring quality of concrete materials. Require representatives of each entity directly concerned with cast-in-place concrete to attend, including the following:
   a. Contractor's superintendent.
   b. Independent testing agency responsible for concrete design mixtures.
   c. Ready-mix concrete manufacturer.
   d. Concrete Subcontractor.

2. Review special inspection and testing and inspecting agency procedures for field quality control, concrete finishes and finishing, cold- and hot-weather concreting procedures, curing procedures, construction contraction and isolation joints, and joint-filler strips, semirigid joint fillers, forms and form removal limitations, shoring and reshoring procedures, steel reinforcement installation, methods for achieving specified floor and slab flatness and levelness, floor and slab flatness and levelness measurement, concrete repair procedures, and concrete protection.

1.05 ACTION SUBMITTALS

A. Product Data: For each type of product (e.g., cement, aggregates, ad-mix items, waterstops, construction joints, expansion joints, etc…).

B. Design Mixtures: For each concrete mixture. Submit alternate design mixtures when characteristics of materials, Project conditions, weather, test results, or other circumstances warrant adjustments.

1. Indicate amounts of mixing water to be withheld for later addition at Project site.

C. Steel Reinforcement Shop Drawings: Placing Drawings that detail fabrication, bending, and placement. Include bar sizes, lengths, material, grade, bar schedules, stirrup spacing, bent bar diagrams, bar arrangement, splices and laps, mechanical connections, tie spacing, hoop spacing, and/or supports for concrete reinforcement.

D. Construction Joint Layout: Indicate proposed construction joints required to construct the structure.

1. Location of construction joints is subject to approval of the Engineer.

1.06 INFORMATIONAL SUBMITTALS

A. Welding certificates.

B. Material Certificates: For each of the following, signed by manufacturers:

1. Cementitious materials.
2. Admixtures (if used).
3. Form materials and form-release agents.
4. Steel reinforcement and accessories.
5. Fiber reinforcement (if used).
6. Water-stops.
7. Curing compounds (if used).
8. Floor and slab treatments (if used).
9. Bonding agents (if used).
10. Adhesives (if used).
11. Vapor retarders (if used).
12. Semi-rigid joint filler.
13. Joint-filler strips.
14. Repair materials (if used).

C. Material Test Reports: For the following, from a qualified testing agency:

1. Aggregates: Include service record data indicating absence of deleterious expansion of concrete due to alkali aggregate reactivity.

D. Formwork Shop Drawings: Prepared by or under the supervision of a qualified professional engineer, detailing fabrication, assembly, and support of formwork.

1. Shoring and Reshoring: Indicate proposed schedule and sequence of stripping formwork, shoring removal, and reshoring installation and removal.

E. Floor surface flatness and levelness measurements indicating compliance with specified tolerances.

F. Field quality-control reports.

G. Minutes of preinstallation conference.

1.07 QUALITY ASSURANCE

A. Installer Qualifications: A qualified installer who employs on Project personnel qualified as ACI-certified Flatwork Technician and Finisher and a supervisor who is an ACI-certified Concrete Flatwork Technician.

B. Manufacturer Qualifications: A firm experienced in manufacturing ready-mixed concrete products and that complies with ASTM C 94/C 94M requirements for production facilities and equipment.

1. Manufacturer certified according to NRMCA's "Certification of Ready Mixed Concrete Production Facilities."

C. Testing Agency Qualifications: An independent agency, acceptable to authorities having jurisdiction, qualified according to ASTM C 1077 and ASTM E 329 for testing indicated.

1. Personnel conducting field tests shall be qualified as ACI Concrete Field Testing Technician, Grade 1, according to ACI CP-1 or an equivalent certification program.

2. Personnel performing laboratory tests shall be ACI-certified Concrete Strength Testing Technician and Concrete Laboratory Testing Technician, Grade I. Testing agency laboratory supervisor shall be an ACI-certified Concrete Laboratory Testing Technician, Grade II.

D. Welding Qualifications: Qualify procedures and personnel according to AWS D1.4/D 1.4M.

1.08 PRECONSTRUCTION TESTING

A. Preconstruction Testing Service: Engage a qualified testing agency to perform preconstruction testing on concrete mixtures.

1.09 DELIVERY, STORAGE, AND HANDLING

A. Steel Reinforcement: Deliver, store, and handle steel reinforcement to prevent bending and damage.

B. Water-stops: Store water-stops under cover to protect from moisture, sunlight, dirt, oil, and other contaminants.

1.10 FIELD CONDITIONS

A. Cold-Weather Placement: Comply with ACI 306.1 and as follows. Protect concrete work from physical damage or reduced strength that could be caused by frost, freezing actions, or low temperatures.

1. When average high and low temperature is expected to fall below 40 deg F for three successive days, maintain delivered concrete mixture temperature within the temperature range required by ACI 301.

2. Do not use frozen materials or materials containing ice or snow.

3. Do not place concrete on frozen subgrade or on subgrade containing frozen materials.

4. Do not use calcium chloride, salt, or other materials containing antifreeze agents or chemical accelerators unless otherwise specified and approved in mixture designs.

B. Hot-Weather Placement: Comply with ACI 301 and as follows:

1. Maintain concrete temperature below 90 deg F at time of placement.

2. Chilled mixing water or chopped ice may be used to control temperature, provided water equivalent of ice is calculated to total amount of mixing water.
3. Using liquid nitrogen to cool concrete is Contractor's option.
4. Fog-spray forms, steel reinforcement, and subgrade just before placing concrete. Keep subgrade uniformly moist without standing water, soft spots, or dry areas.

PART 2 - PRODUCTS

2.01 CONCRETE, GENERAL

A. ACI Publications: Comply with the following unless modified by requirements in the Contract Documents: ACI 301 and ACI 117.

2.02 FORM-FACING MATERIALS

A. Smooth-Formed Finished Concrete: Form-facing panels that provide continuous, true, and smooth concrete surfaces. Furnish in largest practicable sizes to minimize number of joints.

B. Rough-Formed Finished Concrete: Plywood, lumber, metal, or another approved material. Provide lumber dressed on at least two edges and one side for tight fit.

C. Forms for Cylindrical Columns, Pedestals, and Supports: Metal, glass-fiber-reinforced plastic, paper, or fiber tubes that produce surfaces with gradual or abrupt irregularities not exceeding specified formwork surface class. Provide units with sufficient wall thickness to resist plastic concrete loads without detrimental deformation.

D. Pan-Type Forms: Glass-fiber-reinforced plastic or formed steel, stiffened to resist plastic concrete loads without detrimental deformation.

E. Chamfer Strips: Wood, metal, PVC, or rubber strips, 1 by 1 inch, minimum.

F. Rustication Strips: Wood, metal, PVC, or rubber strips, kerfed for ease of form removal.

G. Form-Release Agent: Commercially formulated form-release agent that does not bond with, stain, or adversely affect concrete surfaces and does not impair subsequent treatments of concrete surfaces.

1. Formulate form-release agent with rust inhibitor for steel form-facing materials.

H. Form Ties: Factory-fabricated, removable or snap-off glass-fiber-reinforced plastic or metal form ties designed to resist lateral pressure of fresh concrete on forms and to prevent spalling of concrete on removal.

1. Furnish units that leave no corrodible metal closer than 1 inch (25 mm) to the plane of exposed concrete surface.
2. Furnish ties that, when removed, leave holes no larger than 1 inch (25 mm) in diameter in concrete surface.
3. Furnish ties with integral water-barrier plates to walls indicated to receive dampproofing or waterproofing.

2.03 STEEL REINFORCEMENT

A. Reinforcing Bars: ASTM A 615, Grade 60, deformed.

B. Deformed-Steel Welded-Wire Reinforcement: ASTM A 1064, flat sheet or rolls.

2.04 REINFORCEMENT ACCESSORIES

A. Joint Dowel Bars: ASTM A 615, Grade 60, plain-steel bars, cut true to length with ends square and free of burrs.

B. Bar Supports: Bolsters, chairs, spacers, and other devices for spacing, supporting, and fastening reinforcing bars and welded-wire reinforcement in place. Manufacture bar supports from steel wire, plastic, or precast concrete according to CRSI's "Manual of Standard Practice," of greater compressive strength than concrete and as follows:

1. For concrete surfaces exposed to view, where legs of wire bar support contact forms, use CRSI Class 1 plastic-protected steel wire or CRSI Class 2 stainless-steel bar supports.

2.05 CONCRETE MATERIALS

A. Regional Materials: Concrete shall be manufactured within a distance from the Project site so as to meet the time requirements for delivery and placement.

B. Aggregates and cementitious materials shall have been extracted, harvested, or recovered, as well as manufactured, within 500 miles of Project site.

C. Source Limitations: Obtain each type or class of cementitious material of the same brand from the same manufacturer's plant, obtain aggregate from single source, and obtain admixtures from single source from single manufacturer.

D. Cementitious Materials:

1. Portland Cement: ASTM C 150/C 150M, Type I, Type II, or Type I/II.

2. Fly Ash: ASTM C 618, Class F or C.

3. Slag Cement: ASTM C 989, Grade 100 or 120.

E. Normal-Weight Aggregates: ASTM C 33, Class 3S coarse aggregate or better, graded. Provide aggregates from a single source with documented service record data of at least 10 years' satisfactory service in similar applications and service conditions using similar aggregates and cementitious materials.

1. Maximum Coarse-Aggregate Size: 1-1/2 inches nominal.

2. Fine Aggregate: Free of materials with deleterious reactivity to alkali in cement.

F. Air-Entraining Admixture: ASTM C 260

G. Chemical Admixtures: Certified by manufacturer to be compatible with other admixtures and that do not contribute water-soluble chloride ions exceeding those permitted in hardened concrete. Do not use calcium chloride or admixtures containing calcium chloride.

1. Water-Reducing Admixture: ASTM C 494/C 494M, Type A.

2. Retarding Admixture: ASTM C 494/C 494M, Type B.

3. Water-Reducing and Retarding Admixture: ASTM C 494/C 494M, Type D.

4. High-Range, Water-Reducing Admixture: ASTM C 494/C 494M, Type F.

5. High-Range, Water-Reducing and Retarding Admixture: ASTM C 494/C 494M, Type G.

6. Plasticizing and Retarding Admixture: ASTM C 1017/C 1017M, Type II.

H. Water: ASTM C 94 and potable.

2.06 WATERSTOPS

A. Chemically Resistant Flexible Waterstops: Thermoplastic elastomer rubber waterstops with factory-installed metal eyelets, for embedding in concrete to prevent passage of fluids through joints; resistant to oils, solvents, and chemicals. All corners, intersections, and directional changes identified shall be fabricated at the factory.

1. Profile: Ribbed with center bulb OR ribbed without center bulb.
2. Dimensions: 9 inches by 3/8 inch thick non tapered.

2.07 FLOOR SLAB AND SIDEWALK TREATMENTS

A. Broom finish with 2-inch troweled/tooled edges for all panels. Broom finish shall be perpendicular to the length of the slab OR perpendicular to the direction of pedestrian traffic.

2.08 CURING MATERIALS

A. Absorptive Cover: AASHTO M 182, Class 2, burlap cloth made from jute or kenaf, weighing approximately 9 oz./sq. yd. when dry.

B. Moisture-Retaining Cover: ASTM C 171, polyethylene film or white burlap-polyethylene sheet.

C. Water: Potable.

2.09 RELATED MATERIALS

A. Expansion- and Isolation-Joint-Filler Strips: ASTM D 1751, asphalt-saturated cellulosic fiber or ASTM D 1752, cork or self-expanding cork.

B. Bonding Agent: ASTM C 1059/C 1059M, Type II, non-redispersible, acrylic emulsion or styrene butadiene.

C. Epoxy Bonding Adhesive: ASTM C 881, two-component epoxy resin, capable of humid curing and bonding to damp surfaces, of class suitable for application temperature and of grade to suit requirements, and as follows:

1. Types I and II, no-load bearing or Types IV and V, load bearing, for bonding hardened or freshly mixed concrete to hardened concrete.

2.10 REPAIR MATERIALS

A. Repair Overlayment: Cement-based, polymer-modified, self-leveling product that can be applied in thicknesses from 1/4 inch and that can be filled in over a scarified surface to match adjacent floor / slab elevations.

1. Cement Binder: ASTM C 150, Portland cement or hydraulic or blended hydraulic cement as defined in ASTM C 219.
2. Primer: Product of topping manufacturer recommended for substrate, conditions, and application.
3. Aggregate: Well-graded, washed gravel, 1/8 to 1/4 inch or coarse sand as recommended by topping manufacturer.
4. Compressive Strength: Not less than 5000 psi at 28 days when tested according to ASTM C 109.

2.11 CONCRETE MIXTURES, GENERAL

A. Prepare design mixtures for each type and strength of concrete, proportioned on the basis of laboratory trial mixture or field test data, or both, according to ACI 301.

1. Use a qualified independent testing agency for preparing and reporting proposed mixture designs based on laboratory trial mixtures.

B. Cementitious Materials: Limit percentage, by weight, of cementitious materials other than portland cement in concrete as follows:

1. Fly Ash: 25 percent.
2. Combined Fly Ash and Pozzolan: 25 percent.
3. Slag Cement: 50 percent.
4. Combined Fly Ash or Pozzolan and Slag Cement: 50 percent portland cement minimum, with fly ash or pozzolan not exceeding 25 percent.

C. Admixtures: Use admixtures according to manufacturer's written instructions.

1. Use water-reducing high-range water-reducing or plasticizing admixture in concrete, as required, for placement and workability.
2. Use water-reducing and -retarding admixture when required by high temperatures, low humidity, or other adverse placement conditions.
3. Use water-reducing admixture in pumped concrete, concrete for heavy-use industrial slabs and parking structure slabs, concrete required to be watertight, and concrete with a w/c ratio below 0.50.

2.12 CONCRETE MIXTURES FOR CONSTRUCTION ELEMENTS

A. Footings: Normal-weight concrete.

1. Minimum Compressive Strength: 4500 psi at 28 days.
2. Maximum W/C Ratio: 0.50.
3. Slump Limit: 5 inches plus or minus 1 inch.
4. Air Content: 5.5 percent, plus or minus 1.5 percent at point of delivery for 1-1/2-inch nominal maximum aggregate size.

B. Foundation Walls: Normal-weight concrete.

1. Minimum Compressive Strength: 3000 psi at 28 days.
2. Maximum W/C Ratio: 0.45 max.
3. Slump Limit: 4 inches, plus or minus 1 inch.
4. Air Content: 6 percent
5. Aggregate: ¾”

C. Slabs-on-Grade: Normal-weight concrete.

1. Minimum Compressive Strength: 4500 psi at 28 days.
2. Maximum W/C Ratio: 0.45 max.
3. Minimum Cementitious Materials Content: 520 lb/cu. yd.

4. Slump Limit: 4 inches, plus or minus 1 inch.
5. Air Content: 6 percent
6. Aggregate: ¾”

2.13 FABRICATING REINFORCEMENT

A. Fabricate steel reinforcement according to CRSI's "Manual of Standard Practice."

2.14 CONCRETE MIXING

A. Ready-Mixed Concrete: Measure, batch, mix, and deliver concrete according to ASTM C 94 and/or ASTM C 1116, and furnish batch ticket information.
   1. When air temperature is below 85 deg F, missing and delivery time shall be 90 minutes or less.
   2. When air temperature is between 85 and 90 deg F, mixing and delivery time shall be 75 minutes or less.
   3. When air temperature is above 90 deg F, mixing and delivery time shall be 60 minutes or less.

PART 3 - EXECUTION

3.01 FORMWORK INSTALLATION

A. Design, erect, shore, brace, and maintain formwork, according to ACI 301, to support vertical, lateral, static, and dynamic loads, and construction loads that might be applied, until structure can support such loads.

B. Construct formwork so concrete members and structures are of size, shape, alignment, elevation, and position indicated, within tolerance limits of ACI 117.

C. Limit concrete surface irregularities, designated by ACI 347 as abrupt or gradual, as follows:
   1. Class A, 1/8 inch for smooth-formed finished surfaces.
   2. Class B, 1/4 inch for rough-formed finished surfaces.
   3. Class C, 1/2 inch for rough-formed finished surfaces.
   4. Class D, 1 inch for rough-formed finished surfaces.

D. Construct forms tight enough to prevent loss of concrete mortar.

E. Construct forms for easy removal without hammering or prying against concrete surfaces. Provide crush or wrecking plates where stripping may damage cast-concrete surfaces. Provide top forms for inclined surfaces steeper than 1.5 horizontal to 1 vertical.
   1. Install keyways, recesses, and the like, for easy removal.
   2. Do not use rust-stained steel form-facing material.

F. Set edge forms, bulkheads, and intermediate screed strips for slabs to achieve required elevations and slopes in finished concrete surfaces. Provide and secure units to support screed strips; use strike-off templates or compacting-type screeds.

G. Provide temporary openings for cleanouts and inspection ports where interior area of formwork is inaccessible. Close openings with panels tightly fitted to forms and securely

braced to prevent loss of concrete mortar. Locate temporary openings in forms at inconspicuous locations.

H. Chamfer exterior corners and edges of permanently exposed concrete at 1” x 1” minimum.

I. Form openings, chases, offsets, sinkage, keyways, reglets, blocking, screeds, and bulkheads required in the Work. Determine sizes and locations from trades providing such items.

J. Clean forms and adjacent surfaces to receive concrete. Remove chips, wood, sawdust, dirt, and other debris just before placing concrete.

K. Retighten forms and bracing before placing concrete, as required, to prevent mortar leaks and maintain proper alignment.

L. Coat contact surfaces of forms with form-release agent, according to manufacturer's written instructions, before placing reinforcement.

3.02 EMBEDDED ITEM INSTALLATION

A. Place and secure anchorage devices and other embedded items required for adjoining work that is attached to or supported by cast-in-place concrete. Use setting drawings, templates, diagrams, instructions, and directions furnished with items to be embedded.

1. Install anchor rods, accurately located, to elevations required and complying with tolerances in Section 7.5 of AISC 303.

3.03 REMOVING AND REUSING FORMS

A. General: Formwork for sides of beams, walls, columns, and similar parts of the Work that does not support weight of concrete may be removed after cumulatively curing at not less than 50 deg F for 24-hours after placing concrete. Concrete has to be hard enough to not be damaged by form-removal operations, and curing and protection operations need to be maintained.

1. Leave formwork for beam soffits, joists, slabs, and other structural elements that support weight of concrete in place until concrete has achieved at least 70 percent of its 28-day design compressive strength.

2. Remove forms only if shores have been arranged to permit removal of forms without loosening or disturbing shores.

B. Clean and repair surfaces of forms to be reused in the Work. Split, frayed, delaminated, or otherwise damaged form-facing material are not acceptable for exposed surfaces. Apply new form-release agent.

C. When forms are reused, clean surfaces, remove fins and laitance, and tighten to close joints. Align and secure joints to avoid offsets. Do not use patched forms for exposed concrete surfaces unless approved by the Engineer.

3.04 SHORING AND RESHORING INSTALLATION

A. Comply with ACI 318 and ACI 301 for design, installation, and removal of shoring and reshoring.

1. Do not remove shoring or reshoring until measurement of slab tolerances is complete.

3.05 STEEL REINFORCEMENT INSTALLATION

A. General: Comply with CRSI's "Manual of Standard Practice" for fabricating, placing, and supporting reinforcement.

1. Do not cut or puncture vapor retarder. Repair damage and reseal vapor retarder before placing concrete.

B. Clean reinforcement of loose rust and mill scale, earth, ice, and other foreign materials that reduce bond to concrete.

C. Accurately position, support, and secure reinforcement against displacement. Locate and support reinforcement with bar supports to maintain minimum concrete cover. Do not tack weld crossing reinforcing bars.

D. Set wire ties with ends directed into concrete, not toward exposed concrete surfaces.

E. Install welded-wire reinforcement in longest practicable lengths on bar supports spaced to minimize sagging. Lap edges and ends of adjoining sheets at least one mesh spacing. Offset laps of adjoining sheet widths to prevent continuous laps in either direction. Lace overlaps with wire.

3.06 JOINTS

A. General: Construct joints true to line with faces perpendicular to surface plane of concrete.

B. Construction Joints: Install so strength and appearance of concrete are not impaired, at locations indicated or as approved by Engineer.

1. Place joints perpendicular to main reinforcement. Continue reinforcement across construction joints unless otherwise indicated. Do not continue reinforcement through sides of strip placements of floors and slabs.

2. Form keyed joints as indicated. Embed keys at least 3-inches wide and 2-inches deep into concrete.

3. Locate joints for beams, slabs, joists, and girders in the middle third of spans. Offset joints in girders a minimum distance of twice the beam width from a beam-girder intersection.

4. Locate horizontal joints in walls and columns at underside of floors, slabs, beams, and girders and at the top of footings or floor slabs.

5. Space vertical joints in walls every 20 feet. Locate joints beside piers integral with walls, near corners, and in concealed locations where possible.

6. Use a bonding agent at cold joint locations.

C. Contraction Joints in Slabs-on-Grade: Form weakened-plane contraction joints, sectioning concrete into areas as indicated. Construct contraction joints for a depth equal to at least one-fourth of concrete thickness as follows:

1. Grooved Joints: Form contraction joints after initial floating by grooving and finishing each edge of joint to a radius of 1/8 inch. Repeat grooving of contraction joints after applying surface finishes. Eliminate groover tool marks on concrete surfaces.

2. Sawed Joints: Form contraction joints with power saws equipped with shatterproof abrasive or diamond-rimmed blades. Cut 1/8-inch-wide joints into concrete when cutting action does not tear, abrade, or otherwise damage surface and before concrete develops random contraction cracks.

3. Isolation Joints in Slabs-on-Grade: After removing formwork, install joint-filler strips at slab junctions with vertical surfaces, such as column pedestals, foundation walls, grade beams, and other locations, as indicated.
4. Extend joint-filler strips full width and depth of joint, terminating flush with finished concrete surface unless otherwise indicated.
5. Install joint-filler strips in lengths as long as practicable. Where more than one length is required, lace or clip sections together.

3.07 WATER-STOP INSTALLATION

A. Flexible Water-stops:

1. Install in construction joints and at other joints indicated to form a continuous diaphragm.
2. Install in longest lengths practicable.
3. Field fabricate joints in water-stops according to manufacturer's written instructions.
4. Support and protect exposed water-stops during progress of the Work.

3.08 CONCRETE PLACEMENT

A. Before placing concrete, verify that installation of formwork, reinforcement, and embedded items is complete and that required inspections are completed.

B. Before test sampling and placing concrete, water may be added at Project site, subject to limitations of ACI 301.

C. Deposit concrete continuously in one layer or in horizontal layers of such thickness that no new concrete is placed on concrete that has hardened enough to cause seams or planes of weakness. If a section cannot be placed continuously, provide construction joints as indicated. Deposit concrete to avoid segregation.

1. Deposit concrete in horizontal layers of depth not to exceed formwork design pressures and in a manner to avoid inclined construction joints.
2. Consolidate placed concrete with mechanical vibrating equipment according to ACI 301.
3. Do not use vibrators to transport concrete inside forms. Insert and withdraw vibrators vertically at uniformly spaced locations to rapidly penetrate placed layer and at least 6 inches into preceding layer.
4. Do not insert vibrators into lower layers of concrete that have begun to lose plasticity.
5. At each insertion, limit duration of vibration to time necessary to consolidate concrete and complete embedment of reinforcement and other embedded items without causing mixture constituents to segregate.

D. Deposit and consolidate concrete for floors and slabs in a continuous operation, within limits of construction joints, until placement of a panel or section is complete.

1. Consolidate concrete during placement operations, so concrete is thoroughly worked around reinforcement and other embedded items and into corners.
2. Maintain reinforcement in position on chairs during concrete placement.
3. Screed slab surfaces with a straightedge and strike off to correct elevations.

4. Slope surfaces uniformly to drains where required (e.g., Truck Unloading Pad).
5. Begin initial floating using bull floats or darbies to form a uniform and open-textured surface plane, before excess bleed water appears on the surface. Do not further disturb slab surfaces before starting finishing operations.

3.09 FINISHING FORMED SURFACES

A. Rough-Formed Finish: As-cast concrete texture imparted by form-facing material with tie holes and defects repaired and patched. Remove fins and other projections that exceed specified limits on formed-surface irregularities.
   1. Apply to concrete surfaces not exposed to public view (e.g. below ground surface).

B. Smooth-Formed Finish: As-cast concrete texture imparted by form-facing material, arranged in an orderly and symmetrical manner with a minimum of seams. Repair and patch tie holes and defects. Remove fins and other projections that exceed specified limits on formed-surface irregularities.
   1. Apply to concrete surfaces exposed to public view, (i.e., Retaining Wall and Knee Wall exposed surfaces).

C. Rubbed Finish: Apply the following to smooth-formed-finished as-cast concrete where indicated:
   1. Cork-Floated Finish: Wet concrete surfaces and apply a stiff grout. Mix 1 part portland cement and 1 part fine sand with a 1:1 mixture of bonding agent and water. Add white Portland cement in amounts determined by trial patches, so color of dry grout matches adjacent surfaces. Compress grout into voids by grinding surface. In a swirling motion, finish surface with a cork float.

D. Related Unformed Surfaces: At tops of walls, horizontal offsets, and similar unformed surfaces adjacent to formed surfaces, strike off smooth and finish with a texture matching adjacent formed surfaces. Continue final surface treatment of formed surfaces uniformly across adjacent unformed surfaces unless otherwise indicated.

3.10 FINISHING FLOORS AND SLABS

A. General: Comply with ACI 302.1R recommendations for screeding, re-straightening, and finishing operations for concrete surfaces. Do not wet concrete surfaces.

B. Scratch / Broom Finish: While still plastic, texture concrete surface that has been screeded and bull-floated or darbied. Use stiff bristle brushes or brooms to produce a profile amplitude of 1/4 inch in one direction.
   1. Apply scratch finish to surfaces to all slabs on grade in a direction perpendicular to the longest length where pedestrian traffic is present in a direction perpendicular to the walking route.
   2. Finish surfaces to the following tolerances, according to ASTM E 1155, for a randomly trafficked floor surface.
   3. Finish and measure surface, so gap at any point between concrete surface and an unleveled, freestanding, 20-ft.- long straightedge resting on two high spots and placed anywhere on the surface does not exceed 1/8 inch with the exception of the Truck Unloading Slab that is pitched towards the center drain.

3.11 MISCELLANEOUS CONCRETE ITEM INSTALLATION

A. Filling In: Fill in holes and openings left in concrete structures after work of other trades is in place unless otherwise indicated. Mix, place, and cure concrete, as specified, to blend with in-place construction. Provide other miscellaneous concrete filling indicated or required to complete the Work.

B. Curbs: Provide monolithic finish to interior curbs by stripping forms while concrete is still green and by steel-troweling surfaces to a hard, dense finish with corners, intersections, and terminations slightly rounded.

3.12 CONCRETE PROTECTING AND CURING

A. General: Protect freshly placed concrete from premature drying and excessive cold or hot temperatures. Comply with ACI 306.1 for cold-weather protection and ACI 301 for hot-weather protection during curing.

B. Evaporation Retarder: Apply evaporation retarder to unformed concrete surfaces if hot, dry, or windy conditions cause moisture loss approaching 0.2 lb/sq. ft. x h before and during finishing operations. Apply according to manufacturer's written instructions after placing, screeding, and bull floating or darbying concrete, but before float finishing.

C. Formed Surfaces: Cure formed concrete surfaces, including underside of beams, supported slabs, and other similar surfaces. If forms remain during curing period, moist cure after loosening forms. If removing forms before end of curing period, continue curing for remainder of curing period.

D. Unformed Surfaces: Begin curing immediately after finishing concrete. Cure unformed surfaces, including floors and slabs, concrete floor toppings, and other surfaces.

E. Cure concrete according to ACI 308.1, by one or a combination of the following methods:

1. Moisture Curing: Keep surfaces continuously moist for not less than seven days with the following materials:
   a. Water.
   b. Continuous water-fog spray.
   c. Absorptive cover, water saturated, and kept continuously wet. Cover concrete surfaces and edges with 12-inch lap over adjacent absorptive covers.

2. Moisture-Retaining-Cover Curing: Cover concrete surfaces with moisture-retaining cover for curing concrete, placed in widest practicable width, with sides and ends lapped at least 12 inches, and sealed by waterproof tape or adhesive. Cure for not less than seven days. Immediately repair any holes or tears during curing period, using cover material and waterproof tape.
   a. Moisture cure or use moisture-retaining covers to cure concrete surfaces to receive floor coverings.
   b. Moisture cure or use moisture-retaining covers to cure concrete surfaces to receive penetrating liquid floor treatments.
   c. Cure concrete surfaces to receive floor coverings with either a moisture-retaining cover or a curing compound that the manufacturer certifies does not interfere with bonding of floor covering used on Project.

3. Curing Compound: Apply uniformly in continuous operation by power spray or roller according to manufacturer's written instructions. Recoat areas subjected to heavy rainfall within three hours after initial application. Maintain continuity of coating and repair damage during curing period.

a. Removal: After curing period has elapsed, remove curing compound without damaging concrete surfaces by method recommended by curing compound manufacturer.

4. Curing and Sealing Compound: Apply uniformly to floors and slabs indicated in a continuous operation by power spray or roller according to manufacturer's written instructions. Recoat areas subjected to heavy rainfall within three hours after initial application. Repeat process 24 hours later and apply a second coat. Maintain continuity of coating and repair damage during curing period.

3.13 CONCRETE SURFACE REPAIRS

A. Defective Concrete: Repair and patch defective areas when approved by the Engineer. Remove and replace concrete that cannot be repaired and patched to Engineer's approval.

B. Patching Mortar: Mix dry-pack patching mortar, consisting of 1-part portland cement to 2-1/2 parts fine aggregate passing a No. 16 (1.18-mm) sieve, using only enough water for handling and placing.

C. Repairing Formed Surfaces: Surface defects include color and texture irregularities, cracks, spalls, air bubbles, honeycombs, rock pockets, fins and other projections on the surface, and stains and other discolorations that cannot be removed by cleaning.

1. Immediately after form removal, cut out honeycombs, rock pockets, and voids more than 1/2 inch in any dimension to solid concrete. Limit cut depth to 3/4 inch. Make edges of cuts perpendicular to concrete surface. Clean, dampen with water, and brush-coat holes and voids with bonding agent. Fill and compact with patching mortar before bonding agent has dried. Fill form-tie voids with patching mortar or cone plugs secured in place with bonding agent.

2. Repair defects on surfaces exposed to view by blending white portland cement and standard portland cement so that, when dry, patching mortar matches surrounding color. Patch a test area at inconspicuous locations to verify mixture and color match before proceeding with patching. Compact mortar in place and strike off slightly higher than surrounding surface.

3. Repair defects on concealed formed surfaces that affect concrete's durability and structural performance as determined by Engineer.

D. Repairing Unformed Surfaces: Test unformed surfaces, such as floors and slabs, for finish and verify surface tolerances specified for each surface. Correct low and high areas. Test surfaces sloped to drain for trueness of slope and smoothness; use a sloped template.

1. Repair finished surfaces containing defects. Surface defects include spalls, popouts, honeycombs, rock pockets, crazing and cracks in excess of 0.01 inch wide or that penetrate to reinforcement or completely through unreinforced sections regardless of width, and other objectionable conditions.

2. After concrete has cured at least 14 days, correct high areas by grinding.

3. Correct localized low areas during or immediately after completing surface finishing operations by cutting out low areas and replacing with patching mortar. Finish repaired areas to blend into adjacent concrete.

4. Correct other low areas scheduled to remain exposed with a repair topping. Cut out low areas to ensure a minimum repair topping depth of 1/4 inch to match adjacent floor

elevations. Prepare, mix, and apply repair topping and primer according to manufacturer's written instructions to produce a smooth, uniform, plane, and level surface.

5. Repair defective areas, except random cracks and single holes 1 inch or less in diameter, by cutting out and replacing with fresh concrete. Remove defective areas with clean, square cuts and expose steel reinforcement with at least a 3/4-inch clearance all around. Dampen concrete surfaces in contact with patching concrete and apply bonding agent. Mix patching concrete of same materials and mixture as original concrete, except without coarse aggregate. Place, compact, and finish to blend with adjacent finished concrete. Cure in same manner as adjacent concrete.
6. Repair random cracks and single holes 1 inch or less in diameter with patching mortar. Groove top of cracks and cut out holes to sound concrete and clean off dust, dirt, and loose particles. Dampen cleaned concrete surfaces and apply bonding agent. Place patching mortar before bonding agent has dried. Compact patching mortar and finish to match adjacent concrete. Keep patched area continuously moist for at least 72 hours.

E. Perform structural repairs of concrete, subject to Engineer's approval, using epoxy adhesive and patching mortar.

F. Repair materials and installation not specified above may be used, subject to Engineer's approval.

3.14 FIELD QUALITY CONTROL

A. Testing Agency: Owner will engage a qualified testing and inspecting agency to perform tests and inspections and to submit reports.

B. Inspections:

1. Steel reinforcement placement.
2. Steel reinforcement welding.
3. Headed bolts and studs (if included in structure).
4. Verification of use of required design mixture.
5. Concrete placement, including conveying and depositing.
6. Curing procedures and maintenance of curing temperature.
7. Verification of concrete strength before removal of shores and forms from beams and slabs.

C. Concrete Tests: Testing of composite samples of fresh concrete obtained according to ASTM C 172 shall be performed according to the following requirements:

1. Testing Frequency: Obtain one composite sample from each ready-mix truck delivery.

1. Slump: ASTM C 143; one test for each truck. Perform additional tests when concrete consistency appears to change.
2. Air Content: ASTM C 231 pressure method, for normal-weight concrete; one test for each truck.
3. Concrete Temperature: ASTM C 1064; one test for each truck.
4. Compression Test Specimens: ASTM C 31/C 31M.

a. Cast and laboratory cure standard cylinder specimens for 100 cubic yards or portion thereof of concrete poured each day.
b. A total of 6 test cylinders shall be made for compressive strength tests.

5. Compressive-Strength Tests: ASTM C 39; test on the following schedule: 2 at 7-days; 1 at 14 days; 2 at 28 days OR 2 at 56 days depending upon the results of the first cylinder at the 28-day break
   a. A compressive-strength test shall be the average compressive strength from a set of two specimens obtained from same composite sample and tested at age indicated.
6. Strength of each concrete mixture will be satisfactory if the average of the 28 day OR 56 day compressive-strength tests equal or exceeds specified compressive strength and no compressive-strength test value falls below specified compressive strength by more than 250 psi.
7. Test results shall be reported in writing to the Engineer, concrete manufacturer, and Contractor within 48 hours of testing. Reports of compressive-strength tests shall contain Project identification name and number, date of concrete placement, name of concrete testing and inspecting agency, location of concrete batch in Work, design compressive strength at 28 days, concrete mixture proportions and materials, compressive breaking strength, and type of break for all tests.
8. Nondestructive Testing: Impact hammer, Sonoscope, or other nondestructive device may be permitted by the Engineer but will not be used as sole basis for approval or rejection of concrete.
9. Additional Tests: Testing and inspecting agency shall make additional tests of concrete when test results indicate that slump, air entrainment, compressive strengths, or other requirements have not been met, as directed by the Engineer. Testing and inspecting agency may conduct tests to determine adequacy of concrete by cored cylinders complying with ASTM C 42 or by other methods as directed by the Engineer.
10. Additional testing and inspecting, at Contractor's expense, will be performed to determine compliance of replaced or additional work with specified requirements.
11. Correct deficiencies in the Work that test reports and inspections indicate do not comply with the Contract Documents.

END OF SECTION

SECTION 05 12 00
STRUCTURAL STEEL

PART 1 - GENERAL

1.01 SUMMARY

A. Section includes structural steel and grout.

B. Related Sections:

1. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 1 Specification Sections, apply to this Section.

1.02 DEFINITIONS

A. Structural Steel: Elements of structural-steel frame, as classified by AISC 303, "Code of Standard Practice for Steel Buildings and Bridges."

1.03 PERFORMANCE REQUIREMENTS

A. Connections: Provide details of simple shear connections required by the Contract Documents to be selected or completed by structural-steel fabricator to withstand loads indicated and comply with other information and restrictions indicated.

1. Select and complete connections using schematic details indicated and AISC 360.

1.04 ACTION SUBMITTALS

A. Product Data: For each type of product indicated.

B. Shop Drawings: Show fabrication of structural-steel components.

1. Include details of cuts, connections, splices, camber, holes, and other pertinent data.

2. Include embedment drawings.

3. Indicate welds by standard AWS symbols, distinguishing between shop and field welds, and show size, length, and type of each weld. Show backing bars that are to be removed and supplemental fillet welds where backing bars are to remain.

4. Indicate type, size, and length of bolts, distinguishing between shop and field bolts. Identify pretensioned and slip-critical high-strength bolted connections.

1.05 INFORMATIONAL SUBMITTALS

A. Qualification Data: For qualified fabricator.

B. Welding certificates.

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

D. Mill test reports for structural steel, including chemical and physical properties.

E. Source quality-control reports.

1.06 QUALITY ASSURANCE

A. Fabricator Qualifications: A qualified fabricator that participates in the AISC Quality Certification Program and is designated an AISC-Certified Plant, Category STD.

B. Installer Qualifications: A qualified installer who participates in the AISC Quality Certification Program and is designated an AISC-Certified Erector, Category CSE.

C. Shop-Painting Applicators: Qualified according to AISC's Sophisticated Paint Endorsement P1 or SSPC-QP 3, "Standard Procedure for Evaluating Qualifications of Shop Painting Applicators."

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

E. Comply with applicable provisions of the following specifications and documents:

1. AISC 303.
2. AISC 360.
3. RCSC's "Specification for Structural Joints Using ASTM A 325 or A 490 Bolts."

1.07 DELIVERY, STORAGE, AND HANDLING

A. Store materials to permit easy access for inspection and identification. Keep steel members off ground and spaced by using pallets, dunnage, or other supports and spacers. Protect steel members and packaged materials from corrosion and deterioration.

1. Do not store materials on structure in a manner that might cause distortion, damage, or overload to members or supporting structures. Repair or replace damaged materials or structures as directed.

B. Store fasteners in a protected place in sealed containers with manufacturer's labels intact.

1. Fasteners may be repackaged provided Owner's testing and inspecting agency observes repackaging and seals containers.
2. Clean and re-lubricate bolts and nuts that become dry or rusty before use.
3. Comply with manufacturers' written recommendations for cleaning and lubricating ASTM F 1852 fasteners and for retesting fasteners after lubrication.

1.08 COORDINATION

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

B. Coordinate installation of anchorage items to be embedded in or attached to other construction without delaying the Work. Provide setting diagrams, sheet metal templates, instructions, and directions for installation.

PART 2 - PRODUCTS

2.01 STRUCTURAL-STEEL MATERIALS

A. Recycled Content of Steel Products: Provide products with an average recycled content of steel products so postconsumer recycled content plus one-half of pre-consumer recycled content is not less than the following:

1. W-Shapes: 25 percent.
2. Channels, Angles, S-Shapes: 25 percent.

3. Plate and Bar: 25 percent.
4. Steel Pipe: 25 percent.
5. All Other Steel Materials: 25 percent.

B. W-Shapes: ASTM A 992/A 992M.

C. Channels, Angles-Shapes: ASTM A 36/A 36M.

D. Plate and Bar: ASTM A 36/A 36M.

E. Cold-Formed Hollow Structural Sections: ASTM A 500, Grade B, structural tubing.

F. Steel Pipe: ASTM A 53/A 53M, Type E or S, Grade B.

1. Weight Class: Standard.

G. Welding Electrodes: Comply with AWS requirements.

2.02 BOLTS, CONNECTORS, AND ANCHORS

A. High-Strength Bolts, Nuts, and Washers: ASTM A 325, Type 1, heavy-hex steel structural bolts; ASTM A 563, Grade C, heavy-hex carbon-steel nuts; and ASTM F 436, Type 1, hardened carbon-steel washers; all with plain finish.

2.03 GROUT

A. Nonmetallic, Shrinkage-Resistant Grout: ASTM C 1107, factory-packaged, nonmetallic aggregate grout, noncorrosive and non-staining, mixed with water to consistency suitable for application and a 30-minute working time.

2.04 FABRICATION

A. Structural Steel: Fabricate and assemble in shop to greatest extent possible. Fabricate according to AISC's "Code of Standard Practice for Steel Buildings and Bridges" and AISC 360.

1. Identify high-strength structural steel according to ASTM A 6/A 6M and maintain markings until structural steel has been erected.
2. Mark and match-mark materials for field assembly.
3. Complete structural-steel assemblies, including welding of units, before starting shop-priming operations.

B. Thermal Cutting: Perform thermal cutting by machine to greatest extent possible.

1. Plane thermally cut edges to be welded to comply with requirements in AWS D1.1/D1.1M.

C. Bolt Holes: Cut, drill, or punch standard bolt holes perpendicular to metal surfaces.

D. Finishing: Accurately finish ends of columns and other members transmitting bearing loads.

E. Cleaning: Clean and prepare steel surfaces that are to remain unpainted according to SSPC-SP 3, "Power Tool Cleaning."

F. Holes: Provide holes required for securing other work to structural steel and for other work to pass through steel framing members.

1. Cut, drill, or punch holes perpendicular to steel surfaces. Do not thermally cut bolt holes or enlarge holes by burning.

2. Baseplate Holes: Cut, drill, or punch holes perpendicular to steel surfaces.
3. Weld threaded nuts to framing and other specialty items indicated to receive other work.

2.05 SHOP CONNECTIONS

A. High-Strength Bolts: Shop install high-strength bolts according to RCSC's "Specification for Structural Joints Using ASTM A 325 or A 490 Bolts" for type of bolt and type of joint specified.

1. Joint Type: Snug tightened.

B. Weld Connections: Comply with AWS D1.1/D1.1M for tolerances, appearances, welding procedure specifications, weld quality, and methods used in correcting welding work.

2.06 GALVANIZING

A. Hot-Dip Galvanized Finish: Apply zinc coating by the hot-dip process to structural steel according to ASTM A 123/A 123M.

1. Galvanize embedded steel angles (in concrete) located at exterior door locations.

2.07 SOURCE QUALITY CONTROL

A. Testing Agency: Owner will engage an independent testing and inspecting agency to perform shop tests and inspections and prepare test reports.

1. Provide testing agency with access to places where structural-steel work is being fabricated or produced to perform tests and inspections.

B. Correct deficiencies in Work that test reports and inspections indicate does not comply with the Contract Documents.

C. Bolted Connections: Shop-bolted connections will be tested and inspected according to RCSC's "Specification for Structural Joints Using ASTM A 325 or A 490 Bolts."

D. Welded Connections: In addition to visual inspection, shop-welded connections will be tested and inspected according to AWS D1.1/D1.1M and the following inspection procedures, at testing agency's option:

1. Liquid Penetrant Inspection: ASTM E 165.
2. Magnetic Particle Inspection: ASTM E 709; performed on root pass and on finished weld. Cracks or zones of incomplete fusion or penetration will not be accepted.
3. Ultrasonic Inspection: ASTM E 164.
4. Radiographic Inspection: ASTM E 94.

PART 3 - EXECUTION

3.01 EXAMINATION

A. Verify, with steel Erector present, elevations of concrete- and masonry-bearing surfaces and locations of anchor rods, bearing plates, and other embedment for compliance with requirements.

1. Prepare a certified survey of bearing surfaces, anchor rods, bearing plates, and other embedment showing dimensions, locations, angles, and elevations.

B. Proceed with installation only after unsatisfactory conditions have been corrected.

3.02 PREPARATION

A. Provide temporary shores, guys, braces, and other supports during erection to keep structural steel secure, plumb, and in alignment against temporary construction loads and loads equal in intensity to design loads. Remove temporary supports when permanent structural steel, connections, and bracing are in place unless otherwise indicated.

1. Do not remove temporary shoring supporting composite deck construction until cast-in-place concrete has attained its design compressive strength.

3.03 ERECTION

A. Set structural steel accurately in locations and to elevations indicated and according to AISC 303 and AISC 360.

B. Base Bearing and Leveling Plates: Clean concrete- and masonry-bearing surfaces of bond-reducing materials, and roughen surfaces prior to setting plates. Clean bottom surface of plates.

1. Set plates for structural members on wedges, shims, or setting nuts as required.

2. Weld plate washers to top of baseplate.

3. Snug-tighten anchor rods after supported members have been positioned and plumbed. Do not remove wedges or shims but, if protruding, cut off flush with edge of plate before packing with grout.

4. Promptly pack grout solidly between bearing surfaces and plates so no voids remain. Neatly finish exposed surfaces; protect grout and allow to cure. Comply with manufacturer's written installation instructions for shrinkage-resistant grouts.

C. Maintain erection tolerances of structural steel within AISC's "Code of Standard Practice for Steel Buildings and Bridges."

D. Align and adjust various members that form part of complete frame or structure before permanently fastening. Before assembly, clean bearing surfaces and other surfaces that will be in permanent contact with members. Perform necessary adjustments to compensate for discrepancies in elevations and alignment.

1. Level and plumb individual members of structure.

E. Splice members only where indicated.

F. Do not use thermal cutting during erection.

G. Do not enlarge unfair holes in members by burning or using drift pins. Ream holes that must be enlarged to admit bolts.

3.04 FIELD CONNECTIONS

A. High-Strength Bolts: Install high-strength bolts according to RCSC's "Specification for Structural Joints Using ASTM A 325 or A 490 Bolts" for type of bolt and type of joint specified.

1. Joint Type: Snug tightened.

B. Weld Connections: Comply with AWS D1.1/D1.1M for tolerances, appearances, welding procedure specifications, weld quality, and methods used in correcting welding work.

1. Comply with AISC 303 and AISC 360 for bearing, alignment, adequacy of temporary connections, and removal of paint on surfaces adjacent to field welds.

3.05 FIELD QUALITY CONTROL

A. Testing Agency: Owner will engage a qualified independent testing and inspecting agency to inspect field welds and high-strength bolted connections.

B. Bolted Connections: Bolted connections will be tested and inspected according to RCSC's "Specification for Structural Joints Using ASTM A 325 or A 490 Bolts."

C. Welded Connections: Field welds will be visually inspected according to AWS D1.1/D1.1M.

1. In addition to visual inspection, field welds will be tested and inspected according to AWS D1.1/D1.1M and the following inspection procedures, at testing agency's option:

a. Liquid Penetrant Inspection: ASTM E 165.
b. Magnetic Particle Inspection: ASTM E 709; performed on root pass and on finished weld. Cracks or zones of incomplete fusion or penetration will not be accepted.
c. Ultrasonic Inspection: ASTM E 164.
d. Radiographic Inspection: ASTM E 94.

D. Correct deficiencies in Work that test reports and inspections indicate does not comply with the Contract Documents.

3.06 REPAIRS AND PROTECTION

A. Galvanized Surfaces: Clean areas where galvanizing is damaged or missing and repair galvanizing to comply with ASTM A 780.

B. Touchup Painting: Immediately after erection, clean exposed areas where primer is damaged or missing and paint with the same material as used for shop painting to comply with SSPC-PA 1 for touching up shop-painted surfaces.

1. Clean and prepare surfaces by SSPC-SP 2 hand-tool cleaning or SSPC-SP 3 power-tool cleaning.

END OF SECTION

SECTION 05 51 19
METAL GRATING STAIRS

PART 1 - GENERAL

1.01 SUMMARY

A. Section includes industrial-type, straight-run stairs with steel-grating treads and railings attached to metal grating stairs.

1.02 ACTION SUBMITTALS

A. Product Data: For metal grating stairs.

B. Shop Drawings: Include plans, elevations, sections, details, and attachments.

C. Delegated-Design Submittal: For stairs, including analysis data signed and sealed by the qualified professional engineer responsible for their preparation.

PART 2 - PRODUCTS

2.01 PERFORMANCE REQUIREMENTS

A. Delegated Design: Engage a qualified professional engineer, as defined in Section 01400 "Quality Requirements," to design stairs and railings.

B. Structural Performance of Stairs: Metal stairs shall withstand the effects of gravity loads and the following loads and stresses within limits and under conditions indicated:

1. Uniform Load: 100 lbf/sq. ft.
2. Concentrated Load: 300 lbf applied on an area of 4 sq. in.
3. Uniform and concentrated loads need not be assumed to act concurrently.
4. Stair Framing: Capable of withstanding stresses resulting from railing loads in addition to loads specified above.

C. Seismic Performance of Stairs: Metal stairs shall withstand the effects of earthquake motions determined according to ASCE/SEI 7.

1. Component Importance Factor: 1.5.

2.02 METALS

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

B. Recycled Content of Steel Products: Postconsumer recycled content plus one-half of pre-consumer recycled content not less than 25 percent.

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

D. Rolled-Steel Floor Plate: ASTM A 786/A 786M, rolled from plate complying with ASTM A 36/A 36M or ASTM A 283/A 283M, Grade C or D.

E. Steel Bars for Grating Treads: ASTM A 36/A 36M or steel strip, ASTM A 1011/A 1011M or ASTM A 1018/A 1018M.

F. Wire Rod for Grating Crossbars: ASTM A 510.

G. Cast Iron: Either gray iron, ASTM A 48/A 48M, or malleable iron, ASTM A 47/A 47M, unless otherwise indicated.

H. Cast-Abrasive Nosings: Cast iron, with an integral abrasive, as-cast finish consisting of aluminum oxide, silicon carbide, or a combination of both.

2.03 FASTENERS

A. Provide zinc-plated fasteners with coating complying with ASTM B 633 or ASTM F 1941, Class Fe/Zn 12 for exterior use, and Class Fe/Zn 5, where built into exterior walls. Select fasteners for type, grade, and class required.

2.04 FABRICATION, GENERAL

A. Provide complete stair assemblies, including metal framing, hangers, clips, brackets, bearing plates, and other components necessary to support and anchor stairs and platforms on supporting structure.

1. Join components by welding unless otherwise indicated.
2. Use connections that maintain structural value of joined pieces.

B. Weld connections to comply with the following:

1. Use materials and methods that minimize distortion and develop strength and corrosion resistance of base metals.
2. Obtain fusion without undercut or overlap.
3. Remove welding flux immediately.
4. Weld exposed corners and seams continuously unless otherwise indicated.
5. At exposed connections, finish exposed welds to comply with NOMMA's "Voluntary Joint Finish Standards" for Type 4 welds: good quality, uniform undressed weld with minimal splatter.

C. Fabricate joints that are exposed to weather in a manner to exclude water. Provide weep holes where water may accumulate.

2.05 STEEL-FRAMED STAIRS

A. NAAMM Stair Standard: Comply with "Recommended Voluntary Minimum Standards for Fixed Metal Stairs" in NAAMM AMP 510, "Metal Stairs Manual," Industrial Class, unless more stringent requirements are indicated.

B. Stair Framing:

1. Fabricate stringers of steel channels.
    a. Provide closures for exposed ends of channel stringers.
2. Construct platforms of steel channel headers and miscellaneous framing members as indicated.
3. Bolt stringers to headers; bolt framing members to stringers and headers. There shall be no field welded connections.

C. Bar-Grating Stairs: Form treads and platforms to configurations shown from galvanized steel bar grating.

1. Fabricate treads and platforms from galvanized steel, non-slip grating as detailed with openings in gratings no more than 1/2 inch in least dimension.

2. Fabricate grating treads with cast-abrasive nosing and with galvanized steel angle or steel plate carrier at each end for stringer connections. Secure treads to stringers with bolts.

2.06 STAIR RAILINGS

A. Comply with applicable requirements in Section 055213 "Pipe and Tube Railings."

1. Rails may be bent at corners, rail returns, and wall returns, instead of using prefabricated fittings.

2. Connect posts to stair framing by direct welding unless otherwise indicated.

2.07 FINISHES

A. Finish metal stairs after assembly. All stair components shall be hot-dip galvanized.

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

PART 3 - EXECUTION

2.08 INSTALLATION

A. Cutting, Fitting, and Placement: Perform cutting, drilling, and fitting required for installing metal stairs. Set units accurately in location, alignment, and elevation, measured from established lines and levels and free of rack.

B. Field Welding: No field welding allowed.

2.09 ADJUSTING AND CLEANING

A. Galvanized Surfaces: Clean bolted connections and abraded areas and repair galvanizing to comply with ASTM A 780/A 780M.

END OF SECTION

SECTION 05 52 13
PIPE AND TUBE RAILINGS

PART 1 - GENERAL

1.01 SUMMARY

A. Section Includes:

1. Steel pipe and tube railings.

B. Related Requirements:

1. Section 05514 "Metal Grating Stairs" for steel tube railings associated with metal pan stairs.

1.02 ACTION SUBMITTALS

A. Product Data: For the following:

1. Manufacturer's product lines of mechanically connected railings.
2. Railing brackets.
3. Grout, anchoring cement, and paint products.

B. Shop Drawings: Include plans, elevations, sections, details, and attachments to other work.

C. Delegated-Design Submittal: For railings, including analysis data signed and sealed by the qualified professional engineer responsible for their preparation.

1.03 INFORMATIONAL SUBMITTALS

A. Product Test Reports: For pipe and tube railings, for tests performed by a qualified testing agency, according to ASTM E 894 and ASTM E 935.

PART 2 - PRODUCTS

2.01 MANUFACTURERS

A. Steel Pipe and Tube Railings:

1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
2. Basis-of-Design Product: Subject to compliance with requirements, provide product indicated on Drawings or comparable product.

2.02 PERFORMANCE REQUIREMENTS

A. Delegated Design: Engage a qualified professional engineer, as defined in Section 01400 "Quality Requirements," to design railings, including attachment to building construction.

B. Structural Performance: Railings, including attachment to building construction, shall withstand the effects of gravity loads and the following loads and stresses within limits and under conditions indicated:

1. Handrails and Top Rails of Guards:

a. Uniform load of 50 lbf/ ft. applied in any direction.
b. Concentrated load of 200 lbf applied in any direction.
c. Uniform and concentrated loads need not be assumed to act concurrently.

2. Infill of Guards:

a. Concentrated load of 50 lbf applied horizontally on an area of 1 sq. ft.
b. Infill load and other loads need not be assumed to act concurrently.

2.03 METALS, GENERAL

A. Brackets, Flanges, and Anchors: Cast or formed metal of same type of material and finish as supported rails unless otherwise indicated.

2.04 STEEL AND IRON

A. Recycled Content of Steel Products: Postconsumer recycled content plus one-half of pre-consumer recycled content not less than 25 percent.

B. Tubing: ASTM A 500 (cold formed).

C. Pipe: ASTM A 53/A 53M, Type F or Type S, Grade A, Standard Weight (Schedule 40), unless another grade and weight are required by structural loads.

1. Provide galvanized finish for exterior installations and where indicated.

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

E. Cast Iron: Either gray iron, ASTM A 48/A 48M, or malleable iron, ASTM A 47/A 47M, unless otherwise indicated.

2.05 FASTENERS

A. General: Provide the following:

1. Hot-Dip Galvanized Railings: Type 304 stainless-steel or hot-dip zinc-coated steel fasteners complying with ASTM A 153/A 153M or ASTM F 2329 for zinc coating.

B. Post-Installed Anchors: Torque-controlled expansion anchors or chemical anchors capable of sustaining, without failure, a load equal to 6 times the load imposed when installed in unit masonry and 4 times the load imposed when installed in concrete, as determined by testing according to ASTM E 488/E 488M, conducted by a qualified independent testing agency.

1. Material for Exterior Locations and Where Stainless Steel Is Indicated: Alloy Group 1 stainless-steel bolts, ASTM F 593, and nuts, ASTM F 594.

2.06 MISCELLANEOUS MATERIALS

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

B. Low-Emitting Materials: Paints and coatings shall comply with the testing and product requirements of the Florida Department of Health's "Standard Method for the Testing and Evaluation of Volatile Organic Chemical Emissions from Indoor Sources Using Environmental Chambers."

C. Etching Cleaner for Galvanized Metal: Complying with MPI#25.

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

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

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

2.07 FABRICATION

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

B. Form work true to line and level with accurate angles and surfaces.

C. Welded Connections: Cope components at connections to provide close fit, or use fittings designed for this purpose. Weld all around at connections, including at fittings.

1. Use materials and methods that minimize distortion and develop strength and corrosion resistance of base metals.

2. Obtain fusion without undercut or overlap.

3. Remove flux immediately.

4. At exposed connections, finish exposed surfaces smooth and blended so no roughness shows after finishing and welded surface matches contours of adjoining surfaces.

D. Welded Connections for Aluminum Pipe: Fabricate railings to interconnect members with concealed internal welds that eliminate surface grinding, using manufacturer's standard system of sleeve and socket fittings.

E. Nonwelded Connections: Connect members with concealed mechanical fasteners and fittings. Fabricate members and fittings to produce flush, smooth, rigid, hairline joints.

F. Form changes in direction by bending.

G. For changes in direction made by bending, use jigs to produce uniform curvature for each repetitive configuration required. Maintain cross section of member throughout entire bend without buckling, twisting, cracking, or otherwise deforming exposed surfaces of components.

H. Close exposed ends of railing members with prefabricated end fittings.

I. Provide wall returns at ends of wall-mounted handrails unless otherwise indicated.

J. Brackets, Flanges, Fittings, and Anchors: Provide wall brackets, flanges, miscellaneous fittings, and anchors to interconnect railing members to other work unless otherwise indicated.

1. At brackets and fittings fastened to plaster or gypsum board partitions, provide crush-resistant fillers or other means to transfer loads through wall finishes to structural supports and prevent bracket or fitting rotation and crushing of substrate.

2.08 STEEL AND IRON FINISHES

A. Galvanized Railings:

1. Hot-dip galvanize all steel railings, including hardware, after fabrication.

2. Comply with ASTM A 123/A 123M for hot-dip galvanized railings.

3. Comply with ASTM A 153/A 153M for hot-dip galvanized hardware.

B. Preparing Galvanized Railings for Shop Priming: After galvanizing, thoroughly clean railings of grease, dirt, oil, flux, and other foreign matter, and treat with etching cleaner.

C. High-Performance Coating: Apply epoxy intermediate and polyurethane topcoats to prime-coated surfaces. Comply with coating manufacturer's written instructions and with requirements in SSPC-PA 1, "Shop, Field, and Maintenance Painting of Steel," for shop painting. Apply at spreading rates recommended by coating manufacturer.

PART 3 - EXECUTION

3.01 INSTALLATION, GENERAL

A. Set railings accurately in location, alignment, and elevation; measured from established lines and levels and free of rack.

1. Do not weld, cut, or abrade surfaces of railing components that are coated or finished after fabrication and that are intended for field connection by mechanical or other means without further cutting or fitting.

2. Set posts plumb within a tolerance of 1/16 inch in 3 feet.

3. Align rails so variations from level for horizontal members and variations from parallel with rake of steps and ramps for sloping members do not exceed 1/4 inch in 12 feet.

B. Control of Corrosion: Prevent galvanic action and other forms of corrosion by insulating metals and other materials from direct contact with incompatible materials.

1. Coat, with a heavy coat of bituminous paint, concealed surfaces of aluminum that are in contact with grout, concrete, masonry, wood, or dissimilar metals.

3.02 ANCHORING POSTS

A. Anchor posts to metal surfaces with oval flanges, angle type, or floor type as required by conditions, connected to posts and to metal supporting members.

3.03 ADJUSTING AND CLEANING

A. Galvanized Surfaces: Clean bolted connections, abraded areas, and repair galvanizing to comply with ASTM A 780/A 780M.

END OF SECTION

SECTION 09 97 13.51

AVIATION FUEL SYSTEM COATINGS

PART 1 - GENERAL

1.01 DESCRIPTION

A. The work to be performed in this specification includes the cleaning, preparation, painting, coating, and identification of fuel system equipment and components.

B. The preparation and application for the coating systems shall include both field and shop operations.

C. The applicable methods and coating 'system' identification to be used shall be as follows in this Section. Reference the data sheets that follow for each 'system' and that are included in this Section for the individual listed systems:

Item	Surface	Application	System
All Equipment (not including tanks)	Interior	Shop	1
Equipment (including tanks)	Exterior	Field	2
Aboveground Tanks	Interior	Shop	3
Galvanizing	Exterior	Field	4

D. All carbon steel, ductile iron and any other ferrous metal bodied valves, vessels, tanks, equipment and piping shall be coated in accordance with this section. Stainless Steel piping and equipment shall required coating.

1.02 REFERENCES

A. American Petroleum Institute (API)

1. STD. 1542 - Airport Equipment Marking for Fuel Identification

B. American Society of Mechanical Engineers (ASME)

1. A13.1 – Scheme for the Identification of Piping System
2. Z53.1 - Safety Color Code for Marking Physical hazards

C. Military Specifications

1. MIL-C-4556 - Epoxy for Interior of Steel Fuel Tanks

D. National Fire Protection Association

1. NFPA 407 - Aircraft Fuel Servicing
2. NFPA 704 - Standard System for the Identification of the Fire Hazards of Materials for Emergency Response

E. Steel Structures Painting Council

1. SSPC-SP1 – Solvent Cleaning: Removal of all visible oil, grease, soil, drawing and cutting compounds, and other soluble contaminants from steel surfaces with solvent, vapor, cleaning compound, alkali, emulsifying agent, or steam.
2. SSPC-SP2 – Hand Tool Cleaning: Removes all loose mill scale, loose rust, loose paint, and other loose detrimental foreign matter by hand chipping, scraping, sanding, and wire brushing.

3. SSPC-SP3 – Power Tool Cleaning: Removes all loose mill scale, loose rust, loose paint, and other loose detrimental foreign matter by power wire brushing, power sanding, power grinding, power tool chipping, and power tool descaling.
4. SSPC-SP5 – NACE 1 White Metal Blast Cleaning: When viewed without magnification, the surface shall be free of all visible oil, grease, dust, dirt, mill scale, rust, coating, oxides, corrosion products and other foreign matter.
5. SSPC-SP6 – NACE 2 Commercial Blast Cleaning: When viewed without magnification, the surface shall be free of all visible oil, grease, dust, dirt, mill scale, rust, coating, oxides, corrosion products and other foreign matter of at least 66-2/3% of unit area, which shall be a square 3 in. x 3 in. (9 sq. in.). Light shadows, slight streaks, or minor discolorations caused by stains of rust, stains of mill scale, or stains of previously applied coating in less than 33-1/3% of the unit area is acceptable.
6. SSPC-SP10 – Near White Blast Cleaning: When viewed without magnification shall be free of all visible oil, grease, dust, dirt, mill scale, rust, coating, oxides, corrosion products and other foreign matter of at least 95% of each unit area. Staining shall be limited to no more than 5 percent of each unit area, and may consist of light shadows, slight streaks, or minor discolorations caused by stains of rust, stains of mill scale, or stains of previously applied coatings. Unit area shall be approximately 3 in. x 3 in. (9 sq. in.).

1.03 SUBMITTALS

A. Submit as specified in Division 01 and Division 33. Submittals shall include, but not be limited to:

1. Surface preparation requirements.
2. Product manufacturer, name of coating, and number designation of coating.
3. Method of application and the minimum and maximum dry film thickness of coating (per coat) to be applied.
4. Certification from the manufacturer that the un-thinned maximum VOC content of the field applied coating products is below the maximum allowable for the project location.
5. Color charts for selection of paint color by the Owner.
6. Technical and material safety data sheets.
7. Equipment labels:
    a. Submit a drawing that clearly indicates the proposed location of equipment labels.
    b. Catalog cuts and samples of the equipment labels
8. Third party testing agency and their graphical report indicating test locations and results.

1.04 QUALITY ASSURANCE

A. The coating applicator for field operations or for shop operations shall have a minimum of 5 years of experience in the Systems specified. The coating applicator shall certify in writing that he has previous experience applying all of the coating systems in this specification for which he is responsible.

B. Compliance submittals and certification of experience shall be submitted to the Engineer prior to starting the work.

C. The coating applicator shall provide a certificate of quality control procedures utilized during application of internal and external coatings. The certification shall include surface preparation, film thickness per coat, curing procedures, and holiday testing.

D. All coatings shall be applied in strict accordance with the manufacturer's recommendations including environmental conditions, surface preparation, coating method and coverage, etc.

E. Equipment labels shall comply with listed codes and standards for color coding, lettering size, and length of color field.

F. Contractor shall ensure painting sequence does not contaminate or overspray existing and/or newly painted equipment. Contractor shall ensure that all newly painted surfaces remain clean and are not contaminated by subsequent blasting and painting operations. Contractor shall clean and/or recoat surfaces deemed not acceptable due to product contamination at no cost to the Owner.

G. Contractor shall employ the services of a third-party testing agency to perform all dry film thickness testing on all field applied coatings. Contractor shall submit to the Engineer the proposed testing agency for approval.

PART 2 - MATERIALS

2.01 SYSTEM TABLES

A. System tables for interior and exterior coatings are included within this specification to indicate the degree of preparation, methods of application, finish thickness, acceptable manufacturer names and product numbers. This specification addresses coatings for components and materials for the fuel system. For other finishes see individual Contract Documents.

PART 3 - EXECUTION

3.01 INTERNAL COATING OF EQUIPMENT

A. Reference System 1 of the attached tables.

B. This section shall apply to shop applied epoxy internal coatings for equipment.

C. All fuel contact surfaces shall receive the epoxy coating.

D. The surfaces to be painted shall be sandblasted or shot blasted immediately before applying the prime coat. Remove all surface irregularities such as burrs, weld splatter, etc., before proceeding with blasting. Blasting shall be in strict accordance with Steel Structures Painting Council Surface Preparation Specification. 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 re-blasted.

E. Coatings shall be a two (2) coat system of epoxy paint qualified to meet government Specification MIL-C-4556-E and be applied in accordance with the manufacturer's instruction and procedure and shall be approved by the manufacturer's representative. Paint shall be applied to the full length of pipe and fittings. The total dry film thickness of the paint shall be within the range recommended by the manufacturer.

F. Dry film thickness shall be spot checked at random, or as indicated by the Engineer's representative, on the coated surfaces after each coat has been applied and has cured. The tank interior shall be tested once every 100 square feet. If film thickness is not found to be uniform and to specification by the Engineer, the Contractor shall be required to apply additional coats at no cost to the Owner until the specified film thickness has been obtained. If the dry film thickness exceeds the maximum allowable film thickness per the manufacturer, the Contractor shall remove and reapply the coating in those areas at no cost to the Owner. Dry film thickness is to be checked by the Contractor at his expense by a third-party testing agency.

G. If, in the opinion of the Engineer the coatings show ridges, waves, runs, orange peeling, or holidays indicating uneven coverage or improper application, the Contractor shall be required to remove and re-apply the coating at no cost to the Owner.

3.02 EXTERNAL COATING OF EQUIPMENT AND TANKS

A. Reference System 2 of the attached tables.

B. All equipment which are installed above ground shall be given a protective covering applied in the shop and the field with equipment especially designed for this purpose. Before the coating is applied, the surface of the equipment shall be thoroughly cleaned of all rust, scale, oil, grease and other matter that will interfere with the proper adhesion of the primer coat. Those pieces of equipment, valves, pumps, motors, actuators, etc. that have been shop primed or delivered to the site with a finish coat shall be properly prepared for application of the coating. Contractor shall coordinate with the equipment suppliers and the coating manufacturer on the proper preparation and application of the coating.

C. The surfaces to be painted shall be sandblasted or shot blasted immediately before applying the prime coat. Remove all surface irregularities such as burrs, weld splatter, etc., before proceeding with blasting. Blasting shall be in strict accordance with Steel Structures Painting Council Surface Preparation Specification. 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 re-blasted.

D. All fieldwork shall be done in a manner and with materials that will produce a covering equal in effectiveness to that of the factory applied coating.

E. Prepare the surface as specified, defined and remove any loose rust, scale, dust or dirt. Oil and grease are to be removed with suitable solvent. All field-applied coatings shall conform to the contour leaving no moisture traps between or under the coating.

F. ALL equipment labels, data plates, control tubing, pressure gauges, etc., shall be masked prior to painting adjacent piping. If these items are painted, the Contractor shall clean them to the satisfaction of the Owner or replace them at no cost to the Owner.

G. Coatings shall be a two (2) coat system with an epoxy first coat and a polyurethane top coat applied in accordance with the manufacturer's instructions and procedure and shall be approved by the manufacturer's representative. The total dry film thickness of the paint shall be within the range recommended by the manufacturer.

H. Dry film thickness shall be spot checked at random, or as indicated by the Engineer's representative, on the coated surfaces after each coat has been applied and has cured. At a minimum, the thickness shall be checked every 20 linear feet of piping and at each

fitting, flange, etc. If film thickness is not found to be uniform and to specification by the Engineer, the Contractor shall be required to apply additional coats at no cost to the Owner until the specified film thickness has been obtained. If the dry film thickness exceeds the maximum allowable film thickness per the manufacturer, the Contractor shall remove and reapply the coating in those areas at no cost to the Owner. Dry film thickness is to be checked by the Contractor at his expense by a third-party testing agency.

3.03 INTERNAL COATING OF ABOVE GROUND TANKS

A. Reference System 3 of the attached tables.

B. This section shall apply to field-applied epoxy internal coatings for above ground tanks.

C. Paint each tank bottom and the first shell course with the specified epoxy coating system.

D. The surfaces to be painted shall be sandblasted or shot blasted immediately before applying the prime coat. Remove all surface irregularities such as burrs, weld splatter, etc., before proceeding with blasting. Blasting shall be in strict accordance with Steel Structures Painting Council Surface Preparation Specification. 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 re-blasted.

E. Coatings shall be a two (2) coat system of epoxy phenolic paint qualified to meet government Specification MIL-PRF -4556F and be applied in accordance with the manufacturer's instruction and procedure and shall be approved by the manufacturer's representative. The total dry film thickness of the paint shall be within the range recommended by the manufacturer.

F. Dry film thickness shall be spot checked at random, or as indicated by the Engineer's representative, on the coated surfaces after each coat has been applied and has cured. At a minimum, the thickness shall be checked once every 100 square feet of the tank interior and at all flanges, manways, and appurtenances. If film thickness is not found to be uniform and to specification by the Engineer, the Contractor shall be required to apply additional coats at no cost to the Owner until the specified film thickness has been obtained. If the dry film thickness exceeds the maximum allowable film thickness per the manufacturer, the Contractor shall remove and reapply the coating in those areas at no cost to the Owner. Dry film thickness is to be checked by the Contractor at his expense by a third-party testing agency.

G. If, in the opinion of the Engineer the coatings show ridges, waves, runs, orange peeling, or holidays indicating uneven coverage or improper application, the Contractor shall be required to remove and re-apply the coating at no cost to the Owner.

3.04 FIELD GALVANIZING

A. Reference System 4 of the attached tables.

B. Substrates acceptable for coating

1. Substrates shall be of iron, steel or aluminum including structural shapes, pipe, sheet, fabrications and assemblies. Substrates of iron, steel or aluminum may be satisfactorily coated regardless of carbon, phosphorus, manganese or silicon inclusion.

C. Coating shall be applied by brush, roller, low pressure compressor-type spray or airless-type spray.

D. Iron, steel, or aluminum surfaces to be coated shall be clean; i.e. devoid of grease, oil, mill scale, oxidation, loosely adherent rust, paint, etc.

E. Coating shall be applied directly to metal surface to be galvanically active.

F. Preparation:

1. Surface preparation is dependent upon substrate condition and intended service.

2. Typical examples are as follows:

a. Grease and Oils - Solvent clean to SSPC-SP1
b. Rust scale or easy to remove paint - Power tool clean to SSPC-SP3
c. Mill scale or firmly adhered paint - Sandblast to SSPC-SP6 (commercial)
d. Water immersion - (100 degrees F maximum) Sandblast to SSPCSP10(near-white)

G. Drying time of coating is dependent upon temperatures, but product has no application temperature limit.

H. Surface temperature of the substrate to be coated shall be at least 50 above the dew point to avoid possible condensation.

I. Humidity shall be less than 85% R.H.

3.05 PIPING AND EQUIPMENT IDENTIFICATION

A. Clean area of surface to receive label or other pressure-sensitive item free of oil, grease, dust, dirt, or other substances that would affect adhesion.

B. On painted surfaces, install label only after coating system is complete and dry film thickness testing completed and accepted.

C. Use proper label type suitable for interior or exterior location as applicable.

D. Locate labels on piping near connections to equipment, adjacent to valves or fittings, and at intervals not to exceed 25 feet. Final location shall be determined by Owner and Engineer.

E. For piping with arrows to indicate direction of flow, place arrows adjacent to or below labels, depending upon visibility. For dual-flow piping, indicate both directions.

F. Locate legends and labels so as to be visible from normal line of vision above finished floor or grade level.

3.06 PROTECTION

A. Cover and protect all surfaces that are not to be painted which are in close proximity to the painting operation. Remove all protective materials when appropriate and before materials such as masking tape becomes difficult to remove.

B. Provide signs to indicate fresh paint areas.

C. Mask, remove, or otherwise protect finish hardware, control tubing, pressure gauges, control devices, and equipment nameplates as necessary. Provide cover to prevent paints from entering orifices in electrical or mechanical equipment.

D. Provide daily cleanup of both storage and working areas and removal of all paint refuse, trash, rags, thinners, etc. Dispose of leftover containers, thinners, rags, brushes, rollers, etc. in accordance with applicable regulations.

3.07 CLEANING

A. Touch up and restore damaged finishes to original condition as required. Remove all masking tape residue and glues that may be left on surfaces.

B. Remove spilled, dripped or splattered paint from all surfaces.

3.08 COATING REPAIRS

A. Repair all damages to pipe, tank and equipment coating systems before the coating is holiday tested. This includes all cuts, breaks, voids, bruised or scarred spots, or other damage caused prior to delivery, or resulting from handling or installation of the pipe, or from any cause whatsoever.

B. Included also are damaged coatings where new connections are made to existing coated pipes or where existing coated pipes are uncovered or exposed for any reason.

C. Also repair the coating where welds are made and where damaged or broken by the installation of instrumentation or other accessories or appurtenances.

D. Repair all holidays detected during inspection of coatings. Use the same coatings for repair as was used for the base.

3.09 INSPECTION

A. Use wet film gauges to check each application about every 15 minutes in order to correct low or heavy film build immediately.

B. Use dry film gauge to check each coat when dry, and the total system when completed.

C. Use holiday or pinhole detector to detect and correct voids when indicated on system sheet.

D. Provide daily reports of environmental conditions including ambient temperature, substrate temperature, relative humidity, and wind speed and direction.

FUEL SYSTEM COATINGS
SYSTEM - 1

SERVICE: Equipment - Interior

Surface Preparation: SSPC-SP10 to a profile depth recommended by product manufacturer.

First Coat: High solids amine epoxy or epoxy phenolic coating with minimum of 74% solids by volume. Apply at a rate to meet the manufacturer's recommended dry film thickness. Do not exceed the maximum dry film thickness as published by the manufacturer. Wipe coating 1-1/2" from end of pipe.

Second Coat: Same as first coat except color shall be different than first coat to distinguish between coats. Second coat shall be white, light gray, or beige for light reflectance and to facilitate inspection. Wipe coating 1-1/2" from end of pipe.

Third Coat: Not required.

System Total: System total shall meet the recommended dry film thickness.

Volatile Organic Content: Maximum 2.1 lbs/gal

Manufacturer	First Coat	Touch Up	Second Coat	Third Coat
PPG	Amercoat 240 (Epoxy, 5-7mil DFT)	N/A	Amercoat 240 (Epoxy, 5-7mil DFT)	N/A
International	Interline 85 (Epoxy, 4-6mil DFT)	N/A	Interline 85 (Epoxy, 4-6mil DFT)	N/A
Sherwin-Williams	Phenicon HS (Epoxy, 5-8mil DFT)	N/A	Phenicon HS (Epoxy,5-8mil DFT)	N/A
Sherwin-Williams	Fast Clad 105ER (Epoxy, 20mil DFT)	N/A	N/A	N/A

Notes:
1. Upon completion, check for voids with a suitable electric holiday detection operating at the proper voltage as recommended by the manufacturer. Repair all holidays.

FUEL SYSTEM COATINGS
SYSTEM - 2

SERVICE: Tanks and Equipment- Exterior

Surface Preparation: SSPC-SP10 to a profile depth recommended by product manufacturer.

First Coat: High build, zinc-rich epoxy or zinc-rich silicate with minimum 70% solids by volume. Apply at dry film thickness (DFT) recommended by manufacturer.

Second Coat: High build, high solids polyurethane low sheen enamels with minimum 70% solids by volume. Apply at 5.0 mils dry film thickness.

Third Coat: Not required.

System Total: System total shall meet the recommended dry film thickness.

Volatile Organic Content: Maximum lbs/gal: 2.7 epoxy, 2.3 Polyurethane.

Manufacturer	First Coat	Touch Up	Second Coat	Third Coat
PPG	Amercoat 68HS VOC (Epoxy, 3-4mil DFT)	Same as first coat	Amercoat 450H (Polyurethane, 2-3mil DFT)	N/A
International	Interzinc 22HS (Zinc-rich silicate, 2-3mil DFT)	Interzinc 52 (Organic Zinc 3-4mil DFT)	Intergrad 345 (Epoxy, 4-6mil DFT)	Interthane 990 (Polyurethane, 2-3mil DFT)
Sherwin-Williams	Macropoxy 646 (Epoxy, 5-10mil DFT)	Same as first coat	Corothane II (3Polyurethane, 3-4mil DFT)	N/A

Notes:
1. A low sheen material is required. Gloss or high gloss will not be acceptable.

FUEL SYSTEM COATINGS
SYSTEM - 3

SERVICE: Field Applied Coating for Aboveground Tanks - Interior

Surface Preparation: SSPC-SP 10 to a profile depth recommended by product manufacturer

First Coat: High solids amine epoxy with minimum of 71% solids by volume. Apply at a rate to meet the manufacturer's recommended dry film thickness. Do not exceed the maximum dry film thickness as published by the manufacturer.

Second Coat: Same as first coat except color shall be different than first coat to distinguish between coats. Second coat shall be white, light gray, or beige for light reflectance and to facilitate.

Third Coat: Not required.

System Total: System total shall meet the recommended dry film thickness.

Inspection: Check for voids with an electronic holiday detector.

Volatile Organic Content: Maximum 1.0 lbs/gal

Manufacturer	First Coat	Touch Up	Second Coat	Third Coat
Ameron	Amercoat 395FD	N/A	Amercoat 395FD	
Tnemec	Tneme-liner 61	N/A	Tneme-liner 61	
Sherwin-Williams	Phenicon HS (Epoxy, 5-8mil DFT)		Phenicon HS (Epoxy, 5-8mil DFT)	

Notes:
1. Upon completion, check for voids with a suitable electric holiday detection operating at the proper voltage as recommended by the manufacturer. Repair all holidays.

FUEL SYSTEM COATINGS
SYSTEM - 4

SERVICE: Field Applied Galvanizing Coating

Surface Preparation: SSPC SP-3. Clean free of dirt, rust scale, oil, millscale and all other foreign material.

First Coat: Apply ZRC Cold Galvanizing Compound without runs, drips or sags. Apply to manufacturer's recommended dry film thickness.

Second Coat: Same as First Coat, allow 12 hours of cure time between coats.

Top Coat: Available top coats include acrylic, chlorinated rubber, epoxy, urethane or vinyl type products, see manufacturer's recommendation for specific environments.

Inspection: ASME E376 – Standard Practice for Measuring Coating Thickness by Magnetic-Field or Eddy-Current (Electromagnetic) Testing Methods

Manufacturer	First Coat	Touch Up	Second Coat	Third Coat
ZRC Worldwide	ZRC Cold Galvanizing Compound 2.5-3.5 mil DFT		ZRC Cold Galvanizing Compound 2.5-3.5 mil DFT	

Notes:

END OF SECTION

SECTION 23 05 29
HANGERS AND SUPPORTS FOR HVAC PIPING AND EQUIPMENT

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

A. Section Includes:

1. Metal pipe hangers and supports.
2. Fastener systems.
3. Equipment supports.

B. Related Requirements:
1. Section 233113 "Metal Ducts" for duct hangers and supports.

1.3 ACTION SUBMITTALS

A. Product Data: For each type of product.

B. Shop Drawings: Show fabrication and installation details and include calculations for the following; include Product Data for components:
1. Equipment supports.
2. Fastener systems.
3. Metal pipe hangers and supports.

1.4 INFORMATIONAL SUBMITTALS

A. Welding certificates.

1.5 QUALITY ASSURANCE

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

B. Pipe Welding Qualifications: Qualify procedures and operators according to ASME Boiler and Pressure Vessel Code, Section IX.

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

A. Structural Performance: Hangers and supports for HVAC piping and equipment shall withstand the effects of gravity loads and stresses within limits and under conditions indicated according to ASCE/SEI 7.

1. Design supports for multiple pipes, including pipe stands, capable of supporting combined weight of supported systems, system contents, and test water.
2. Design equipment supports capable of supporting combined operating weight of supported equipment and connected systems and components.

2.2 METAL PIPE HANGERS AND SUPPORTS

A. Carbon-Steel Pipe Hangers and Supports:

1. Description: MSS SP-58, Types 1 through 58, factory-fabricated components.
2. Galvanized Metallic Coatings: Pregalvanized, hot-dip galvanized, or electro-galvanized.
3. Nonmetallic Coatings: Plastic coated, or epoxy powder-coated.
4. Padded Hangers: Hanger with fiberglass or other pipe insulation pad or cushion to support bearing surface of piping.
5. Hanger Rods: Continuous-thread rod, nuts, and washer made of stainless steel.

B. Copper Pipe and Tube Hangers:

1. Description: MSS SP-58, Types 1 through 58, copper-plated steel, factory-fabricated components.
2. Hanger Rods: Continuous-thread rod, nuts, and washer made of copper-plated steel or stainless steel.

2.3 FASTENER SYSTEMS

A. Powder-Actuated Fasteners: Threaded-steel stud, for use in hardened portland cement concrete with pull-out, tension, and shear capacities appropriate for supported loads and building materials where used.

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

a. Hilti, Inc.
b. ITW Ramset/Red Head; Illinois Tool Works, Inc.
c. MKT Fastening, LLC.

B. Mechanical-Expansion Anchors: Insert-wedge-type anchors for use in hardened portland cement concrete; with pull-out, tension, and shear capacities appropriate for supported loads and building materials where used.

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

a. Cooper B-line; brand of Eaton, Electrical Sector.

b. Hilti, Inc.
c. ITW Ramset/Red Head; Illinois Tool Works, Inc.

2. Indoor Applications: Zinc-coated or stainless-steel.
3. Outdoor Applications: Stainless steel.

2.4 EQUIPMENT SUPPORTS

A. Description: Welded, shop- or field-fabricated equipment support made from structural carbon-steel shapes.

2.5 MATERIALS

A. Aluminum: ASTM B221.

B. Carbon Steel: ASTM A1011/A1011M.

C. Structural Steel: ASTM A36/A36M, carbon-steel plates, shapes, and bars; galvanized.

D. Stainless Steel: ASTM A240/A240M.

E. Threaded Rods: Continuously threaded. Zinc-plated or galvanized steel for indoor applications and stainless steel for outdoor applications. Mating nuts and washers of similar materials as rods.

F. Grout: ASTM C1107/C1107M, factory-mixed and -packaged, dry, hydraulic-cement, nonshrink and nonmetallic grout; suitable for interior and exterior applications.

1. Properties: Nonstaining, noncorrosive, and nongaseous.
2. Design Mix: 5000-psi, 28-day compressive strength.

PART 3 - EXECUTION

3.1 APPLICATION

A. Comply with requirements in Section 078413 "Penetration Firestopping" for firestopping materials and installation for penetrations through fire-rated walls, ceilings, and assemblies.

B. Strength of Support Assemblies: Where not indicated, select sizes of components so strength will be adequate to carry present and future static loads within specified loading limits. Minimum static design load used for strength determination shall be weight of supported components plus 200 lb.

3.2 HANGER AND SUPPORT INSTALLATION

A. Metal Pipe-Hanger Installation: Comply with MSS SP-58. Install hangers, supports, clamps, and attachments as required to properly support piping from the building structure.

B. Fastener System Installation:

1. Install powder-actuated fasteners for use in lightweight concrete or concrete slabs less than 4 inches thick in concrete after concrete is placed and completely cured. Use operators that are licensed by powder-actuated tool manufacturer. Install fasteners according to powder-actuated tool manufacturer's operating manual.
2. Install mechanical-expansion anchors in concrete after concrete is placed and completely cured. Install fasteners according to manufacturer's written instructions.

C. Install hangers and supports complete with necessary attachments, inserts, bolts, rods, nuts, washers, and other accessories.

D. Equipment Support Installation: Fabricate from welded-structural-steel shapes.

E. Install hangers and supports to allow controlled thermal and seismic movement of piping systems, to permit freedom of movement between pipe anchors, and to facilitate action of expansion joints, expansion loops, expansion bends, and similar units.

F. Install building attachments within concrete slabs or attach to structural steel. Install additional attachments at concentrated loads and larger and at changes in direction of piping. Install concrete inserts before concrete is placed; fasten inserts to forms and install reinforcing bars through openings at top of inserts.

G. Load Distribution: Install hangers and supports so that piping live and dead loads and stresses from movement will not be transmitted to connected equipment.

H. Pipe Slopes: Install hangers and supports to provide indicated pipe slopes and to not exceed maximum pipe deflections allowed by ASME B31.9 for building services piping.

I. Insulated Piping:

1. Attach clamps and spacers to piping.

    a. Piping Operating above Ambient Air Temperature: Clamp may project through insulation.
    b. Piping Operating below Ambient Air Temperature: Use thermal-hanger shield insert with clamp sized to match OD of insert.
    c. Do not exceed pipe stress limits allowed by ASME B31.9 for building services piping.

2. Install MSS SP-58, Type 40, protective shields on cold piping with vapor barrier. Shields shall span an arc of 180 degrees.

3. Shield Dimensions for Pipe: Not less than the following:

    a. NPS 1/4 to NPS 3-1/2: 12 inches long and 0.048 inch thick.

3.3 EQUIPMENT SUPPORTS

A. Fabricate structural-steel stands to suspend equipment from structure overhead or to support equipment above floor.

B. Grouting: Place grout under supports for equipment and make bearing surface smooth.

C. Provide lateral bracing, to prevent swaying, for equipment supports.

3.4 METAL FABRICATIONS

A. Cut, drill, and fit miscellaneous metal fabrications for equipment supports.

B. Fit exposed connections together to form hairline joints. Field weld connections that cannot be shop welded because of shipping size limitations.

C. Field Welding: Comply with AWS D1.1/D1.1M procedures for shielded, metal arc welding; appearance and quality of welds; and methods used in correcting welding work; and with the following:

1. Use materials and methods that minimize distortion and develop strength and corrosion resistance of base metals.
2. Obtain fusion without undercut or overlap.
3. Remove welding flux immediately.
4. Finish welds at exposed connections so no roughness shows after finishing and so contours of welded surfaces match adjacent contours.

3.5 ADJUSTING

A. Hanger Adjustments: Adjust hangers to distribute loads equally on attachments.

B. Trim excess length of continuous-thread hanger and support rods to 1-1/2 inches.

3.6 PAINTING

A. Touchup: Clean field welds and abraded areas of shop paint. Paint exposed areas immediately after erecting hangers and supports. Use same materials as used for shop painting. Comply with SSPC-PA 1 requirements for touching up field-painted surfaces.

1. Apply paint by brush or spray to provide a minimum dry film thickness of 2.0 mils.

B. Touchup: Comply with requirements in Division 09 specifications for cleaning and touchup painting of field welds, bolted connections, and abraded areas of shop paint on miscellaneous metal.

C. Galvanized Surfaces: Clean welds, bolted connections, and abraded areas and apply galvanizing-repair paint to comply with ASTM A780/A780M.

3.7 HANGER AND SUPPORT SCHEDULE

A. Specific hanger and support requirements are in Sections specifying piping systems and equipment.

B. Use hangers and supports with galvanized metallic coatings for piping and equipment that will not have field-applied finish.

C. Hanger-Rod Attachments: Unless otherwise indicated and except as specified in piping system Sections, install the following types:

1. Steel Turnbuckles (MSS Type 13): For adjustment up to 6 inches for heavy loads.
2. Steel Clevises (MSS Type 14): For 120 to 450 deg F piping installations.

3. Swivel Turnbuckles (MSS Type 15): For use with MSS Type 11, split pipe rings.
4. Malleable-Iron Sockets (MSS Type 16): For attaching hanger rods to various types of building attachments.
5. Steel Weldless Eye Nuts (MSS Type 17): For 120 to 450 deg F piping installations.

D. Building Attachments: Unless otherwise indicated and except as specified in piping system Sections, install the following types:

1. Steel or Malleable Concrete Inserts (MSS Type 18): For upper attachment to suspend pipe hangers from concrete ceiling.
2. Top-Beam C-Clamps (MSS Type 19): For use under roof installations with bar-joist construction, to attach to top flange of structural shape.
3. Side-Beam or Channel Clamps (MSS Type 20): For attaching to bottom flange of beams, channels, or angles.
4. Center-Beam Clamps (MSS Type 21): For attaching to center of bottom flange of beams.
5. Welded Beam Attachments (MSS Type 22): For attaching to bottom of beams if loads are considerable and rod sizes are large.
6. C-Clamps (MSS Type 23): For structural shapes.
7. Top-Beam Clamps (MSS Type 25): For top of beams if hanger rod is required tangent to flange edge.
8. Side-Beam Clamps (MSS Type 27): For bottom of steel I-beams.
9. Steel-Beam Clamps with Eye Nuts (MSS Type 28): For attaching to bottom of steel I-beams for heavy loads.
10. Linked-Steel Clamps with Eye Nuts (MSS Type 29): For attaching to bottom of steel I-beams for heavy loads, with link extensions.
11. Malleable-Beam Clamps with Extension Pieces (MSS Type 30): For attaching to structural steel.
12. Welded-Steel Brackets: For support of pipes from below or for suspending from above by using clip and rod. Use one of the following for indicated loads:

    a. Light (MSS Type 31): 750 lb.
    b. Medium (MSS Type 32): 1500 lb.
    c. Heavy (MSS Type 33): 3000 lb.

13. Side-Beam Brackets (MSS Type 34): For sides of steel or wooden beams.
14. Plate Lugs (MSS Type 57): For attaching to steel beams if flexibility at beam is required.
15. Horizontal Travelers (MSS Type 58): For supporting piping systems subject to linear horizontal movement where headroom is limited.

E. Use powder-actuated fasteners or mechanical-expansion anchors instead of building attachments where required in concrete construction.

END OF SECTION 230529

SECTION 23 05 53
IDENTIFICATION FOR HVAC PIPING AND EQUIPMENT

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

A. Section Includes:

1. Equipment labels.
2. Pipe labels.

1.3 ACTION SUBMITTALS

A. Product Data: For each type of product.

B. Samples: For color, letter style, and graphic representation required for each identification material and device.

C. Equipment Label Schedule: Include a listing of all equipment to be labeled with the proposed content for each label.

D. Valve numbering scheme.

E. Valve Schedules: For each piping system to include in maintenance manuals.

PART 2 - PRODUCTS

2.1 EQUIPMENT LABELS

A. Plastic Labels for Equipment:
1. Material and Thickness: Multilayer, multicolor, plastic labels for mechanical engraving, 1/8 inch thick, and having predrilled holes for attachment hardware.
2. Letter Color: White.
3. Background Color: Black.
4. Maximum Temperature: Able to withstand temperatures up to 160 deg F.
5. Minimum Label Size: Length and width vary for required label content, but not less than 2-1/2 by 3/4 inch.
6. Minimum Letter Size: 1/4 inch for name of units if viewing distance is less than 24 inches, 1/2 inch for viewing distances up to 72 inches, and proportionately larger lettering for greater viewing distances. Include secondary lettering two-thirds to three-quarters the size of principal lettering.
7. Fasteners: Stainless-steel rivets or self-tapping screws.
8. Adhesive: Contact-type permanent adhesive, compatible with label and with substrate.

B. Label Content: Include equipment's Drawing designation or unique equipment number, Drawing numbers where equipment is indicated (plans, details, and schedules), and the Specification Section number and title where equipment is specified.

C. Equipment Label Schedule: For each item of equipment to be labeled, on 8-1/2-by-11-inch bond paper. Tabulate equipment identification number, and identify Drawing numbers where equipment is indicated (plans, details, and schedules) and the Specification Section number and title where equipment is specified. Equipment schedule shall be included in operation and maintenance data.

2.2 PIPE LABELS

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

1. Brady Corporation.
2. Kolbi Pipe Marker Co.
3. Pipemarker.com; Brimar Industries, Inc.
4. Seton Identification Products; a Brady Corporation company.

B. General Requirements for Manufactured Pipe Labels: Preprinted, color-coded, with lettering indicating service, and showing flow direction according to ASME A13.1.

C. Pretensioned Pipe Labels: Precoiled, semirigid plastic formed to partially cover circumference of pipe and to attach to pipe without fasteners or adhesive.

D. Self-Adhesive Pipe Labels: Printed plastic with contact-type, permanent-adhesive backing.

E. Pipe Label Contents: Include identification of piping service using same designations or abbreviations as used on Drawings; also include pipe size and an arrow indicating flow direction.

1. Flow-Direction Arrows: Integral with piping system service lettering to accommodate both directions or as separate unit on each pipe label to indicate flow direction.
2. Lettering Size: Size letters according to ASME A13.1 for piping.
3. Pipe labels on condensate piping shall indicate whether the pipe connects to a primary drain pan or a secondary/overflow/emergency drain pan.

PART 3 - EXECUTION

3.1 PREPARATION

A. Clean piping and equipment surfaces of substances that could impair bond of identification devices, including dirt, oil, grease, release agents, and incompatible primers, paints, and encapsulants.

3.2 GENERAL INSTALLATION REQUIREMENTS

A. Coordinate installation of identifying devices with completion of covering and painting of surfaces where devices are to be applied.

B. Coordinate installation of identifying devices with locations of access panels and doors.

C. Install identifying devices before installing acoustical ceilings and similar concealment.

3.3 EQUIPMENT LABEL INSTALLATION

A. Install or permanently fasten labels on each major item of mechanical equipment.

B. Locate equipment labels where accessible and visible.

3.4 PIPE LABEL INSTALLATION

A. Piping Color Coding: Painting of piping is specified in Division 09 specifications

B. Pipe Label Locations: Locate pipe labels where piping is exposed or above accessible ceilings in finished spaces; machine rooms; accessible maintenance spaces such as shafts, tunnels, and plenums; and exterior exposed locations as follows:

1. Near each valve and control device.
2. Near each branch connection, excluding short takeoffs for fixtures and terminal units. Where flow pattern is not obvious, mark each pipe at branch.
3. Near penetrations and on both sides of through walls, floors, ceilings, and inaccessible enclosures.
4. At access doors, manholes, and similar access points that permit view of concealed piping.
5. Near major equipment items and other points of origination and termination.
6. Spaced at maximum intervals of 50 feet along each run. Reduce intervals to 25 feet in areas of congested piping and equipment.
7. On piping above removable acoustical ceilings. Omit intermediately spaced labels.

C. Directional Flow Arrows: Arrows shall be used to indicate direction of flow in pipes, including pipes where flow is allowed in both directions.

D. Pipe Label Color Schedule:
1. Refrigerant Piping: White letters on a safety-purple background.
2. Cooling Coil Condensate Piping: White letters on a safety-green background.

END OF SECTION 230553

SECTION 23 07 13
DUCT INSULATION

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

A. Section includes insulating the following duct services:

1. Indoor, concealed supply and outdoor air.
2. Indoor, exposed supply and outdoor air.

B. Related Sections:
1. Section 230719 "HVAC Piping Insulation."

1.3 ACTION SUBMITTALS

A. Product Data: For each type of product indicated. Include thermal conductivity, water-vapor permeance thickness, and jackets (both factory- and field-applied if any).

B. Shop Drawings: Include plans, elevations, sections, details, and attachments to other work.

1. Detail application of protective shields, saddles, and inserts at hangers for each type of insulation and hanger.
2. Detail insulation application at elbows, fittings, dampers, specialties and flanges for each type of insulation.
3. Detail application of field-applied jackets.
4. Detail application at linkages of control devices.

1.4 INFORMATIONAL SUBMITTALS

A. Qualification Data: For qualified Installer.

B. Material Test Reports: From a qualified testing agency acceptable to authorities having jurisdiction indicating, interpreting, and certifying test results for compliance of insulation materials, sealers, attachments, cements, and jackets, with requirements indicated. Include dates of tests and test methods employed.

C. Field quality-control reports.

1.5 QUALITY ASSURANCE

A. Installer Qualifications: Skilled mechanics who have successfully completed an apprenticeship program or another craft training program certified by the Department of Labor, Bureau of Apprenticeship and Training.

B. Surface-Burning Characteristics: For insulation and related materials, as determined by testing identical products according to ASTM E84, by a testing agency acceptable to authorities having jurisdiction. Factory label insulation and jacket materials and adhesive, mastic, tapes, and cement material containers, with appropriate markings of applicable testing agency.

1. Insulation Installed Indoors: Flame-spread index of 25 or less, and smoke-developed index of 50 or less.
2. Insulation Installed Outdoors: Flame-spread index of 75 or less, and smoke-developed index of 150 or less.

1.6 DELIVERY, STORAGE, AND HANDLING

A. Packaging: Insulation material containers shall be marked by manufacturer with appropriate ASTM standard designation, type and grade, and maximum use temperature.

1.7 COORDINATION

A. Coordinate sizes and locations of supports, hangers, and insulation shields specified in Section 230529 "Hangers and Supports for HVAC Piping and Equipment."

B. Coordinate clearance requirements with duct Installer for duct insulation application. Before preparing ductwork Shop Drawings, establish and maintain clearance requirements for installation of insulation and field-applied jackets and finishes and for space required for maintenance.

C. Coordinate installation and testing of heat tracing.

1.8 SCHEDULING

A. Schedule insulation application after pressure testing systems and, where required, after installing and testing heat tracing. Insulation application may begin on segments that have satisfactory test results.

B. Complete installation and concealment of plastic materials as rapidly as possible in each area of construction.

PART 2 - PRODUCTS

2.1 INSULATION MATERIALS

A. Comply with requirements in "Duct Insulation Schedule, General," "Indoor Duct and Plenum Insulation Schedule," and "Aboveground, Outdoor Duct and Plenum Insulation Schedule" articles for where insulating materials shall be applied.

B. Products shall not contain asbestos, lead, mercury, or mercury compounds.

C. Products that come in contact with stainless steel shall have a leachable chloride content of less than 50 ppm when tested according to ASTM C871.

D. Insulation materials for use on austenitic stainless steel shall be qualified as acceptable according to ASTM C795.

E. Foam insulation materials shall not use CFC or HCFC blowing agents in the manufacturing process.

F. Mineral-Fiber Blanket Insulation: Mineral or glass fibers bonded with a thermosetting resin. Comply with ASTM C553, Type II and ASTM C1290, Type III with factory-applied FSK jacket. Insulation k-value shall be no greater than 0.27 (inch-pound units). Factory-applied jacket requirements are specified in "Factory-Applied Jackets" Article.

1. Subject to compliance with the specifications, provide products by one of the following:
   a. Johns Manville
   b. Owens Corning
   c. Knauf

2.2 ADHESIVES

A. Materials shall be compatible with insulation materials, jackets, and substrates and for bonding insulation to itself and to surfaces to be insulated unless otherwise indicated.

B. Mineral-Fiber Adhesive: Comply with MIL-A-3316C, Class 2, Grade A.

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

   a. Childers Brand; H. B. Fuller Construction Products.
   b. Foster Brand; H. B. Fuller.
   c. Mon-Eco Industries, Inc.

C. ASJ Adhesive, and FSK Jacket Adhesive: Comply with MIL-A-3316C, Class 2, Grade A for bonding insulation jacket lap seams and joints.

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

   a. Childers Brand; H. B. Fuller Construction Products.
   b. Foster Brand; H. B. Fuller.
   c. Mon-Eco Industries, Inc.

2.3 MASTICS AND COATINGS

A. Materials shall be compatible with insulation materials, jackets, and substrates.

B. Vapor-Retarder Mastic: Water based; suitable for indoor use on below ambient services.

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

a. Childers Brand; H. B. Fuller Construction Products.
b. Foster Brand; H. B. Fuller.
c. Knauf Insulation.

2. Water-Vapor Permeance: Comply with ASTM C755, Section 7.2.2, Table 2, for insulation type and service conditions.
3. Service Temperature Range: Minus 20 to plus 180 deg F.
4. Comply with MIL-PRF-19565C, Type II, for permeance requirements, with supplier listing on DOD QPD - Qualified Products Database.
5. Color: White.

C. Vapor-Retarder Mastic: Solvent based; suitable for outdoor use on below ambient services.

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

a. Childers Brand; H. B. Fuller Construction Products.
b. Eagle Bridges - Marathon Industries.
c. Foster Brand; H. B. Fuller.

2. Water-Vapor Permeance: Comply with ASTM C755, Section 7.2.2, Table 2, for insulation type and service conditions.
3. Service Temperature Range: Minus 50 to plus 220 deg F.
4. Color: White.

D. Breather Mastic: Water based; suitable for indoor and outdoor use on above ambient services.

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

a. Childers Brand; H. B. Fuller Construction Products.
b. Foster Brand; H. B. Fuller.
c. Mon-Eco Industries, Inc.

2. Water-Vapor Permeance: ASTM E96, greater than 1.0 perm at manufacturer's recommended dry film thickness.
3. Service Temperature Range: Minus 20 to plus 180 deg F.
4. Color: White.

2.4 SEALANTS

A. FSK and Metal Jacket Flashing Sealants:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

a. Childers Brand; H. B. Fuller Construction Products.
b. Eagle Bridges - Marathon Industries.
c. Foster Brand; H. B. Fuller.
d. Mon-Eco Industries, Inc.

2. Materials shall be compatible with insulation materials, jackets, and substrates.
3. Fire- and water-resistant, flexible, elastomeric sealant.
4. Service Temperature Range: Minus 40 to plus 250 deg F.

5. Color: Aluminum.

2.5 FACTORY-APPLIED JACKETS

A. Insulation system schedules indicate factory-applied jackets on various applications. When factory-applied jackets are indicated, comply with the following:
   1. FSK Jacket: Aluminum-foil, fiberglass-reinforced scrim with kraft-paper backing; complying with ASTM C1136, Type II.

2.6 FIELD-APPLIED FABRIC-REINFORCING MESH

A. Woven Glass-Fiber Fabric: Approximately 6 oz./sq. yd. with a thread count of 5 strands by 5 strands/sq. in. for covering ducts.

   1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

      a. Childers Brand; H. B. Fuller Construction Products.
      b. Foster Brand; H. B. Fuller.
      c. Mon-Eco.

2.7 TAPES

A. FSK Tape: Foil-face, vapor-retarder tape matching factory-applied jacket with acrylic adhesive; complying with ASTM C1136.

   1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

      a. 3M Industrial Adhesives and Tapes Division.
      b. Avery Dennison Corporation, Specialty Tapes Division.
      c. Knauf Insulation.

   2. Width: 3 inches.
   3. Thickness: 6.5 mils.
   4. Adhesion: 90 ounces force/inch in width.
   5. Elongation: 2 percent.
   6. Tensile Strength: 40 lbf/inch in width.
   7. FSK Tape Disks and Squares: Precut disks or squares of FSK tape.

2.8 SECUREMENTS

A. Bands:

   1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

      a. Johns Manville; a Berkshire Hathaway company.
      b. RPR Products, Inc.
      c. Approved equal.

2. Stainless Steel: ASTM A167 or ASTM A240/A240M, Type 304 or Type 316; 0.015 inch thick, 1/2 inch wide with closed seal.
3. Springs: Twin spring set constructed of stainless steel with ends flat and slotted to accept metal bands. Spring size determined by manufacturer for application.

B. Insulation Pins and Hangers:

1. Cupped-Head, Capacitor-Discharge-Weld Pins: Copper- or zinc-coated steel pin, fully annealed for capacitor-discharge welding, 0.135-inch- diameter shank, length to suit depth of insulation indicated with integral 1-1/2-inch galvanized carbon-steel washer.

    a. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

        1) AGM Industries, Inc.
        2) CL WARD & Family Inc.
        3) Gemco.
        4) Midwest Fasteners, Inc.
        5) Nelson Stud Welding.

2. Metal, Adhesively Attached, Perforated-Base Insulation Hangers: Baseplate welded to projecting spindle that is capable of holding insulation, of thickness indicated, securely in position indicated when self-locking washer is in place. Comply with the following requirements:

    a. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

        1) AGM Industries, Inc.
        2) Gemco.
        3) Midwest Fasteners, Inc.

    b. Baseplate: Perforated, galvanized carbon-steel sheet, 0.030 inch thick by 2 inches square.
    c. Spindle: Copper- or zinc-coated, low-carbon steel, fully annealed, 0.106-inch-diameter shank, length to suit depth of insulation indicated.
    d. Adhesive: Recommended by hanger manufacturer. Product with demonstrated capability to bond insulation hanger securely to substrates indicated without damaging insulation, hangers, and substrates.

3. Insulation-Retaining Washers: Self-locking washers formed from 0.016-inch- thick, stainless-steel sheet, with beveled edge sized as required to hold insulation securely in place but not less than 1-1/2 inches in diameter.

    a. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

        1) AGM Industries, Inc.
        2) Gemco.
        3) Midwest Fasteners, Inc.
        4) Nelson Stud Welding.

    b. Protect ends with capped self-locking washers incorporating a spring steel insert to ensure permanent retention of cap in exposed locations.

C. Staples: Outward-clinching insulation staples, nominal 3/4-inch- wide, stainless steel or Monel.

D. Wire: 0.080-inch nickel-copper alloy.

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

a. C & F Wire Products.
b. Johns Manville; a Berkshire Hathaway company.
c. RPR Products, Inc.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine substrates and conditions for compliance with requirements for installation tolerances and other conditions affecting performance of insulation application.

1. Verify that systems to be insulated have been tested and are free of defects.
2. Verify that surfaces to be insulated are clean and dry.

B. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 PREPARATION

A. Surface Preparation: Clean and dry surfaces to receive insulation. Remove materials that will adversely affect insulation application.

3.3 GENERAL INSTALLATION REQUIREMENTS

A. Install insulation materials, accessories, and finishes with smooth, straight, and even surfaces; free of voids throughout the length of ducts and fittings.

B. Install insulation materials, vapor barriers or retarders, jackets, and thicknesses required for each item of duct system as specified in insulation system schedules.

C. Install accessories compatible with insulation materials and suitable for the service. Install accessories that do not corrode, soften, or otherwise attack insulation or jacket in either wet or dry state.

D. Install insulation with longitudinal seams at top and bottom of horizontal runs.

E. Install multiple layers of insulation with longitudinal and end seams staggered.

F. Keep insulation materials dry during application and finishing.

G. Install insulation with tight longitudinal seams and end joints. Bond seams and joints with adhesive recommended by insulation material manufacturer.

H. Install insulation with least number of joints practical.

I. Where vapor barrier is indicated, seal joints, seams, and penetrations in insulation at hangers, supports, anchors, and other projections with vapor-barrier mastic.

1. Install insulation continuously through hangers and around anchor attachments.
2. For insulation application where vapor barriers are indicated, extend insulation on anchor legs from point of attachment to supported item to point of attachment to structure. Taper and seal ends at attachment to structure with vapor-barrier mastic.
3. Install insert materials and install insulation to tightly join the insert. Seal insulation to insulation inserts with adhesive or sealing compound recommended by insulation material manufacturer.

J. Apply adhesives, mastics, and sealants at manufacturer's recommended coverage rate and wet and dry film thicknesses.

K. Install insulation with factory-applied jackets as follows:

1. Draw jacket tight and smooth.
2. Cover circumferential joints with 3-inch- wide strips, of same material as insulation jacket. Secure strips with adhesive and outward clinching staples along both edges of strip, spaced 4 inches o.c.
3. Overlap jacket longitudinal seams at least 1-1/2 inches. Clean and dry surface to receive self-sealing lap. Staple laps with outward clinching staples along edge at 2 inches o.c.

    a. For below ambient services, apply vapor-barrier mastic over staples.

4. Cover joints and seams with tape, according to insulation material manufacturer's written instructions, to maintain vapor seal.
5. Where vapor barriers are indicated, apply vapor-barrier mastic on seams and joints and at ends adjacent to duct flanges and fittings.

L. Cut insulation in a manner to avoid compressing insulation more than 75 percent of its nominal thickness.

M. Finish installation with systems at operating conditions. Repair joint separations and cracking due to thermal movement.

N. Repair damaged insulation facings by applying same facing material over damaged areas. Extend patches at least 4 inches beyond damaged areas. Adhere, staple, and seal patches similar to butt joints.

3.4 PENETRATIONS

A. Insulation Installation at Aboveground Exterior Wall Penetrations: Install insulation continuously through wall penetrations.

1. Seal penetrations with flashing sealant.
2. For applications requiring only indoor insulation, terminate insulation inside wall surface and seal with joint sealant. For applications requiring indoor and outdoor insulation, install insulation for outdoor applications tightly joined to indoor insulation ends. Seal joint with joint sealant.
3. Extend jacket of outdoor insulation outside wall flashing and overlap wall flashing at least 2 inches.
4. Seal jacket to wall flashing with flashing sealant.

B. Insulation Installation at Interior Wall and Partition Penetrations (That Are Not Fire Rated): Install insulation continuously through walls and partitions.

C. Insulation Installation at Fire-Rated Wall and Partition Penetrations: Terminate insulation at fire damper sleeves for fire-rated wall and partition penetrations. Externally insulate damper sleeves to match adjacent insulation and overlap duct insulation at least 2 inches.

1. Comply with requirements in Section 078413 "Penetration Firestopping."

3.5 INSTALLATION OF MINERAL-FIBER INSULATION

A. Blanket Insulation Installation on Ducts and Plenums: Secure with adhesive and insulation pins.

1. Apply adhesives according to manufacturer's recommended coverage rates per unit area, for 100 percent coverage of duct and plenum surfaces.
2. Apply adhesive to entire circumference of ducts and to all surfaces of fittings and transitions.
3. Install either capacitor-discharge-weld pins and speed washers or cupped-head, capacitor-discharge-weld pins on sides and bottom of horizontal ducts and sides of vertical ducts as follows:

    a. On duct sides with dimensions 18 inches and smaller, place pins along longitudinal centerline of duct. Space 3 inches maximum from insulation end joints, and 16 inches o.c.
    b. On duct sides with dimensions larger than 18 inches, place pins 16 inches o.c. each way, and 3 inches maximum from insulation joints. Install additional pins to hold insulation tightly against surface at cross bracing.
    c. Pins may be omitted from top surface of horizontal, rectangular ducts and plenums.
    d. Do not overcompress insulation during installation.
    e. Impale insulation over pins and attach speed washers.
    f. Cut excess portion of pins extending beyond speed washers or bend parallel with insulation surface. Cover exposed pins and washers with tape matching insulation facing.

4. For ducts and plenums with surface temperatures below ambient, install a continuous unbroken vapor barrier. Create a facing lap for longitudinal seams and end joints with insulation by removing 2 inches from one edge and one end of insulation segment. Secure laps to adjacent insulation section with 1/2-inch outward-clinching staples, 1 inch o.c. Install vapor barrier consisting of factory- or field-applied jacket, adhesive, vapor-barrier mastic, and sealant at joints, seams, and protrusions.

    a. Repair punctures, tears, and penetrations with tape or mastic to maintain vapor-barrier seal.
    b. Install vapor stops for ductwork and plenums operating below 50 deg F at 18-foot intervals. Vapor stops shall consist of vapor-barrier mastic applied in a Z-shaped pattern over insulation face, along butt end of insulation, and over the surface. Cover insulation face and surface to be insulated a width equal to two times the insulation thickness, but not less than 3 inches.

5. Overlap unfaced blankets a minimum of 2 inches on longitudinal seams and end joints. At end joints, secure with steel bands spaced a maximum of 18 inches o.c.

6. Install insulation on rectangular duct elbows and transitions with a full insulation section for each surface. Install insulation on round and flat-oval duct elbows with individually mitered gores cut to fit the elbow.
7. Insulate duct stiffeners, hangers, and flanges that protrude beyond insulation surface with 6-inch- wide strips of same material used to insulate duct. Secure on alternating sides of stiffener, hanger, and flange with pins spaced 6 inches o.c.

3.6 FINISHES

A. Insulation with ASJ, Glass-Cloth, or Other Paintable Jacket Material: Paint jacket with paint system identified below and as specified in Section 099113 "Exterior Painting" and Section 099123 "Interior Painting."

1. Flat Acrylic Finish: Two finish coats over a primer that is compatible with jacket material and finish coat paint. Add fungicidal agent to render fabric mildew proof.

a. Finish Coat Material: Interior, flat, latex-emulsion size.

B. Color: Final color as selected by Architect. Vary first and second coats to allow visual inspection of the completed Work.

C. Do not field paint aluminum or stainless-steel jackets.

3.7 FIELD QUALITY CONTROL

A. Perform tests and inspections.

B. Tests and Inspections:

1. Inspect ductwork, randomly selected by Architect, by removing field-applied jacket and insulation in layers in reverse order of their installation. Extent of inspection shall be limited to three locations for supply duct insulation and three locations for return duct insulation.

C. All insulation applications will be considered defective Work if sample inspection reveals noncompliance with requirements.

3.8 DUCT INSULATION SCHEDULE, GENERAL

A. Plenums and Ducts Requiring Insulation:

1. Indoor supply and outdoor air.

B. Items Not Insulated:

1. Fibrous-glass ducts.
2. Metal ducts with duct liner of sufficient thickness to comply with energy code and ASHRAE/IESNA 90.1.
3. Factory-insulated flexible ducts.
4. Factory-insulated plenums and casings.
5. Flexible connectors.
6. Vibration-control devices.

7. Factory-insulated access panels and doors.

3.9 INDOOR DUCT AND PLENUM INSULATION SCHEDULE

A. Indoor supply and outdoor air ductwork shall be insulated with flexible mineral fiber insulation with a minimum R-value of 6.0 (inch-pound units).

END OF SECTION 230713

SECTION 23 07 19
HVAC PIPING INSULATION

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

A. Section includes insulating the following HVAC piping systems:

1. Condensate drain piping, indoors and outdoors.
2. Refrigerant suction and liquid piping, indoors and outdoors.

B. Related Sections:

1. Section 230713 "Duct Insulation."

1.3 ACTION SUBMITTALS

A. Product Data: For each type of product indicated. Include thermal conductivity, water-vapor permeance thickness, and jackets (both factory and field applied if any).

B. Shop Drawings: Include plans, elevations, sections, details, and attachments to other work.

1. Detail application of protective shields, saddles, and inserts at hangers for each type of insulation and hanger.
2. Detail insulation application at elbows, fittings, flanges, valves, and specialties for each type of insulation.
3. Detail removable insulation at piping specialties.
4. Detail application of field-applied jackets.
5. Detail application at linkages of control devices.

1.4 INFORMATIONAL SUBMITTALS

A. Qualification Data: For qualified Installer.

B. Material Test Reports: From a qualified testing agency acceptable to authorities having jurisdiction indicating, interpreting, and certifying test results for compliance of insulation materials, sealers, attachments, cements, and jackets, with requirements indicated. Include dates of tests and test methods employed.

C. Field quality-control reports.

1.5 QUALITY ASSURANCE

A. Installer Qualifications: Skilled mechanics who have successfully completed an apprenticeship program or another craft training program certified by the Department of Labor, Bureau of Apprenticeship and Training.

B. Surface-Burning Characteristics: For insulation and related materials, as determined by testing identical products according to ASTM E 84, by a testing and inspecting agency acceptable to authorities having jurisdiction. Factory label insulation and jacket materials and adhesive, mastic, tapes, and cement material containers, with appropriate markings of applicable testing agency.

1. Insulation Installed Indoors: Flame-spread index of 25 or less, and smoke-developed index of 50 or less.
2. Insulation Installed Outdoors: Flame-spread index of 75 or less, and smoke-developed index of 150 or less.

1.6 DELIVERY, STORAGE, AND HANDLING

A. Packaging: Insulation material containers shall be marked by manufacturer with appropriate ASTM standard designation, type and grade, and maximum use temperature.

1.7 COORDINATION

A. Coordinate sizes and locations of supports, hangers, and insulation shields specified in Section 230529 "Hangers and Supports for HVAC Piping and Equipment."

B. Coordinate clearance requirements with piping Installer for piping insulation application. Before preparing piping Shop Drawings, establish and maintain clearance requirements for installation of insulation and field-applied jackets and finishes and for space required for maintenance.

1.8 SCHEDULING

A. Schedule insulation application after pressure testing systems and, where required, after installing and testing heat tracing. Insulation application may begin on segments that have satisfactory test results.

B. Complete installation and concealment of plastic materials as rapidly as possible in each area of construction.

PART 2 - PRODUCTS

2.1 INSULATION MATERIALS

A. Products shall not contain asbestos, lead, mercury, or mercury compounds.

B. Products that come in contact with stainless steel shall have a leachable chloride content of less than 50 ppm when tested according to ASTM C 871.

C. Foam insulation materials shall not use CFC or HCFC blowing agents in the manufacturing process.

D. Flexible Elastomeric Insulation: Closed-cell, sponge- or expanded-rubber materials. Comply with ASTM C534, Type I for tubular materials. Maximum K-value of 0.245 (inch-pound units).

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

a. Armacell – AP Armaflex
b. Aeroflex
c. K-Flex

2.2 ADHESIVES/SEALANTS

A. Materials shall be compatible with insulation materials, jackets, and substrates and for bonding insulation to itself and to surfaces to be insulated unless otherwise indicated.

B. Flexible Elastomeric and Polyolefin Adhesive: Solvent-based adhesive.

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
a. Aeroflex
b. K-Flex
c. Armacell

2. Flame-spread index shall be 25 or less and smoke-developed index shall be 50 or less as tested in accordance with ASTM E84.
3. Wet Flash Point: Below 0 deg F.
4. Service Temperature Range: 40 to 200 deg F.
5. K-value no greater than 0.245 (inch-pound units).

2.3 FIELD-APPLIED JACKETS

A. Field-applied jackets shall comply with ASTM C921, Type I, unless otherwise indicated.

B. Metal Jacket:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

a. ITW
b. Johns Manville; a Berkshire Hathaway company.
c. GLT Products.

2. Aluminum Jacket: Comply with ASTM B209, Alloy 3003, 3005, 3105, or 5005, Temper H-14.

a. Factory cut and rolled to size.
b. Finish: Stucco embossed.
c. Thickness: 0.024 inches.

d. Moisture Barrier for Indoor Applications: 1-mil- thick, heat-bonded polyethylene and kraft paper.
e. Moisture Barrier for Outdoor Applications: 3-mil- thick, heat-bonded polyethylene and kraft paper.
f. Factory-Fabricated Fitting Covers:

1) Same material, finish, and thickness as jacket.
2) Preformed 2-piece or gore, 45- and 90-degree, short- and long-radius elbows.
3) Tee covers.
4) Flange and union covers.
5) End caps.
6) Beveled collars.
7) Valve covers.
8) Field fabricate fitting covers only if factory-fabricated fitting covers are not available.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine substrates and conditions for compliance with requirements for installation tolerances and other conditions affecting performance of insulation application.

1. Verify that systems to be insulated have been tested and are free of defects.
2. Verify that surfaces to be insulated are clean and dry.
3. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 PREPARATION

A. Surface Preparation: Clean and dry surfaces to receive insulation. Remove materials that will adversely affect insulation application.

B. Coordinate insulation installation with the trade installing heat tracing. Comply with requirements for heat tracing that apply to insulation.

C. Mix insulating cements with clean potable water; if insulating cements are to be in contact with stainless-steel surfaces, use demineralized water.

3.3 GENERAL INSTALLATION REQUIREMENTS

A. Install insulation materials, accessories, and finishes with smooth, straight, and even surfaces; free of voids throughout the length of piping including fittings, valves, and specialties.

B. Install insulation materials, forms, vapor barriers or retarders, jackets, and thicknesses required for each item of pipe system as specified in insulation system schedules.

C. Install accessories compatible with insulation materials and suitable for the service. Install accessories that do not corrode, soften, or otherwise attack insulation or jacket in either wet or dry state.

D. Install insulation with longitudinal seams at top and bottom of horizontal runs.

E. Install multiple layers of insulation with longitudinal and end seams staggered.

F. Do not weld brackets, clips, or other attachment devices to piping, fittings, and specialties.

G. Keep insulation materials dry during application and finishing.

H. Install insulation with tight longitudinal seams and end joints. Bond seams and joints with adhesive recommended by insulation material manufacturer.

I. Install insulation with least number of joints practical.

J. Where vapor barrier is indicated, seal joints, seams, and penetrations in insulation at hangers, supports, anchors, and other projections with vapor-barrier mastic.

1. Install insulation continuously through hangers and around anchor attachments.
2. For insulation application where vapor barriers are indicated, extend insulation on anchor legs from point of attachment to supported item to point of attachment to structure. Taper and seal ends at attachment to structure with vapor-barrier mastic.
3. Install insert materials and install insulation to tightly join the insert. Seal insulation to insulation inserts with adhesive or sealing compound recommended by insulation material manufacturer.
4. Cover inserts with jacket material matching adjacent pipe insulation. Install shields over jacket, arranged to protect jacket from tear or puncture by hanger, support, and shield.

K. Apply adhesives, mastics, and sealants at manufacturer's recommended coverage rate and wet and dry film thicknesses.

L. Install insulation with factory-applied jackets as follows:

1. Draw jacket tight and smooth.
2. Cover circumferential joints with 3-inch- wide strips, of same material as insulation jacket. Secure strips with adhesive and outward clinching staples along both edges of strip, spaced 4 inches o.c.

3. Cover joints and seams with tape, according to insulation material manufacturer's written instructions, to maintain vapor seal.
4. Where vapor barriers are indicated, apply vapor-barrier mastic on seams and joints and at ends adjacent to pipe flanges and fittings.

M. Cut insulation in a manner to avoid compressing insulation more than 75 percent of its nominal thickness.

N. Finish installation with systems at operating conditions. Repair joint separations and cracking due to thermal movement.

O. Repair damaged insulation facings by applying same facing material over damaged areas. Extend patches at least 4 inches beyond damaged areas. Adhere, staple, and seal patches similar to butt joints.

P. For above-ambient services, do not install insulation to the following:

1. Vibration-control devices.

2. Testing agency labels and stamps.
3. Nameplates and data plates.
4. Cleanouts.

3.4 PENETRATIONS

A. Insulation Installation at Aboveground Exterior Wall Penetrations: Install insulation continuously through wall penetrations.

1. Seal penetrations with flashing sealant.
2. For applications requiring only indoor insulation, terminate insulation inside wall surface and seal with joint sealant. For applications requiring indoor and outdoor insulation, install insulation for outdoor applications tightly joined to indoor insulation ends. Seal joint with joint sealant.
3. Extend jacket of outdoor insulation outside wall flashing and overlap wall flashing at least 2 inches.
4. Seal jacket to wall flashing with flashing sealant.

B. Insulation Installation at Interior Wall and Partition Penetrations (That Are Not Fire Rated): Install insulation continuously through walls and partitions.

C. Insulation Installation at Fire-Rated Wall and Partition Penetrations: Install insulation continuously through penetrations of fire-rated walls and partitions.

1. Comply with requirements in Section 078413 "Penetration Firestopping" for firestopping and fire-resistive joint sealers.

3.5 GENERAL PIPE INSULATION INSTALLATION

A. Requirements in this article generally apply to all insulation materials except where more specific requirements are specified in various pipe insulation material installation articles.

3.6 INSTALLATION OF FLEXIBLE ELASTOMERIC INSULATION

A. Seal longitudinal seams and end joints with manufacturer's recommended adhesive to eliminate openings in insulation that allow passage of air to surface being insulated.

B. Insulation Installation on Pipe Flanges:

1. Install pipe insulation to outer diameter of pipe flange.
2. Make width of insulation section same as overall width of flange and bolts, plus twice the thickness of pipe insulation.
3. Fill voids between inner circumference of flange insulation and outer circumference of adjacent straight pipe segments with cut sections of sheet insulation of same thickness as pipe insulation.
4. Secure insulation to flanges and seal seams with manufacturer's recommended adhesive to eliminate openings in insulation that allow passage of air to surface being insulated.

C. Insulation Installation on Pipe Fittings and Elbows:

1. Install mitered sections of pipe insulation.

2. Secure insulation materials and seal seams with manufacturer's recommended adhesive to eliminate openings in insulation that allow passage of air to surface being insulated.

D. Insulation Installation on Valves and Pipe Specialties:

1. Install preformed valve covers manufactured of same material as pipe insulation when available.
2. When preformed valve covers are not available, install cut sections of pipe and sheet insulation to valve body. Arrange insulation to permit access to packing and to allow valve operation without disturbing insulation.
3. Install insulation to flanges as specified for flange insulation application.
4. Secure insulation to valves and specialties and seal seams with manufacturer's recommended adhesive to eliminate openings in insulation that allow passage of air to surface being insulated.

3.7 FIELD-APPLIED JACKET INSTALLATION

A. Metal Jackets: Install with 2-inch overlap at longitudinal seams and end joints. Overlap longitudinal seams arranged to shed water. Seal end joints with weatherproof sealant recommended by insulation manufacturer. Secure jacket with stainless-steel bands 12 inches o.c. and at end joints. All exterior piping shall have metal jacket.

3.8 PIPING INSULATION SCHEDULE, GENERAL

A. Indoor and outdoor refrigerant piping shall be insulated with minimum 3/4" thick flexible elastomeric insulation.

B. Indoor and outdoor condensate piping shall be insulated with minimum 1/2” thick flexible elastomeric insulation.

C. Outdoor exposed piping/insulation shall be covered with aluminum jacketing.

END OF SECTION 230719

SECTION 23 23 00
REFRIGERANT PIPING

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

A. Section Includes:

1. Refrigerant pipes and fittings.

2. Condensate pipes and fittings.
3. Refrigerant piping valves and specialties.
4. Refrigerants.

1.3 ACTION SUBMITTALS

A. Product Data: For each type of valve, refrigerant piping, condensate piping, and piping specialty.

1. Include pressure drop, based on manufacturer's test data, for the following:

a. Thermostatic expansion valves.
b. Solenoid valves.
c. Filter dryers.
d. Strainers.

B. Shop Drawings:

1. Show layout of refrigerant piping and specialties, including pipe, tube, and fitting sizes; flow capacities; valve arrangements and locations; slopes of horizontal runs; oil traps; double risers; wall and floor penetrations; and equipment connection details.
2. Show piping size and piping layout, including oil traps, double risers, specialties, and pipe and tube sizes to accommodate, as a minimum, equipment provided, elevation difference between compressor and evaporator, and length of piping to ensure proper operation and compliance with warranties of connected equipment.
3. Show interface and spatial relationships between piping and equipment.
4. Shop Drawing Scale: 1/4 inch equals 1 foot.

1.4 INFORMATIONAL SUBMITTALS

A. Welding certificates.

B. Field quality-control reports.

1.5 CLOSEOUT SUBMITTALS

A. Operation and Maintenance Data: For refrigerant valves and piping specialties to include in maintenance manuals.

1.6 QUALITY ASSURANCE

A. Welding Qualifications: Qualify procedures and personnel according to 2010 ASME Boiler and Pressure Vessel Code: Section IX, "Welding and Brazing Qualifications."

B. Comply with ASHRAE 15, "Safety Code for Refrigeration Systems."

C. Comply with ASME B31.5, "Refrigeration Piping and Heat Transfer Components."

1.7 PRODUCT STORAGE AND HANDLING

A. Store piping with end caps in place to ensure that piping interior and exterior are clean when installed.

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

A. Line Test Pressure for Refrigerant R-410A:

1. Suction Lines for Air-Conditioning Applications: 300 psig.
2. Suction Lines for Heat-Pump Applications: 535 psig.
3. Hot-Gas and Liquid Lines: 535 psig.

2.2 COPPER TUBE AND FITTINGS

A. Copper Tube for Refrigerant: ASTM B 280, Type ACR.

B. Copper Tube for Condensate: ASTM B88 Type DWV hard drawn.

C. Wrought-Copper Fittings: ASME B16.22.

D. Wrought-Copper Unions: ASME B16.22.

E. Brazing Filler Metals: AWS A5.8/A5.8M.

F. Solder Metal: ASTM B32 lead free, with lead-free flux.

G. Flexible Connectors:

1. Body: Tin-bronze bellows with woven, flexible, tinned-bronze-wire-reinforced protective jacket.
2. End Connections: Socket ends.
3. Offset Performance: Capable of minimum 3/4-inch misalignment in minimum 7-inch- long assembly.

4. Working Pressure Rating: Factory test at minimum 500 psig.
5. Maximum Operating Temperature: 250 deg F.

2.3 VALVES AND SPECIALTIES

A. Diaphragm Packless Valves:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

    a. Danfoss, Inc.
    b. Henry Technologies Inc.; The Henry Group.
    c. Parker (Parker Hannifin).

2. Body and Bonnet: Forged brass or cast bronze; globe design with straight-through or angle pattern.
3. Diaphragm: Phosphor bronze and stainless steel with stainless-steel spring.
4. Operator: Rising stem and hand wheel.
5. Seat: Nylon.
6. End Connections: Socket, union, or flanged.
7. Working Pressure Rating: 500 psig.
8. Maximum Operating Temperature: 275 deg F.

B. Check Valves:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

    a. Apollo Valves; a part of Aalberts Integrated Piping Systems.
    b. Danfoss, Inc.
    c. Emerson Climate Technologies; Emerson Electric Co.

2. Body: Ductile iron, forged brass, or cast bronze; globe pattern.
3. Bonnet: Bolted ductile iron, forged brass, or cast bronze; or brass hex plug.
4. Piston: Removable polytetrafluoroethylene seat.
5. Closing Spring: Stainless steel.
6. Manual Opening Stem: Seal cap, plated-steel stem, and graphite seal.
7. End Connections: Socket, union, threaded, or flanged.
8. Maximum Opening Pressure: 0.50 psig.
9. Working Pressure Rating: 500 psig.
10. Maximum Operating Temperature: 275 deg F.

C. Service Valves:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

    a. Danfoss, Inc.
    b. Emerson Climate Technologies; Emerson Electric Co.
    c. Parker (Parker Hannifin).
    d. RectorSeal HVAC; a CSW Industrials Company.

2. Body: Forged brass with brass cap including key end to remove core.
3. Core: Removable ball-type check valve with stainless-steel spring.

4. Seat: Polytetrafluoroethylene.
5. End Connections: Copper spring.
6. Working Pressure Rating: 500 psig.

D. Solenoid Valves: Comply with AHRI 760 and UL 429; listed and labeled by a National Recognized Testing Laboratory (NRTL).

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

    a. Danfoss, Inc.
    b. Emerson Climate Technologies; Emerson Electric Co.
    c. Henry Technologies Inc.; The Henry Group.
    d. Parker (Parker Hannifin).

2. Body and Bonnet: Plated steel.
3. Solenoid Tube, Plunger, Closing Spring, and Seat Orifice: Stainless steel.
4. Seat: Polytetrafluoroethylene.
5. End Connections: Threaded.
6. Electrical: Molded, watertight coil in NEMA 250 enclosure of type required by location with 1/2-inch conduit adapter, and 24-V ac coil. Provide transformer as required to power valve.
7. Working Pressure Rating: 400 psig.
8. Maximum Operating Temperature: 240 deg F.

E. Safety Relief Valves: Comply with 2010 ASME Boiler and Pressure Vessel Code; listed and labeled by an NRTL.

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

    a. Danfoss, Inc.
    b. Henry Technologies Inc.; The Henry Group.
    c. Parker (Parker Hannifin).

2. Body and Bonnet: Ductile iron and steel, with neoprene O-ring seal.
3. Piston, Closing Spring, and Seat Insert: Stainless steel.
4. Seat: Polytetrafluoroethylene.
5. End Connections: Threaded.
6. Working Pressure Rating: 400 psig.
7. Maximum Operating Temperature: 240 deg F.

F. Thermostatic Expansion Valves: Comply with AHRI 750.

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

    a. Danfoss, Inc.
    b. Emerson Climate Technologies; Emerson Electric Co.
    c. Henry Technologies Inc.; The Henry Group.
    d. Parker Hannifin; Sporlan Division (Zoomlock).

2. Body, Bonnet, and Seal Cap: Forged brass or steel.
3. Diaphragm, Piston, Closing Spring, and Seat Insert: Stainless steel.
4. Packing and Gaskets: Non-asbestos.

5. Capillary and Bulb: Copper tubing filled with refrigerant charge.
6. Suction Temperature: 40 deg F.
7. Superheat: Adjustable.
8. Reverse-flow option (for heat-pump applications).
9. End Connections: Socket, flare, or threaded union.
10. Working Pressure Rating: 700 psig.

G. Straight-Type Strainers:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

    a. Danfoss, Inc.
    b. Henry Technologies Inc.; The Henry Group.
    c. Parker (Parker Hannifin).

2. Body: Welded steel with corrosion-resistant coating.
3. Screen: 100-mesh stainless steel.
4. End Connections: Socket or flare.
5. Working Pressure Rating: 500 psig.
6. Maximum Operating Temperature: 275 deg F.

H. Angle-Type Strainers:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

    a. Danfoss, Inc.
    b. Henry Technologies Inc.; The Henry Group.
    c. Parker (Parker Hannifin).

2. Body: Forged brass or cast bronze.
3. Drain Plug: Brass hex plug.
4. Screen: 100-mesh monel.
5. End Connections: Socket or flare.
6. Working Pressure Rating: 500 psig.
7. Maximum Operating Temperature: 275 deg F.

I. Moisture/Liquid Indicators:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

    a. Danfoss, Inc.
    b. Emerson Climate Technologies; Emerson Electric Co.
    c. Henry Technologies Inc.; The Henry Group.
    d. Parker (Parker Hannifin).

2. Body: Forged brass.
3. Window: Replaceable, clear, fused glass window with indicating element protected by filter screen.
4. Indicator: Color coded to show moisture content in parts per million (ppm).
5. Minimum Moisture Indicator Sensitivity: Indicate moisture above 60 ppm.
6. End Connections: Socket or flare.
7. Working Pressure Rating: 500 psig.

8. Maximum Operating Temperature: 240 deg F.

J. Replaceable-Core Filter Dryers: Comply with AHRI 730.

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

   a. Danfoss, Inc.
   b. Emerson Climate Technologies; Emerson Electric Co.
   c. Henry Technologies Inc.; The Henry Group.
   d. Parker (Parker Hannifin).

2. Body and Cover: Painted-steel shell with ductile-iron cover, stainless-steel screws, and neoprene gaskets.
3. Filter Media: 10 micron, pleated with integral end rings; stainless-steel support.
4. Desiccant Media: Activated alumina or charcoal.
5. Designed for reverse flow (for heat-pump applications).
6. End Connections: Socket.
7. Access Ports: NPS 1/4 connections at entering and leaving sides for pressure differential measurement.
8. Maximum Pressure Loss: 2 psig.
9. Working Pressure Rating: 500 psig.
10. Maximum Operating Temperature: 240 deg F.

K. Permanent Filter Dryers: Comply with AHRI 730.

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

   a. Danfoss, Inc.
   b. Emerson Climate Technologies; Emerson Electric Co.
   c. Henry Technologies Inc.; The Henry Group.
   d. Parker (Parker Hannifin).

2. Body and Cover: Painted-steel shell.
3. Filter Media: 10 micron, pleated with integral end rings; stainless-steel support.
4. Desiccant Media: Activated alumina or charcoal.
5. Designed for reverse flow (for heat-pump applications).
6. End Connections: Socket.
7. Access Ports: NPS 1/4 connections at entering and leaving sides for pressure differential measurement.
8. Maximum Pressure Loss: 2 psig.
9. Working Pressure Rating: 500 psig.
10. Maximum Operating Temperature: 240 deg F.

L. Receivers: Comply with AHRI 495.

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

   a. Henry Technologies Inc.; The Henry Group.
   b. Parker Hannifin; Sporlan Division (Zoomlock).
   c. Approved equal.

2. Comply with 2010 ASME Boiler and Pressure Vessel Code; listed and labeled by an NRTL.
3. Comply with UL 207; listed and labeled by an NRTL.
4. Body: Welded steel with corrosion-resistant coating.
5. Tappings: Inlet, outlet, liquid level indicator, and safety relief valve.
6. End Connections: Socket or threaded.
7. Working Pressure Rating: 500 psig.
8. Maximum Operating Temperature: 275 deg F.

M. Liquid Accumulators: Comply with AHRI 495.

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

   a. Emerson Climate Technologies; Emerson Electric Co.
   b. Henry Technologies Inc.; The Henry Group.
   c. Parker (Parker Hannifin).

2. Body: Welded steel with corrosion-resistant coating.
3. End Connections: Socket or threaded.
4. Working Pressure Rating: 500 psig.
5. Maximum Operating Temperature: 275 deg F.

2.4 REFRIGERANTS

A. ASHRAE 34, R-410A: Pentafluoroethane/Difluoromethane.

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

   a. Arkema Inc.
   b. DuPont Fluorochemicals Div.
   c. Genetron Refrigerants; Honeywell International Inc.
   d. Mexichem Fluor, Inc. (Koura).

PART 3 - EXECUTION

3.1 PIPING APPLICATIONS FOR REFRIGERANT R-410A

A. All refrigerant piping and safety relief valve discharge piping shall be copper, Type ACR, drawn-temper tubing and wrought-copper fittings with brazed joints.

B. Condensate piping shall be copper, Type DWV drawn-temper tubing, with wrought copper fittings and soldered joints.

3.2 VALVE AND SPECIALTY APPLICATIONS

A. Install diaphragm packless valves in suction and discharge lines of compressor.

B. Install service valves for gage taps at inlet and outlet of hot-gas bypass valves and strainers if they are not an integral part of valves and strainers.

C. Install a check valve at the compressor discharge and a liquid accumulator at the compressor suction connection.

D. Except as otherwise indicated, install diaphragm packless valves on inlet and outlet side of filter dryers.

E. Install a full-size, three-valve bypass around filter dryers.

F. Install solenoid valves upstream from each expansion valve and hot-gas bypass valve. Install solenoid valves in horizontal lines with coil at top.

G. Install thermostatic expansion valves as close as possible to distributors on evaporators.

1. Install valve so diaphragm case is warmer than bulb.
2. Secure bulb to clean, straight, horizontal section of suction line using two bulb straps. Do not mount bulb in a trap or at bottom of the line.
3. If external equalizer lines are required, make connection where it will reflect suction-line pressure at bulb location.

H. Install safety relief valves where required by 2010 ASME Boiler and Pressure Vessel Code. Pipe safety-relief-valve discharge line to outside according to ASHRAE 15.

I. Install moisture/liquid indicators in liquid line at the inlet of the thermostatic expansion valve or at the inlet of the evaporator coil capillary tube.

J. Install strainers upstream from and adjacent to the following unless they are furnished as an integral assembly for the device being protected:

1. Solenoid valves.
2. Thermostatic expansion valves.
3. Hot-gas bypass valves.
4. Compressor.

K. Install filter dryers in liquid line between compressor and thermostatic expansion valve, and in the suction line at the compressor.

L. Install receivers sized to accommodate pump-down charge.

M. Install flexible connectors at compressors.

3.3 PIPING INSTALLATION

A. Drawing plans, schematics, and diagrams indicate general location and arrangement of piping systems. Contractor shall size, route and install refrigerant piping in strict accordance with equipment manufacturer's instructions.

B. Install refrigerant piping according to ASHRAE 15.

C. Install piping in concealed locations unless otherwise indicated and except in equipment rooms and service areas.

D. Install piping indicated to be exposed and piping in equipment rooms and service areas at right angles or parallel to building walls. Diagonal runs are prohibited unless specifically indicated otherwise.

E. Install piping above accessible ceilings to allow sufficient space for ceiling panel removal.

F. Install piping adjacent to machines to allow service and maintenance.

G. Install piping free of sags and bends.

H. Install fittings for changes in direction and branch connections.

I. Select system components with pressure rating equal to or greater than system operating pressure.

J. Install piping as short and direct as possible, with a minimum number of joints, elbows, and fittings.

K. Arrange piping to allow inspection and service of refrigeration equipment. Install valves and specialties in accessible locations to allow for service and inspection. Install access doors or panels as specified in Section 083113 "Access Doors and Frames" if valves or equipment requiring maintenance is concealed behind finished surfaces.

L. Install refrigerant piping in protective conduit where installed belowground.

M. Install refrigerant piping in rigid or flexible conduit in locations where exposed to mechanical damage.

N. Slope refrigerant piping as follows:

1. Install horizontal hot-gas discharge piping with a uniform slope downward away from compressor.
2. Install horizontal suction lines with a uniform slope downward to compressor.
3. Install traps and double risers to entrain oil in vertical runs.
4. Liquid lines may be installed level.

O. When brazing or soldering, remove solenoid-valve coils and sight glasses; also remove valve stems, seats, and packing, and accessible internal parts of refrigerant specialties. Do not apply heat near expansion-valve bulb.

P. Install piping with adequate clearance between pipe and adjacent walls and hangers or between pipes for insulation installation.

Q. Identify refrigerant piping and valves according to Section 230553 "Identification for HVAC Piping and Equipment."

3.4 PIPE JOINT CONSTRUCTION

A. Ream ends of pipes and tubes and remove burrs. Bevel plain ends of steel pipe.

B. Remove scale, slag, dirt, and debris from inside and outside of pipe and fittings before assembly.

C. Fill pipe and fittings with an inert gas (nitrogen or carbon dioxide), during brazing or welding, to prevent scale formation.

D. Brazed Joints: Construct joints according to AWS's "Brazing Handbook," Chapter "Pipe and Tube."

1. Use Type BCuP (copper-phosphorus) alloy for joining copper socket fittings with copper pipe.
2. Use Type BAg (cadmium-free silver) alloy for joining copper with bronze or steel.

E. Flanged Joints: Select appropriate gasket material, size, type, and thickness for service application. Install gasket concentrically positioned. Use suitable lubricants on bolt threads.

F. Soldered Joints: Construct joints according to ASTM B 828 or CDA's "Copper Tube Handbook."

3.5 INSTALLATION OF HANGERS AND SUPPORTS

A. Comply with Section 230529 "Hangers and Supports for HVAC Piping and Equipment" for hangers, supports, and anchor devices.

B. Install the following pipe attachments:

1. Adjustable steel clevis hangers for individual horizontal runs less than 20 feet long.
2. Roller hangers and spring hangers for individual horizontal runs 20 feet or longer.
3. Pipe Roller: MSS SP-58, Type 44 for multiple horizontal piping 20 feet or longer, supported on a trapeze.
4. Spring hangers to support vertical runs.
5. Copper-clad hangers and supports for hangers and supports in direct contact with copper pipe.

C. Install hangers for copper tubing, with maximum horizontal spacing and minimum rod diameters, to comply with MSS-58, locally enforced codes, and authorities having jurisdiction requirements, whichever are most stringent.

D. Support horizontal piping within 12 inches of each fitting.

E. Support vertical runs of copper tubing to comply with MSS-58, locally enforced codes, and authorities having jurisdiction requirements, whichever are most stringent.

3.6 FIELD QUALITY CONTROL

A. Perform the following tests and inspections:

1. Comply with ASME B31.5, Chapter VI.
2. Test refrigerant piping, specialties, and receivers. Isolate compressor, condenser, evaporator, and safety devices from test pressure if they are not rated above the test pressure.
3. Test high- and low-pressure side piping of each system separately at not less than the pressures indicated in "Performance Requirements" Article.

    a. Fill system with nitrogen to the required test pressure.
    b. System shall maintain test pressure at the manifold gage throughout duration of test.
    c. Test joints and fittings with electronic leak detector or by brushing a small amount of soap and glycerin solution over joints.
    d. Remake leaking joints using new materials, and retest until satisfactory results are achieved.

B. Prepare test and inspection reports.

3.7 SYSTEM CHARGING

A. Charge system using the following procedures:

1. Install core in filter dryers after leak test but before evacuation.
2. Evacuate entire refrigerant system with a vacuum pump to 500 micrometers. If vacuum holds for 12 hours, system is ready for charging.
3. Break vacuum with refrigerant gas, allowing pressure to build up to 2 psig.
4. Charge system with a new filter-dryer core in charging line.

3.8 ADJUSTING

A. Adjust thermostatic expansion valve to obtain proper evaporator superheat.

B. Adjust high- and low-pressure switch settings to avoid short cycling in response to fluctuating suction pressure.

C. Adjust set-point temperature of air-conditioning or chilled-water controllers to the system design temperature.

D. Perform the following adjustments before operating the refrigeration system, according to manufacturer's written instructions:

1. Open shutoff valves in condenser water circuit.
2. Verify that compressor oil level is correct.
3. Open compressor suction and discharge valves.
4. Open refrigerant valves except bypass valves that are used for other purposes.
5. Check open compressor-motor alignment and verify lubrication for motors and bearings.

E. Replace core of replaceable filter dryer after system has been adjusted and after design flow rates and pressures are established.

END OF SECTION 232300

SECTION 23 31 13
METAL DUCTS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

A. Section Includes:
1. Single-wall round ducts and fittings.
2. Sheet metal materials.
3. Sealants and gaskets.
4. Hangers and supports.

B. Related Sections:

1. Section 230593 "Testing, Adjusting, and Balancing for HVAC" for testing, adjusting, and balancing requirements for metal ducts.
2. Section 233300 "Air Duct Accessories" for dampers, sound-control devices, duct-mounting access doors and panels, turning vanes, and flexible ducts.

1.3 DEFINITIONS

A. OSHPD: Office of Statewide Health Planning and Development (State of California).

1.4 ACTION SUBMITTALS

A. Product Data: For each type of the following products:
1. Sealants and gaskets.
2. Ductwork and fittings

B. Sustainable Design Submittals:

1. Product Data: For adhesives, indicating VOC content.
2. Laboratory Test Reports: For adhesives, indicating compliance with requirements for low-emitting materials.
3. Product Data: For sealants, indicating VOC content.
4. Laboratory Test Reports: For sealants, indicating compliance with requirements for low-emitting materials.
5. Laboratory Test Reports: For antimicrobial coatings, indicating compliance with requirements for low-emitting materials.

C. Shop Drawings:

1. Fabrication, assembly, and installation, including plans, elevations, sections, components, and attachments to other work.

2. Factory- and shop-fabricated ducts and fittings.
3. Duct layout indicating sizes, configuration, liner material, and static-pressure classes.
4. Elevation of top and bottom of ducts.
5. Dimensions of main duct runs from building grid lines.
6. Fittings.
7. Reinforcement and spacing.
8. Seam and joint construction.
9. Penetrations through fire-rated and other partitions.
10. Equipment installation based on equipment being used on Project.
11. Locations for duct accessories, including dampers, turning vanes, and access doors and panels.
12. Hangers and supports, including methods for duct and building attachment and vibration isolation.
13. .

D. Delegated-Design Submittal:

1. Sheet metal thicknesses.
2. Joint and seam construction and sealing.
3. Reinforcement details and spacing.
4. Materials, fabrication, assembly, and spacing of hangers and supports.
5. Design Calculations: Calculations for selecting hangers and supports.

1.5 INFORMATIONAL SUBMITTALS

A. Coordination Drawings: A single set of plans or BIM model, drawn to scale, showing the items described in this Section, and coordinated with all building trades.

B. Welding certificates.

C. Field quality-control reports.

1.6 QUALITY ASSURANCE

A. Welding Qualifications: Qualify procedures and personnel in accordance with the following:

1. AWS D1.1/D1.1M, "Structural Welding Code - Steel," for hangers and supports.
2. AWS D1.2/D1.2M, "Structural Welding Code - Aluminum," for aluminum supports.
3. AWS D9.1/D9.1M, "Sheet Metal Welding Code," for duct joint and seam welding.

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

A. Delegated Duct Design: Duct construction, including sheet metal thicknesses, seam and joint construction, reinforcements, and hangers and supports, shall comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible" and with performance requirements and design criteria indicated in "Duct Schedule" Article.

B. Structural Performance: Duct hangers and supports shall withstand the effects of gravity loads and stresses within limits and under conditions described in SMACNA's "HVAC Duct Construction Standards - Metal and Flexible".

C. Airstream Surfaces: Surfaces in contact with airstream shall comply with requirements in ASHRAE 62.1.

D. ASHRAE Compliance: Applicable requirements in ASHRAE 62.1, Section 5 - "Systems and Equipment," and Section 7 - "Construction and System Startup."

E. ASHRAE/IES Compliance: Applicable requirements in ASHRAE/IES 90.1, Section 6.4.4 - "HVAC System Construction and Insulation."

F. Duct Dimensions: Unless otherwise indicated, all duct dimensions indicated on Drawings are inside clear dimensions and do not include insulation or duct wall thickness.

2.2 SINGLE-WALL ROUND DUCTS AND FITTINGS

A. General Fabrication Requirements: Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Ch. 3, "Round, Oval, and Flexible Duct," based on indicated static-pressure class unless otherwise indicated.

1. Construct ducts of galvanized sheet steel unless otherwise indicated.
2. For ducts exposed to weather, construct of Type 304 or Type 316 stainless steel indicated by manufacturer to be suitable for outdoor installation.

3. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

    a. Elgen Manufacturing.
    b. McGill AirFlow LLC.
    c. Nordfab Ducting.
    d. SEMCO, LLC; part of FlaktGroup.
    e. Ductmate Industries, Inc; a DMI company.

B. Transverse Joints: Select joint types and fabricate in accordance with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Figure 3-1, "Round Duct Transverse Joints," for static-pressure class, applicable sealing requirements, materials involved, duct-support intervals, and other provisions in SMACNA's "HVAC Duct Construction Standards - Metal and Flexible."

1. Transverse Joints in Ducts Larger Than 60 Inches in Diameter: Flanged.

C. Longitudinal Seams: Select seam types and fabricate in accordance with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Figure 3-2, "Round Duct Longitudinal Seams," for static-pressure class, applicable sealing requirements, materials involved, duct-support intervals, and other provisions in SMACNA's "HVAC Duct Construction Standards - Metal and Flexible."

1. Fabricate round ducts larger than 90 inches in diameter with butt-welded longitudinal seams.
2. Fabricate flat-oval ducts larger than 72 inches in width (major dimension) with butt-welded longitudinal seams.

D. Tees and Laterals: Select types and fabricate in accordance with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Figure 3-5, "90 Degree Tees and Laterals," and Figure 3-6, "Conical Tees," for static-pressure class, applicable sealing requirements, materials involved, duct-support intervals, and other provisions in SMACNA's "HVAC Duct Construction Standards - Metal and Flexible."

2.3 SHEET METAL MATERIALS

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

B. Galvanized Sheet Steel: Comply with ASTM A653/A653M.

1. Galvanized Coating Designation: G90.
2. Finishes for Surfaces Exposed to View: Mill phosphatized.

C. Aluminum Sheets: Comply with ASTM B209 Alloy 3003, H14 temper; with mill finish for concealed ducts, and standard, one-side bright finish for duct surfaces exposed to view. Exhaust ductwork in the office building serving the laboratory and serving shower rooms shall be aluminum.

D. Reinforcement Shapes and Plates: ASTM A36/A36M, steel plates, shapes, and bars; black and galvanized.

1. Where black- and galvanized-steel shapes and plates are used to reinforce aluminum ducts, isolate the different metals with butyl rubber, neoprene, or EPDM gasket materials.

E. Tie Rods: Galvanized steel, 1/4-inch- minimum diameter for lengths 36 inches or less; 3/8-inch-minimum diameter for lengths longer than 36 inches.

2.4 SEALANT AND GASKETS

A. General Sealant and Gasket Requirements: Surface-burning characteristics for sealants and gaskets shall be a maximum flame-spread index of 25 and a maximum smoke-developed index of 50 when tested in accordance with UL 723; certified by an NRTL.

B. Water-Based Joint and Seam Sealant:

1. Application Method: Brush on.
2. Solids Content: Minimum 65 percent.
3. Shore A Hardness: Minimum 20.
4. Water resistant.
5. Mold and mildew resistant.
6. VOC: Maximum 75 g/L (less water).
7. Maximum Static-Pressure Class: 10 inch wg, positive and negative.
8. Service: Indoor or outdoor.
9. Substrate: Compatible with galvanized sheet steel (both PVC coated and bare), stainless steel, or aluminum sheets.

C. Flanged Joint Sealant: Comply with ASTM C920.

1. General: Single-component, acid-curing, silicone, elastomeric.
2. Type: S.
3. Grade: NS.
4. Class: 25.
5. Use: O.
6. Sealant shall have a VOC content of 420 g/L or less.
7. Sealant shall comply with the testing and product requirements of the California Department of Public Health's "Standard Method for the Testing and Evaluation of Volatile Organic Chemical Emissions from Indoor Sources Using Environmental Chambers."

D. Flange Gaskets: Butyl rubber, neoprene, or EPDM polymer with polyisobutylene plasticizer.

E. Round Duct Joint O-Ring Seals:

1. Seal shall provide maximum leakage class of 3 cfm/100 sq. ft. at 1-inch wg and shall be rated for 10-inch wg static-pressure class, positive or negative.
2. EPDM O-ring to seal in concave bead in coupling or fitting spigot.
3. Double-lipped, EPDM O-ring seal, mechanically fastened to factory-fabricated couplings and fitting spigots.

2.5 HANGERS AND SUPPORTS

A. Hanger Rods for Noncorrosive Environments: Galvanized-steel rods and nuts.

B. Hanger Rods for Corrosive Environments: Electrogalvanized, all-thread rods or galvanized rods with threads painted with zinc-chromate primer after installation.

C. Strap and Rod Sizes: Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Table 5-1, "Rectangular Duct Hangers Minimum Size," and Table 5-2, "Minimum Hanger Sizes for Round Duct."

D. Steel Cables for Galvanized-Steel Ducts: Galvanized steel complying with ASTM A603.

E. Steel Cable End Connections: Galvanized-steel assemblies with brackets, swivel, and bolts designed for duct hanger service; with an automatic-locking and clamping device.

F. Duct Attachments: Sheet metal screws, blind rivets, or self-tapping metal screws; compatible with duct materials.

G. Trapeze and Riser Supports:

1. Supports for Galvanized-Steel Ducts: Galvanized-steel shapes and plates.
2. Supports for Aluminum Ducts: Aluminum or galvanized steel coated with zinc chromate.

PART 3 - EXECUTION

3.1 DUCT INSTALLATION

A. Drawing plans, schematics, and diagrams indicate general location and arrangement of duct system. Indicated duct locations, configurations, and arrangements were used to size ducts and calculate friction loss for air-handling equipment sizing and for other design considerations.

Install duct systems as indicated unless deviations to layout are approved on Shop Drawings and coordination drawings.

B. Install ducts in accordance with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible" unless otherwise indicated.

C. Install ducts in maximum practical lengths with fewest possible joints.

D. Install factory- or shop-fabricated fittings for changes in direction, size, and shape and for branch connections.

E. Unless otherwise indicated, install ducts vertically and horizontally, and parallel and perpendicular to building lines.

F. Install ducts close to walls, overhead construction, columns, and other structural and permanent enclosure elements of building.

G. Install ducts with a clearance of 1 inch, plus allowance for insulation thickness.

H. Route ducts to avoid passing through transformer vaults and electrical equipment rooms and enclosures.

I. Where ducts pass through non-fire-rated interior partitions and exterior walls and are exposed to view, cover the opening between the partition and duct or duct insulation with sheet metal flanges of same metal thickness as the duct. Overlap openings on four sides by at least 1-1/2 inches.

J. Install dampers, and all other duct-mounted accessories in air ducts where indicated on Drawings.

K. Protect duct interiors from moisture, construction debris and dust, and other foreign materials both before and after installation. Comply with SMACNA's "IAQ Guidelines for Occupied Buildings Under Construction," Appendix G, "Duct Cleanliness for New Construction Guidelines."

L. Elbows: Use long-radius elbows wherever they fit. If long-radius will not fit due to space constraints, use short-radius elbows. If short-radius elbows will not fit, use rectangular mitered elbows with turning vanes.

1. Fabricate 90-degree rectangular mitered elbows to include turning vanes.
2. Fabricate 90-degree round elbows with a minimum of three segments for 12 inches and smaller and a minimum of five segments for 14 inches and larger.

M. Branch Connections: Use lateral or conical branch connections.

3.2 INSTALLATION OF EXPOSED DUCTWORK

A. Protect ducts exposed in finished spaces from being dented, scratched, or damaged.

B. Trim duct sealants flush with metal. Create a smooth and uniform exposed bead. Do not use two-part tape sealing system.

C. Grind welds to provide smooth surface free of burrs, sharp edges, and weld splatter. When welding stainless steel with a No. 3 or 4 finish, grind the welds flush, polish the exposed welds, and treat the welds to remove discoloration caused by welding.

D. Maintain consistency, symmetry, and uniformity in arrangement and fabrication of fittings, hangers and supports, duct accessories, and air outlets.

E. Repair or replace damaged sections and finished work that does not comply with these requirements.

3.3 DUCT SEALING

A. Seal ducts for duct static-pressure, seal classes, and leakage classes specified in "Duct Schedule" Article in accordance with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible."

B. Seal ducts at a minimum to the following seal classes in accordance with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible":

1. Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible."

2. All ductwork shall be sealed to Seal Class A.

3.4 HANGER AND SUPPORT INSTALLATION

A. Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Chapter 5, "Hangers and Supports."

B. Building Attachments: Concrete inserts, powder-actuated fasteners, or structural-steel fasteners appropriate for construction materials to which hangers are being attached.

1. Where practical, install concrete inserts before placing concrete.
2. Install powder-actuated concrete fasteners after concrete is placed and completely cured.
3. Use powder-actuated concrete fasteners for standard-weight aggregate concretes or for slabs more than 4 inches thick.
4. Do not use powder-actuated concrete fasteners for lightweight-aggregate concretes or for slabs less than 4 inches thick.
5. Do not use powder-actuated concrete fasteners for seismic restraints.

C. Hanger Spacing: Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Table 5-1, "Rectangular Duct Hangers Minimum Size," and Table 5-2, "Minimum Hanger Sizes for Round Duct," for maximum hanger spacing; install hangers and supports within 24 inches of each elbow and within 48 inches of each branch intersection.

D. Hangers Exposed to View: Threaded rod and angle or channel supports.

E. Support vertical ducts with steel angles or channel secured to the sides of the duct with welds, bolts, sheet metal screws, or blind rivets; support at each floor and at a maximum intervals of 16 feet.

F. Install upper attachments to structures. Select and size upper attachments with pull-out, tension, and shear capacities appropriate for supported loads and building materials where used.

3.5 CONNECTIONS

A. Make connections to equipment with flexible connectors complying with Section 233300 "Air Duct Accessories."

B. Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible" for branch, outlet and inlet, and terminal unit connections.

3.6 FIELD QUALITY CONTROL

A. Perform tests and inspections.

B. Duct System Cleanliness Tests:

1. Visually inspect duct system to ensure that no visible contaminants are present.
2. Test sections of metal duct system, chosen randomly by Owner, for cleanliness in accordance with "Description of Method 3 - NADCA Vacuum Test" in NADCA ACR, "Assessment, Cleaning and Restoration of HVAC Systems."

a. Acceptable Cleanliness Level: Net weight of debris collected on the filter media shall not exceed 0.75 mg/100 sq. cm.

C. Duct system will be considered defective if it does not pass tests and inspections.

D. Prepare test and inspection reports.

3.7 DUCT CLEANING

A. Clean new duct system(s) before testing, adjusting, and balancing.

B. Use duct cleaning methodology as indicated in NADCA ACR.

3.8 STARTUP

A. Air Balance: Comply with requirements in Section 230593 "Testing, Adjusting, and Balancing for HVAC."

3.9 DUCT SCHEDULE

A. Fabricate ducts with galvanized sheet steel except as otherwise indicated and as follows:

1. Fabricate all ducts to achieve SMACNA pressure class, seal class, and leakage class as indicated below.

B. Supply Ducts:

C. Outdoor-Air (Not Filtered, Heated, or Cooled) Ducts:

1. All outdoor air ductwork

a. Pressure Class: Positive or negative 2-inch wg.

b. Minimum SMACNA Seal Class: A.
c. SMACNA Leakage Class for Rectangular: 4
d. SMACNA Leakage Class for Round and Flat Oval: 2.

D. Intermediate Reinforcement:

1. Aluminum Ducts: Aluminum or galvanized steel coated with zinc chromate.

E. Elbow Configuration:

1. Round Duct: Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Figure 3-4, "Round Duct Elbows."

a. Minimum Radius-to-Diameter Ratio and Elbow Segments: Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Table 3-1, "Mitered Elbows." Elbows with less than 90-degree change of direction have proportionately fewer segments.

1) Velocity 1000 fpm or Lower: 0.5 radius-to-diameter ratio and three segments for 90-degree elbow.
2) Velocity 1000 to 1500 fpm: 1.0 radius-to-diameter ratio and four segments for 90-degree elbow.
3) Velocity 1500 fpm or Higher: 1.5 radius-to-diameter ratio and five segments for 90-degree elbow.
4) Radius-to Diameter Ratio: 1.5.

b. Round Elbows, 12 Inches and Smaller in Diameter: Stamped or pleated.
c. Round Elbows, 14 Inches and Larger in Diameter: Welded.

F. Branch Configuration:

1. Round and Flat Oval: Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Figure 3-5, "90 Degree Tees and Laterals," and Figure 3-6, "Conical Tees." Saddle taps are permitted in existing duct.

a. Velocity 1000 fpm or Lower: 90-degree tap.
b. Velocity 1000 to 1500 fpm: Conical tap.
c. Velocity 1500 fpm or Higher: 45-degree lateral.

END OF SECTION 233113

SECTION 23 33 00
AIR DUCT ACCESSORIES

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

A. Section Includes:
1. Manual volume dampers.
2. Backdraft dampers
3. Duct-mounted access doors.
4. Flexible connectors.
5. Duct accessory hardware.

B. Related Requirements:
1.

1.3 ACTION SUBMITTALS

A. Product Data: For each type of product.

1.4 INFORMATIONAL SUBMITTALS

A. Source quality-control reports.

1.5 CLOSEOUT SUBMITTALS

A. Operation and Maintenance Data: For air duct accessories to include in operation and maintenance manuals.

PART 2 - PRODUCTS

2.1 ASSEMBLY DESCRIPTION

A. Comply with NFPA 90A, "Installation of Air Conditioning and Ventilating Systems," and with NFPA 90B, "Installation of Warm Air Heating and Air Conditioning Systems."

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

2.2 MATERIALS

A. Galvanized Sheet Steel: Comply with ASTM A653/A653M.

1. Galvanized Coating Designation: G90.
2. Exposed-Surface Finish: Mill phosphatized.

B. Aluminum Sheets: Comply with ASTM B209, Alloy 3003, Temper H14; with mill finish for concealed ducts and standard, 1-side bright finish for exposed ducts.

C. Extruded Aluminum: Comply with ASTM B221, Alloy 6063, Temper T6.

D. Reinforcement Shapes and Plates: Galvanized-steel reinforcement where installed on galvanized sheet metal ducts; compatible materials for aluminum and stainless-steel ducts.

E. Tie Rods: Galvanized steel, 1/4-inch minimum diameter for lengths 36 inches or less; 3/8-inch minimum diameter for lengths longer than 36 inches.

2.3 BACKDRAFT AND PRESSURE RELIEF DAMPERS

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

1. Greenheck Fan Corporation.
2. Nailor Industries Inc.
3. Pottorff.
4. Ruskin; Air Distribution Technologies, Inc.; Johnson Controls, Inc.
5. United Enertech Corp.

B. Description: Gravity balanced.

C. Maximum Air Velocity: 2000 fpm.

D. Maximum System Pressure: 2-inch wg.

E. Frame: Hat-shaped, 0.063-inch- thick extruded aluminum, with welded corners or mechanically attached.

F. Blades: Multiple single-piece blades, end pivoted, maximum 6-inch width, 0.050-inch- thick aluminum sheet with sealed edges.

G. Blade Action: Parallel.

H. Blade Seals: Neoprene, mechanically locked.

I. Blade Axles:

1. Material: Nonmetallic.
2. Diameter: 0.20 inch.

J. Tie Bars and Brackets: Aluminum.

K. Return Spring: Adjustable tension.

L. Bearings: Synthetic pivot bushings.

M. Accessories:

1. Adjustment device to permit setting for varying differential static pressure.
2. Counterweights and spring-assist kits.
3. Chain pulls.
4. Screen Mounting: Front mounted in sleeve.
    a. Sleeve Thickness: 20 gauge minimum.
    b. Sleeve Length: 6 inches minimum.
5. Screen Mounting: Rear mounted.
6. Screen Material: Aluminum.
7. Screen Type: Bird.
8. 90-degree stops.

2.4 MANUAL VOLUME DAMPERS

A. Standard, Steel, Manual Volume Dampers:
1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
    a. Greenheck Fan Corporation.
    b. Nailor Industries Inc.
    c. Pottorff.
    d. Ruskin; Air Distribution Technologies, Inc.; Johnson Controls, Inc.
    e. United Enertech Corp.
2. Standard leakage rating, with linkage outside airstream.
3. Suitable for horizontal or vertical applications.
4. Frames:
    a. Frame: Hat-shaped, 0.094-inch- thick, galvanized sheet steel.
    b. Mitered and welded corners.
    c. Flanges for attaching to walls and flangeless frames for installing in ducts.
5. Blades:
    a. Multiple or single blade.
    b. Parallel- or opposed-blade design.
    c. Stiffen damper blades for stability.
    d. Galvanized-steel, 0.064 inch thick.
6. Blade Axles: Stainless steel.
7. Bearings:
    a. Molded synthetic.
    b. Dampers in ducts with pressure classes of 3-inch wg or less shall have axles full length of damper blades and bearings at both ends of operating shaft.
8. Tie Bars and Brackets: Galvanized steel.

B.

C. Jackshaft:

1. Size: 0.5-inch diameter.
2. Material: Galvanized-steel pipe rotating within pipe-bearing assembly mounted on supports at each mullion and at each end of multiple-damper assemblies.
3. Length and Number of Mountings: As required to connect linkage of each damper in multiple-damper assembly.

D. Damper Hardware:

1. Zinc-plated, die-cast core with dial and handle made of 3/32-inch- thick zinc-plated steel, and a 3/4-inch hexagon locking nut.
2. Include center hole to suit damper operating-rod size.
3. Include elevated platform for insulated duct mounting.

2.5 DUCT-MOUNTED ACCESS DOORS

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

1. Ductmate Industries, Inc; a DMI company.
2. Duro Dyne Inc.
3. Elgen Manufacturing.
4. McGill AirFlow LLC.
5. United Enertech Corp.

B. Duct-Mounted Access Doors: Fabricate access panels according to SMACNA's "HVAC Duct Construction Standards - Metal and Flexible"; Figures 7-2, "Duct Access Doors and Panels," and 7-3, "Access Doors - Round Duct."

1. Door:

a. Double wall, rectangular.
b. Galvanized sheet metal with insulation fill and thickness as indicated for duct pressure class.
c. Vision panel.
d. Hinges and Latches: 1-by-1-inch butt or piano hinge and cam latches.
e. Fabricate doors airtight and suitable for duct pressure class.

2. Frame: Galvanized sheet steel, with bend-over tabs and foam gaskets.
3. Number of Hinges and Locks:

a. Access Doors Less Than 12 Inches Square: No hinges and two sash locks.
b. Access Doors up to 18 Inches Square: Continuous and two sash locks.

2.6 DUCT ACCESS PANEL ASSEMBLIES

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

1. CL WARD & Family Inc.
2. Ductmate Industries, Inc; a DMI company.
3. Flame Gard, Inc.

B. Labeled according to UL 1978 by an NRTL.

C. Panel and Frame: Minimum thickness 0.0528-inch carbon steel.

D. Fasteners: Stainless steel. Panel fasteners shall not penetrate duct wall.

E. Gasket: Comply with NFPA 96; grease-tight, high-temperature ceramic fiber, rated for minimum 2000 deg F.

F. Minimum Pressure Rating: 10-inch wg, positive or negative.

2.7 FLEXIBLE CONNECTORS

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

1. CL WARD & Family Inc.
2. Ductmate Industries, Inc; a DMI company.
3. Duro Dyne Inc.

B. Materials: Flame-retardant or noncombustible fabrics.

C. Coatings and Adhesives: Comply with UL 181, Class 1.

D. Metal-Edged Connectors: Factory fabricated with a fabric strip 3-1/2 inches wide attached to two strips of 2-3/4-inch- wide, 0.028-inch- thick, galvanized sheet steel or 0.032-inch- thick aluminum sheets. Provide metal compatible with connected ducts.

E. Indoor System, Flexible Connector Fabric: Glass fabric double coated with neoprene.

1. Minimum Weight: 26 oz./sq. yd..
2. Tensile Strength: 480 lbf/inch in the warp and 360 lbf/inch in the filling.
3. Service Temperature: Minus 40 to plus 200 deg F.

F. Thrust Limits: Combination coil spring and elastomeric insert with spring and insert in compression, and with a load stop. Include rod and angle-iron brackets for attaching to fan discharge and duct.

1. Frame: Steel, fabricated for connection to threaded rods and to allow for a maximum of 30 degrees of angular rod misalignment without binding or reducing isolation efficiency.
2. Outdoor Spring Diameter: Not less than 80 percent of the compressed height of the spring at rated load.
3. Minimum Additional Travel: 50 percent of the required deflection at rated load.
4. Lateral Stiffness: More than 80 percent of rated vertical stiffness.
5. Overload Capacity: Support 200 percent of rated load, fully compressed, without deformation or failure.
6. Elastomeric Element: Molded, oil-resistant rubber or neoprene.
7. Coil Spring: Factory set and field adjustable for a maximum of 1/4-inch movement at start and stop.

2.8 DUCT ACCESSORY HARDWARE

A. Instrument Test Holes: Cast iron or cast aluminum to suit duct material, including screw cap and gasket. Size to allow insertion of pitot tube and other testing instruments and of length to suit duct-insulation thickness.

B. Adhesives: High strength, quick setting, neoprene based, waterproof, and resistant to gasoline and grease.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Install duct accessories according to applicable details in SMACNA's "HVAC Duct Construction Standards - Metal and Flexible" for metal ducts and in NAIMA AH116, "Fibrous Glass Duct Construction Standards," for fibrous-glass ducts.

B. Install duct accessories of materials suited to duct materials; use galvanized-steel accessories in galvanized-steel and fibrous-glass ducts, stainless-steel accessories in stainless-steel ducts, and aluminum accessories in aluminum ducts.

C. Install control dampers as indicated on drawings, at inlet of exhaust fans and louvers as close as possible to exhaust fan or louver unless otherwise indicated. Install control dampers in outside air ductwork. Provide low-voltage wiring from transformer to control damper actuator.

D. Install volume dampers at points on supply, return, and exhaust systems where branches extend from larger ducts. Where dampers are installed in ducts having duct liner, install dampers with hat channels of same depth as liner, and terminate liner with nosing at hat channel.

1. Install steel volume dampers in steel ducts.

2. Install aluminum dampers in aluminum ducts.

E. Set dampers to fully open position before testing, adjusting, and balancing.

F. Install backdraft dampers in outside air ducts to indoor fan coils units. Adjusting tension to allow the fan coil fan suction pressure to open the damper, and to close when the fan turns off.

G. Install test holes at fan inlets and outlets and elsewhere as indicated.

H. Install duct access doors on sides of ducts to allow for inspecting, adjusting, and maintaining accessories and equipment at the following locations:
1. Downstream from manual volume dampers, backdraft dampers, and equipment.
2. At each change in direction and at maximum 50-foot spacing.
3. Control devices requiring inspection.
4. Elsewhere as indicated.

I. Install access doors with swing against duct static pressure.

J. Access Door Sizes:

1. One-Hand or Inspection Access: 8 by 5 inches.
2. Two-Hand Access: 12 by 6 inches.
3. Head and Hand Access: 18 by 10 inches.
4. Head and Shoulders Access: 21 by 14 inches.
5. Body Access: 25 by 14 inches.
6. Body plus Ladder Access: 25 by 17 inches.

K. Label access doors according to Section 230553 "Identification for HVAC Piping and Equipment" to indicate the purpose of access door.

L. Install flexible connectors to connect ducts to equipment.

M. Install duct test holes where required for testing and balancing purposes.

3.2 FIELD QUALITY CONTROL

A. Tests and Inspections:

1. Operate dampers to verify full range of movement.
2. Inspect locations of access doors and verify that purpose of access door can be performed.
3. Inspect turning vanes for proper and secure installation.

END OF SECTION 233300

SECTION 23 81 26
SPLIT-SYSTEM AIR-CONDITIONERS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

A. Section includes split-system heat-pump units consisting of separate evaporator-fan and compressor-condenser components.

1.3 ACTION SUBMITTALS

A. Product Data: For each type of product indicated. Include rated capacities, operating characteristics, and furnished specialties and accessories. Include performance data in terms of capacities, outlet velocities, static pressures, sound power characteristics, motor requirements, and electrical characteristics.

B. Sustainable Design Submittals:

C. Shop Drawings: Include plans, elevations, sections, details, and attachments to other work.

1. Detail equipment assemblies and indicate dimensions, weights, loads, required clearances, method of field assembly, components, and location and size of each field connection.
2. Wiring Diagrams: For power, signal, and control wiring.

D. Samples for Initial Selection: For units with factory-applied color finishes.

1.4 INFORMATIONAL SUBMITTALS

A. Field quality-control reports.

B. Warranty: Sample of special warranty.

1.5 CLOSEOUT SUBMITTALS

A. Operation and Maintenance Data: For split-system air-conditioning units to include in emergency, operation, and maintenance manuals.

1.6 MAINTENANCE MATERIAL SUBMITTALS

A. Furnish extra materials that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.

1. Filters: One set(s) for each air-handling unit.
2. Gaskets: One set(s) for each access door.

1.7 QUALITY ASSURANCE

A. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.

B. ASHRAE Compliance:

1. Fabricate and label refrigeration system to comply with ASHRAE 15, "Safety Standard for Refrigeration Systems."
2. ASHRAE Compliance: Applicable requirements in ASHRAE 62.1, Section 4 - "Outdoor Air Quality," Section 5 - "Systems and Equipment," Section 6 - " Procedures," and Section 7 - "Construction and System Start-up."

C. ASHRAE/IES Compliance: Applicable requirements in ASHRAE/IES 90.1.

1.8 COORDINATION

A. Coordinate sizes and locations of concrete bases with actual equipment provided. Cast anchor-bolt inserts into bases. Concrete, reinforcement, and formwork are specified in Section 033000 "Cast-in-Place Concrete."

B. Coordinate sizes and locations of roof curbs, equipment supports, and roof penetrations with actual equipment provided.

1.9 WARRANTY

A. Special Warranty: Manufacturer's standard form in which manufacturer agrees to repair or replace components of split-system air-conditioning units that fail in materials or workmanship within specified warranty period.

1. Warranty Period:

a. For Compressor: Five years from date of Substantial Completion.
b. For Parts: One year from date of Substantial Completion.
c. For Labor: One year from date of Substantial Completion.

PART 2 - PRODUCTS

2.1 DUCTLESS SPLIT SYSTEM HEAT PUMPS

A. MANUFACTURERS

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

a. Mitsubishi/Trane
b. Samsung HVAC.

c. LG

2. Indoor unit shall be ceiling cassette style, constructed of a galvanized steel plate designed to recess into the ceiling, with a surface-mounted concentric grille on the bottom of the unit. Unit shall have four supply air outlets and one return air inlet. Supply air outlet shall have four-directional slot diffusers, each equipped with an independent oscillating motorized guide vane to change airflow direction. Four-way grille shall be an off-white ABS polymeric resin grille with a tapered trim edge.

3. Outdoor condensing unit casing shall be constructed from pre-coated metal (PCM) that has been tested in accordance with ASTM B-117 salt spray procedure for a minimum of 1,000 hours. Casing shall have a removable panel to allow access to major internal components, and legs to secure the unit during installation.

4. Compressors shall be hermetically sealed, digitally controlled, inverter-driven twin rotary style to modulate capacity in 1-Hz increments. Compressors shall have Teflon-coated bearings, overcurrent protection, and vibration isolation.

5. Outdoor unit coils shall be made of nonferrous louvered aluminum fins protected with an integral coil guard. Coil shall have a minimum of 14 fins per inch. Heat exchanger shall two rows. Coil fins shall have a factory applied corrosion resistant hydrophilic coating tested in accordance with ASTM B-117 salt spray test procedure for a minimum of 1,000 hours. Coils shall be factory tested to a pressure of 551 psig.

6. Indoor unit coils shall be factory built and shall be comprised of aluminum fins mechanically bonded to copper tubing. Unit shall have a minimum of two rows of coil, pressure tested to 551 psig at the factory. Each unit shall be provided with a factory installed condensate drain pan below the coil.

7. Outdoor units shall have a direct drive, variable speed axial/propeller type fan with a horizontal air discharge. Fan blades shall be made of ABS material and shall have a brushless digitally controlled (BLDC) fan motor. Fan motor shall have inherent protection, permanently lubricated bearings, and variable speed operation. Raised guards shall be provided to limit contact with moving parts.

8. Indoor units shall have a single, direct-drive, turbo fan manufactured of high-strength ABS HT-700 polymeric resin. Fans shall be statically and dynamically balanced. Fan motor shall be brushless digitally controlled (BLDC) with permanently lubricated and sealed ball bearings. The fan/motor assembly shall be mounted on vibration-attenuating rubber grommets. Fan speed shall be controlled using a microprocessor-based direct digital control algorithm that provides pre-programmed, field-selectable fixed or auto fan speeds. Indoor unit filter shall be a factory-supplied, removable, washable filter. Indoor unit shall have a factory installed and wired condensate lift/pump capable of providing a minimum 31-1/2 inch lift from the bottom surface of the unit. Drain pump shall have a safety switch to shut off the indoor unit if the condensate rises too high in the drain pan.

9. System shall have factory-installed microprocessor-based controls. Control algorithms shall provide component protection, soft-start capability, refrigeration system pressure, temperature, defrost and ambient controls. Provide manufacturer’s wall-mounted 7-day programmable thermostat.

10. System shall be capable of providing cooling down the 14 degrees F outdoor air, and providing heating down to negative 4 degrees F outdoor air.

2.2 ACCESSORIES

A. Thermostat: Low voltage with subbase to control compressor and evaporator fan. Thermostat shall have the following features:

1. Compressor time delay.
2. 24-hour time control of system stop and start.
3. Liquid-crystal display indicating temperature, set-point temperature, time setting, operating mode, and fan speed.
4. Fan-speed selection including auto setting.

B. Automatic-reset timer to prevent rapid cycling of compressor.

C. Refrigerant Piping: Refer to specification section 23 23 00. Refrigerant piping shall be sized, routed and installed in strict accordance with manufacturer’s instructions.

D. Drain Hose: For condensate.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Install units level and plumb.

B. Install indoor unit components using manufacturer's standard mounting devices securely fastened to building structure.

C. Equipment Mounting:

1. Install outdoor condensing units on concrete building pad.
2. Suspend indoor units from structure using spring isolators.

D. Install and connect precharged refrigerant tubing to component's quick-connect fittings. Install tubing to allow access to unit.

3.2 CONNECTIONS

A. Piping installation requirements are specified in other Sections. Drawings indicate general arrangement of piping, fittings, and specialties.

B. Where piping is installed adjacent to unit, allow space for service and maintenance of unit.

C. Duct Connections: Duct installation requirements are specified in Section 233113 "Metal Ducts." Drawings indicate the general arrangement of ducts. Connect supply and return ducts to split-system air-conditioning units with flexible duct connectors. Flexible duct connectors are specified in Section 233300 "Air Duct Accessories."

3.3 FIELD QUALITY CONTROL

A. Manufacturer's Field Service: Engage a factory-authorized service representative to inspect, test, and adjust components, assemblies, and equipment installations, including connections.

B. Perform tests and inspections.

1. Manufacturer's Field Service: Engage a factory-authorized service representative to inspect components, assemblies, and equipment installations, including connections, and to assist in testing.

C. Tests and Inspections:

1. Leak Test: After installation, charge system and test for leaks. Repair leaks and retest until no leaks exist.
2. Operational Test: After electrical circuitry has been energized, start units to confirm proper motor rotation and unit operation.
3. Test and adjust controls and safeties. Replace damaged and malfunctioning controls and equipment.

D. Remove and replace malfunctioning units and retest as specified above.

E. Prepare test and inspection reports.

3.4 STARTUP SERVICE

A. Perform startup service.

1. Complete installation and startup checks according to manufacturer's written instructions.

3.5 DEMONSTRATION

A. Train Owner's maintenance personnel to adjust, operate, and maintain units.

END OF SECTION 238126

SECTION 26 01 00
BASIC ELECTRICAL REQUIREMENTS

PART 1 - GENERAL

1.01 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including Contractual Conditions and other Division 01 Specification sections apply to this section.

1.02 SUMMARY

A. This section includes Basic Electrical Requirements specifically applicable to Division 26 Sections.

1.03 DESCRIPTION

A. Provide and install all equipment, labor, material and accessories, and mounting hardware for a complete and operating system as described within these Division 26 Specification Sections.

B. Furnish, perform, or provide all labor including planning, purchasing, transporting, storing, installing, testing, cutting and patching, trenching, excavating, backfilling, coordination, field verification, equipment (installation and safety), supplies, and materials necessary for the installation of complete electrical systems (as described or implied by these specifications and the applicable drawings) in strict accordance with applicable codes, which may not be repeated in these specifications, but are expected to be common knowledge of qualified Bidders.

C. All work shall comply with all applicable codes as a minimum and with the additional requirements called for in these Contract Documents.

D. Only trained and licensed personnel shall perform work. No Work shall be performed which violates applicable Codes, even if called for in the Contract Documents.

E. Coordinate and verify power and telephone company service requirements. The submitted bid shall include all work required.

F. Coordinate all Work with the local aviation authority having jurisdiction prior to bid and again prior to performing any work on this project.

G. Make connections of all items in the Work using electric power including wire, conduit, circuit protection, disconnects and accessories. Securing of roughing-in drawings and connection information for the equipment involved shall also be included under this division. See other divisions for specifications for electrically operated equipment.

1.04 WORK SEQUENCE

A. Install Work in stages or phases to accommodate the Owner's occupancy requirements. Coordinate electrical schedule and operations with Owner Authorized Representative (OAR).

1.05 QUALITY ASSURANCE

A. Install Work in locations shown or described in the Contract Documents, unless prevented by Project conditions.

B. Install all equipment so that all Code and Manufacturer recommended working and servicing clearances are maintained. Properly arrange and install all equipment within

designated spaces. If a departure from the Contract Documents is necessary, submit to the OAR for approval, detailed drawings of the proposed changes with written reasons for the changes. No change shall be implemented without the issuance of a change order or other directive permitted by the General Conditions.

C. The Contractor shall verify finish dimensions at the project site in preference to using dimensions noted on Contract Documents.

1.06 INVESTIGATION OF SITE

A. Investigate the site and existing conditions thoroughly before bidding. Advise OAR of discrepancies or questions noted.

B. During the course of his site visit, the electrical bidder shall become familiar with all aspects of the proposed work and the existing field conditions of the work. No compensation or reimbursement for additional expenses for failure to investigate the existing facilities will be authorized. This shall include rerouting around existing obstructions.

C. Submission of a proposal will be construed as evidence that such examination has been made and later claims for labor, equipment or materials required because of difficulties encountered will not be recognized.

D. Existing conditions and utilities indicated are taken from existing construction documents, surveys, and field investigations. Unforeseen conditions probably exist and existing conditions shown on drawings may differ from the actual existing installation with the result being that new work may not be field located exactly as shown on the drawings. Notify OAR if deviations are found.

E. All existing electrical is not shown. The Contractor shall become familiar with all existing conditions prior to bidding, and include in his bid the removal of all electrical equipment, wire, conduit, devices, fixtures, etc. that is abandoned due to renovation.

F. Protect all existing electrical raceways within concrete slabs, below concrete slabs, overhead raceways, equipment, etc. from damage due to renovation. Repair or replacement of utilities or other property damaged by operations in conjunction with the Work will be at no cost to the Owner.

G. Remove existing power, lighting, systems, material and equipment which are made obsolete or which interfere with the construction of the project. Reinstall power, lighting, systems, materials and equipment which are required to remain active for the facility to be fully functional.

H. Reroute conduit and wiring in the area of construction remaining active. Include temporary connections necessary to maintain the continuity of existing circuitry required to remain active during the renovation. Existing conduits indicated in Contract Documents are approximate locations only. Determine the routing of existing conduits and pipes prior to any excavation, cutting or demolition.

I. Occupied existing buildings must remain in operation while work is being performed. Schedule work for a minimum outage to the Owner. Notify the OAR appropriately for any shut-down of existing systems.

J. The bid shall include all removal and relocation of all piping, fixtures or other items required for completion of alterations and new construction.

1.07 CONTRACT DOCUMENTS

A. The drawings are diagrammatic and are not intended to include every detail of construction, materials, methods, and equipment. They indicate the result to be achieved by an assemblage of various systems. Coordinate equipment locations with Architectural and Structural drawings. Layout equipment before installation so that all trades may install equipment in spaces available. Coordinate installation in a neat and workmanlike manner. Provide 1/4” scale coordination drawings per specifications prior to the start of work.

B. The contractor shall provide 1/4” scale coordination drawings for all electrical, mechanical and communications rooms during the shop drawing submittal phase, utilizing detailed dimensions from equipment actually submitted (all disciplines) and field-measured/verified existing conditions. These drawings are also required for any room where conduits equal to or over 1-1/4” in size, equipment (panels, HVAC, disconnects, comm. racks) or other large objects are being installed. Drawings shall show all electrical, mechanical, plumbing, fire protection, structural, etc. coordinated so that problems are discovered/prevented prior to installation. Claims during construction for additional funding in rooms where properly coordinated drawings were not submitted will not be considered.

C. Wiring arrangements for equipment shown on the drawings are intended to be diagrammatic and do not show all required conductors and functional connections. All such items incidental to a complete and operating system shall be provided.

D. Submit specific shop drawings that indicate the fabrication, assembly, installation, and erection of particular systems’ components. Drawings that are part of the Contract Documents shall not be considered a substitute for required shop drawings, field installation drawings, code requirements, or applicable standards.

E. Locations indicated for outlets, switches, and equipment are approximate and shall be coordinated with the Contract Documents. Where instructions or notes are insufficient to locate the item, notify the OAR.

1.08 MATERIALS AND EQUIPMENT

A. Unless otherwise noted, all material shall be new and UL listed or labeled. In lieu of UL listing or labeling, a statement or data demonstrating compliance with contract documents from a nationally recognized testing agency shall be submitted to the OAR.

B. Where Contract Documents list design selection, manufacturer or type, this model shall set the standard of quality and performance required. Where no brand name is specified, the source and quality shall be subject to Designers/OAR review and approval. Where Contract Documents list approved substitutions, these items shall comply with Division 01 requirements for substitutions.

C. When a product is specified to be in accordance with a trade association or government standard and at the request of Designers/OAR the Contractor shall furnish a certificate that the product complies with the referenced standard and supporting test data to substantiate compliance.

D. Where multiple items of the same equipment or materials are required, they shall be the product of the same Manufacturer.

E. Prior to placing equipment orders, verify the physical size of specified equipment to fit spaces allotted on the drawings and with NEC working clearances. Internal access for proposed equipment substitutions shall be provided. Provide 1/4” scale drawings showing that this coordination has taken place.

F. Electrical equipment shall be protected from the weather, during shipment, storage, and construction per manufacturer's recommendations. Should any apparatus be subjected to possible damage by water, it shall be thoroughly dried and put through a dielectric test, at the expense of the Contractor, to ascertain the suitability of the apparatus, or it shall be replaced without additional cost to the Owner.

G. Inspect all electrical equipment and materials prior to installation. Damaged equipment and materials shall not be installed or placed in service. Replace or repair and test damaged equipment in compliance with industry standards at no additional cost to the Owner. Equipment required for the test shall be provided by the Contractor.

H. Material and equipment shall be provided complete and shall function up to the specified capacity/function. Should any material or equipment as a part or as a whole fail to meet performance requirements, replacements shall be made to bring performance up to specified requirements. Damages to finish by such replacements, alterations, or repairs shall be restored to prior conditions, at no additional cost to the Owner.

I. Where tamperproof screws are specified or required, Phillips head or Allen head devices shall not be accepted. For each type used, provide OAR with three tools. OAR will designate the specific hardware design to correspond with existing devices elsewhere in the building, to limit special tool requirements.

J. Communications backboards shall be 3/4" A/B grade, Class A, flame spread, painted with light gray fire-retardant paint. Neatly mask off a minimum of one (1) plywood Manufacturer’s pre-printed certified fire rating stamp per section of the board prior to the application of paint. Remove masking after the paint has cured.

1.09 SUPERVISION OF THE WORK

A. Reference the General Conditions for additional requirements.

B. A qualified and experienced electrical superintendent shall be in charge of the work in progress at all times. If, in the judgment of the OAR, the electrical superintendent is not performing his duties satisfactorily, the Contractor shall immediately replace him upon receipt of a letter of request from the OAR. Once a satisfactory electrical superintendent has been assigned to the work, he shall not be withdrawn by the Contractor without the written consent of the OAR.

C. Provide a field superintendent who has had a minimum of four (4) years of previous successful experience on projects of comparable sizes and complexity. The superintendent shall be present at all times that work under this Division is being installed or affected. All work performed by a non-licensed Journeyman shall be under the direct supervision (in the presence of) of a Licensed Journeyman as specified herein. Increase the quantity of licensed Journeymen as required for supervision of all areas where direct contact is not possible. The project superintendent and supervising Journeyman shall have passed a proctored H.H. Block Journeyman Exam with 75% grade or better and shall be a licensed Journeyman within the State of Florida. A resume of the Project superintendent's experience shall be submitted to OAR before starting work. At least one member of the electrical contracting firm shall hold a State Master Certificate of Competency. Each Journeyman shall have possession of licensing documentation at all times during work. Display to designer/OAR when requested.

D. Superintendent shall be employed by a State Registered (Type "E.R." License) or State-certified (Type "E.C." License) electrical contractor.

1.10 COORDINATION

A. Provide all required coordination and supervision where work connects to or is affected by the work of others, and comply with all requirements affecting this Division. Work required under other divisions, specifications or drawings to be performed by this Division shall be coordinated with the Contractor and such work performed at no additional cost to the Owner including but not limited to electrical work required for:

   1. Door hardware
   2. Signage
   3. Mechanical Division of the Specifications

B. Provide the electrical subcontractor a set of Contract Documents for all areas of Electrical Work.

C. Installation studies shall be made to coordinate the electrical work with other trades. Work shall be preplanned. Unresolved conflicts shall be referred to the OAR prior to the installation of the equipment.

D. Coordination drawings shall be prepared prior to the start of work. Drawings shall show the actual physical dimension required for the installation to assure proper integration of equipment with building systems and NEC required clearances. The location of conduit racking, etc., shall be provided. Coordination drawings shall be provided for all areas. Comply with the requirements of Division 01.

E. Secure approved shop drawings from all required disciplines and verify final electrical characteristics before roughing power feeds to any equipment. When electrical data on approved shop drawings differs from that shown or called for in Construction Documents, make adjustments to the wiring, disconnects, and branch circuit protection to match that required for the equipment installed.

F. Damage from interference caused by inadequate coordination shall be corrected at no additional cost to the Owner.

G. Coordinate the exact location of floor outlets, floor ducts, floor stub-ups, etc. with OAR and Designer (and receive their approval) prior to rough-in. Locations indicated in Contract Documents are only approximate locations.

H. The Contract Documents describe specific sizes of switches, breakers, fuses, conduits, conductors, motor starters and other items of wiring equipment. These sizes are based on specific items of power consuming equipment (heaters, lights, motors for fans, compressors, pumps, etc.). Coordinate the requirements of each load with each load's respective circuitry shown and with each load's requirements as noted on its nameplate data and manufacturer's published electrical criteria. Adjust circuit breaker, fuse, conduit, and conductor sizes to meet the actual requirements of the equipment being provided and installed and change from a single point to multiple points of connection (or vice versa) to meet equipment requirements. Changes shall be made at no additional cost to the Owner.

1.11 PROVISION FOR OPENINGS

A. Locate openings required for work. Provide sleeves, guards or other approved methods to allow passage of items installed.

B. Where work pierces waterproofing, it shall maintain the integrity of the waterproofing. Coordinate roofing materials that pierce the roof for compatibility with membrane or other roof types with the Contractor.

1.12 CONCRETE PADS

A. Furnish and install reinforced concrete pads for transformers, switchgear, generators, motor control centers, and other free-standing equipment. Unless otherwise noted, pads shall be four (4) inches high and shall exceed dimensions of equipment being set on them, including future sections, by six (6) inches each side, except when equipment is flush against a wall where the side against the wall shall be flush with the equipment. Pads shall be reinforced with W1.4 x 1.4 6 x 6 welded wire mesh. Chamfer top edges 1/2". Trowel all surfaces smooth. Provide 3000 psi concrete.

1.13 SURFACE MOUNTED EQUIPMENT

A. Surface-mounted fixtures, outlets, cabinets, conduits, panels, etc. shall have a finish or shall be painted as directed by the designer. Paint shall be in accordance with applicable sections and/or divisions of these specifications.

1.14 CUTTING AND PATCHING

A. Reference Division 01 - General Requirements.

B. New Construction:

1. Cutting of work in place shall be cut, drilled, patched and refinished by trade responsible for initial installation.

2. Backfill new grades to match the adjacent undisturbed surface.

1.15 INSTALLATION

A. Erect equipment to minimize interference and delays with the execution of the Work.

B. Take care in the erection and installation of equipment and materials to avoid marring finishes or surfaces. Any damage shall be repaired or replaced as determined by the designer/OAR at no additional cost to the Owner.

C. Equipment requiring electrical service shall not be energized or placed in service until OAR is notified and is present or has waived their right to be present. Where equipment to be placed in service involves service or connection from another Contractor or the OAR, notify the OAR in writing as appropriate when the equipment will be ready.

D. Equipment supports shall be secured and supported from structural members unless written approval is granted by OAR.

E. Plywood material shall not be used as a backboard for mounting panel boards, disconnects, motor starters, and dry-type transformers. Provide "cast in place" type inserts or install expansion type anchor bolts. Electrical equipment shall not be mounted directly to drywall for support without additional channels as anchors. Channels shall be anchored to the floor and structure above. Panelboards and terminal cabinets shall be provided with structural framing located within drywall partitions.

F. Inserts, pipe sleeves, supports, and anchorage of electrical equipment shall be provided. Where items are to be set or embedded in concrete or masonry, the items shall be furnished and layout made for setting or embedment thereof so as to cause no delay.

G. Conduit or piping systems that contain water or liquid of any kind shall not be installed over the top of any electrical equipment, transformers, racks, cabinets, or enclosures without prior written approval from the OAR.

1.16 AS-BUILT DOCUMENTS

A. As-Built Documents: As-built Documents include Drawings, Shop Drawings, Specifications, Addenda, Change Orders, and other modifications permitted by the General Conditions.

B. Comply with all requirements of Division 01.

C. Verify aspects of redlined as-builts for accuracy. As-Built Documents shall show all components including but not limited to:

1. All raceways 1-1/4" and above, cable tray systems, and grouped raceway racking as installed, including dimensions from fixed building lines such as column lines.
2. All site underground raceways and duct banks indicating burial depths and distances from fixed building lines or global tracking coordinates.
3. Underground pull boxes and manholes including elevations. Detail manhole and pull boxes, conduit terminations (butterfly layout) including conduit sizes, pull point distances, designated systems and cabling description.
4. General conduit routing and termination to termination conductor lengths from receptacle to receptacle, fixture to fixture, device to device. (Exact routing is not required for raceways 1” and smaller.)
5. Lighting: Diagrammatically show junction boxes that are located above an accessible ceiling with flexible conduit connections to luminaries.
6. All junction boxes for Section 28 16 43 shall be shown exactly where installed.
7. Junction box splices shall be shown in the exact location and clearly noted referring to the written authorization by the OAR.
8. The first junction box within each homerun, regardless of size shall be shown in the installed location.
9. All junction boxes and pull boxes located above non-accessible ceilings shall be shown in the exact location. All junction boxes 6 X 6 inches and larger shall be shown in the exact location.
10. Any combining of circuits (which is only allowed by specific permission) or change in homerun outlet box shall be indicated.
11. Any circuit number changes.
12. All conductors and cables, conductors and cable sizes, raceway sizes, etc. not shown on contract documents and any changes from the documents.
13. Any switchboard, panelboard, motor control center, relay panel, or dimming control panel schedule changes, including load changes.
14. All access panels.
15. All existing conditions.
16. Location of lighting control devices such as photocell controls, space occupancy sensors, etc.

17. Exact quantity of conductors and cables shall be shown for all raceway systems.
18. All devices, wall outlet boxes, and control components.
19. All wireway and cable tray systems.
20. Exact location of all driven grounding electrodes including burial depths and dimensions from fixed building lines. Location of all grounding system busbars.
21. Riser diagrams exactly as installed.
22. Switchboard, panelboards, motor control center, motor control devices, terminal cabinets, equipment racks, relays, disconnects and switches and surge protection devices.
23. Change the equipment schedules (i.e. symbol legends, light fixture schedule, etc.) to agree with items actually furnished.
24. Change plan notes to agree with items actually furnished, actual installation methods, etc. respectfully.
25. Cross-out all items, circuitry, devices, etc. not applicable.

D. As-Built redline information shall not compromise the clarity of the Contract Documents and Shop Drawings. Major components such as grouped raceway assemblies, cable tray systems, larger conduits, duct banks, racking, elevations, dimensions, etc. shall be shown on a clean architectural base plan(s) separate from the Contract Electrical Documents, as required to clearly delineate work. Obtain an electronic base plan file from OAR.

1.17 "OBSERVATION OF WORK" REPORT

A. Reference the General Conditions.

B. Items noted by designer/OAR during construction and before final acceptance which do not comply with the Contract Documents will be listed in an "Observation of Work" report which will be sent to the Contractor for action. Correct all deficiencies in a prompt concise manner. After completion of the outstanding items, provide a written confirmation report for each item. The report shall indicate each item noted, and method of correction. Enter the date on which the item was corrected, and return the signed reports so items can be rechecked. Failure to correct the deficiencies in a prompt concise manner or failure to return the signed reports shall be cause for disallowing request for payments.

C. The electrical project superintendent shall be present at all required observation of work reviews as the project progresses. Provide the OAR with equipment for access and review of all Work in place, as well as personnel fully familiar with all aspects of the work. Provide access to all electrical components such as junction boxes, panelboards, switchboards, devices and fixtures for their review by the designer/OAR.

D. Prior to the start of Substantial Completion inspection, provide access to and prepare all electrical equipment and related components complete and ready for review by designer/OAR including but not limited to the following:

1. All panelboard covers removed
2. Switchboard and distributions panelboards readily for immediate removal of covers
3. Terminal cabinet covers open or removed.
4. Wireway covers open or removed

5. Underground pull boxes ready for immediate removal of cover(s)
6. Access to all grounding/bonding terminations
7. Access to a rated wall and through floor fire stopping
8. Access to all control systems for the CCTV, Voice, Data, Fire Alarm, and Sound/Paging.
9. Access to mechanical equipment, electrical connection points, and control devices
10. Access to all raceways crossing structural expansion/deflection joints.
11. Access to power company vault
12. Removal of access panels
13. Each and every item deemed necessary by A/E to perform a comprehensive review of the work as installed relative to the contract documents.

E. Items noted after acceptance during a one-year guarantee period shall be checked by the Contractor in the same manner as above. The signed reports are to be returned by him when the items have been corrected.

1.18 SYSTEMS WARRANTY

A. Reference the General Conditions.

B. Warranty shall be by the Contractor to the Owner and shall cover for a period of one year from the date of the Substantial Completion. Warranty shall not include light bulbs in service after one month from the date of substantial completion of the System.

1. Explain the provisions of warranty to the Owner at the "Demonstration of Completed System" meeting to be scheduled with the OAR upon project completion.

C. Where items of equipment or materials carry a manufacturer's warranty for any period in excess of twelve (12) months, then the manufacturer's warranty shall apply for that particular piece of equipment or material.

D. Where extended Guarantees are called for herein, furnish three copies to be inserted in Operation and Maintenance Manuals.

E. All preventative maintenance and normal service will be performed by the Owner's maintenance personnel after final acceptance of the work which shall not alter the Contractor's warranty.

1.19 WASTE MATERIALS DISPOSAL

A. Include in base bid the transport and disposal or recycling of all waste materials generated by this project in accordance with all rules, regulations and guidelines applicable. Comply fully with local statutes regarding mercury-containing devices and lamps. Lamps, ballasts and other materials shall be transported and disposed of in accordance with all DEP and EPA guidelines applicable at the time of disposal. Provide OAR with written certification of approved disposal.

1.20 PROHIBITION OF ASBESTOS AND PCB

A. Prior to the Final Review field visit the Contractor shall certify in writing that the equipment and materials installed in this Project under this Division 26 contain no asbestos or PCB. Additionally, all manufacturers shall provide a statement with their

submittal that indicates that their product contains no asbestos or PCB. This statement shall be signed by a duly authorized agent of the manufacturer.

END OF SECTION

SECTION 26 01 10
ELECTRICAL SUBMITTALS

PART 1 - GENERAL

1.01 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including Contractual Conditions and other Division 01 Specification sections apply to this section.

1.02 SUBMITTAL REQUIREMENTS

A. Technical data is required for all items specified regardless if item furnished is as specified.

B. See specific sections of the specifications for further requirements.

C. Prepare submittals in accordance with the requirements of Section 01 33 00 Submittal Procedures, Product Data and Samples.

1.03 PROCESSING SUBMITTALS

A. General: Refer to Section 01 33 00, Submittal Procedures, Product Data, and Samples.

B. Note that the approval of shop drawings or other information submitted in accordance with the requirements specified herein, does not assure that the Designer, or any other Owner's Authorized Representative's Representative, attests to the dimensional accuracy or dimensional suitability of the material or equipment involved, the ability of the material or equipment involved or the Mechanical/Electrical performance of equipment. Approval of shop drawings does not invalidate the plans and specifications if in conflict, unless a letter requesting such change is submitted and approved on the Designer's letterhead.

END OF SECTION

SECTION 26 01 30
ELECTRICAL SYMBOLS

PART 1 - GENERAL

1.01 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including Contractual Conditions and Division 01 Specification sections apply to this section.

1.02 SYMBOLS

A. In general, the symbols used on the drawings conform to the Standard Symbols of the Institute of Electrical and Electronics Engineers with the exception of special systems or agencies as hereinafter noted.

1. Special Symbols as shown in schedules or legends.

END OF SECTION

SECTION 26 05 19
CONDUIT

PART 1 - GENERAL

1.01 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including Contractual Conditions and Division 01 Specification sections apply to this section.

1.02 SUMMARY

A. This section includes the requirements for the provision and installation of the conduit.

1.03 DESCRIPTION

A. Provide and install all equipment, labor, material, accessories, and mounting hardware for a complete and operating system for the following:

1. Rigid Metallic Conduit (RMC) (RGC)
2. PVC coated Metal Conduit.
3. Flexible metal conduit (FMC)
4. Liquid tight flexible metal conduit (LFMC)
5. Rigid non-metallic conduit (PVC) (RNC)
6. Fittings and conduit bodies.

B. Raceways and conduits shall begin at an acceptable enclosure and terminate only in another such enclosure except for conduit/raceway stub-outs.

C. A raceway shall be provided for all electrical power, lighting and electrical systems.

D. Where the Contract Documents refer to the terms "raceway," or "conduit" the materials shall be as listed above in conjunction with NEC article 100, the definition of "raceway". MC and HFC flexible metal cables shall not be considered a substitute for raceway or conduit.

1.04 SUBMITTALS

A. Submit catalog cut sheet showing the brand of conduit to be used and showing that conduit is UL listed and labeled, and manufactured in the United States.

B. Submit catalog cut sheet on all types of conduit bodies, and fittings.

C. Submit product data on:

1. Conduits.
2. Conduit straps, hangers and fittings.
3. PVC solvent(s) and bending box.
4. Fitting entering and leaving the ground or pavement.
5. Cables
6. Expansion/deflection fittings.

D. Submit UL listed fire and smoke stopping assemblies for each applicable application. Provide details from UL Fire Directory and manufacturers' corresponding product data and details.

E. Product data shall prove compliance with Specifications, National Electrical Code, National Board of Fire Underwriters, manufacturer's specifications and written installation data.

1.05 PROJECT AS-BUILT DOCUMENTS

A. As-built documents shall accurately record the actual routing of conduits.

1.06 REFERENCE AND REGULATORY REQUIREMENTS

A. Furnish products listed and classified by Underwriters Laboratories, Inc. as suitable for the purpose specified and shown. Underwriter's Laboratories, Inc. (U.L.) Publications:

1. No. 1: Flexible Metal Electrical Conduit
2. No. 6: Rigid Galvanized Conduit
3. No. 467: Electrical Grounding and Bonding
4. No. 651: Rigid Nonmetallic Electrical Conduit

B. Conform to the following:

1. ANSI/NFPA 70 - National Electrical Code.
2. ANSI C80.1 - Rigid Steel Conduit, Hot-dip galvanized.
3. ANSI/UL 651 - Rigid Non-Metallic Conduit (PVC)
4. ANSI/NEMA FB 1 - Fittings, Cast Metal Boxes, and Conduit Bodies for Conduit and Cable Assemblies.
5. NECA "Standard of Installation."
6. ANSI C80.1/NEMA RN 1 - Polyvinyl Chloride (PVC) Externally Coated Galvanized Rigid Steel Conduit and Intermediate Metal Conduit.
7. NEMA TC 3 - PVC Fittings for Use with Rigid PVC Conduit and Tubing.

1.07 DELIVERY, STORAGE, AND HANDLING

A. Protect conduit during unloading by using the equipment designed to offload materials or by carefully offloading by hand.

B. Protect conduit from corrosion and entrance of debris by storing the above grade. Provide appropriate covering.

C. Protect PVC conduit from sunlight.

1.08 PROJECT CONDITIONS

A. Verify that field measurements are as shown on Drawings.

B. Verify routing and termination locations of conduit prior to rough-in.

C. Conduit routing is shown on Drawings in approximate locations unless dimensioned. Route as required to complete the wiring system.

PART 2 - PRODUCTS

2.01 GENERAL

A. All materials shall be new.

B. Furnish all materials specified herein or indicated on the drawings.

C. Materials of the same type shall be the products of one manufacturer.

D. All conduits shall bear UL label (or other nationally recognized testing agency) and shall be manufactured in the United States.

E. Conduit systems and all related fittings, boxes, supports and hangers must meet all the requirements of national, state, requirements and all related FAA codes and other Federal codes where applicable.

2.02 MINIMUM TRADE SIZE

A. Power/Lighting Homeruns 3/4”

B. Power/Lighting Branch Circuits 1/2”

C. Systems Conduit 1”

D. Flexible and Seal-tite metallic conduit – 1/2” C (maximum 6 ft. long).

2.03 RIGID METAL CONDUIT

A. Comply with:

1. ANSI C80.1
2. UL 6
3. NEC
4. Fed. Specification WW-C-581e.

B. Conduit material:

1. Hot-dipped galvanized steel.

C. Fittings:

1. Threaded.
2. Insulated bushings shall be used on all rigid metal conduits terminating in panels, boxes, wire gutters, or cabinets, and shall be impact-resistant plastic molded in an irregular shape at the top to provide smooth insulating surface at top and inner edge. Material in these bushings must not melt or support flame.
3. Hot-dipped galvanized steel manufactured in accord with ANSI C80.4.

D. Conduit Bodies:

1. Comply with ANSI/NEMA FB 1.
2. Threaded hubs.
3. Hot-dipped galvanized malleable iron.

2.04 PVC COATED METAL CONDUIT

A. Comply with:

1. UL6
2. ANSI C80.1
3. NEC ANSI/NFPA 70

4. NEMA RN1
5. Fed. Specification WW-C-581E.
6. Standard for Electrical Installations, NOM-001-SEDE

B. Conduit material: Hot-dipped galvanized rigid steel with external PVC coating, 40 mil. thick and interior urethane coating 2 mil. thick.

C. Fittings:

1. Threaded.
2. Insulated bushings on terminations.
3. Hot-dipped galvanized malleable iron or steel with external PVC coating, 40 mil. thick.

D. Conduit bodies:

1. Comply with:
   a. ANSI/NEMA FB 1
   b. Threaded hubs
   c. Hot-dipped galvanized malleable iron.

2.05 FLEXIBLE METAL CONDUIT

A. Comply with:

1. NEC
2. ANSI/UL 1
3. Fed. Specification WW-C-566

B. Conduit material: Hot-dip galvanized Steel, interlocked.

C. Fittings:

1. ANSI/NEMA FB 1
2. ANSI/UL 514B
3. Electrical Metallic Tubing [EMT] couplings and connectors shall be steel “raintight” type. Malleable iron, die-cast or pressure cast fittings are not permitted
4. Direct flexible conduit bearing set screw type not acceptable.
5. Insulated throat on terminations.
6. Compression EMT to flexible conduit coupling is not acceptable unless special written permission is granted by OAR.
7. Comply also with Fed. Specification W-F-406

2.06 LIQUID-TIGHT FLEXIBLE METAL CONDUIT

A. Comply with:

1. NEC
2. ANSI/UL 360

B. Conduit material:

1. Flexible hot-dipped galvanized steel core, interlocked.

2. Continuous copper ground, built into core up to 1-1/4" size.
3. Extruded polyvinyl gray jacket.

C. Fittings:

1. Threaded for IMC/rigid conduit connections.
2. Approved for hazardous locations where so installed.
3. Provide sealing washer in wet/damp locations.
4. Compression type.
5. ANSI/NEMA FB 1.
6. ANSI/UL 5148.
7. Hot-dipped galvanized steel.
8. Insulated throat on terminations.
9. Comply with Fed. Specification W-F-406.
10. Connections to vibrating equipment and transformers.
    a. Connectors to have wire mesh conduit grip.

2.07 RIGID NON-METALLIC CONDUIT (PVC)

A. Comply with:

1. NEMA TC-2
2. UL 651
3. NEC
4. Fed. Specification WC1094A.

B. Conduit material:

1. Shall be high impact Schedule 40 P.V.C. - tensile strength 55 PSI, flexural strength 11000 PSI.

C. Fittings:

1. Comply with: NEMA TC-3 and UL 514.

D. General:

1. Shall be UL listed.
2. Fittings and elbows shall be by the same manufacturer as the conduit.

2.08 EXPANSION FITTINGS

A. Expansion/deflection fittings shall be:

1. Listed, hot-dipped galvanized inside and outside providing a 4" expansion chamber and deflection (where applicable) when used with rigid conduit, intermediate metal conduit and electrical metallic conduit, or:
2. U.L. Listed, polyvinyl chloride providing a minimum 6” expansion chamber when used with non-metallic conduit (PVC), and shall meet the requirements of and as specified

elsewhere for non-metallic conduit. Provide fittings as specified above for expansion/deflection conditions.

3. Hot dipped galvanized expansion and deflection (where applicable) fitting shall be provided with an external braided grounding and bonding jumper with approved clamps, UL Listed for the application.

4. Expansion fitting, UL Listed for the application and in compliance with the National Electrical Code without the necessity of an external bonding jumper may be considered. Submit fitting with manufacturer's data and UL Listing for approval prior to installation.

PART 3 - EXECUTION

3.01 LOCATION REQUIREMENTS

A. Underground Installations:

1. Use Schedule 40 thickwall nonmetallic conduit only unless local authority having jurisdiction or applicable codes/utility requirements, etc. require rigid steel conduit.

2. Encase conduit in a 2500 lb. concrete ½" aggregate envelope of not less than 3" thickness on all sides and not less than 1-1/2" between conduits (where more than one conduit is installed together) for:

   a. All conduits installed under roads, taxiways, and runways shall be reinforced by the installation of No. 5 bars, at each corner and 6 inches on center on all sides, parallel to the duct, and with continuous No. 3 bar perpendicular to the duct on 16 inch centers. Concrete cover for reinforced duct banks shall be not less than six inches with not less than three inches of concrete cover on reinforcing steel. When reinforced duct bank is indicated on the drawings, reinforcing shall extend not less than ten feet beyond each side of the designated area.
   b. All conduits installed for primary electric circuits, main feeders, and data/communications systems (i.e. Telephone, data, parking revenue, radio, flight information, air traffic control systems, security, fiber optic).
   c. Conduits shall be anchored to and supported in the trench with fiber or plastic conduit spacers, designed and provided by the manufacturer for the purpose, and installed not more than 5 foot on center.

3. Install a 6" wide, yellow plastic, foil-backed warning tape, eighteen inches below grade, over the conduit. Tape legend to indicate 'Warning-Buried Electric Line'

4. All conduits or elbows entering or leaving any slab or the ground shall be rigid steel conduit coated with asphalt paint or PVC coated rigid steel conduit.

5. Where rigid metallic conduit is installed underground as noted above it shall be coated with waterproofing black mastic before installation, and all joints shall be re-coated after installation.

6. All PVC runs over 100 ft. in length shall utilize rigid steel 90° elbows at each horizontal change in direction. All PVC risers shall utilize rigid steel 90° elbows. Elbows shall be coated with black mastic or PVC coating. Bond all metal elbows per NEC.

7. Underground raceway systems shall conform to all national, state, local and FAA regulations, in general and Article 300, Section 300.5 of the National Electrical Code specifically.

a. Depth of conduits shall be not less than 24 with the following exceptions:
   1) Conduits installed in concrete floors of buildings to have a minimum concrete cover not less than 2".
   2) Conduits passing under taxiways, runways, ramps, holding areas, and docking areas, must be installed below the concrete pour, in the sub-base, and shall be encased in not less than 3" of concrete, the specifications of which shall meet the same standards required for runways and taxiways except that slump shall be 3 to 4 inches.

8. Verify finished lines in areas where raceways will be installed underground before the grading is complete.

B. In Slab, Above or On Grade:

1. Use coated rigid steel conduit, coated intermediate metal conduit (if approved) or thickwall nonmetallic conduit.

2. In slab conduit is permitted only where written consent is granted by Architect and Structural Engineer, regardless of that shown or noted by drawings. Install as directed by Architect/Structural Engineer.

C. Penetration of Slab:

1. Exposed Location:

   a. Where penetrating a floor in an exposed location from underground or in the slab, a black mastic or PVC coated galvanized rigid steel conduit shall be used.

2. Concealed Location:

   a. Where penetrating a floor in a location concealed in block wall and acceptable by applicable codes, a non-metallic conduit may be used up to the first outlet box, provided the outlet box is at a maximum height of 40" above the finished floor.
   b. Where penetrating a floor from underground or in the slab, a coated galvanized rigid steel conduit shall be used.

D. Outdoor Location:

1. Above Grade:

   a. Where penetrating the finished grade, a coated galvanized rigid steel conduit shall be used.
   b. All exterior conduit runs shall be a rigid conduit and threaded connectors as specified elsewhere.
   c. All areas subject to exterior conditions such as overhangs, galvanized rigid steel conduit shall be used.

E. Concrete Columns or Poured in-place Concrete Wall Locations:

1. Use thickwall non-metallic conduit. Penetration shall be by approved metal raceway (i.e. metal conduit as required elsewhere in these specifications).

F. Locations Near 400Hz Distribution Systems:

1. Metal ferrous conduit or support equipment is not to be installed within 6" of any 400Hz distribution system conduit or wire. Increase distance if so required by 400Hz system manufacturer.

G. Corrosive Locations:

1. Comply with all codes and standards.

3.02 ADDITIONAL REQUIREMENTS FOR RIGID METAL STEEL CONDUIT

A. Rigid metal conduit shall be cut and threaded with tools approved for the purpose and by qualified personnel.

1. Approved pipe vise.
2. Roller/bade type cutter or band saw.
3. Reamer capable of completely removing all ridges or burrs left by the cutter. Reaming with pliers is not acceptable.

B. Hangers shall be installed not more than 10 ft. apart and within 3 ft. of each outlet, junction box, panelboard, enclosure or cabinet.

C. Conduits stubbed through floor slabs, above grade and not contained inside walls, shall be coated rigid galvanized metallic conduit.

D. One hole pipe straps shall be malleable iron. Wet location applications shall include malleable iron back clamp spacers.

E. Use of two-piece threaded union fittings and rigid set screw fittings are not permitted. Threaded unions may be acceptable where required for special field conditions only when special written permission is granted by OAR.

3.03 ADDITIONAL REQUIREMENTS FOR FLEXIBLE STEEL CONDUIT AND LIQUID-TITE FLEXIBLE METAL CONDUIT

A. Shall be properly grounded.

B. Shall be installed with approved fittings.

C. Shall be used for final connections to vibrating equipment such as motors, pumps, transformers, etc

D. Liquid-tight conduit termination connectors at vibration equipment (i.e. pumps, AHU’s, motors, moveable equipment, etc) shall be provided with wire mesh grips.

3.04 ADDITIONAL REQUIREMENTS FOR NON-METALLIC CONDUIT (PVC)

A. PVC conduit is not allowed anywhere inside building(s) except underground, in the slab, in poured in place concrete, and in block wall up to the first outlet box (if not over 40" AFF) if allowed by codes. In elevated slabs, the conduit is permitted only where written consent is granted by Structural Engineer, regardless of that shown or noted by drawings. Install as directed by Architect/Structural Engineer.

B. Join the nonmetallic conduit using PVC cement as recommended by the manufacturer. Wipe nonmetallic conduit dry and clean before joining. Apply full even coat of cement to the entire area inserted in the fitting. Allow joint to cure for 20 minutes, minimum.

C. Threads will not be permitted on PVC conduit and fittings, except for rigid steel to PVC couplings.

D. The installation of the PVC conduit shall be in accordance with the manufacturer's recommendations.

E. PVC conduit shall not be used to support fixtures or equipment.

F. Field bends or direction changes shall be by commercial PVC pipe heaters or manufactured bends only. Heating with flame and handheld dryers are prohibited.

G. PVC fittings and elbows shall be by the same manufacturer as the conduit.

3.05 ADDITIONAL REQUIREMENTS FOR PVC-COATED CONDUIT

A. All cuts, pinholes and ends shall be sealed using liquid PVC patch. PVC-coated conduit shall be thoroughly inspected after installation to assure all voids, cuts, pinholes or other violations of the integrity of the PVC coating are sealed.

3.06 SUPPORTS

A. Comply with the requirements of Section 26 05 29 Supporting Devices.

B. Arrange supports to prevent misalignment during wiring installation.

3.07 EXPANSION/DEFLECTION FITTINGS

A. Provide suitable fittings to accommodate expansion and deflection where conduit crosses control and expansion joints.

B. Expansion fittings shall be installed in the following cases:

1. In each conduit run wherever it crosses an expansion joint in the concrete structure.
2. On one side of the joint with its sliding sleeve end flush with the joint, and with a length of bonding jumper in expansion/deflection equal to at least three times the normal width of joints.
3. In each conduit run which mechanically attaches to separate structures to relieve strain caused by shift on one structure in relation to the other.
4. In straight conduit run above ground that is more than one hundred feet long and the interval between expansion/deflection fittings in such runs shall not be greater than 100 feet.

3.08 GROUNDING

A. All raceways shall have a copper system ground conductor throughout the entire length of the circuit installed within the conduit in strict accordance with NEC codes.

B. The grounding conductor shall be included in total conduit fill determining conduit sizes, even though not included or shown on drawings.

C. Grounding conductors run with exterior/ underground feeders shall be bare only.

D. Grounding conductors run with feeders shall be bonded to portions of conduit that are metal by approved ground bushings.

E. See other sections of these specifications for additional requirements.

F. Grounding conductors (including lightning protection down conductors) run in metal conduit shall be bonded to the metal conduit at both ends.

3.09 CONDUITS PENETRATING 2 HOUR ASSEMBLIES OR GREATER

A. Conduits with conductors penetrating the wall shall have blow out patches on each side of the wall.

B. Multiple conduits run through rated walls side by side shall have blow out patches on each side of the wall.

C. Data or telephone conductors run exposed and penetrating a wall rated 2 hour for fire, smoke or smoke/fire shall be sleeved with steel conduits 30" each side of the wall and conduit ends packed with approved fire sealant.

3.10 FIRE AND SMOKE STOPPING

A. The contractor is to provide fire stopping and smoke sealing for all penetrations of existing (or new if applicable) fire or smoke assemblies as required to maintain the rating of the assembly.

B. All penetrations shall be fire stopped in strict accordance with UL Fire Directory. Submit applicable details for acceptance. Prepare and install as delineated by UL detail(s).

C. Each penetration shall be identified with the corresponding UL fire assembly number. Labels shall be typed or computer-generated minimum 1/2” high black lettering, self-adhesive type.

D. Comply with UL Fire Directory "F" and "T" ratings respectfully.

3.11 FIRE PROTECTION

A. Emergency life safety feeder-circuit wiring shall be installed either in spaces fully protected by an approved automatic fire suppression system or shall be a listed electrical circuit protection system with a 1-hour fire rating. Fire circuit protection shall be in accordance with UL Fire Protection equipment Directory and UL Building Materials Directory (latest edition).

3.12 VERTICAL RACEWAYS

A. Cables in vertical raceways shall be supported per NEC Article 300.19. Provide supporting devices for cables, including any necessary accessible pull boxes as required regardless if shown on drawings or not. Provide and install access panels as required. Coordinate the location of the pull box and access panel with the designer prior to installation. This includes empty raceways for future use.

3.13 GENERAL

A. Install conduit in accordance with NECA "Standard of Installation." The contractor shall layout all work prior to rough-in.

B. Install nonmetallic conduit in accordance with the manufacturer's instructions.

C. Arrange conduit to maintain headroom and present a neat appearance.

D. Route conduit installed above accessible ceilings or exposed to view parallel or perpendicular to walls. Do not run from point to point.

E. Route conduit in and under the slab from point-to-point.

F. Do not cross conduits in the slab.

G. Maintain adequate clearance between conduit and piping.

H. Maintain 12-inch (300-mm) clearance between conduit and surfaces with temperatures exceeding 104 degrees F (40 degrees C).

I. Maintain a minimum of 6-inch separation between parallel and 3-inch separation between crossing power and communications raceways. Increase separation if so required to comply with EIA/TIA referenced standards.

J. Systems raceways shall be installed in accordance with ANSI/EIA/TIA Communications Standards.

1. Maintain proper separation between PDS system cables and all power and unshielded cables, as required to prevent noise or crosstalk interference.

2. Raceway bends shall have a minimum inside radius of 6 times the internal diameter. Increase bend radius to 10 times for raceway larger than 2 inches in size. Provide proper bend for all changes of direction. Pull and splice boxes shall not be used in lieu of a bend.
3. Install raceways so no more than two 90^{o} bends are in any raceway section without a pullbox. Install additional pull boxes as required to maintain a maximum of two 90^{o} bends between pull boxes and termination points.
4. Install boxes in straight sections of the raceway.

K. Cut conduit square using saw or pipecutter; de-burr cut ends.

L. Bring conduit to shoulder of fittings; fasten securely.

M. Use conduit hubs or sealing locknuts to fasten conduit to sheet metal boxes in damp locations and to cast boxes. Use threaded conduit hubs to fasten conduit to sheet metal boxes, disconnects switches and equipment control panels in wet and exterior locations.

N. Install no more than the equivalent of three 90-degree bends between boxes for power and lighting systems. Use conduit bodies to make sharp changes in direction, as around beams, Use appropriate boxes and conduit bodies for fire alarm, voice/data and sound/paging systems. Use factory elbows for bends in metal conduit larger than 2-inch size.

O. Avoid moisture traps; provide junction box with drain fitting at low points in the conduit system.

P. Provide pull boxes, junction boxes and fire barrier at fire-rated walls as required by NEC Article 300, whether shown on drawings or not.

Q. Provide continuous fiber polyline 1000 lb. minimum tensile strength pull string in each empty conduit except sleeves and nipples. All conduits are to be confirmed clean and dry by passing a foam and rigid mandrel through each before installing a pull string. This includes all raceways which do not have furnished conductors. Pull cords must be fastened to prevent accidental removal. A phenolic or brass nameplate shall be attached to each end indicating the location of both ends of the conduit as follows: THIS END = "LOCATION," OTHER END = "LOCATION."

R. Use suitable seals to protect installed conduit against the entrance of dirt and moisture and insects. Pull strings should be attached to watertight plugs.

S. Ground and bond conduit under provisions of Section 26 05 26.

T. Identify conduit under provisions of Section 26 05 53.

U. Install all conduit concealed from view unless specifically shown otherwise on drawings

V. Rigid steel box connections shall be made with double locknuts and bushings.

W. All wire raceways shall be kept clear of plumbing fixtures to facilitate future repair or replacement of said plumbing fixtures without disturbing wire raceways. Except where it is necessary for control purposes, all raceways shall be kept away from items producing heat.

X. All raceway runs in masonry shall be installed at the same time as the masonry so that no face cutting is required, except to accommodate boxes.

Y. All raceways shall be run from outlet to outlet as shown on the drawings, unless permission is granted, to alter the arrangement shown. If permission is granted arrangement shall be marked on redlined As-Built drawings as previously specified.

Z. Spare conduit stubs shall be capped and location and use marked with a concrete marker set flush with finish grade. The marker shall be 6" round x 6" deep with an appropriate symbol embedded into the top to indicate use. Also, tag conduits in panels where originating.

AA. All conduit stubbed above the floor shall be strapped to a metal channel supported by conduit driven into the ground or tied to steel. Spare conduit stubs shall be capped with a UL listed and approved cap or plug for the specific intended use and identified with ink markers as to source and labeled "Spare".

BB. All connections to motors or other vibrating equipment including transformers or at other locations where required shall be made with not less than 12" nor more than 24" of flexible liquid-tight steel conduit, with nylon insulated throat connectors and wire mesh grip fittings at both terminations of the conduit. Use angle connectors wherever necessary to relieve angle strain on the flex conduit.

CC. Provide a conduit sealing fitting or pliable compound wherever the conduit system is exposed to wide temperature changes which may cause condensation within the raceway; as from the inside to the outside of coolers or freezers.

DD. Route conduit through roof openings for piping and ductwork or through suitable roof jack with pitch pocket. Coordinate location with roofing installation specified under other Sections of these specifications.

EE. All raceways shall be run in a neat and workmanlike manner and shall be properly in accordance with the latest edition of NEC with approved conduit clamps, hanger rods and structural fasteners.

FF. All raceway runs, whether terminated in boxes or not, shall be capped during the course of construction and until wires are pulled in, and covers are in place. No conductors shall be pulled into raceways until construction work which might damage the raceways has been completed.

GG. Electrical raceways shall be supported independently of all other systems and supports, and shall in every case avoid proximity to other systems which might cause confusion with such systems or might provide a chance of electrolytic actions, contact with live parts or excessive induced heat.

HH. Raceways, boxes, etc shall not be attached to an acoustical grid ceiling system or support wire per NEC Article 300.11. Support all components directly from building structure.

END OF SECTION

SECTION 26 05 26
GROUNDING AND BONDING

PART 1 - GENERAL

1.01 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including Contractual Conditions and Division 01 Specification sections apply to this section.

1.02 SUMMARY

A. This section includes the requirements for the provision and installation of grounding and bonding.

1.03 DESCRIPTION

A. Provide all labor, materials, and equipment necessary to properly install a grounding system conductor in all new branch wiring and feeder installations that shall be in full compliance with all applicable Codes as approved by the authorities having jurisdiction. The secondary distribution system shall include a grounding conductor in all raceways in addition to the return path of the metallic conduit.

B. In general, all electrical equipment (metallic conduit, motor frames, panelboards, etc.) shall be bonded together with a green insulated or bare copper system grounding conductor in accordance with specific rules of Article 250 of the N.E.C. and State codes. Bonding conductor through the raceway system shall be continuous from the main switch ground bus to the panel ground bar of each panelboard, and from the panel grounding bar of each panelboard to branch circuit equipment and devices.

C. All raceways shall have an insulated copper system ground conductor throughout the entire length of the circuit installed with-in conduit in strict accordance with NEC. The grounding conductor shall be included in total conduit fill determining conduit sizes, even though not included or shown on drawings. Grounding conductors run with feeders in PVC conduit outside of the building(s) shall be bare only.

D. Section Includes:

1. Grounding electrodes and conductors.
2. Equipment grounding conductors.
3. Bonding.
4. Counterpoise System.
5. Ground Ring.

1.04 SUBMITTALS

A. Submit catalog cut sheet showing brand and selection for all conductors, test wells, components, etc., as specified herein showing that all materials are UL listed and labeled as applicable and manufactured in the United States.

B. Product data shall prove compliance with Contract Documents, National Electric Code, Underwriters Laboratories, manufacturer’s specifications, manufacturer’s written installation data and compliance with all performance criteria.

C. Include instructions for storage, handling, protection, examination, preparation, operation and installation of the product.

D. Indicate application conditions and limitations of use stipulated by product testing agency specified under regulatory requirements.

E. Show all dimensions, colors, configurations, covers and applicable labeling/stamping.

F. Record actual locations of grounding electrodes on redlined as-built documents.

G. Submit the test results of each ground rod. See Section 26 01 50.

1.05 REFERENCES AND REGULATORY REQUIREMENTS

A. Furnish products listed and classified by Underwriters Laboratories, Inc. as suitable for the purpose specified and shown.

B. Conform to requirements of ANSI/NFPA 70 - National Electrical Code.

PART 2 - PRODUCTS

2.01 ROD ELECTRODE

A. Material: Copper-clad steel.

B. Diameter: 3/4 inch.

C. Length: 10 feet minimum. Increase lengths as required to achieve specified resistance.

2.02 MECHANICAL CONNECTORS

A. All grounding connectors shall be in accordance with UL 467 and UL listed for use with rods, conductors, reinforcing bars, etc., as appropriate.

B. Connectors and devices used in the grounding systems shall be fabricated of copper or bronze materials, and properly applied for their intended use. Specified items of designated manufacturers indicate required criteria and equal products may be provided if approved. All connectors and devices shall be compatible with the surfaces being bonded and shall not cause galvanic corrosion by dissimilar metals. Materials in items not listed herein shall be of equal quality to the following specified items:

1. Lugs: Substantial construction, of cast copper or cast bronze, with "ground" (micro-flat) surfaces equal to Burndy QQA-B Series, two-hole, T&B, or approved substitution. Light weight and "competitive" devices shall be rejected.

2. Grounding and Bonding Bushings: Malleable iron, Thomas and Betts (T&B), or approved substitution.

3. Piping Clamps: Burndy "GAR-TC series" with two-hole compression lug under U-Bolt nut, or T&B, or approved substitution.

4. Grounding Screw and Pigtail: Raco No. 983 or approved substitution.

5. Fastening hardware: Grade 5 silicone bronze with beveled washers. Copperplate is not acceptable

C. Mechanical lugs or wire terminals shall be used to bond ground wires together or to junction boxes and panel cabinets and shall be manufactured by Anderson, Buchanan, Thomas and Betts Co., or Burndy.

2.03 WIRE

A. Material: Stranded copper.

B. Size: Size to meet NFPA 70 requirements as a minimum, increase the size if called for on drawings, in these specifications, or as required for voltage drop.

C. Insulated THWN (or bare as noted elsewhere).

2.04 GROUNDING WELL COMPONENTS

A. Grass Non-Traffic Areas:

1. Well: Minimum 12 inch long by 12 inch wide by 18 inches deep with an open bottom in open areas.
2. Well Cover: High-density plastic, COMPOSOLITE, polymer concrete or cast iron with legend "GROUND" embossed on the cover.
3. Material: Structural Plastic, COMPOSOLITE, polymer concrete or concrete.
4. Manufacturer: Advanced Lighting Technologies, Brooks Products, Hubbell or equal by Quazite or approved substitution.
5. Increase depth, diameter or size as required to provide proper access at the installed location.

B. Paving and Low Traffic Areas:

1. Well: Minimum 12-inch-long by 12-inch-wide by 18 inches deep with open bottom.
2. Well Cover: Traffic rated for use with "GROUND" embossed on the cover.
3. Material: COMPOSOLITE.
4. Manufacturer: Quazite or approved substitution.
5. Increase depth, diameter or size as required to provide proper access at the installed location.

2.05 GROUNDING BARS/GROUND BUS (INCLUDING 'SYSTEMS' GROUND BUS/BARS AND GROUND BUS BARS)

A. Ground bars shall be copper of the size and description as shown on the drawings. If not sized on drawings, the bus bar shall be minimum 1/4" x 2" bus grade copper, spaced from the wall on insulating 2" polyester molded insulator standoff/supports, and be 12" or greater minimum overall length, allowing 2" length per lug connected thereto. Increase overall length as required to facilitate all lugs required while maintaining 2" spacing. The size of the bus bar used in the main electrical room shall be similar except a minimum of 4" high and 24" long.

B. Provide bolt tapping lug with two hex head mounting bolts for each terminating ground conductor, sized to match conductors. Mount on bus bar at 2 inches on center spacing. Lugs to be manufactured by Burndy, T&B or approved substitution.

C. The bus bar shall have rows of holes in accordance with NEMA Standards for specified lugs.

D. Standoff supports to be 2" polyester as manufactured by Glastic #2015-4C or approved substitution.

PART 3 - EXECUTION

3.01 GENERAL

A. Install products in accordance with the manufacturer's instructions.

B. Install grounding electrodes conductor, bonding conductors, ground rods, etc. with all required accessories.

C. Grounding shall meet (or exceed) all the requirements of the N.E.C., the NFPA, and applicable standards of IEEE.

D. Where there is a conflict between these specifications and the above applicable codes or standards, or between this section and other specifications sections then the most stringent or excessive requirement shall govern. Where there is an omission of a code/standard requirement in these specifications then the code/standard requirements shall be complied with.

E. A requirement in these specifications to comply with a specific code/standard article, etc. is not to be construed as deleting of requirements of other applicable codes/standards and their articles, etc.

F. Verify that final backfill and compaction has been completed before driving rod electrodes

G. All ground rings, counterpoises systems, lightning protection systems, and ground rods shall be installed below the frost line. For the remainder of this section substitute below frost line at any point identified as one foot below grade if the frost line is more than 1 foot.

3.02 GROUNDING ELECTRODES

A. All connections shall be exothermically welded unless otherwise noted herein. All connections above grade and in accessible locations may be by exothermic welding or by brazing or clamping with devices UL listed as suitable for use except in locations where exothermic welding is specifically specified in these specifications or called for on drawings.

B. Each rod shall be dye stamped with the identification of manufacturer and rod length.

C. Install rod electrodes at locations indicated and/or as called for in these specifications.

D. Ground Resistance

1. Main Electrical Service (to each building and Site) and Generator Locations:

    a. Grounding resistance measured at each main service electrode system and at each generator electrode system shall not exceed 5 ohms.

2. Lightning Protection Ground Locations:

    a. Lightning Protection system ground locations shall not exceed 5 ohms measured at the ground electrode.

3. Site Distribution Counterpoise Ground Locations:

    a. Counterpoise system ground locations shall not exceed 25 ohms measured at the ground electrode.

4. Other Locations

    a. Resistance to ground of all non-current carrying metal parts shall not exceed 25 ohms measured at motors, panels, busses, cabinets, equipment racks, light poles, transformers, and other equipment.

5. The resistance called for above shall be the maximum resistance of each ground electrode prior to connection to the grounding electrode conductor. Where the ground electrode system being measured consists of two (2) or more ground rod electrodes at each location, then the resistance specified above shall be the maximum resistance with two (2) or more rods connected together but not connected to the grounding electrode conductor.

E. Install additional rod electrodes as required to achieve specified resistance to ground (specified ground resistance is for each ground rod location prior to connection to ground electrode conductor).

F. Provide grounding well with cover at each rod location, with the only exception being a site distribution counterpoise ground rod. Install grounding well top flush with finished grade.

G. Install ground rods not less than 1 foot below grade level and not less than 2 feet from structure foundation.

3.03 GROUND RESISTANCE AT LOCATION OTHER THAN LOCATION OF GROUNDING ELECTRODES.

A. Resistance to the ground of all non-current carrying metal parts shall not exceed 25 ohms measured at motors, panels, busses, cabinets, equipment racks, light poles, transformers, and other equipment.

3.04 GROUNDING ELECTRODE CONDUCTOR

A. The conductor shall be sized to meet (or exceed requirements of Contract Documents) the requirements of NEC 250.66.

3.05 EQUIPMENT GROUNDING CONDUCTOR

A. Grounding conductors shall be provided with every circuit to meet (or exceed requirements of Contract Documents) the requirements of NEC 250.122.

B. At every voltage level, new portions of the electrical power distribution system shall be grounded with a dedicated copper conductor which extends from termination back to the power source in the supply panelboard.

C. Provide separate, insulated (bare if with feeder in PVC conduit) conductor within each feeder and branch circuit raceway. Terminate each end on a suitable lug, bus, or bushing.

D. Except as otherwise indicated, each feeder raceway on the load side of the service entrance shall contain a ground conductor sized as indicated and where not shown shall be sized to meet (or exceed requirements of Contract Documents) the requirements of NEC 250.122. The conductor shall be connected to the equipment grounding bus in switchboards and panelboards, to the Grounding Bus in all motor control centers, and as specified, to lighting fixtures, motors and other types of equipment and outlets. The ground shall be in addition to the metallic raceway and shall be connected, using a lug device located within each item enclosure at the point of electric power connections to permit convenient inspection.

E. Provide green insulated ground wire for all grounding type receptacles and for equipment of all voltages. In addition to grounding strap connection to metallic outlet boxes, a supplemental grounding wire and screw equal to Raco No. 983 shall be provided to connect the receptacle ground terminal to the box.

F. All plug strips and metallic surface raceway shall contain a green insulation ground conductor from the supply panel ground bus connected to the grounding screw on each receptacle in strip and to strip channel, the conductor shall be continuous.

G. Where integral grounding conductor is specified elsewhere in bus duct construction, provide equivalent capacity conductor from the supply switchboard or panelboard grounding bus to the bus duct grounding conductor. Bond integral conductor to bus duct enclosure at each tap and each termination.

H. All motors, all heating coil assemblies, and all building equipment requiring flexible connections shall have a green grounding conductor properly connected to the frames and extending continuously inside conduit with circuit conductors to the supply source bus with approved connectors regardless of conduit size or type. This shall include Food Service equipment, Laundry equipment, and all other "Equipment By Owner" to which an electric conduit is provided under this Division.

3.06 MAIN ELECTRICAL SERVICE

A. Complete installation shall meet or exceed the requirements of the NEC 250.

B. Artificial electrodes shall be provided for the main service in sufficient number and configuration to secure resistance specified.

C. Provide and bond to all of the following:

1. Ground rods.
2. Metal water pipe.
3. Building metal frame, structural steel or reinforced structural concrete.
4. Encased Electrodes.
5. Ground ring.
6. Site distribution counterpoise ground system.
7. Lightning protection system.

D. A main ground, bare copper conductor, sized per NEC Table 250.66, but in no case less than #2/0, shall be run in conduit from the main switchgear of each building to the building steel in respective building. This ground conductor shall also be run individually from the main switchgear and be bonded to the main water service ahead of any union in the pipe and must be a metal pipe of length and location as acceptable by authorities having jurisdiction. Provide properly sized bonding shunt around the water meter and/or dielectric unions in the water pipe. Also required is the same size ground wire to ground rod electrode as called for below:

1. Three 10 ft. ground rods in a delta configuration at no less than 20 ft. spacing driven to a minimum depth of 10 feet, one foot below grade.
2. Bond ground rod electrodes together with a bare copper ground conductor that matches the size required by NEC Table 250.66, but in no case less than #2/0.
3. Provide additional rod electrodes as required to achieve specified ground resistance.

E. Ground/bond neutral per NEC 250.

F. A main ground, bare copper conductor, sized per applicable Table in NEC 250, but in no case less than #2/0, shall be run in conduit from the main switchgear of each building to a concrete-encased electrode per NEC 250.52(3).

G. Bond grounding electrodes to site counterpoise grounding system and lightning protection system where provided.

H. Provide and install a ground bus bar on the wall near the main service disconnect/switchboard. Connect to ground bar in disconnect/switchboard bonded to switchboard/disconnect enclosure/neutral with copper grounding conductor sized per NEC Table 250.66.

3.07 TRANSFORMER GROUNDING

A. Ground all transformers and enclosures of 120/208V and 277/480V "separately derived systems" as specified herein.

1. Ground per NEC 250 and these specifications.
2. Bond neutral to transformer frame/enclosure and the equipment grounding conductors of the derived system with copper ground conductor sized per NEC Table 250.66.
3. Connect the transformer neutral/ground to grounding electrode per NEC 250.30 with grounding electrode conductor sized per NEC Table 250.66.
4. In addition to a connection to the grounding electrode conductor called for above, provide supplemental grounding electrode as follows:
    a. Where grounding required per NEC 250.30 is to building steel/structure, supplement this grounding with connection to the nearest available effectively grounded metal water pipe.
    b. Where grounding connection required per NEC 250.30 is to a grounded metal water pipe, supplement with connection to building steel/structure in addition to any other available electrodes specified in NEC 250.50 and 250.52.
    c. Where supplemental grounding electrodes required above is a ground rod electrode, provide two or more 10 ft. ground rod electrodes at no less than - 20 ft. spacing, driven full length into the earth one foot below grade.
5. Where neither building steel nor water pipe grounding electrodes are available (i.e. exterior locations with no available water pipe electrode) provide two (2) ground connections: each 10 ft. ground rod electrodes at not less than 20 ft. spacing, driven full length into the earth one foot below grade.
6. Where the transformer is mounted to the exterior of the building, one (1) of the two (2) ground electrodes required shall be ground rod electrode as called for in 5. above. This ground rod electrode shall also be connected to the counterpoise system.

B. Provide additional ground electrodes as required to achieve specified ground resistance.

C. Where two or more ground electrodes are used at any required ground location, they shall be bonded together with a copper ground conductor, sized to meet NEC Table 250.66, but in no case less than #2/0.

D. Complete installation shall meet or exceed the minimum requirements of NEC 250.

E. Equipment ground conductors shall be provided in addition to the above grounding. See 'EQUIPMENT GROUNDING CONDUCTOR'.

F. Provide ground bus bar on the wall near the transformer (or in an associated electrical room for exterior mounted transformers). Connect to ground lug in transformer bonded to transformer enclosure/neutral with copper ground conductor sized per NEC Table 250.66.

G. Multiple separately derived systems may be grounded as allowed in NEC 250-30(A)(4).

3.08 GENERATOR GROUNDING

A. Separately derived systems (i.e. systems where generator neutral is not solidly interconnected to service supplied system neutral such as 4 pole switched neutral transfer switch systems).

1. Ground per NEC 250.20, 250.30, 250.66 and these specifications.
2. Bond neutral to transformer frame/enclosure and the equipment grounding conductors of the derived system with copper ground conductor sized per NEC Table 250.66.
3. Connect generator neutral/ground to grounding electrodes per NEC 250.30 with grounding electrode conductor sized per NEC Table 250.66.
4. In addition, provide supplemental grounding electrode as follows:
    a. Where grounding required per NEC 250.30 is to building steel/structure, supplement with connection to the nearest available effectively grounded metal water pipe.
    b. Where grounding connection required per NEC 250.30 is to a grounded metal water pipe, grounding with connection to other electrodes specified in NEC 250.50 and 250.52.
    c. Where a supplemental grounding electrode required above is a ground rod electrode, provide two or more 10 ft. ground rod electrodes at no less than 20 ft. spacing, driven vertical to a minimum depth of 10 ft. plus 1 foot below grade.
5. Where neither building steel nor water pipe grounding electrodes are available provide two (2) ground connections: each to two (2) or more 10 ft. ground rod electrodes at no less than 20 ft. spacing, driven vertical to a minimum depth of 10 ft. plus 1 foot below grade.
6. Where a generator is mounted to the exterior of the building, one (1) of the two (2) ground electrodes required shall be ground rod electrode as called for in Paragraph 3.8 A.5. This ground rod electrode shall also be connected to the counterpoise system.

B. Non-separately derived systems (i.e. systems where generator neutral is solidly interconnected to service supplied system neutral such as 3 pole non-switched neutral transfer switch systems).

1. Ground per NEC 250.20, 250.30, 250.66 and these specifications.
2. Do not bond neutral to the transformer frame/enclosure or the equipment grounding conductors of the derived system.
3. Connect generator frame/enclosures ground to grounding electrode per NEC 250.30 with grounding electrode conductor sized per NEC Table 250.66.
4. In addition, provide supplemental grounding electrode as follows:
    a. Where grounding required per NEC 250.30 is to building steel/structure, supplement with connection to the nearest available effectively grounded metal water pipe.
    b. Where grounding connection required per NEC 250.30 is to a grounded metal water pipe, supplement with connection to other electrodes specified in NEC 250.50 and 250.52.

c. Where supplemental grounding electrodes required above is a ground rod electrode, provide two or more 10 ft. ground rod electrodes at no less than 20 ft. spacing, driven full length into the earth one foot below grade.

5. Where neither building steel nor water pipe grounding electrodes are available provide two (2) ground connections: each to two (2) or more 10 ft. ground rod electrodes at no less than 20 ft. spacing, driven full length into the earth one foot below grade.

6. Where a generator is mounted to the exterior of the building, one (1) of the two (2) ground electrodes required shall be ground rod electrode as called for in Paragraph 3.8 B.5. This ground rod electrode shall also be connected to the counterpoise system.

C. Provide additional ground electrodes as required to achieve specified ground resistance.

D. Where two or more ground electrodes are used at any one required ground location, they shall be bonded together with a copper ground conductor, sized to meet NEC Table 250.66, but in no case less than #2/0.

E. Complete installation shall meet or exceed the minimum requirements of NEC 250.

F. Equipment ground conductors shall be provided in addition to the above grounding. See 'EQUIPMENT GROUNDING CONDUCTOR'.

3.09 LIGHTNING PROTECTION SYSTEMS

A. Ground per Section 26 41 13 _ Lightning Protection System, NFPA 780, and as specified herein. The most stringent requirements shall govern.

B. Bond lightning protection systems grounds to electrical service system ground, and counterpoise system ground where provided.

3.10 EXTERIOR GRADE (OR FREESTANDING ABOVE GROUND) MOUNTED EQUIPMENT

A. General

1. All equipment mounted exterior to building shall have their enclosures grounded directly to a grounding electrode at the equipment location in addition to the building equipment ground connection.

2. Bond each equipment enclosure, metal rack support, mounting channels, etc. to ground electrode system at each rack with an insulated copper ground conductor sized to match the grounding electrode conductor required by NEC Table 250.66 based on equipment feeder size, but in no case, shall conductor be smaller than #6 copper or larger than #2 copper. This connection is in addition to grounding electrode connections required for services.

B. Main electrical service rack mounted equipment.

1. Ground per "MAIN ELECTRICAL SERVICE".

2. Bond all metal parts as noted in this section.

C. Electrical sub-service rack mounted equipment.

1. Ground per "MAIN ELECTRICAL SERVICE", except do not bond neutral to ground.

2. Bond all metal parts as noted in this section.

D. Electrical equipment connection rack mounted equipment.

1. Bond all metal parts as noted in this section.

E. Grounding electrodes (ground electrodes system) shall be:

1. Located at each rack location.
2. For service equipment: Ground electrode required per "MAIN ELECTRICAL SERVICE".
3. For equipment connection: Two or more 10 ft. ground rods at no less than 20 ft. spacing, driven vertical to a minimum depth of 10 ft. plus 1 ft. below grade. Bond ground rods together with a size to meet NEC Table 250.66, but no less than a #2 copper ground conductor. Provide additional rod electrodes as required to achieve specified ground resistance.

F. Complete installation shall meet or exceed the minimum requirements of NEC 250 and, when applicable, NFPA 78.

3.11 LIGHTING FIXTURES

A. All new and reinstalled fixtures shall be provided with a green grounding conductor, solidly connected to the unit. Individual fixtures grounds shall be with lug to fixture body, located at the point of electrical connection to the fixture unit.

B. All suspended fixtures and those supplied through flexible metallic conduit shall have a green ground conductor from the outlet box to fixture. Cord connected fixtures shall contain a separate green ground conductor.

C. Pole Light Fixtures

1. Metal Pole Light Fixtures
   a. Freestanding pole-mounted lighting fixtures shall each have a - Class I or Class II Materials - lightning protection main copper down conductor connected to grounding electrodes at the base of the pole.
   b. The conductor shall be bonded to a metal pole via UL Listed ground clamp suitable for use. Locate ground lug opposite to handhole (or adjacent if visible through handhole).
2. Concrete or Non-Metallic Pole
   a. Freestanding pole-mounted lighting fixtures shall each have a Class I or Class II lightning protection main copper down conductor connected to grounding electrodes at the base of the pole.
   b. The conductor shall be extended from the grounding electrode to the top of the pole and terminate at the top of the pole in a Class I or Class II copper lightning protection air terminal.
   c. Each metal part of a light fixture assembly, bracket, ballast cabinet, disconnect, transformer, etc. that is mounted to the pole shall be bonded to the down conductor.
3. Fixtures located on elevated roadway ramps: provide with a connection to lightning counterpoise grounding system.
4. Grounding electrode(s) at each pole shall be bonded to the site distribution counterpoise system.
5. Grounding Electrodes
   a. Two or more 10 ft. ground rods at no less than 20 ft. spacing shall be driven full length into the earth one foot below grade.

b. Bond ground rod electrodes together with a Class I or Class II lightning protection main copper conductor.
c. Provide additional rod electrodes as required to achieve specified ground resistance.
d. Two (2) or more grounding rod electrodes shall be installed at each light pole.

6. Installation shall exceed the minimum requirements of NFPA 780.

3.12 HAZARDOUS LOCATIONS

A. Grounding in hazardous locations shall be done in accordance with applicable portions of Articles 500, 501, 502, 503, 511 and 514 of the National Electrical Code.

3.13 GROUND RING

A. Provide complete underground building perimeter ground ring system, completely encircling building.

B. Install a minimum of 2-1/2 feet depth into the earth or below the frost line.

C. Install ground rods (minimum 10 ft. long) every 150 feet section of ground ring conductor.

D. Bond ground ring to building steel every 150 feet of building perimeter, bond to any and all electrical and piping systems that cross the ground ring system, bond to lightning protection down conductors and to any lightning or other earth grounding electrodes that may be present on the premises.

E. Bond to building service and counterpoise ground systems.

3.14 MISCELLANEOUS GROUNDING CONNECTIONS

A. Provide bonding to meet regulatory requirements.

B. Required connections to building steel shall be with UL approved non-reversible crimp type ground lugs exothermically welded to bus bar that is either exothermically welded to steel or bolted to steel in locations where the weld will affect the structural properties of the steel.

C. Install grounding conductors to permit shortest and most direct path from equipment to ground; install in conduit; bond to a conduit at both ends when the conduit is metal; have connections accessible for inspection; and made with approved solderless connectors brazed (or bolted) to the equipment ground; in NO case be a current-carrying conductor; have a green jacket unless it is run in conduit with power and branch circuit conductors. The main grounding electrodes conductor shall be exothermically welded to ground rods, water pipe, and building steel.

D. All surfaces to which grounding connections are made shall be thoroughly cleaned to maximum conductive condition immediately before connections are made thereto. Metal rustproofing shall be removed at grounding contact surfaces, for 0 ohms by a digital voltmeter. Exposed bare metal at the termination point shall be painted.

E. All ground connections that are buried or in otherwise inaccessible locations, shall be welded exothermically. The weld shall provide a connection which shall not corrode or loosen and which shall be equal or larger in size than the conductors joined together. The connection shall have the same current carrying capacity as the largest conductor.

F. Install ground bushings on all metal conduits entering enclosures where the continuity of grounding is broken between the conduit and enclosure (i.e. metal conduit stub-up into a motor control center enclosure or at ground bus bar). Provide an appropriately sized

bond jumper from the ground bushing to the respective equipment ground bus or ground bus bar.

G. Each feeder metallic conduit shall be bonded at all discontinuities, including at switchboards and all sub distribution and branch circuit panels with conductors in accordance with Table 250.122 of NEC for parallel return with a respective interior grounding conductor.

H. Grounding provisions shall include double locknuts on all heavy wall conduits.

I. Install grounding bus in all existing panelboards of remodeled areas, for connection of new grounding conductors, connected to an approved ground point.

J. Bond together reinforcing steel and metal accessories in pool and fountain structures and bond to electrical system per NEC.

K. Where reinforced concrete is utilized for building grounding system, proper reinforced bonding shall be provided to secure low resistance to earth with "thermite" type devices, and #10AWG wire ties shall be provided to not less than ten (10) full-length rebars which contact the connected rebar. Provide size and length of the rod to meet NEC requirements.

3.15 GROUNDING BAR/GROUND BUS (INCLUDING 'SYSTEMS' GROUND BUS/BAR ON GROUND BUS/BAR) INSTALLATION

A. Where indicated on the drawings, provide a grounding bar/ground bus (bus bar). Metal sheaths of underground cables are also to be grounded thereto at points of building entrance.

B. Mount bolt tapping lugs with hex head bolts to bus bar at 2" o.c. spacing, one for each ground conductor.

C. Mount bus bar to the wall using 2" polyester molded insulator stand-off.

D. Extend a #2/0 (minimum size) or larger THWN insulated copper ground conductor (if a larger size is called for on drawings or required by N.E.C. for service ground, etc.) in PVC conduit to approved service ground installation or ground bus/bar in a main service equipment enclosure.

E. Extend #6 insulated copper ground wire from respective bus/bar to each 'local' ground bus/bar in each cabinet for Section system.

F. 'SYSTEMS' grounding bus/bar must be connected with #2/0 insulated copper conductor to grounding electrodes system as defined in NEC "Article 800-40(b).

3.16 COUNTERPOISE SYSTEM

A. Install a counterpoise and ground over all sections of underground ductbanks, conduits, or cables outside (exterior) to the building.

B. No. 2 bare stranded copper counterpoise shall be run six (6) inches above all underground duct banks, conduits and cables outside (exterior) to building.

C. Provide one (1) counterpoise conductor for ductbanks (or conduit groupings) 12 inches wide or less. Provide two (2) counterpoise conductors above outside edge of ductbank (or conduit groupings) over 12 inches wide.

D. Counterpoise shall run to the building and be grounded at each building to the main building electrical service ground rod electrode (exterior to building). Counterpoise shall be bonded to ground rod at all light poles, pullboxes, manholes, handholes and at each

building. Provide and install appropriate ground rod every 150-ft. length of counterpoise conductor (see "GROUNDING ELECTRODES"). The counterpoise conductor shall not be run into the interior of the building. Route counterpoise underground around the exterior perimeter of the building to main service ground rod installation.

3.17 TESTING AND REPORTS

A. Raceway Continuity: Metallic raceway system as a component of the facilities' ground system shall be tested for electrical continuity. Resistance to ground throughout the system shall not exceed specified limits.

B. Ground resistance measurements shall be made on each system utilized including:

1. Building structural steel.
2. Driven grounding system.
3. Water pipe grounding system.
4. Other approved systems.

C. Ground resistance measurements shall be made in normally dry weather, not less than 24 hours after rainfall, and with the ground under test isolated from other grounds and equipment. Resistances measured shall not exceed specified limits.

D. Upon completion of testing, the testing conditions and results shall be certified by the Contractor and submitted to the Designer as called for in Section 26 01 50 - Test and Performance Verification.

3.18 INTERFACE WITH OTHER PRODUCTS

A. Interface with site grounding system.

B. Interface with a lightning protection system installed under Section 26 41 13.

3.19 FIELD QUALITY CONTROL

A. Inspect grounding and bonding system conductors and connections for tightness and proper installation.

B. Use suitable test instruments to measure resistance to ground of the system. Perform testing in accordance with the test instrument manufacturer's recommendations using the fall-of-potential method.

END OF SECTION

SECTION 26 05 34
PULL AND JUNCTION BOXES

PART 1 - GENERAL

1.01 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including Contractual Conditions and Division 01 Specification sections apply to this section.

1.02 SUMMARY

A. This section includes the requirements for the provision and installation of pull and junction boxes.

1.03 DESCRIPTION

A. Provide and install all equipment, labor, material, accessories, and mounting hardware for a complete and operating distribution system.

B. Install pull and junction boxes as shown on drawings or as required by the National Electric Code (NEC).

C. Install pull and junction boxes wherever required for a complete and operating distribution system whether shown on drawings or not.

D. Where outlet boxes are used for pull or junction boxes, they shall meet the requirements of the outlet box section of these specifications.

1.04 SUBMITTALS

A. Submit product data on all pull boxes showing.

1. Covers.
2. Dimensions - inside and out.
3. Rating of concrete or gauge of metal.
4. Manufacturer.

1.05 PROJECT AS-BUILT DOCUMENTS

A. Record actual locations and mounting heights of pull and junction boxes.

1.06 REFERENCES AND REGULATORY REQUIREMENTS

A. Furnish products listed and classified by Underwriters Laboratories, Inc. and requirements of NEC as suitable for the purpose specified and shown.

B. Conform to requirements of the following:

1. ANSI/NEMA FB 1 - Fittings and Supports for Conduit and Cable Assemblies.
2. ANSI/NEMA OS 1 - Sheet-steel Outlet Boxes, Device Boxes, Covers, and Box Supports.
3. ANSI/NEMA OS 2 - Nonmetallic Outlet Boxes, Device Boxes, Covers and Box Supports.
4. ANSI/NFPA 70 - National Electrical Code.
5. NEMA 250 - Enclosures for Electrical Equipment (1000 Volts Maximum).

1.07 PROJECT CONDITIONS

A. Verify field measurements shown on Drawings.

B. Verify locations of pull and junction boxes prior to the rough-in.

C. Electrical boxes are shown on drawings in approximate locations unless dimensioned. Install at a location required for the box to serve the intended purpose and to maintain the required access.

PART 2 - PRODUCTS

2.01 GENERAL

A. Dimensions of pull and junction boxes shall meet dimensions shown on drawings or dimensions required by NEC, whichever is largest.

B. Standard 25 cubic inches pull boxes shall meet the requirements of these specifications for outlet boxes as a minimum.

C. All boxes of 100 cubic inches or more shall be constructed of 14-gauge steel with hot-dip galvanized coating.

2.02 SHEET METAL BOXES:

A. NEMA OS 1, galvanized steel.

B. Pull and junction boxes (not in-ground type) used for systems (Division 28) larger than 25 square inches shall be a hinged cover type with flush latches operated with a screwdriver.

C. Large Pull Boxes: Boxes larger than 400 cubic inches in volume or 20 inches in any dimension

1. Use hinged enclosure under provisions of Section 26 05 35 Cabinets and Enclosures.

D. Exterior, damp location and wet location pull and junction boxes shall be NEMA 4x stainless steel.

2.03 SURFACE-MOUNTED CAST METAL BOX:

A. NEMA 250, Type 4; flat-flanged, surface-mounted junction box.

B. Material: Cast aluminum.

C. Cover: Furnish with ground flange, neoprene gasket, and stainless-steel cover screws.

D. Provide all hubs as required for conduit connections.

PART 3 - EXECUTION

3.01 GENERAL

A. Install per NEC.

B. Install electrical boxes as shown on Drawings, and as required for splices, taps, wire pulling, equipment connections and compliance with regulatory requirements.

C. Install boxes to preserve the fire-resistance rating of partitions and other elements.

D. Align adjacent wall-mounted boxes with each other.

E. Use flush mounting boxes in finished areas.

F. Pull and junction boxes larger than 25 square inches shall be supported with (2) all-thread rod hanger's minimum. Increase quantity and size of all-thread rod hangers as required for application, and to eliminate movement and swaying.

G. Support boxes independently of the conduit.

3.02 INTERFACE WITH OTHER PRODUCTS

A. Coordinate locations and sizes of required access doors.

B. Locate flush mounting box in a masonry wall to require cutting of masonry unit corner only. Coordinate masonry cutting to achieve a neat opening.

3.03 ADJUSTING

A. Install knockout closure in unused box opening.

END OF SECTION

SECTION 26 05 35

CABINETS AND ENCLOSURES

PART 1 - GENERAL

1.01 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including Contractual Conditions and Division 01 Specification sections apply to this section.

1.02 SUMMARY

A. This section includes the requirements for provision and installation of cabinets and enclosures.

1.03 DESCRIPTION

A. Provide and install all equipment, labor, material, accessories, and mounting hardware for a complete and operating system for the following:

1. Hinged cover enclosures.
2. Cabinets.

B. Cabinets and enclosures are to include:

1. Terminal blocks,
2. Mounting panel,
3. Ground bus/bar, and
4. All accessories as required for a complete and operating system.

C. Provide cabinets and enclosures for all systems specified in Divisions 26 and 28.

1.04 REFERENCES AND REGULATORY REQUIREMENTS

A. Furnish products listed and classified by Underwriters Laboratories, Inc. as suitable for purpose specified and shown.

B. Conform to the requirements of the following:

1. NEMA 250 - Enclosures for Electrical Equipment (1000 Volts Maximum).
2. NEMA ICS 4 - Terminal Blocks for Industrial Control Equipment and Systems.
3. ANSI/NFPA 70 - National Electrical Code.

1.05 SUBMITTALS

A. Submit Product Data: Provide manufacturer's standard data for enclosures and cabinets.

B. Submit Manufacturer's Instructions: Indicate application conditions and limitations of use stipulated by product testing agency specified under regulatory requirements. Include instructions for storage, handling, protection, examination, preparation, installation, and starting of product.

C. Submit shop drawings on all cabinets and enclosures showing:

1. Covers.
2. Dimensions - inside and out.
3. Gauge of metal.
4. Manufacturer.
5. Terminal mounting plate, construction, etc.
6. Ground bus/bar.

1.06 EXTRA MATERIALS

A. Provide two keys for each type of lock.

PART 2 - PRODUCTS

2.01 GENERAL

A. Unless specifically called for otherwise on contract drawings, provide "CABINETS" as specified herein for terminal cabinets mounted indoor. Similarly, provide "HINGED COVER ENCLOSURES" as specified herein for terminal cabinets mounted outdoors or in locations other than NEMA 1 locations. Also, provide "HINGED COVER ENCLOSURES" for locations where size required is not available in "CABINET" construction, or if specifically specified as "enclosure" on contract documents.

B. Size.

1. Dimensions of cabinets and enclosures shall meet the dimensions shown on drawings, dimensions required by NEC, or dimensions sized as required to facilitate all equipment/connections involved installation, whichever is largest.
2. Coordinate sizes required and assure that equipment cabinets or enclosures will house and facilitate proper installation and access to equipment.

C. Provide metal barriers to separate compartments containing control wiring operating at less than 50 volts from power wiring or where wiring from separate systems of Normal and Emergency Power are required to be in one enclosure.

D. Provide accessory feet or mounting brackets for free-standing equipment.

2.02 HINGED COVER ENCLOSURES

A. Construction:

1. Exterior and Interior Wet Locations: NEMA Type 3R or 4X: Steel or Stainless steel.

B. Covers: Continuous hinge.

C. Enclosure Finish:

1. NEMA 3R or 4X: Stainless steel or manufacturer's standard metallic gray enamel over phosphatized surfaces.

D. Lock/handle.

1. Provide key lock handle on all enclosures mounted in areas that are not dedicated electrical or mechanical rooms.

E. Interior mounting plate.

1. Each enclosure is to have interior mounting plate/panel for mounting terminal blocks and electrical components.

2. Plate/panel is to be metal.

F. Ground bus/bar.

1. Each enclosure housing surge suppression equipment or other equipment shall have "local" ground bar/bus installed. See Article "Local Ground Bus/Bar".

2.03 CABINETS

A. Construction: Specified gauge steel with removable enwalls.

B. Finish:

1. Boxes:

a. Flush mounted: Stainless or Galvanized steel,

2. Fronts: Stainless or Gray baked enamel.

C. Fronts:

1. Other locations: mono-flat with concealed trim clamps, concealed hinges, flush lock lockable handle, and custom color finish in interior public areas to match mounting surface.

2. Flush or surface type as shown or called for on contract documents.

D. Interior mounting plate.

1. Each enclosure is to have interior mounting plate/panel for mounting terminal blocks and electrical components.

2. Panel/plate shall be metal.

E. Ground bus/bar.

1. Each cabinet housing surge suppression equipment or other equipment shall have "local" ground bar/bus installed. See specification for "Local Ground Bus/Bar" included within this section.

2.04 TERMINAL BLOCKS

A. Terminal Blocks: ANSI/NEMA ICS 4.

B. Power Terminals: Unit construction type with closed back and tubular pressure screw connectors, rated 600 volts.

C. Signal and Control Terminals: Modular construction type, suitable for channel mounting, with tubular pressure screw connectors, rated 300 volts.

D. Provide ground bus terminal block, with each connector bonded to enclosure.

2.05 LOCAL GROUND BUS/BAR

A. Size to handle #6 through #14 AWG copper ground wire.

B. Length as required for circuits.

PART 3 - EXECUTION

3.01 EXAMINATION

A. Verify that surfaces are ready to receive Work.

3.02 INSTALLATION

A. Install Products in accordance with manufacturer's instructions.

B. Install enclosures and cabinets plumb. Anchor securely to wall and structural supports at each corner.

C. Install cabinet fronts plumb.

D. Install per N.E.C. and as required for proper clearance. Coordinate with panels.

E. Provide and install terminal cabinets as shown on drawings or as required by the National Electrical Code (NEC).

F. Provide terminal cabinets wherever required for a complete and operating distribution system whether shown on drawings or not.

G. Install local ground bus/bar in each terminal cabinet/enclosure that houses surge suppression equipment or other equipment and bond to cabinet enclosure via mounting screws or #6 AWG copper ground wire.

H. Ground local ground bus to "SYSTEMS" ground bus/bar with minimum #6 AWG copper ground wire. Increase size if so required on drawings.

I. Install enclosures.

END OF SECTION

SECTION 26 05 53
ELECTRICAL IDENTIFICATION

PART 1 - GENERAL

1.01 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including Contractual Conditions and Division 01 Specification sections apply to this section.

1.02 SUMMARY

A. This section includes the requirements for the provision and installation of identification for electrical equipment.

1.03 DESCRIPTION

A. Provide and install all equipment, labor and material for a complete identification system, including but not limited to:

1. Nameplates and labels.
2. Wire and cable markers.
3. Conduit markers.
4. Identify all new and existing conductors, conduits, boxes, equipment, etc. as specified herein.

1.04 REFERENCES AND REGULATORY REQUIREMENTS

A. Furnish products listed and classified by Underwriters Laboratories, Inc. as suitable for the purpose specified and shown.

B. Conform to the requirements of the following

1. ANSI/NFPA 70 - National Electrical Code.
2. Americans with Disabilities Act - 1990.

PART 2 - PRODUCTS

2.01 NAMEPLATES

A. Nameplates for Life Safety Branch Power shall be laminated red phenolic plastic with chamfered edges and white engraved lettering. Orange phenolic plastic border to be added around the nameplate to denote branch.

B. Nameplates for Critical Branch Power shall be laminated red phenolic plastic with chamfered edges and white engraved lettering. Green phenolic plastic border to be added around the nameplate to denote branch.

C. Nameplates for Security Branch Power shall be laminated red phenolic plastic with chamfered edges and white engraved lettering. Purple phenolic plastic border to be added around the nameplate to denote branch.

D. Nameplates for Equipment Branch Power shall be laminated red phenolic plastic with chamfered edges and white engraved lettering. Blue phenolic plastic border to be added around the nameplate to denote branch.

E. Nameplates for Normal Branch Power shall be laminated black phenolic plastic with chamfered edges and white engraved lettering.

F. Letter Size

1. 1/8 inch for identifying individual equipment and loads.

2. 1/4 inch for identifying grouped equipment and loads.

G. Nameplates shall adequately describe the function of the particular equipment involved. Where nameplates are detailed on the drawings, inscription and size of letters shall be as shown and shop drawing submitted for approval. Nameplates for panelboards and switchboards shall include the panel designation, voltage and phase of the supply. For example, "Panel A, 120/208V, 3-phase, 4-wire". In addition, provide phenolic label in the panel to describe where the panel is fed from. For example, "Fed From MDP-1:3:5". The name of the machine on the nameplates for a particular machine shall be the same as the one used on all motor starters, disconnect and P.B. station nameplates for that machine.

H. The following items shall be equipped with nameplates: All motors, motor starters, motor-control centers, push-button stations, control panels, time switches, disconnect switches, transformers, panelboards, circuit breakers (i.e., all 2 pole, 3 pole C.B.'s), contactors or relays in separate enclosures, power receptacles where the nominal voltage between any pair of contacts is greater than 150V, wall switches controlling outlets that are not located within sight of the controlling switch, high voltage boxes and cabinets, large electrical, and electrical systems (Systems Division 28) junction and pull boxes (larger than 4 11/16"), terminal cabinets, terminal boards, and equipment racks. Nameplates shall also describe the associated panel and circuit number (if applicable).

I. All Electrical System panels, transfer switches, etc. shall be labeled per branch, i.e.: "Panel ABC-Life Safety Branch" (similar for critical or equipment branch).

J. All receptacles shall be clearly labeled with panel/circuit designation.

K. All junction/pull boxes shall receive phenolic labels clearly labeling circuitry/cabling/etc., within.

2.02 WIRE MARKERS

A. Description: Cloth, tape, split sleeve, or tubing type wire markers.

B. Locations: Each conductor at panelboard gutters, pull boxes, outlet and junction boxes, and each load connection.

C. Legend

1. Power and Lighting Circuits: Branch circuit or feeder number indicated on drawings including neutral conductor.

2. Low voltage circuits (circuits under 120V):

D. Control wire number indicated on schematic and interconnection diagrams on shop drawings.

2.03 CONDUIT/JUNCTION BOX COLOR CODE

A. All conduit system junction boxes (except those subject to view in public areas) shall be color coded as listed below:

Color Code for Junction Boxes	Krylon Paint Number
System Emergency 277/480 volt	Cherry Red K02101
System Emergency 120/208 volt	Zinger Pink S01150
Fire Alarm	Popsicle Orange K02410
Normal Power 277/480 Volt	Leather Brown K02501
Normal Power 120/208 Volt	Glossy Black K01601
Fiber Optics	Plum Purple K01929
Sound System	Daisy Yellow K01813
Clock	Light Blue S01540
Intercom	True Blue K01910
Computer Data	Gold K01701
TV	Glossy White K01501
BAS	Cameo White K04129
FIDS/BIDS	Saddle Tan K03554
Security/CCTV	John Deer Green K01817
Telephone	Clover Green K02012
Grounding	Fluorescent Green K03106
Access Control System	John Deer Green K01817
Dictaphone	Dusty Pink K02117
Lightning Detection & Notification	Global Blue K03546
Elevator Status	Georgia Clay K03531
800 Mhz Radio	Copper Metallic K02203
FCIC	Clover Green K02012
Positron	Clover Green K02012
DC Controls	Clover Green K02012
Duress	Fresh Salmon K03536
Fire Pump Status	Popsicle Orange K02410
Emergency Generator Status	Zinger Pink S01150

B. Conduits (not subject to public view) longer than 20 feet shall be painted with above color paint band 20 ft. on center. The paint band shall be 4" in length. Where conduits are parallel and on conduit racking, the paint bands shall be evenly aligned. Paint shall be neatly applied and uniformed. Paint boxes and raceways prior to installation or tape conduits and surrounding surfaces to avoid overspray. Paint overspray shall be removed.

C. Emergency (Backed by Generator). The conduit shall be painted red 20 ft. on center. Paint band shall be 4” in length. A smaller band, 1” in length, centered over the 4” red band shall be applied to denote Emergency Branch as follows:

Emergency Branch	Color Band
Life Safety	Orange
Critical	Green
Security	Purple
Equipment	Blue

D. Junction boxes and conduit located in public areas (i.e. areas that can be seen by the public) shall be painted to match the surface attached to. Provide written request to the Designer for interpretation of those public areas which may be in question.

E. Where two colors apply to the same raceway, paint on opposite corners leaving the room for panel/ckt./system/etc., labeling in the center.

F. The Contractor may utilize conduit banding tape instead of paint, on interior conduits only, where specified colors are available. The surface of conduits shall be thoroughly cleaned prior to tape application, and tape shall be applied in a neat and workmanlike manner. Tape to be manufactured by Seton Identification Products only.

2.04 CONDUIT/JUNCTION BOX MARKER

A. All new and existing junction boxes/cover plates for power, lighting and systems (except those installed in public areas) shall adequately identify its associated systems panel and circuit number. Identification shall be by means of a black permanent marker. (Paint one-half cover plate with appropriate color above, and one-half with associated panel/circuit or system as described above.)

2.05 DEVICE COVER PLATE IDENTIFICATION

A. Description: Self-adhesive clear printed labels with Black typed letters (pre-printed, dot matrix, or laser).

B. Locations

1. Each new receptacle cover plate.
2. Each existing receptacle cover plate in areas of remodel/renovation.
3. Each new communications cover plate (Systems Division 28).
4. Each existing communications cover plate (Systems Division 28) in areas of remodel/renovation.

C. Legend

1. Receptacle plates shall adequately describe its associated panelboard and circuit reference.
2. System plates shall adequately describe its terminal board, or terminal cabinet, termination cable identifier and assigned user code number.

2.06 UNDERGROUND WARNING TAPE

A. Description: 6-inch-wide plastic foil-backed warning tape, detectable type, colored yellow with suitable warning legend describing buried electrical lines, one strip per 18” of duct.

PART 3 - EXECUTION

3.01 PREPARATION

A. Degrease and clean surfaces to receive nameplates and labels.

3.02 APPLICATION

A. Install nameplate parallel to equipment lines.

B. Secure nameplate to equipment front using stainless steel pop rivets or permanent self-adhesive backing.

C. Secure nameplate to inside surface of door on panelboard that is recessed in finished locations.

D. Nameplates installed inside on dead front cover shall be self-adhesive tape. (Do not drill or install screws in dead front.)

E. Identify new and existing conduit, junction boxes, and outlet boxes using field painting.

F. Identify new underground conduits using underground warning tape. Install one tape per 18 inches of trench at 24 to 30 inches below finished grade and/or at least 6 inches above conduits.

G. Install wire markers at all new and existing connections and terminations.

END OF SECTION

SECTION 26 11 14

DRY TYPE TRANSFORMERS

PART 1 - GENERAL

1.01 DESCRIPTION:

A. The work required under this section of the Specifications consists of the furnishing, connection and installation of dry type transformers.
B. Definition: Dry type transformers, as described herein, applies to those with primary and secondary voltage connections of 600 volts and less. Autotransformers are not acceptable, except where indicated for buck boost or zigzag connections.

1.02 QUALITY ASSURANCE:

A. Referenced Industry Standards: The following Specifications and standards are incorporated into and become a part of this Specification by reference. Except where a specific date is given, the issue is effect (including amendments, addenda, revisions, supplements and errata) on the date if invitation for bids, shall apply. In text, such Specifications and standards are referenced to by designation only.

1. Underwriter's Laboratories, Inc. (U.L.) Publications:
    a. No. 506: Transformers (1000 KVA, 3 phase and below; 167 KVA, 1 phase and below)
2. National Fire Protection Associations (NFPA):
    a. No. 70: National Electrical Code (N.E.C.)
3. National Electrical Manufacturers Association (NEMA):
    a. No. ST-20: Dry-type transformers for general applications
4. American National Standards Institute (ANSI):
    a. No. C89.2

B. Acceptable Manufacturers: Product of the following manufacturers, which comply with these Specifications, are acceptable.

1. Eaton/Cutler Hammer Heavy Duty
2. General Electric
3. Square D
4. ITE/Seimens

C. Coordination: Coordinate installation with architectural and structural features, equipment installed under other sections of the Specifications and electrical

equipment to insure transformer access, clearance minimums are provided, and adequate ventilation is permitted.

1.03 SUBMITTALS:

A. Refer to Section 26 01 00, "Basic Electrical Requirements," for submittal requirements.
B. Manufacturers Product Data:

1. Submit material specifications and installation data for products specified under Part 2 - Products. Product data shall indicate sound and temperature rating, overload capacity and efficiency at 25%, 50% and 100% load, available taps, voltage, impedance, nameplate data, wiring diagrams, physical dimensions and net weight. Product data shall also contain certification that transformers are constructed and tested in accordance with standards specified herein.

C. Record Drawings. Include in each set:

1. A complete set of manufacturers product data indicating all post bid revisions and field changes.

PART 2 - PRODUCTS

2.01 GENERAL MATERIALS REQUIREMENTS:

A. Furnish all materials specified herein and indicated on the drawings.
B. All transformers shall be U.L. listed and bear a U.L. label.
C. Transformers shall be self-cooled rated for continuous operation at rated KVA, 24 hours per day, 365 days per year with normal life expectancy (IEEE Standard No. 65). KVA ratings shall be as indicated on the drawings.

2.02 GENERAL PURPOSE DRY TYPE TRANSFORMERS:

A. Insulation System

1. Single phase 25 - 167 KVA and three phase 30 - 1500 KVA: Transformers shall be rated for average temperature rise by resistance of [150] [115] [80] degrees C. in 40 degrees C. maximum ambient, 30 degrees C. average ambient. Transformer insulation system shall be UL rated as 220 degrees C. system.

B. Sound rating shall not exceed NEMA and ANSI standards for KVA rating. Internal vibration dampening shall be provided as a standard feature of all transformers.
C. Single-phase transformers rated up to 15 KVA shall have two, 5 percent full capacity taps below normal rated primary voltage. All other single phase and all three phase transformers shall be provided with six 2-1/2% full capacity taps, two above and four below normal voltage unless only four 2-1/2% taps, two above and two below normal voltage, are standard.
D. Construction and Enclosures

1. Transformers 30 - 1500 KVA: Transformer enclosures shall be open, ventilated, drip-proof with removable front and rear cover panels. Transformers

shall be suitable for floor mounting, unless wall mounting is indicated on the drawings.

E. Dry type transformers shall provide 3 phase, 4 wire, 208Y/120 volt service to designated panelboards or other equipment. Primary rating shall be 480 volts.
F. Nominal transformer impedance shall be 4.5 percent minimum, unless otherwise indicated on the drawings.
G. Core assemblies and the center ground connection point of the coil secondaries shall be grounded to their enclosures by adequate, flexible ground straps. Provide grounding lug at the strap to enclosure bonding location for connection of three conductors; the primary and secondary equipment grounding conductors and the grounding electrode conductor.
H. Provide K-factor rated transformers where indicated. Transformer shall be marked "suitable for non-sinusoidal current load with K-factor not to exceed x" where x = the UL-listed K-factor rating (x= 4, 9, 13, 20, 30, 40 or 50). Transformers that feed equipment controlled by a PLC, controls equipment or PC's shall have a minimum K-factor rating of 4 to minimize harmonic interference.

PART 3 - EXECUTION

3.01 INSTALLATION:

A. Dry type transformers larger than 15 KVA shall be floor mounted, unless wall or suspension mounting is indicated on the drawings. Transformers 15 KVA and smaller shall be wall mounted. Installation shall provide not less than 12" clearance from combustible materials and not less than six inch clearance from walls or equipment. Where floor mounted, bolt transformer to building floor slab per manufacturer's directions but with no less than (4) ½" diameter concrete wedge anchors with a minimum of 4" of concrete embedment or per seismic requirements for the area. Floor mounted transformers shall be mounted on neoprene, waffle type vibration pads, 5/8" thick. Where transformers are indicated on the drawings, or specified herein to be mounted on suspended channels of angles or mounted, transformers shall be bolted to structure with 5/8" thick vibration pad between transformer base and structural surface.
B. Primary and secondary connections to dry type transformers shall be made with flexible conduit.
C. The secondary windings of each dry type transformer shall be grounded in accordance with the National Electrical Code requirements for separately derived electrical systems. Extend a grounding electrode conductor from the transformer grounding lug to the nearest building structural steel or main column rebar. Connect the primary and secondary feeder, equipment grounding conductors to the grounding lug, also. Refer to the grounding section of these Specifications for additional requirements.
D. Install secondary overcurrent protective device within 10 feet horizontally from transformer. Where none is indicated on plans, provide enclosed circuit breaker within 10 feet rated at 125 percent of the transformer full load ampacity but not greater than the secondary conductor ampacity.
E. Do not install equipment over transformers, unless indicated on the drawings.

F. Locate transformers to provide working clearance and full accessibility as required by the National Electrical Code.

3.02 CLEANING AND ADJUSTMENT:

A. Prior to final inspection, under maximum available load, measure secondary voltage and adjust tap setting to deliver nominal rated voltage within the percentage limits of one tap setting. Record the voltages of each transformer and submit in accordance with the requirements specified in Section 26 01 00.
B. After completion, clean the interior and exterior of dirt, paint and construction debris.
C. Touch up paint scratched or marred surfaces with factory furnished touch up paint of the same color as the factory applied paint.

3.03 IDENTIFICATION

A. Refer to Section 26 05 53 for Identification requirements

END OF SECTION

SECTION 26 24 16
PANELBOARDS

PART 1 - GENERAL

1.01 DESCRIPTION

A. The work required under this section of the specifications consists of the furnishing, installation and connection of lighting and appliance panelboards and distribution type panelboards.

B. Definitions: The term panelboard, as used in this Specification or on the drawings, shall mean the complete assembly including the enclosure, bus work, trim hardware and circuit breaker or fused devices. The words panel and panelboard are used synonymously in these contract documents.

1.02 QUALITY ASSURANCE

A. Industry Referenced Standards. The following Specifications and standards are incorporated into and become a part of this Specification by Reference. Except where a specific date is given, the issue in effect (including amendments, addenda, revisions, supplements and errata) on the date of invitation for bids, shall apply. In text, such specifications and standards are referenced to by basic designation only.

1. Underwriter's Laboratories, Inc. (U.L.) Publications:

    a. No. 50: Cabinets and Boxes, Electrical
    b. No. 67: Panelboards
    c. No. 489: Molded Case Circuit Breakers and Circuit Breaker Enclosures

2. Federal Specifications (Fed. Spec.):

    a. WC-375: Circuit Breakers
    b. W-P-115C: Power Distribution

3. National Electrical Manufacturer's Association (NEMA) Publications:

    a. No. PB-1: Panelboards
    b. No. PB-1.1: Instructions for Safe Installation, Operation and Maintenance of Panelboards Rated 600 Volts or less.
    c. No. AB-1: Molded Case Circuit Breakers

4. National Fire Protection Association (NFPA):

    a. No. 70: National Electrical Code (N.E.C.)

5. National Electrical Contractor Association (NECA)

    a. Standard of Installation

B. Acceptable Manufacturers: Products of the following manufacturers, which comply with these Specifications, are acceptable.

1. General Electric
2. Westinghouse/Cutler Hammer
3. Square D
4. I.T.E./Siemens-Allis

C. Coordination: Coordinate installation with architectural and structural features, equipment installed under other sections of the Specifications and electrical equipment to ensure panel access and so that clearance minimums are provided.

1.03 SUBMITTALS

A. Refer to Section 26 01 10, “Electrical Submittals”, for submittal requirements.

B. Manufacturers Product Data:

1. Submit material Specifications and installation data for products specified under Part 2 - Products to include:

   a. Circuit Breakers
   b. Panelboards
   c. Fuse switch devices

C. Shop Drawings: Submit shop drawings to indicate information not fully described by the product data to indicate compliance with the contract drawings.

1. Include electrical characteristics and ratings for each panelboard with dimensions, mounting, bus material, voltage, ampere rating, mains, poles and wire connection, and any accessories. Indicate method of ground bus attachment to the enclosure.

2. Include a bussing diagram indicating each bussing circuit breaker position.

3. Provide a schedule indicating circuit breaker type, trip and size, poles, frame type, interrupting capacity.

D. Record Drawings. Include in each set:

1. A complete set of panelboard manufacturers product data and shop drawings indicating all post bid revisions and field changes.

2. A copy of each panelboard directory incorporating all post bid revisions and field changes.

PART 2 - PRODUCTS

2.01 GENERAL MATERIALS REQUIREMENTS

A. Furnish all materials specified herein.

B. All panelboards and circuit breakers shall be U.L. listed and bear a U.L. label. Where the panel serves as service entrance equipment, the panel shall bear a U.L. label indicating suitability as service entrance equipment.

C. Panels shall be of the dead front safety type.

D. Provide panels complete with factory assembled circuit breakers connected to the bus bars in the positions shown on the panel schedules or bus diagrams as indicated on the drawings. Where not shown on the drawings, position circuit breakers in panelboards with single pole breakers, equally divided, occupying top positions with two and three pole breakers occupying lower positions.

E. Number all panelboards circuit in the following sequence:

1. Circuits No. 1 and 2, Phase A; Circuits No. 3 and 4, Phase B; Circuits No. 5 and 6, Phase C. Connect two-pole breakers to phase indicated on the drawings.

2.02 BUSSING AND INTERIORS

A. All bus bars shall be copper. Main lugs and main breakers shall be U.L. approved for copper or aluminum conductors and shall be of a size range for the conductors indicated on the drawings. Each panel shall contain a full size insulated neutral bus. Where distribution type panelboard is indicated on the drawings to have a neutral bus, the bus shall be insulated and full size, unless otherwise indicated on the drawings.

B. The neutral and ground bus shall have a sufficient number of lugs to singularly terminate each individual conductor requiring a connection.

C. The ground bus shall be factory brazed, riveted or installed on studs welded to the panel enclosure. The ground bus shall not be attached to the panel interior.

D. Where designated on panel schedule as “space”, include all necessary bussing, device support and connections. Provide a blank cover for each space.

E. Where specified or indicated on the drawings, provide feed-through lugs opposite end of mains] and increase box heights to provide additional cable bending and termination space. Lugs to be the same size and capacity as mains and rated for aluminum or copper conductor terminations.

2.03 ENCLOSURES

A. Panelboards width shall not be less than twenty inches unless indicated on the drawings. Panelboard depth shall not exceed 5-¾ inches. Maximum enclosure width shall be twenty-two inches for panelboards less than 400 amp, forty-eight inches for 600 amp and less.

B. Distribution panelboard width shall not be less than 32 inches and the depth shall not exceed 11 inches.

C. Review panelboard schedules and system one-line diagram and provide panelboard gutter and bending space at terminals to conform to the National Electrical Code.

D. Provide concealed captive clamping devices, concealed hinges and chrome lock for all flush and surface mounted panels. Key all panels throughout the project alike.

E. All surface mounted panels shall be provided with door-indoor-hinged cover trims. Trims to be secured by piano hinges to the enclosure and secure closed by two trim clamps.

F. Where two-section panels are required, both sections shall have a fully-rated bus, separate cabinets connected by conduit nipples. Interconnect sections with copper conductors with ampacity equal to the rating of the main bus. Route phase and neutral conductors together between panels. Provide separate trims for each section.

G. Provide a directory card, metal holder, and transparent cover permanently mounted on the inside of doors.

H. Where indicated on the drawings or required for the environmental conditions, provide the following NEMA rated enclosure:

1. Type 3R, Interior damp and typical outdoor locations.

2. Type 4X, Interior wet and exterior wet locations where occasional moisture can be wind-driven.

3. Type 4X stainless steel watertight, Interior and exterior wet locations where moisture is regularly wind-driven or pressure-driven conditions (wash-down areas or similar) or if corrosive conditions are present regardless of the noted drawings.

4. Type 7, Hazardous areas regardless of any other conditions.

2.04 CIRCUIT BREAKERS

A. Interrupting rating of all circuit breakers in panelboards operating on 208Y/120 volt system shall have U.L. rating of not less than 18,000 RMS symmetrical amps at system voltage. Panelboards for use on 480Y/277 volt system shall contain circuit breakers with U.L. interrupting rating of not less than [25,000] [65,000] RMS symmetrical amps at system voltage. Provide circuit breakers with higher interrupting capacity when indicated on the drawings.

B. Circuit breakers shall be provided with trip rating, poles and minimum interrupting rating as indicated on the drawings or specified herein. Where “Circuit Breaker Class” is indicated, designation refers to Federal Specialization W-C375B and indicates the frame size and interrupting rating.

C. Multi-pole breakers shall be common trip and common reset; tie handle connection between single pole breakers is not acceptable.

D. Branch circuit breakers in lighting and appliance panels shall be quick-make, quick-break, thermal-magnetic type bolted to the bus. Circuit breakers in distribution type panelboards shall be bolted to the bus except, Square D I-line style plug-in devices are acceptable.

E. Molded case circuit breakers shall have automatic, trip-free, non-adjustable, inverse time, and instantaneous magnetic trips for 100 ampere frame or less. Magnetic trip shall be adjustable from 3X to 10X for breakers with 600 ampere framers and higher. The factory setting shall be HI, unless otherwise noted.

F. Provide the following special devices and accessories when indicated on the drawings or specified herein.

1. Ground fault interrupting circuit breakers (GFI) where indicated on the drawings or required by the NEC.

2. Provide handle lock-off device to prevent manually turning off the device without removal. Install on all circuit breakers serving exit lighting, egress lighting, fire alarm system, security system, communications system, refrigeration equipment.

3. Provide a shunt trip device for electrically tripping circuit breakers indicated on the drawings. Shunt trip to be for operation on a 120V source and have integral coil clearing contacts to de-energize the coil after an operation. Connect shunt trip to circuit indicated on the drawings.

2.05 SEPARATELY ENCLOSED MOLDED CASE CIRCUIT BREAKERS

A. Where separately enclosed molded case circuit breakers are shown on the drawings, provide circuit breakers in accordance with the applicable requirements of those specified for panelboards.

2.06 CURRENT LIMITING CIRCUIT BREAKERS

A. Feeder protective devices as shown shall be molded case circuit breakers built and tested and U.L. labeled per U.L. 489.

B. Breakers 100 ampere frame shall be a thermal magnetic trip with inverse time current characteristics. Breakers 400 amp and 250 ampere frame shall be solid-state trip complete with built-in current transformers, solid-state trip unit and shunt trip. Breakers shall have changeable trip rating plugs with a trip rating as indicated on the drawings. Rating plugs shall be interlocked so they are not interchangeable between frames and interlocks such as the breaker cannot be latched with the rating plug removed. Breakers shall have built-in test points for testing long delay and instantaneous and ground fault (where shown) functions of the breaker by means of 120 volts operated test kit.

2.07 FUSIBLE SWITCH DEVICES

A. Protective devices shall be quick-make, quick-break fusible switches. Fusible switches rated 30 to 600 amperes shall have fuse clips suitable for Class [R] [J] fuses shall be U.L. listed at 100,000 A.I.C. Fusible switches 800 amperes through 1200 amperes shall be furnished with Class L fuse clips and U.L. labels for 200,000 A.I.C. Switches shall incorporate safety cover interlocks to prevent the opening of the cover with a switch in the “on” position or prevent placing the switch in the “on” position with a cover open provide a defeater means for authorized personnel. Handles shall have provisions for padlocking and shall clearly indicate the “on” or “off” position. Front cover doors shall be padlockable in the closed position.

B. The following accessories shall be provided where shown on the drawings:

1. U.L. listed 120 volt shunt trip attachment with 480 volt to 120 volt fused primary and secondary control power transformer.

2. Zero sequence ground fault protection system including test panel. Ground fault relay shall include separate time and current pick adjustment.

2.08 SERVICE ENTRANCE EQUIPMENT

A. Panelboards used as service entrance equipment shall be listed and labeled by UL for use as service equipment.

PART 3 - EXECUTION

3.01 INSTALLATION

A. Mount panelboards with top circuit breaker not more than 6’-6” above the finished floor.

B. Lace and group conductors installed in panels with nylon tie straps. Only one conductor is installed under the terminal of individual circuit breakers. Form and train conductors in panel enclosure neatly parallel and at right angles to sides of the box. The uninsulated conductor shall not extend beyond one-eighths inch from the terminal lug.

C. Do not splice conductors in panels. Where required, install a junction box adjacent to the panel and splice or tap conductors in the box. Refer to the number of conductors and cables section of the Specifications and do not exceed.

D. Mounting and Support

1. Mounting

a. The enclosure shall be secured to the structure by a minimum of four (4) fastening devices. Panelboards 600 amp and larger shall be secured by a minimum of eight (8) devices. A 1.5 inch minimum diameter round washer shall be used between the head of the screw or bolt and enclosure.

b. Enclosures shall be mounted where indicated on the drawings or specified herein. Support from the structure with a fastening device specified.

c. Attach enclosure directly to masonry, concrete, or wood surfaces.

d. Mount enclosure on a metal channel (strut), which is connected to structure with a fastening device specified, for installation on steel structure or sheetrock walls.

E. Conductors not terminating in the panelboard shall not extend through or enter the panel enclosure.

F. Maintain conductor phase color code requirements described in the conductors and cables section of the specifications.

G. Provide in each panelboard a typewritten circuit directory mounted under clear plastic in metal directory frame on the interior or panel door. Directory shall reflect any field changes or additions.

H. Provide four each 1 inch spare conduits out of each recessed panelboard to an accessible location above the ceiling. Identify each as SPARE.

I. Provide a separate neutral conductor for each GFI breaker. These shall not be combined to serve more than 1 circuit, even where on different phases. Increase plan indications of conductors for neutral wires required, as necessary.

J. Conduit or piping systems that contain water or liquid of any kind shall not be installed over the top of any electrical equipment, transformers, racks, cabinets, or enclosures without prior written approval from the Owner.

3.02 SPARES

A. Supply 1 spare panel breaker for each 20 breakers (or portion thereof) of each breaker size and type installed on the project (minimum 1 each).

B. Spares are to be turned over to the owner after substantial completion.

END OF SECTION

SECTION 26 27 13
ELECTRICAL LADDER RACK SYSTEM

PART 1 - GENERAL

1.01 SUMMARY

A. This Section specifies the furnishing, installation, and testing of an electrical ladder rack system for supporting and routing electrical cables.

1.02 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specifications Sections.

B. Division 26 – Electrical Systems (as applicable)

C. National Electrical Code (NEC): (latest edition)

1.03 REFERENCES

A. American National Standards Institute (ANSI) / National Fire Protection Association (NFPA) 70 - National Electrical Code (NEC)

B. International Electrotechnical Commission (IEC) 61537 - Cable Tray Systems and Cable Ladder Systems for Cable Management

1.04 SUBMITTAL PROCEDURES

A. Product Data: For each type of product used, include dimensions and manufacturer's data sheet with technical specifications, material descriptions, load ratings, and installation instructions.

B. Shop Drawings: Show location, size, and routing of ladder racks, including support locations, fittings, and cable layout. Indicate potential conflicts with other building elements.

1.05 QUALITY ASSURANCE

A. Qualifications

1. Installer shall be experienced in the installation of electrical ladder rack systems.

B. Inspection

1. The Engineer shall inspect the ladder rack system for compliance with the Contract Documents.

1.06 SPECIAL PROVISIONS

A. Include any specific project requirements, such as:

1. Seismic zone requirements
2. Cable management accessories (e.g., cable ties, cable tray dividers)
3. Fireproofing requirements (if applicable)

PART 2 - PRODUCTS

2.01 LADDER RACK SYSTEM

A. Material: Stainless steel or aluminum (as specified on drawings)

B. Finish: machined or mill finish (as specified)

C. Size: As indicated on drawings (common sizes include 6", 9", 12”, and 18" rung spacing. Rung spacing recommendation for this project is 9” or 12”.

D. Load Rating: Meet or exceed NEC and project-specific requirements for cable weight and configuration.

E. Manufacturer: Listed and labeled by a nationally recognized testing laboratory (NRTL) for compliance with applicable standards. Approved make and manufactures are:

1. Eaton Cooper B-Line Series
2. Eaton Cooper MP Husky
3. Hubbel
4. Square D

2.02 FITTINGS

A. Bends, elbows, tees, crosses, and other fittings as required to route ladder rack around obstacles and maintain cable separation.

1. The minimum conductor bending radius should be keep in mind when selecting fittings to be used on all ladder runs.
2. The size and number of conductors shall be taken into consideration when sizing the ladder rack for each ladder run section.

B. Material and finish compatible with ladder rack system.

C. Rated for the same load capacity as the ladder rack system.

D. Expansion splice plates and standard section joint splice plates

2.03 SUPPORT HARDWARE

A. Wall brackets, floor stands, overhead supports, and other hardware as required for secure installation of the ladder rack system.

B. Material and finish compatible with ladder rack system and building structure.

C. Designed to support the specified load capacity of the ladder rack system.

PART 3 - EXECUTION

3.01 INSTALLATION

A. Comply with manufacturer's instructions and approved shop drawings.

B. Install ladder rack system level, plumb, and securely fastened to supports.

C. Maintain proper spacing between cables as required by NEC and project specifications.

D. Debur all cut edges of the ladder rack system.

E. Ground the ladder rack system in accordance with NEC requirements. All ladder racks shall be adequately bonded together, including at expansion joints, elevation transitions and spur conduit runs.

F. Conductors on the ladder rack shall be directly secured to the rack and not secured to other conductors already in the rack.

3.02 INSPECTION

A. Allow the Engineer to inspect the installed ladder rack system prior to cable installation.

3.03 CLEANING

A. Remove debris and leave the ladder rack system clean and free from construction materials.

END OF SECTION

SECTION 26 28 16.1
DISCONNECT SWITCHES

PART 1 - GENERAL

1.01 DESCRIPTION

A. This section covers disconnect switches for electrical equipment, 600V and below, and fuses mounted in the disconnect devices.

B. Furnish and install disconnect switches for any of the following conditions:

1. Where indicated on the drawings.
2. For all motor controllers unless installation conforms to exceptions in the National Electrical Code.
3. For all motors located out-of-sight of its motor controller.
4. Where required by the National Electrical Code.

1.02 QUALITY ASSURANCE

A. Referenced Industry Standard: The following Specifications and Standards are incorporated into and become a part of the Specification by reference. Except where a specific date is given, the issue in effect (including amendments, addenda, revisions, supplements and errata) on the date of invitation for bids, shall apply. In text, such specifications and standards are referenced to by basic designation only.

1. Underwriter's Laboratories, Inc. (U.L.) Publications
   a. No. 98: Enclosed Switches
   b. No. 198.2: High-Interrupting Capacity Fuses, Current Limiting Type
   c. No. 198.4: Class R fuses
2. National Fire Protection Association (NFPA) Publications
   a. No. 70: National Electrical Code (N.E.C.)
3. National Electrical Manufacturers Association (NEMA) Publications:
   a. No. KS 1: Enclosed Switches
4. Federal Specification (Fed. Spec.)
   a. No. WS-865-C

B. Acceptable Manufacturers: Products of the following manufacturers, which comply with these Specifications, are acceptable:

1. General Electric
2. Cutler-Hammer
3. Westinghouse
4. Square D
5. ITE-Seimens Allis

C. Coordination: Coordinate installations with architectural and structural features, equipment installed under other sections of the Specifications and electrical equipment to ensure disconnect switch access and so that clearance minimums are provided.

PART 2 - PRODUCTS

2.01 GENERAL MATERIAL REQUIREMENTS

A. Furnish all materials specified herein.
B. All disconnects and fused shall be U.L. listed and bear a U.L. label.
C. Switches shall be heavy-duty, type, minimum 30 amp rated, unless a larger size is indicated, and type HD horsepower rated as required when motor load is served.
D. Switches shall be 600 volt rated, except for use in systems below 240 volt, when they may be 250 volt rated.
E. Furnish a solid neutral bus or lug for each switch being installed in a circuit which includes a neutral conductor.
F. Furnish an equipment grounding conductor lug bonded to the switch enclosure.
G. Disconnect switches shall be non-fusible safety switch, unless a fused type is specified or indicated on the drawings, with the number of poles required to disconnect all ungrounded conductors serving equipment.
H. The enclosure shall be NEMA Type One gasketed in all interior dry locations and shall be NEMA Type 3R in all damp, wet, or exterior locations, unless other type is indicated on the drawings or specified herein Enclosures located.

2.02 PRODUCT/MATERIAL DESCRIPTION

A. Switching mechanism shall be quick-made, quick-break type.

B. Where non-fused disconnect switches are indicated on the drawings or specified for use as disconnects, they shall be the non-fused type.

C. Switches shall have the following features:
   1. Provide line terminal shields in all switches.
   2. Each switch shall have provisions for padlocking in the “OFF” position.
   3. Each switch shall have door interlocks to prevent the door from being opened when the switch is in a closed position. Provide inconspicuous means to defeat the interlock mechanism.
   4. Provide permanent nameplate indicating switch rating in voltage, amperes and horsepower.
   5. ARC chute for each pole.

D. Disconnect switches for three-phase motors rated two horsepower and above shall be three-pole non-fusible type rated as indicated on the drawings. Disconnect switches for three-phase motors rated below two horsepower shall be three-pole manual motor starter switches without overload protection. Disconnect for single-phase motors shall be single or two horsepower rated switches without protection.

E. Fusible switches through 600 amp shall be provided with rejection clips to accept RK1 or RK5 fuses only. Fusible switches larger than 500 amp shall be suitable for class L fuses. Furnish and install a complete set of fuses in each disconnect sized as indicated on the drawings. Fuses serving predominately motor or transformer load shall be dual-element, time-delay type, otherwise non-time delay fast-acting type is required. Fuses shall be current limiting with 200,000 A.I.C.

PART 3 - EXECUTION

3.01 INSTALLATION

A. Locate disconnect switches to provide working clearance and full accessibility as required by the National Electrical Code.

B. Unless indicated otherwise on the drawings, locate disconnects adjacent to equipment served.

C. Lace and group conductors installed in disconnect with nylon tie straps. Only one conductor shall be installed under terminals. Form and train conductors in enclosure neatly parallel and at right angles to sides of the box. Uninsulated conductor shall not extend beyond one-eighths inch from the terminal lug.

D. Mounting and Support

1. The enclosure shall be secured to the structure by a minimum of four (4) fastening devices. Disconnect switches 600 amp and larger shall be secured by a minimum of eight (8) devices. A 1.5-inch minimum diameter round washer shall be used between the head of the screw or bolt and enclosure.

2. Mounting
   a. Enclosures shall be mounted where indicated on the drawings or specified herein. Support from the structure with a fastening device specified.
   b. Attach enclosure directly to masonry, concrete, or wood surface.
   c. Attach enclosure on a metal channel (strut), which is connected to structure with a fastening device specified, for installations on steel structure, sheet metal equipment enclosure, or sheetrock walls.
   d. Where enclosure is not indicated on a wall or structure, construct a metal channel (strut) free-standing frame secured to floor, pad, or other appropriate building structure. Refer to the detail on the drawing for frame installation and construction information.
   e. Mount switch with the handle between 36” and 60” above floor or grade, unless otherwise indicated on the drawings.

E. Do not splice conductors in the enclosure. Where required, install junction box or wireway adjacent to disconnect and splice or tap conductors in the box. Refer to the number of conductors in a conduit limitation defined in the conductors and cables section of the Specifications and do not exceed.

F. Conductors not terminating in disconnect shall not exceed through or enter a disconnect enclosure.

G. Install push-in knock-out closure plugs in any unused knock-out openings.

H. Identification
1. Disconnect switches shall be identified with a 1” x 3” laminated engraved plastic nameplate.
2. Refer to the electrical general section of the Specifications for identification requirements.

3.02 CLEANING AND ADJUSTMENT

A. After completion, clean the interior and exterior of dirt, paint and construction debris.

B. Touch up paint all scratched or marred surfaces with factory furnished touch up paint of the same color as the factory-applied paint.

END OF SECTION

SECTION 26 29 13.03

MANUAL MOTOR CONTROLLER - 600V

PART 1 - GENERAL

1.01 DESCRIPTION

A. The work required under this section of the Specifications consists of the installation of manual or magnetic starters for use on systems 600 Volts and below for all integral or fractional horsepower motors not controlled by starters in a motor control center or by starters provided as an integral component of a specific piece of equipment.

B. Definition: The words motor control units, starters, and motor controllers are used synonymously in these contract documents.

1.02 QUALITY ASSURANCE

A. The following Specifications and standards are incorporated into and become a part of this specification by reference. Except where a specific date is given, the issue in effect (including amendments, addenda, revisions, supplements and errata) on the date of invitation for bids, shall apply. In text, such Specifications and standards are referenced by the basic designation only.

1. Federal Specifications (Fed. Spec.)
   a. W-C-375: Circuit Breakers, Molded Case
   b. W-F-1814: Fuse, Cartridge, High Interrupting Capacity

2. National Electrical Manufacturers Association (NEMA) Standards
   a. ICS-1: General Standards for Industrial Control and Systems
   b. ICS-2: Industrial Control Devices, Controllers and Assemblies.
   c. ICS-3: Industrial Systems
   d. ICS-4: Terminal Blocks for Industrial Control Equipment and Systems
   e. ICS-6: Enclosures for Industrial Controls and Systems

3. Underwriter's Laboratories, Inc. (U.L.) Publications
   a. UL 198.2: High Interrupting Capacity Fuses, Current Limiting Type
   b. UL 198.4: Class R Fuses
   c. UL 508: Industrial Control Equipment

4. National Fire Protection Association (NFPA)
   a. NFPA 70: National Electrical Code

5. American National Standards Institute (A.N.S.I.)
   a. C97.1: Low Voltage Cartridge Fuses, 600 Volts or Less

B. Acceptable Manufacturers: Products of the following manufacturers, which comply with these Specifications, are acceptable.

1. Motor control centers and controllers:
   a. Westinghouse/Cutler-Hammer
   b. Square D
   c. General Electric
   d. Allen-Bradley

e. Siemens (I.T.E.)

C. Coordination

1. Review shop drawings submitted under this and other sections, as well as other divisions, to ensure coordination between work required among different trades. Coordinate the installation sequence with other contractors to avoid conflicts and to provide the fastest overall installation schedule.

2. Coordinate installation with architectural and structural features, equipment installed under other sections of the Specifications and electrical equipment to ensure access and so that clearance minimums are provided.

PART 2 - PRODUCTS

2.01 GENERAL

A. Furnish all materials specified herein. Provide a starter for each motor furnished on the project, except where controllers are specified to be furnished as integral with the motor/equipment.

B. Motor starter units, circuit breakers, and fused devices shall be U.L. listed and bear the U.L. label.

C. The enclosure shall be NEMA Type 12 gasketed in all interior dry locations and shall be NEMA Type 3R stainless steel in all damp locations and or 4X stainless in wet or corrosive exterior locations, unless other type is indicated on the drawings or specified herein.

D. The motor starters shall be rated for the system voltage in which they are installed.

E. Magnetic motor starters shall be across-the-line, full voltage, non-reversing type, unless otherwise indicated on the drawings or specified herein.

F. All combination starters shall have provisions for padlocking unit handle in the open de-energized position.

G. Furnish an equipment grounding conductor lug, bonded to the started enclosure.

2.02 PRODUCT/MATERIAL DESCRIPTION

A. Magnetic starters shall be minimum NEMA Size 0, the combination type, motor circuit protectors unless otherwise indicated on the drawings or specified herein. U.L. listed interrupting rating of motor circuit protectors shall not be less than indicated on the drawings at system voltage.

B. Each magnetic starter shall have three overload relays. The control voltage shall be 120 volts provided from a control power transformer built into the starter. Provide a fuse for the control coil in the primary circuit for each phase connection.

C. Manual motor starters shall be manually operated, trip-free, quick make quick break switching device with motor running protection overload heaters elements in each underground conductor of the motor circuit. Provide red neon "running" pilot lamp on the cover of the starter.

D. Magnetic starter doors shall be interlocked to prevent the door from being opened until the switch is in the "OFF" position. However, a "cheater screw" or other inconspicuous means shall be provided to permit access to the energized starter, by authorized personnel. An interlock contact shall be provided within the starter to open the control circuit to the magnetic starter when the device handle is in the open position. A door activated interlock switch is not acceptable.

E. Each magnetic starter shall be provided with a H.O.A. switch, on-off switch, start-stop push bottom or provisions for remote mounted control device as indicated on the drawings. Where not indicated on the drawings, provide an H.O.A. switch for any motors automatically controlled or an ON-OFF switch for those specified to be manually controlled. Provide each magnetic starter with a "RUN" and "OVERLOAD" pilot lamp. Control devices shall be of oil-tie construction. Identify each control and pilot device with a metal tag or plastic laminated label.

F. Overload heaters shall be non-adjustable and manually reset melting alloy or bi-metallic type shall be selected in accordance with the full load rating of motors actually furnished. A heater schedule applicable to starter size shall be provided on the inside of the door of each magnetic starter. The relay switching mechanism in magnetic starters shall be single pole, double throw normally open position connected to operate a door mounted, oil-tie blue pilot lamp to indicate the starter has tripped on overload.

G. Provide contracts in magnetic starters to provide interlocking control sequence of operation specified under Division 13, 15, or 16. Provide one N.O. and one N.C. spare auxiliary contact in each starter.

H. Starter sizes are based on design conditions using horsepower ratings of motors indicated on drawings. If motors actually furnished have horsepower ratings other than those indicated, motor starters and feeders shall be adjusted in accordance with the rated horsepower at no additional cost to the Owner.

I. Nameplates

1. Each magnetic and manual motor starter shall be provided with an engraved plastic nameplate approximately 1" x 3" permanently attached to the unit exterior door of magnetic starters or to the wall above or below manual motor starters.

2. Refer to the electrical general section of these Specifications for nameplate requirements.

PART 3 - EXECUTION

3.01 INSTALLATION

A. Locate motor starters to provide working clearance and full accessibility as required by the National Electrical Code.

B. Lace and group conductors installed in starter with nylon tie straps. Only one conductor shall be installed under terminals. Form and train conductors in enclosure neatly parallel and at right angles to sides of the box. The uninsulated conductor shall not extend beyond one-eighths inch from the terminal lug.

C. Mounting and Support:

1. Mounting
   a. The enclosure shall be secured to the structure by a minimum of four (4) fastening devices. A 1.5 inch minimum diameter round washer shall be used between the head of the screw or bolt and enclosure.
   b. Enclosures shall be mounted where indicated on the drawings or specified herein. Support form the structure with a fastening device specified. Mount with an operating handle at 60" AFF, unless other height is indicated.
   c. Attach enclosure directly to masonry, concrete, or wood surfaces.
   d. Mounted enclosure on a metal channel (strut), which is connected to the structure with a fastening device.
   e. Where enclosure is not indicated on a wall or structure, construct a metal channel (strut) free-standing frame secured to floor, pad, or other appropriate building structure. Refer to the detail on the drawing for frame installation and construction information.
   f. Mount starter with control devices between 48" and 60" above floor or grade, unless otherwise indicated on the drawings.

D. Do not splice conductors in the enclosure. Where required install junction box or wireway adjacent to disconnect and splice or tap conductors in the box. Refer to the number of conductors in a conduit limitation defined in the conductors and cables section of the Specifications and do not exceed.

E. Conductors not terminating at starter shall not proceed through or enter a starter enclosure.

F. Install push-in knock-out closure plugs in any unused knock-out openings.

3.02 CLEANING AND ADJUSTMENT

A. After completion, clean the interior and exterior of dirt, paint, and construction debris.

B. Touch up paint all scratched or marred surfaces with factory furnished touch up paint of the same color as the factory-applied paint.

C. Select and install overload heaters based on the full load current of the motor actually installed. All heaters which nuisance trip with the next larger size only.

D. Adjust motor circuit protector settings in accordance with the manufacturer's recommendations to sustain the motor locked rotor current.

END OF SECTION

SECTION 26 36 23
AUTOMATIC TRANSFER SWITCHES

PART 1 - GENERAL

1.01 RELATED DOCUMENTS:

A. A.Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.02 1.02 SUMMARY:

A. This Section includes transfer switches rated 600 V and less, including the following:

1. Automatic transfer switches.

1.03 REFERENCES:

A. Applicable Standards (latest edition):

1. National Electrical Manufacturer's Association (NEMA):

a. NEMA ICS 1 - Industrial Control and Systems General Requirements.

2. National Fire Protection Association (NFPA):

a. NFPA 70 - National Electrical Code.
b. NFPA 99 - Health Care Facilities Code.
c. NFPA 101 - Life Safety Code.
d. NFPA 110 - Standard for Emergency and Standby Power Systems.

3. Underwriters' Laboratories (UL):

a. UL 1008 - UL Standard for Safety Transfer Switch Equipment.

1.04 SUBMITTALS:

A. Product Data: For each type of product indicated. Include rated capacities, weights, operating characteristics, furnished specialties, and accessories.

B. Shop Drawings: Dimensioned plans, elevations, sections, and details showing minimum clearances, conductor entry provisions, gutter space, installed features and devices, and material lists for each switch specified.

1. Provide project-specific information indicating specific upstream-protective devices required to achieve indicated withstand current rating. Do not protect a transfer switch with a circuit breaker applied at its series rating.

2. Single-Line Diagram: Show connections between transfer switch, power sources, and load.

3. Controls wiring: Provide drawings showing locations of monitoring connections.

C. Qualification Data: For manufacturer

D. Manufacturer Seismic Qualification Certification: Submit certification that transfer switches accessories, and components will withstand seismic forces defined in Section 26 05 48 - Vibration and Seismic Controls for Electrical Systems.

E. Include the following:

1. Basis for Certification: Indicate whether withstand certification is based on actual test of assembled components or on calculation.

a. The term "withstand" means "the unit will remain in place without separation of any parts from the device when subjected to the seismic forces specified."

b. The term "withstand" means "the unit will remain in place without separation of any parts from the device when subjected to the seismic forces specified and the unit will be fully operational after the seismic event."

2. Dimensioned Outline Drawings of Equipment Unit: Identify center of gravity and locate and describe mounting and anchorage provisions.

3. Detailed description of equipment anchorage devices on which the certification is based and their installation requirements.

F. Field quality-control test reports.

G. Operation and Maintenance Data: For each type of product to include in emergency, operation, and maintenance manuals, including:

1. Features and operating sequences, both automatic and manual.

2. List of all factory settings of relays; provide relay-setting and calibration instructions, including software, where applicable.

1.05 QUALITY ASSURANCE:

A. Manufacturer Qualifications: Maintain a service center capable of providing training, parts, and emergency maintenance repairs within a response period of less than eight hours from time of notification.

B. Source Limitations: Obtain automatic transfer switches through one source from a single manufacturer.

C. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, Article 100, by a testing agency acceptable to authorities having jurisdiction, and marked for intended use.

D. Comply with NEMA ICS 1.

E. Comply with NFPA 70.

F. Comply with NFPA 110.

G. Comply with UL 1008 unless requirements of these Specifications are stricter.

PART 2 - COORDINATE SIZE AND LOCATION OF FRAMING AND SUPPORTS FOR TRANSFER SWITCHES. PRODUCTS

2.01 MANUFACTURERS:

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

1. Contactor Transfer Switches:

a. Emerson; ASCO Power Technologies, LP.
b. GE Zenith Controls.
c. Kohler Power Systems; Generator Division.
d. Onan/Cummins Power Generation; Industrial Business Group.
e. Or Approved Equal.

2.02 GENERAL TRANSFER-SWITCH PRODUCT REQUIREMENTS:

A. Indicated Current Ratings: Apply as defined in UL 1008 for continuous loading and total system transfer, unless otherwise indicated.

1. Where transfer switch includes internal fault-current protection, rating of switch and trip unit combination shall exceed indicated fault-current value at installation location.

B. Solid-State Controls: Repetitive accuracy of all settings shall be plus or minus 2% or better over an operating temperature range of minus 20 to plus 70ºC.

C. Resistance to Damage by Voltage Transients: Components shall meet or exceed voltage-surge withstand capability requirements when tested according to IEEE C62.41. Components shall meet or exceed voltage-impulse withstand test of NEMA ICS 1.

D. Electrical Operation: Accomplish by a nonfused, momentarily energized solenoid or electric- motor-operated mechanism, mechanically and electrically interlocked in both directions.

E. Switch Characteristics: Designed for continuous-duty repetitive transfer of full-rated current between active power sources.

1. Limitation: Switches using molded-case switches or circuit breakers or insulated-case circuit-breaker components are not acceptable.

2. Switch Action: Double throw; mechanically held in both directions.

3. Contacts: Silver composition or silver alloy for load-current switching. Conventional automatic transfer-switch units, rated 225 A and higher, shall have separate arcing contacts, with arc chutes.

F. Neutral Switching. Where four-pole switches are indicated, provide overlapping neutral contacts.

G. Neutral Terminal: Solid and fully rated, unless otherwise indicated.

H. Annunciation, Control, and Programming Interface Components: Devices at transfer switches for communicating with remote programming devices, annunciators, or annunciator and control panels shall have communication capability matched with remote device.

I. Factory Wiring: Train and bundle factory wiring and label, consistent with Shop Drawings, either by color-code or by numbered or lettered wire and cable tape markers at terminations. Color-coding and wire and cable tape markers are specified in Section 26 05 53 - Identification for Electrical Systems.

1. Designated Terminals: Pressure type, suitable for types and sizes of field wiring indicated.

2. Power-Terminal Arrangement and Field-Wiring Space: Suitable for top, side, or bottom entrance of feeder conductors as indicated.
3. Control Wiring: Equipped with lugs suitable for connection to terminal strips.

J. Enclosures: General-purpose NEMA 250, Type 1, complying with NEMA ICS 6 and UL 508, unless otherwise indicated.

2.03 AUTOMATIC TRANSFER SWITCHES:

A. Comply with Level 2 type 10 equipment according to NFPA 110.

B. Switching Arrangement: Double-throw type, incapable of pauses or intermediate position stops during normal functioning, unless otherwise indicated.

C. Manual Switch Operation: Under load, with door closed and with either or both sources energized. Transfer time is same as for electrical operation. Control circuit automatically disconnects from electrical operator during manual operation.

D. Manual Switch Operation: Unloaded. Control circuit automatically disconnects from electrical operator during manual operation.

E. Digital Communication Interface: Matched to capability of remote annunciator or annunciator and control panel.

F. In-Phase Monitor: Factory-wired, internal relay controls transfer so it occurs only when the two sources are synchronized in phase. Relay compares phase relationship and frequency difference between normal and emergency sources and initiates transfer when both sources are within 15 electrical degrees, and only if transfer can be completed within 60 electrical degrees. Transfer is initiated only if both sources are within 2 Hz of nominal frequency and 70% or more of nominal voltage.

G. Automatic Transfer-Switch Features:

1. Undervoltage Sensing for Each Phase of Normal Source and generator: Sense low phase- to-ground voltage on each phase. Pickup voltage shall be adjustable from 85 to 100% of nominal, and dropout voltage is adjustable from 75 to 98% of pickup value. Factory set for pickup at 90% and dropout at 85%.
2. Adjustable Time Delay: For override of normal-source voltage sensing to delay transfer and engine start signals. Adjustable from zero to six seconds, and factory set for one second.
3. Voltage/Frequency Lockout Relay: Prevent premature transfer to generator. Pickup voltage shall be adjustable from 85 to 100% of nominal. Factory set for pickup at 90%. Pickup frequency shall be adjustable from 90 to 100% of nominal. Factory set for pickup at 95%.
4. Time Delay for Retransfer to Normal Source: Adjustable from 0 to 30 minutes, and factory set for 10 minutes to automatically defeat delay on loss of voltage or sustained undervoltage of emergency source, provided normal supply has been restored.
5. Test Switch: Simulate normal-source failure.
6. Switch-Position Pilot Lights: Indicate source to which load is connected, green for "normal", red for "emergency".

7. Source-Available Indicating Lights: Supervise sources via transfer-switch normal- and emergency-source sensing circuits.
    a. Normal Power Supervision: White light with nameplate engraved "Normal Source Available."
    b. Emergency Power Supervision: Yellow light with nameplate engraved "Emergency Source Available."
8. Push-to-Test Lights: All lights shall be push-to-test type.
9. LED Lights: All lights shall be LED-type.
10. Unassigned Auxiliary Contacts: Two normally open, single-pole, double-throw contacts for each switch position, rated 10 A at 240-Vac.
11. Transfer Override Switch: Overrides automatic retransfer control so automatic transfer switch will remain connected to emergency power source regardless of condition of normal source. Pilot light indicates override status.
12. Engine Starting Contacts: One isolated and normally closed, and one isolated and normally open; rated 10 A at 32Vdc minimum, to close (or open) to start engine, and to open (or close for engine shutdown).
13. Shutdown: Time delay adjustable from zero to thirty minutes, and factory set for five minutes. Contacts shall initiate shutdown at remote engine-generator controls after retransfer of load to normal source.
14. Engine-Generator Exerciser: Solid-state, programmable-time switch starts engine generator and transfers load to it from normal source for a preset time, then retransfers and shuts down engine after a preset cool-down period. Initiates exercise cycle at preset intervals adjustable from 7 to 30 days. Running periods are adjustable from 10 to 30 minutes. Factory settings are for 7-day exercise cycle, 20-minute running period, and 5-minute cool-down period. Exerciser features include the following:
    a. Exerciser Transfer Selector Switch: Permits selection of exercise with and without load transfer.
    b. Push-button programming control with digital display of settings.
    c. Integral battery operation of time switch when normal control power is not available.

2.04 SOURCE QUALITY CONTROL:

A. Factory test and inspect components, assembled switches, and associated equipment. Ensure proper operation. Check transfer time and voltage, frequency, and time-delay settings for compliance with specified requirements. Perform dielectric strength test complying with NEMA ICS 1.

2.05 INSTALLATION:

A. Design each fastener and support to carry load indicated by seismic requirements and according to seismic-restraint details. See Section 26 05 48 - Vibration and Seismic Controls for Electrical Systems.

B. Floor-Mounting Switch: Anchor to floor by bolting.

C. Identify components according to Section 26 05 53 – Identification for Electrical Systems.

D. Set field-adjustable intervals and delays, relays, and engine exerciser clock.

2.06 CONNECTIONS:

A. Wiring to Remote Components: Match type and number of cables and conductors to control and communication requirements of transfer switches as recommended by manufacturer. Increase raceway sizes at no additional cost to Owner if necessary to accommodate required wiring.

B. Ground equipment according to Section 26 05 26 - Grounding and Bonding for Electrical Systems.

C. Connect wiring according to Section 26 05 19 - Low-Voltage Electrical Power Conductors and Cables.

2.07 FIELD QUALITY CONTROL:

A. Testing Agency: Engage a qualified independent testing and inspecting agency to perform tests and inspections and prepare test reports.

B. Manufacturer's Field Service: Engage a factory-authorized service representative to inspect, test, and adjust components, assemblies, and equipment installations, including connections. Report results in writing.

C. Perform tests and inspections and prepare test reports.

1. Manufacturer's Field Service: Engage a factory-authorized service representative to inspect components, assemblies, and equipment installation, including connections, and to assist in testing.

2. After installing equipment and after electrical circuitry has been energized, test for compliance with requirements.

3. Perform each visual and mechanical inspection and electrical test stated in NETA Acceptance Testing Specification. Certify compliance with test parameters.

4. Measure insulation resistance phase-to-phase and phase-to-ground with insulation-resistance tester. Include external annunciation and control circuits. Use test voltages and procedure recommended by manufacturer. Comply with manufacturer's specified minimum resistance.

    a. Check for electrical continuity of circuits and for short circuits.
    b. Inspect for physical damage, proper installation and connection, and integrity of barriers, covers, and safety features.
    c. Verify that manual transfer warnings are properly placed.
    d. Perform manual transfer operation.

5. After energizing circuits, demonstrate interlocking sequence and operational function for each switch at least three times.

    a. Simulate power failures of normal source to automatic transfer switches and of emergency source with normal source available.
    b. Simulate loss of phase-to-ground voltage for each phase of normal source.
    c. Verify time-delay settings.
    d. Verify pickup and dropout voltages by data readout or inspection of control settings.

e. Test bypass/isolation unit functional modes and related automatic transfer-switch operations.
f. Perform contact-resistance test across main contacts and correct values exceeding 500 microhms and values for 1 pole deviating by more than 50% from other poles.
g. Verify proper sequence and correct timing of automatic engine starting, transfer time delay, retransfer time delay on restoration of normal power, and engine cool- down and shutdown.

6. Ground-Fault Tests: Coordinate with testing of ground-fault protective devices for power delivery from both sources.

a. Verify grounding connections and locations and ratings of sensors.

D. Testing Agency's Tests and Inspections:

1. After installing equipment and after electrical circuitry has been energized, test for compliance with requirements.

2. Perform each visual and mechanical inspection and electrical test stated in NETA Acceptance Testing Specification. Certify compliance with test parameters.

3. Measure insulation resistance phase-to-phase and phase-to-ground with insulation-resistance tester. Include external annunciation and control circuits. Use test voltages and procedure recommended by manufacturer. Comply with manufacturer's specified minimum resistance.

a. Check for electrical continuity of circuits and for short circuits.
b. Inspect for physical damage, proper installation and connection, and integrity of barriers, covers, and safety features.
c. Verify that manual transfer warnings are properly placed.
d. Perform manual transfer operation.

4. After energizing circuits, demonstrate interlocking sequence and operational function for each switch at least three times.

a. Simulate power failures of normal source to automatic transfer switches and of emergency source with normal source available.
b. Simulate loss of phase-to-ground voltage for each phase of normal source.
c. Verify time-delay settings.
d. Verify pickup and dropout voltages by data readout or inspection of control settings.
e. Test bypass/isolation unit functional modes and related automatic transfer-switch operations.
f. Perform contact-resistance test across main contacts and correct values exceeding 500 microhms and values for 1 pole deviating by more than 50% from other poles.
g. Verify proper sequence and correct timing of automatic engine starting, transfer time delay, retransfer time delay on restoration of normal power, and engine cool- down and shutdown.

5. 5.Ground-Fault Tests: Coordinate with testing of ground-fault protective devices for power delivery from both sources.

a. Verify grounding connections and locations and ratings of sensors.

E. Coordinate tests with tests of generator and run them concurrently.

F. Report results of tests and inspections in writing. Record adjustable relay settings and measured insulation and contact resistances and time delays. Attach a label or tag to each tested component indicating satisfactory completion of tests.

G. Remove and replace malfunctioning units and retest as specified above.

H. Infrared Scanning: After Substantial Completion, but not more than 60 days after Final Acceptance, perform an infrared scan of each switch. Remove all access panels so joints and connections are accessible to portable scanner.

1. Follow-up Infrared Scanning: Perform an additional follow-up infrared scan of each switch 11 months after date of Substantial Completion.

2. Instrument: Use an infrared scanning device designed to measure temperature or to detect significant deviations from normal values. Provide calibration record for device.

3. Record of Infrared Scanning: Prepare a certified report that identifies switches checked and that describes scanning results. Include notation of deficiencies detected, remedial action taken, and observations after remedial action.

2.08 DEMONSTRATION:

A. Engage a factory-authorized service representative to train Owner's maintenance personnel to adjust, operate, and maintain transfer switches and related equipment as specified below. Refer to Section 01 79 00 - Demonstration And Training.

B. Coordinate this training with that for generator equipment.

END OF SECTION

SECTION 26 43 13

SURGE SUPPRESSION EQUIPMENT (120VAC TO 480VAC)

PART 1 - GENERAL

1.01 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including Contractual Conditions and Division 01 Specification sections apply to this section.

1.02 SUMMARY

A. This section includes the requirements for the provision and installation of surge suppression equipment for 120-volt AC to 480-volt AC circuits.

1.03 DESCRIPTION

A. Provide all materials, labor and auxiliaries required to furnish and install complete surge suppression for the protection of building electrical and electronics systems from the effects of line induced transient voltage surge and lightning discharge as specified for systems with voltages between 120VAC and 480VAC.

B. Provide surge suppression equipment for the following equipment:

1. Each existing and new main electrical service switchboard as called for on drawings.
2. Distribution and branch panels as called for on drawings.
3. All electronic communications equipment installed per all Division 28 including but not limited to: monitoring/metering equipment.
4. Point of use locations (receptacles, plug-in units) as required.

C. All surge protection to be connected via a 30A 3 pole circuit breaker (whether shown on Plans/Schedules or not.)

1.04 SUBMITTALS

A. Submit the following Product Data for each type of suppressor:

1. Dimensions
2. Means of mounting
3. Compliance with UL Standards referenced
4. Compliance with IEEE Standards referenced
5. Design type (Hybrid, MOV)
6. Internal fusing/Thermal Protection
7. Recommended overcurrent protection
8. Size of wire leads
9. Visual failure indicator
10. Warrantee
11. Performance data showing compliance with performance as specified herein
12. Non-Potted construction

1.05 PROJECT AS-BUILT DOCUMENTS

A. Record locations of surge protection units; indicate actual units used on redlined as-built documents.

1.06 OPERATION AND MAINTENANCE DATA

A. All approved shop drawings, product data, and cutsheets.

B. Installation, connection, and maintenance information on each type of surge suppression.

C. Procedure and time table for recommended periodic inspection of devices to determine usefulness and life expectancy.

1.07 QUALITY ASSURANCE

A. All surge suppression devices shall be manufactured by a company normally engaged in the design, development, and manufacture of such devices for electrical and electronics systems equipment.

B. The surge suppressor manufacturer shall offer technical assistance through support by a factory representative and local stocking distributor. Factory representatives are to approve installation prior to Substantial Completion.

1.08 REFERENCES AND REGULATORY REQUIREMENTS

A. Equipment Certification: Surge suppression equipment shall be UL listed and labeled for the intended use.

B. Surge suppression devices shall be selected, installed and located in accordance with requirements of the following:

1. ANSI/NFPA 780 - Lightning Protection Code, latest edition.
2. ANSI/NFPA 70 - National Electrical Code, current adopted year.
3. U.L. 1449 – 3rd Edition, Standard for Safety for Surge Protective Devices.
4. 1363-1986 - Standard for Temporary Power Taps.
5. ANSI/IEEE C62.41-1991 (IEEE 587) - Guide for Surge Voltages in Low-Voltage AC Power Circuits.
6. ANSI/IEEE C62.33-1982 - Standard Test Specifications for Varistor Surge Protection Devices.
7. ANSI/IEEE C62.45-1987 - IEEE Guide for Surge Testing for Equipment Connected to Low-Voltage AC Power Circuits.

1.09 COORDINATION/PROJECT CONDITIONS

A. Verify proper grounding is in place.

B. Verify if space and proper clearance for the surge suppressor installation is available.

C. Coordinate so that proper overcurrent device, as recommended by the manufacturer, is installed to feed each surge suppression device.

1.10 WARRANTY

A. All surge suppression devices shall be warranted to be free from defects in materials and workmanship for a period of five (5) years.

B. Any suppressor which shows evidence of failure or incorrect operation during the warranty period shall be repaired or replaced at no cost to the owner.

PART 2 - PRODUCTS

2.01 GENERAL

A. Suppressors shall be designed for the specific type and voltage of electrical service and shall provide clamping action for both normal (L-N) and common (L-N-G) mode protection.

B. Suppressors shall be of a hybrid design, and include circuitry with tight, wave-tracking clamping characteristics.

C. Suppressors shall be designed to withstand a maximum continuous operating voltage of not less than 115% of nominal RMS line voltage.

D. Suppressors shall contain internal safety fusing to disconnect the suppressor from the electrical source if the suppressor fails, in order to prevent catastrophic failure modes.

E. Suppressors shall be fail-safe, shall allow no follow-thru current, shall have repeated surge capability, shall be solid-state, shall be self-restoring, and shall be fully automatic.

F. Suppressors shall be UL 1449 listed and shall be approved for the location in which they are installed.

2.02 SUPPRESSOR CRITERIA

A. Main Electrical Service Entrance Suppressors (First Level of Protection) shall meet or exceed the following

1. General

   a. Suppressors shall be tested as per IEEE C62.41-1991 to determine clamping voltage using Cat. C3 test criteria.
   b. Suppressors shall be sequential surge tested as per IEEE C62.45-1987, and shall withstand 1000 test cycles at 10kA, Cat. C3 test criteria.
   c. Internal fusing for each phase connected.
   d. Fail-safe with no hold over current.
   e. Enclosure
      1) Listed.
      2) Fire retardant.
      3) NEMA 1 as required for each location unless the field conditions require otherwise or indicated on the drawings.

2. 400kA, remote monitoring

   a. Remote Monitoring. Provide complete with normally open and normally closed dry contacts for remote annunciation of unit status for interfacing with PowerNet Monitoring System.
   b. Maximum Surge Capacity: 400,000 Amps. per phase.
   c. Clamping voltage
      1) Category B, UL 1449, Line to Neutral impulse (6KV - 1.2 x 50 µs, 3kA - 8 x 20 µs):
         a) 120/208V, 3Ø, 4W: 600V
         b) 277/480V, 3Ø, 4W: 920V

2) Category C3, Line to Neutral impulse (20KV - 1.2 x 50 µs, 10kA - 8 x 20 µs):
   a) 120/208V, 3Ø, 4W: 1160
   b) 277/480V, 3Ø, 4W: 1660

d. The unit suppressor shall be designed with redundant back-up surge protection in the event of a module failure.
   1) Module status indicators shall be provided to indicate individual module status. When a module has failed, the module LED status indicator shall indicate said failure.
   2) Unit status indicators shall be provided to indicate the status of the complete unit suppressor. The LED status indicators shall be located on the hinged front cover to redundantly indicate module or unit failure.

e. Basis of Design
   1) Advanced Protection Technologies, Inc. #XTE/*XLHP/CL/DC Series for applied voltage in enclosure or integral to switchgear as noted on Drawings.
   2) Alternate manufactures: PowerLogic Model #820 or equal

B. Branch Distribution and/or SubPanels (Second Level of Protection), suppressors shall meet or exceed the following:

1. General

   a. Suppressors shall be tested as per IEEE C62.41-1991 to determine clamping voltage using Cat. B3 test criteria.
   b. Suppressors shall be sequential surge tested as per IEEE C62.45-1987, and shall withstand 1000 test cycles at 3kA, Cat. B3 test criteria.
   c. Internal fusing for each phase connected.
   d. Fail-safe with no hold over current.
   e. Enclosure
      1) Listed.
      2) Fire retardant.
      3) NEMA 1 as required for each location unless the field conditions require otherwise or indicated on the drawings.

2. 160kA, remote monitoring

   a. Remote Monitoring. Provide complete with normally open and normally closed dry contacts for remote annunciation of unit status for interfacing with PowerNet Monitoring System.
   b. Replaceable module design.
   c. Maximum Surge Capacity: 160,000 Amps. per phase.
   d. Clamping voltage
      1) Category B, UL 1449, Line to Neutral impulse (6KV - 1.2 x 50µs, 3kA - 8 x 20µs):
         a) 120/208V, 3Ø, 4W: 530
         b) 277/480V, 3Ø, 4W: 920
   e. The panel-mounted unit suppressor shall be designed with redundant back-up surge protection in the event of a module failure.
      1) Module status indicators shall be provided to indicate individual module status. When a module has failed, the module LED status indicator shall indicate said failure.

2) Unit status indicators shall be provided to indicate the status of the complete unit suppressor. The LED status indicators shall be located on the hinged front cover to redundantly indicate module or unit failure.

f. Basis of Design
1) Advanced Protection Technologies #TE/*XT/160/DC Series for applied voltage in the enclosure as required on drawings, as specified above, and/or as required by applicable codes.

3. 25kA Unit (Third Level of Protection)

a. Maximum Surge Capacity: 25,000 Amps.
b. Clamping Voltage at UL 1449, Line to Neutral Category B Impulse, (6kV – 1.2 x 50µs, 3kA, 8 x 20µs):
1) 120/208V, 3Ø, 4W: 500
2) 277/408V, 3Ø, 4W: 900

C. Point of Use Location (120 Volt), Hardwire.

1. 1449 Listed.
2. 20 Amp, 120V rated. All components must be 20 Amp rated.
3. Suppressors shall be tested per IEEE, C62.41-1991 for categories A and B.
4. Internal fusing.
5. Indicators for normal operation and failure indication.
6. Enclosure: Fire retardant high impact, phenolic or plastic housing or metal enclosure.
7. Clamping voltage UL 1449, Line to Neutral, Category B impulse at (3kA, 8 x 20 µs): 350V @ 120V.
8. Maximum Surge Capacity: 20,000 Amps.
9. Maximum continuous operating voltage: 115% of line voltage.
10. Provide hardwire connection or add 20 amp receptacle device to hardwired devices to match equipment being protected and maintain UL Listing.

D. Point of Use Location (120 Volt) Plug Strip

1. 20 amp, 120V rated.
2. Suppressors shall be tested per IEEE, C62.41-1991 for categories A and B.
3. Normal Mode (L - N), and common mode (L+N-G) protection.
4. Internal fusing.
5. 6 ft. line cord.
6. Protected outlets.
7. Indicators for normal operation and failure indication.
8. Re-settable circuit breaker.
9. On/off switch.
10. Extruded aluminum enclosure.
11. Clamping voltage UL 1449, line to neutral, Category B impulse at (3kA, 8 x 20 µs): 310V @ 120V.

12. Maximum Surge Capacity: 20,000 Amps.
13. Maximum continuous operating voltage: 135V.

PART 3 - EXECUTION

3.01 GENERAL

A. Provide suppressor at the first piece of electrical equipment (switchboard or main distribution panel) that the electrical service encounters as it enters the facility.

B. Provide suppressor at each branch panel as noted on drawings.

C. Provide surge suppression at the location where data, metering, or monitoring equipment is connected to line voltage (120V). Provide cords and receptacles as required to connect TVSS equipment to equipment being protected and maintain UL listing.

3.02 INSTALLATION OF SUPPRESSORS

A. Suppressors shall be installed as close as practical to the electric panel or electronic equipment to be protected, consistent with available space.

B. Suppressors shall be close nippled to the device being protected in a position near the neutral bus which will minimize lead length between the suppressor and the buses or control breaker to which the suppressor connects. Suppressor leads shall not extend beyond the suppressor manufacturer's recommended maximum lead length without specific approval of the Designer.

C. The location shown on drawings is diagrammatic only.

D. Suppressors shall be installed in a neat, workmanlike manner. Lead dress shall be as short and as straight as possible and be consistent with recommended industry practices for the system on which these devices are installed.

E. Supplementary grounding and bonding connections required between the bonding bus or ground plane for each equipment cluster and other locations as indicated herein shall be accomplished using #6 AWG core copper conductor and approved connections unless otherwise noted. Referenced to a common earth ground.

F. Suppressors shall be installed in a manner that allows simple replacement within short periods of downtime.

G. Suppressors other than a point of use type shall be installed with a means of disconnecting the suppressor at the panel. At the main service entrance location, provide a dedicated 30 amp, 3P-CB, 100,000 A.I.C. for the TVSS device. At the distribution secondary and subpanel locations, provide dedicated 20 amp or 30 amp, 3P-CB’s, for the TVSS device. Label disconnect or CB "Surge Protector". Fused disconnects may be substituted for the CB, with the approval of the Designer. Change rating of CB's noted above as required to properly provide a system as recommended by the manufacturer.

H. All suppressors are to be monitored by PowerNet Monitoring System. Provide/install all electrical as required to comply with this.

I. Suppressors at the main switchgear are to be mounted integral to switchgear. Comply with all codes and UL labeling. Provide UL label for a complete system. All status indicators are to be mounted to the switchgear door, visible from the exterior of switchgear without requiring the operation of the door, lid, etc.

J. Suppressors at distribution panels to be mounted external to panel cabinet in NEMA 1 enclosure or as required for the panel's environmental conditions.

END OF SECTION

SECTION 26 56 19

LIGHTING FIXTURES

PART 1 - GENERAL

1.01 DESCRIPTION

A. The work required under this section of the specification consists of the installation of all interior and exterior lighting fixtures, lamps, and lighting control devices described herein.

1.02 QUALITY ASSURANCE

A. The following specifications and standards are incorporated into and become part of this Specification reference. Except where a specific date is given, the issue in effect (including amendments, addenda, revisions, supplements and errata) on the date of invitation for bids, shall apply. In text, such specifications and standards are referenced by the basic designation only.

1. National Fire Protection Association (NFPA)

    a. NFPA 70 National Electrical Code

2. Underwriter's Laboratories, Inc. (U.L.)

    a. U.L. 935: Ballasts, fluorescent lamp
    b. U.L. 1029: Ballasts, high-intensity discharge lamp
    c. U.L. 924: Emergency lighting and power equipment
    d. U.L. 57: Electric lighting fixtures
    e. U.L. 844: Electric lighting fixtures for use in hazardous locations
    f. U.L. 15771: Incandescent lighting fixtures
    g. U.L. 15772: High-intensity discharge lighting fixtures
    h. U.L 8750: LED lighting fixtures
    i. U.L 8755: Field replaceable LED light engines

3. American National Standards Institute (ANSI)

    a. ANSI C82.1, .2, .3: Ballasts

B. Acceptable Manufacturers: Products of the following manufacturers, which comply with these Specifications, are acceptable.

1. Photoelectric Controls: General Electric, Paragon, Tork, Lumatrol
2. Time Clocks: Tork, Intermatic, Paragon
3. Lighting Contractors: ASCO, Square D
4. LED Light engines: Intertek, MaxLite, Phillips, Acuity, Lumecon, Aleo, Tridonic
5. Ballasts: Jefferson, General Electric, Advance, Universal
6. Lamps: Westinghouse, Sylvania, Phillips, General Electric, Venture

1.03 SUBSTITUTION

A. Lighting fixtures shall be selected from those fixtures included in the fixture schedule. Request of fixtures other than those listed in the fixture schedule must be submitted in

accordance with the substitution paragraph of the “01 25 13 Product Substitution Procedures,” section of these specifications.

B. Lighting fixtures indicated by the manufacturer’s catalog number in the fixture schedule are intended to illustrate the type of fixture required with respect to quality construction, appearance, efficiency of operation, photometrics, and method of installation. Fixtures other than those listed in the fixture schedule and having characteristics not less than the fixture specified will be considered for substitution. The right is reversed to require sample fixtures to be submitted for evaluation.

C. Request for fixture substitution must be accompanied by construction specifications, photometric test data including foot-lambert readings, and complete dimensions. Any deviations shall be identified in writing with the submittal.

1.04 COORDINATION

A. The catalog numbers of recessed, incandescent, LED, fluorescent and high-intensity discharge fixtures included in the fixture schedule are for use with a specific type suspended ceiling. Review architectural plans and specifications and provide lighting fixtures compatible with the ceiling suspension system.

B. It is the contractor’s responsibility to coordinate with the ceiling contractor to verify the mounting compatibility of the lighting fixtures for ordering and manufacture.

1.05 SUBMITTALS

A. Refer to, “Electrical General,” for submittal requirements.

B. Manufacturers Product Data:

1. Submit material Specifications and installation data for products specified under Part 2.

1.06 LIGHTING FIXTURES MAINTENANCE MATERIALS

A. Operation and Maintenance Data:

1. Maintenance Data: Include replacement parts list.
2. Special re-lamping instructions
3. Matrix of lamps applicable to each fixture.
4. Replacing LED light engines.

B. Provide to Owner's Authorized Representative:

1. Ten (10) of each size/type of fuses.
2. 2% of each type of the number of lamps installed but not less than six (6) of each type and one (1) replacement LED element for each type of LED fixture.

PART 2 - PRODUCTS

2.01 GENERAL

A. Furnish all materials specified herein or indicated on the drawings.

B. All lighting fixtures, engines, ballasts & lighting controls shall be U.L. listed and bear a U.L. label.

C. Fixtures shall be selected from the fixture schedule not only by catalog number but with consideration to mounting, number and types of lamps, and reference notes as contained in the fixture schedule, and in accordance with these specifications.

D. All fixtures installed in damp areas as classified by the definitions article of the National Electrical Code shall be U.L. listed and labeled as suitable for damp locations. All fixtures installed in wet areas as classified by the definition article of the National Electrical Code shall be suitable for wet locations.

E. Ballasts, engines and transformers shall be rated for operation on electrical system voltage to which they are shown connected.

2.02 PRODUCT/MATERIAL DESCRIPTION

A. Lighting Fixtures

1. Where fixtures are specified to be furnished with a plastic prismatic lens, the lens shall be U.V. stabilized virgin acrylic with thickness not less than 0.125 inches. The lens shall be supported within a hinged door frame in not less than six points and in such a manner to prevent vibration of the lens. Hinged doors for support of lens shall be gasketed on all sides to prevent light leaks.

2. All wrap-around lenses shall be virgin acrylic, one-piece, injection-molded type, with DR additive.

B. LED light engines

1. Provide engine as identified in drawings, if not note assume 4000K.

2. Engine photometric tests shall be performed in accordance with IESNA LM-79-08.

3. Engines to be protected with in-line fuse/fuse holder.

4. Drivers installed in fixtures outdoors or in enclosed loading docks shall have an ambient temperature rating of 0°F.

5. Light elements should be replaceable if an option.

C. Lamps

1. Lamp types for each fixture are in general specified in the fixture schedule and shall also comply with this specification.

D. Lighting Controls

1. Photocontrol shall be for use on system voltage to which they are shown connected. The switching mechanism shall be hermetically sealed and shall be calibrated to close the circuit when illumination drops below two-foot candles and open circuit when illumination exceeds five-foot candles. The switching mechanism shall contain a delay feature to prevent circuit opening in transient illumination such as headlights from passing vehicles. Photocell shall be rated at not less than 1800-volt amps with standard EEI-NEMA 2-3/4” ID locking base. The control shall be mounted on twist lock receptacle on conduit fitting where indicated on the drawings. When mounted on the roof locate the device twelve inches above the roof and orient photo control light-sensing element north.

2. The time switch used for control of exterior lighting shall be twenty-four hours type with skip-a-day feature reserve spring for maintaining time schedule during a power outage

and astronomical dial factory set for the latitude of the project. The time switch enclosure shall be weatherproof. Operation shall be for [120] [277] [480] volt lighting circuits with [120] [277] [480] volt control circuit. The time switch shall be four-pole maintained contacts. Where the number of lighting circuits to be controlled exceeds the number of time switch load contacts, provide auxiliary lighting contractor to control additional circuits.

3. Magnetic contactors shall be multipole, mechanically held, electrically operated with contacts rated for not less than twenty amps at 480 volts A.C. or Tungsten load within a NEMA 1 enclosure. Separate contactors shall be provided for each control function. Contactors shall break all ungrounded conductors of circuits being controlled. Use multiple contactors with operating coils in parallel when the number of contacts required exceeds the contactor pole limit. The contactor shall have coil clearing contacts. The control coil shall be rated [120V] [277V] [480V]. The contractor shall be U.L. listed for a short circuit withstand rating of the source panel serving the contactor load circuits.

4. All exterior lighting shall be controlled by the lighting control center to provide lighting control by the level of exterior illumination as well as by time control.

   a. The lighting control center shall consist of time switch electrically operated, mechanically held magnetic contactors, terminal blocks selector switches and all internal wiring. The enclosure shall be N.E.M.A. type one, wall-mounted with latching facilities. The manual-off-automatic selector switch for each mode of operation shall be mounted on a hinged door. The lighting control center shall be wall mounted where indicated on the drawings.
   b. Internal circuitry of the control center shall prevent all exterior lighting circuits from being energized until the outside illumination level falls below the setting of the photoelectric control device and to de-energize all circuits when the setting of the photoelectric control device is exceeded. Within limits of photo control, designated circuits shall be time-controlled while other circuits are photo controlled only.

PART 3 - EXECUTION

3.01 FIXTURE SUPPORT AND MOUNTING

A. Lighting fixtures shall be installed in accordance with the manufacturer’s recommended mounting methods and the provisions of the specifications and drawings as noted. All lighting shall be supported from the structural components. The fixtures shall be supported in a manner that will ensure the fixture weight being equally distributed from each support and the fixture remaining in a level position.

3.02 INSTALLATION

A. Fixtures will be installed so that no labels will be visible under normal operating conditions of the fixture.

B. If fixtures are installed in a fire-rated ceiling, the contractor will preserve the fire rating according to the U.L. assembly number.

C. Lighting poles shall be grouted to fill the space between the pole base plate and the concrete base.

D. Install lamps in all fixtures.

3.03 CLEANING AND ADJUSTMENT

A. All installed fixtures shall be cleaned and free of fingerprints prior to final acceptance.

B. All lamps shall be illuminated and operational at the time of the final inspection Replace burnt out lamps, inoperative lamps, or other lamps not providing 100% output.

C. All fixtures with lamp positions, tilt, shutters rotation, or other types of adjustment shall be roughly adjusted at the time of the installation. The architect will determine the final aiming and/or adjustments during the final inspection. Fixtures serving areas where daylight is predominant will be adjusted after sunset.

D. Metal-Halide lamps with a discernible color shift after 100 hours of operation shall be replaced with no additional cost to the owner.

3.04 OPERATIONAL MAINTENANCE

A. Include a copy of the documentation listed in Section 1.6 A and include it in the O&M manual to be turned over to the owner.

B. Provide maintenance spares as described in Section 1.6 B in a durable weather resistance box with a list of the contents including the manufacturers, part numbers and quantities provided included inside.

END OF SECTION

SECTION 26 60 00

AVIATION FUEL SYSTEM - ELECTRICAL GENERAL REQUIREMENTS

PART 1 - GENERAL

1.01 GENERAL:

A. The general provision of the Contract including the Conditions and Bidding of the Contract (General, Supplementary and Other Conditions) and Division 00 and 01 as appropriate apply to work specified in this Division.

1.02 DESCRIPTION:

A. This division of the Specifications covers the exterior and applicable interior portions of the Fuel Facility electrical systems and all electrical systems associated with the aircraft fuel system as indicated on the drawings or as specified herein. Provide all materials, labor, equipment and supervision to install the electrical systems.

1.03 QUALITY ASSURANCE:

A. Building Codes
All electrical work shall be in accordance with the following codes and regulations. Except where a specific date is given in the general conditions, specific conditions or herein, the issue in effect (including amendments, addenda, revisions, and supplements) on the date of the contract, shall apply.
1. The National Electrical Code (N.F.P.A. 70)
2. The National Electrical Safety Code (ANSI C-2)
3. The Life Safety Code (NFPA 101)
4. The Palm Beach International Airport, Palm Beach, Florida ordinances governing electrical work.

B. Material Standards:
All material shall be new and shall conform to the standards where such have been established for the particular material in question. Publications and Standards of the organizations listed below are applicable to materials specified herein.

1. American Society for Testing and Materials (ASTM)
2. Underwriter's Laboratories, Inc. (UL)
3. National Electrical Manufacturer Association (NEMA)
4. Insulated Cable Engineers Association (ICEA)
5. Institute of Electrical and Electronics Engineers (IEEE)
6. National Fire Protection Association (NFPA)
7. American National Standards Institute (ANSI)
8. American Petroleum Institute (API)

1.04 PERMITS:

A. Obtain all permits and inspections for the installation of this work and pay all charges incident thereto. Deliver to the Owner all certificates of said inspection issued by authorities having jurisdiction.

1.05 WARRANTY:

A. Refer to the Conditions of the Contract and Division 1 for warranty of work under Division 26.

1.06 DRAWINGS:

A. The drawings indicate the arrangement of electrical equipment. Coordinate installation of electrical equipment with structural system and mechanical equipment and access thereto. Coordinate installation of recessed electrical equipment with concealed ductwork and piping, and wall thickness.

B. Do not scale drawings. Obtain dimensions for the layout of equipment from Civil, Mechanical or Architectural plans unless indicated on electrical plans.

C. Bring all discrepancies on different drawings, between Drawings and Specifications, between contract drawings and equipment installation drawings or between documents and field conditions to the immediate attention of the Engineer.

D. The equipment layout is based on one manufacturer's product. Where equipment is selected by the Contractor for use on the job differs from the layout; the Contractor shall be responsible for coordinating space requirements and connection arrangements.

1.07 DEVIATIONS:

A. The Contractor shall provide written notice of any deviations from the requirements of the Contract or Construction Documents that he proposes to undertake. The Contractor remains liable for any deviations unless reviewed and written acknowledgment is received from the Engineer.

1.08 SUBMITTALS:

A. Manufacturer’s Product Data: Submit material specifications and installation data for products specified under Part 2 – Products of each individual Section.

B. Record Drawings:

1. Prior to the final inspection and at a time designated by the Engineer, provide three (3) sets of data on electrical equipment used in the project. Data shall be in bound form and shall include the following items:
   a. Location of conduit termination. All underground conduits shall be dimensioned from projects’ grid lines, both North-South and East-West.
   b. Actual conduit routing reflecting all field changes.
   c. Certificates of inspection from authorities having jurisdiction.
2. The contractor shall be required to keep a set of drawings on the job site during construction for the sole purpose of tracking the record data on a day-to-day basis.
3. Payment requisition may not be approved if the drawings are not kept current.
4. Refer to the Conditions of the Contract and General Requirements for record (as-built) drawings.

1.09 SITE INVESTIGATION:

A. Prior to submitting bids of the project, visit the site of the work to become aware of existing conditions that may affect the cost of the project. Where work under this project requires an extension, relocation, reconnections or modifications to existing equipment or systems, the existing equipment or systems, shall be restored to their original condition, at minimum, before the completion of this project.

1.10 SCHEDULING OF OUTAGES:

A. Electrical work requiring interruption of electrical power which would adversely affect the normal operation of the other portions of the Owner’s property shall be done at the time acceptable to the operator of the facility.

B. Schedule all work requiring interruption of electrical power two weeks prior to the actual shut down. Submit schedule in writing indicating the extent of the system to be de-energized, date and time when power is intended to be interrupted, and the date and

time power will be restored.

C. The schedule shall be subject to the approval of the Engineer and the Representative of the Owner.

1.11 IDENTIFICATION:

A. Equipment or devices specified in the individual sections to be identified shall be identified with an engraved plastic nameplate. Identification shall be attached on the outside cover. Where labels are installed outside, plastic media shall be UV stabilized. Plastic label with faceplate and core color, as approved by the Engineer. Lettering shall be engraved a minimum of ¼" high letters.

1. Equipment identification is to indicate the following:
   a. Equipment I.D. abbreviation.
   b. Voltage, phrase, wires and frequency.
   c. Emergency or other systems.
   d. Power source origination.

PART 2 - PRODUCTS

2.01 MATERIALS:

A. All materials shall be new.

B. Furnish all materials specified herein or indicated on the drawings.

C. Materials of the same type shall be the products of one manufacturer.

D. UL listed material shall be UL labeled.

2.02 MATERIALS STANDARDS BY MANUFACTURER AND SUBSTITUTION:

A. Materials Standards

1. Where equipment, materials or systems are specified by the designation of the manufacturer, such designation is intended to convey the minimum requirements for construction, electrical characteristics and ratings, and operating function. Equipment having electrical characteristics and ratings, construction features and operating functions not less than those specified shall be acceptable upon approval of the Engineer.

B. Substitutions

1. Refer to the General Conditions, which governs the "Substitution" of specified equipment or materials.
2. The Contractor shall submit for approval by the Engineer data of materials and equipment to be substituted in the work. Submittals shall be supported by descriptive material, catalogs, cuts, diagrams, performance curves, and charts published by the manufacturer to show conformance to specification and drawing requirements; model numbers alone will not be acceptable. Provide complete electrical characteristics for all equipment.
3. Where substitution of materials alters space requirements indicated on the drawings, submit shop drawings indicating the proposed layout of space, all equipment to be installed therein and clearances between equipment. All clearances required by the National Electrical Code and applicable state and local regulations must be maintained.
4. Submittals shall be noted with any differences, deviations, or limitations of the substituted product from the specified materials. Failure to indicate this information, which subsequently results in conflicts or failure to perform comparably to the originally specified material, will result in the product rejection. It will be the Contractor's responsibility to replace the substituted material with the originally specified one and to bare the resulting costs of demolition, repair or other incidental

costs.

PART 3 - EXECUTION

3.01 PRODUCT DELIVERY, STORAGE, HANDLING AND PROTECTION:

A. For storage, protection, and handling requirements, refer to the general requirements section of the specifications and Division 01.
B. Inspect material upon arrival at Project and verify conformance to Contract Documents. Prevent the unloading of unsatisfactory material.
C. Provide trailers or shed for storage of materials, equipment, tools, etc., requiring such a facility. The contractor shall provide areas for general storage and storage trailers or sheds.
D. Provide a dry, weather-tight place for storing materials requiring protection from the weather.
E. Store packaged materials in an original undamaged condition with manufacturer's labels and seals intact.
F. Handle and store materials in accordance with manufacturer's and supplier's recommendations and in a manner to prevent damage to materials during storage and handling. Replace damaged materials.
G. Containers that are broken, opened, watermarked, or otherwise damaged materials are unacceptable and shall be removed from premises.
H. Provide protection against direct sunlight, rain, snow, wind, ice, or heat for suitable storage of materials or equipment delivered to the site to be incorporated into the Project.
I. Equipment and materials shall not be installed until such time as the environmental conditions of the job site are suitable to protect the equipment or materials. Conditions shall be those for which the equipment or materials are designed to be installed. Equipment and materials shall be protected from water, direct sunlight, cold or heat. Equipment or materials damaged or which are subjected to these elements are unacceptable and shall be removed from the premises and replaced.

3.02 CLEANING AND PAINTING:

A. Remove oil, dirt, grease and foreign materials from all raceways, fittings, boxes, panelboard trims and cabinets to provide a clean surface for painting. Touchup scratched or marred surfaces of lighting fixtures, panelboard and cabinet trim, motor control center, switchboard or equipment enclosure with paint furnished by the equipment manufacturers specifically for that purpose. Painting is specified under the "Painting", Section of the Specifications unless noted otherwise herein.

3.03 EQUIPMENT CONNECTIONS:

A. Electrical circuits to equipment furnished under other divisions of these specifications are based on design loads. If actual equipment furnished has loads others than design loads, revise electrical circuits and protective devices to be compatible with equipment furnished and in compliance with the National Electrical Code at no additional cost to the Owner.
B. The Contractor’s attention is directed to other divisions of these specifications, where equipment requiring electrical service is specified, to become aware of the scope of work under this division of these specifications requiring electrical service and connections to equipment specified elsewhere.

3.04 ELECTRICAL SYSTEMS OPERATIONAL TESTS, MANUFACTURERS SYSTEMS CERTIFICATION AND DESIGN AUTHORITY ASSISTANCE:

A. Testing; Refer to the individual specification sections for test requirements.

B. Manufacturers Certifications

1. The electrical systems specified herein shall be reviewed for compliance with these specifications, installation in accordance with the manufacturers' recommendations and system operation by a representative of the manufacturer. The manufacturer shall submit a certification that the recommendations and are operating in accordance with the specifications.
2. Provide manufacturers certification for the systems specified in the individual Sections.

C. Design Authority Assistance

1. The Contractor shall provide personnel to assist the Engineer or his representative during all construction review visits. The Contractor shall provide all necessary tools and equipment to demonstrate the system operation and provide access to equipment, including screwdrivers, wrenches, ladders, flashlights, circuit testing devices, meters, keys, etc.
2. Remove equipment covers (i.e. panelboard trims, motor controls, device plates, and junction box covers) as directed for inspection of internal wiring.
3. Energize and de-energize circuits and equipment as directed. Demonstrate operation of equipment as directed by the representative.
4. Underground pull box covers shall be removed, pumped dry and a ladder provided for inspection of the interior of the manhole.
5. The Contractor shall provide authorized representatives of the manufacturers to demonstrate to the Engineer compliance with the specifications of their respective system during or prior to the final inspection at a time designated by the Engineer. Refer to the specific specification section for additional testing requirements for demonstrations.

END OF SECTION

SECTION 26 60 19

AVIATION FUEL SYSTEM CONDUCTORS & CABLES

PART 1 - GENERAL

1.01 DESCRIPTION

A. This division of the Specifications, Division 26 05 19, covers the exterior and applicable interior portions of the electrical wiring system and circuit systems associated with the aircraft fuel system as indicated on the drawings or as specified herein. Provide all materials, labor, equipment and supervision to install the systems.

B. Definition: The term conduit, as used in this Specification, shall mean any or all of the raceway types specified.

1.02 QUALITY ASSURANCE

A. Referenced Industry Standard: The following specifications and standards are incorporated into and become a part of this Specification by reference. Except where a specific date is given, the issue in effect, including amendments, addenda, revisions, supplements and errata on the date of invitation for bids, shall apply. In text, such specifications and standards are referenced to by basic designation only.

1. Underwriter's Laboratories, Inc. (U.L.) Publications:
   a. No. 44: Rubber - Insulated Wire and Cables
   b. No. 83: Thermoplastic - Insulated Wires
   c. No. 493: Thermoplastic - Insulated Underground Feeder and Branch Circuit Cables
   d. No. 486: Wire Connectors and Soldering Lugs
2. Federal Specifications (Fed. Spec.):
   a. J-C-30A(1): Cable and Wire Electrical (Power Fixed Installations)
   b. HH-I-595C: Insulation Type, Electrical, Pressure-Sensitive Adhesive, Plastic
3. Insulated Power Cable Engineers Association Standards (IPCEA):
   a. S-61-402: Thermoplastic Insulated Wire and Cable
   b. S-66-524: Cross-Linked-Thermosetting Polyethylene Insulated Wire and Cable
4. National Electrical Manufacturer's Standards (NEMA):
   a. WC-5: Thermoplastic Insulated Wire and Cable
   b. WC-7: Cross-Linked-Thermosetting Polyethylene Insulated Wire and Cable
   c. WC-70: Power Cables Rated 2000 Volts or Less for the Distribution of Electrical Energy
5. National Fire Protection Association (NFPA):
   a. No. 70: National Electrical Code (NEC)

B. Acceptable Manufacturers: Products of the following manufacturers, which comply with these specifications, are acceptable.

1. Hydraulically applied conductor terminations:
   a. Square D
   b. Scotch (3M)
   c. Burndy
   d. Thomas and Betts(T&B)
   e. Ilsco

f. Anderson

2. Mechanically applied (crimp) conductor terminations:

   a. Scotch (3M)
   b. Thomas & Betts (T&B)
   c. Ideal
   d. Burndy

3. Vinyl Electrically insulating tape:

   a. Scotch (3M)
   b. Tomic
   c. Permacel

4. Twist-on wire connectors:

   a. Scotch (3M)
   b. Ideal
   c. Buchanan

5. Encapsulated insulating kits:

   a. Scotch (3M)

6. Portable cable fittings:

   a. Crouse-Hinds
   b. Appleton
   c. T & B

7. Fiber terminations:

   a. 3M
   b. AT&T
   c. Amp

C. Quality: All conductors shall be electrically continuous and free from short circuits or grounds. All open, shorted or grounded conductors and any with damaged insulation shall be removed and replaced with new material free from defects.

PART 2 - PRODUCTS

2.01 GENERAL MATERIALS REQUIREMENTS

A. Provide all materials under this Section of the Specifications.

B. All wire and cable shall be U.L. listed and shall bear a U.L. label along the conductor length at intervals not exceeding 24-inches.

C. All conductors shall have size, grade of insulation, voltage and manufacturer’s name permanently marked on the outer cover at intervals not exceeding 24-inches.

D. For power system circuit wiring, the conductor size shall be a minimum of No. 12 AWG. Conductor size shall not be less than indicated on the drawings.

E. The insulation voltage level rating for power and control conductors shall be 600 volts and 300 volts for communications and signal conductors.

2.02 PRODUCT/MATERIALS DESCRIPTION

A. Power Circuit Conductors

1. Conductors for power circuits No. 10 AWG and smaller shall be solid copper, 90°C THHN/THWN/XHHW-2 600-volt insulation.

2. Conductors No. 8 AWG and larger shall be stranded copper, 90°C THHN/THWN/XHHN-2 600 volt insulation.

B. Control, signal and instrumentation conductors:

1. Control conductors for use on 120 volt control wiring systems shall be No. 12 AWG stranded type THHN/THWN/XHHN-2, unless indicated otherwise on the drawings.

2. Remote control and signal circuits:

   a. Class 1: No. 14 AWG (minimum size), standard copper conductors, 600 volt, type THHN/THWN/XHHN-2 90°C insulation
   b. Class 2 and 3: No. 16 AWG (minimum size), solid copper conductors, 300-volt insulation, rated 75°C in dry locations and 60°C in wet locations, individual conductors twisted together and covered with a non-metallic jacket, unless otherwise noted.

3. Instrumentation Wiring

   a. Discrete: 16 gauge tinned copper, PVC insulated, twisted pair, chrome PVC jacket. 300V, 60°C, NEC Type CM. Belden #8471.
   b. Analog: 16 gauge tinned copper, polyethylene insulated twisted pair. Beldfoil shield. 18 AWG stranded drain wire. Chrome PVC jacket 600V, 60°C, NEC Type CL2. Belden #8719.

4. Ethernet and Modbus CAT 6 Cables:

   a. Interior, MCC and TC installation Applications: 24 gauge, 2 conductor stranded copper, polyethylene insulated twisted pair(1-pair), Beldfoil foil shield, 24 AWG stranded TC drain wire and PVC jacket. Belden #9841.
   b. Exterior: 23 gauge stranded copper, 8 conductors stranded copper, polyethylene insulated twisted pairs (4-pair), Beldfoil foil shield, inner FRPO jacket and PVC outer jacket. Belden #7953A.
   c. RJ45 connector compatible.

C. Splices and taps

1. All conductor splices and pigtail connections for solid conductors shall be solderless, screw-on, spring pressure cable type, 600 volt, 105°C. with integral insulation and U.L. approved for aluminum and copper conductors. Connectors for stranded conductors shall be a crimp-on type with an integral insulating cover.

2. All stranded feeders conductors shall be spliced where specified with a hydraulically applied, in-line compression type splicing barrel and integral insulating sleeve cover. The splice shall be installed by a crimp type compression tool designed for this specific purpose with a correctly installed head to match the conductor size.

3. Electrical insulating tape shall be 600 volt, flame retardant, cold and weather-resistant, minimally .85 mil thick plastic vinyl material; Scotch No. 88, Tomic No. 85, Permacel

D. Fiber Optic Cable:

1. Fiber optic cable shall be heavy-duty industrial type. Cable shall be gel-filled, loose tube construction suitable for installation in the underground duct and specifically designed for field termination.
2. The outer jacket shall be high-density double polyethylene resistant to corrosion, moisture, oil and abrasion. The cable shall be impervious to moisture and non-nutrient fungus.
3. Cable shall support installation pulling tension of not less than 600 lbf and be installed tension of not less than 200 lbf. Minimum crush resistance shall be 550 lbf/in.
4. Cable operating temperature range shall be -40°C to 70°C.
5. Each cable shall have a fiber count as specified on the drawings of graded-index multimode, glass fibers. Note cables that provide additional fibers to replace defective fibers in the cable shall not be permitted.
6. Each fiber shall have a core diameter of 50 ±3 microns, and a cladding diameter of 125 ± 2 microns. The numerical aperture shall be 0.20 with a bandwidth of 800 MHz-Km at 1300 nanometers. The attenuation at 1300 nanometers must not exceed 1.00 dB/Km.
7. Meet all applicable specifications for FDDI physical media.
8. The fiber used in cable shall:
    a. Be reusable and capable of Category 5E 100 Mbps data rates or greater.
    b. Meet EIA/TIA 492 AAAA standard.
9. All fibers shall be terminated with field installable, ceramic ferrule, ST compatible connectors.
10. Interior building cables shall be tight-buffered, non-gel-filled design.
11. Cable shall be plenum rated and marked OFNP (UL) and UL-910 standards.
12. The cable may be non-plenum rated where installed in non-plenum spaces/areas.
13. A cable used for multi-story building risers must be marked OFNR (UL) and meet UL 1666 flame test or be plenum cable as specified above.
14. Underground and exterior cables shall be loose tube, gel-filled design.
15. Loose Tube, gel-filled cables shall be cleaned and terminated according to Cable Manufacturer and specifications within this document. The use of fan-out kits are required.
16. Acceptable manufacturers: Siecor, Berktek, Lucent and Optical Cable Corporation
17. Fiber Patch Cords: Multi-mode: duplex style multi-mode 62.5 micron core diameter / 125 micron cladding diameter for multimode patch cables. Multimode patch cords shall be orange.
    a. The fiber optic cladding shall be covered by aramid yarn and an OFNR jacket. Specialty use patch cords shall have a jacket suitable for intended use.
    b. Provided factory assembled patch cords with ST style connectors with ceramic ferrules.
    c. Provide one (1) duplex patch cord for each Fiber Optic Patch Panel termination pair.
    d. Provide patch cables sized to routing requirements.
    e. Approved manufacturers: Superior Modular, BerkTek or OrtronicsNo. 295.

PART 3 - EXECUTION

3.01 INSTALLATION

A. Install all wiring in a raceway system, except where direct burial cable or other conductors are indicated or specified not to be installed in a raceway.

B. All conductors installed in cable tray shall be lilsted for cable tray use, sunlight resistant, oil & gas resistant and direct buried rated. Cable tray installations shall be performed by qualified electricians in accordance with the NEC and manufacturer's instructions

C. Connect all conductors. Torque each terminal connection to the manufacturers recommended torque value. A calibrated torqueing tool shall be used to ensure proper torque application.

D. Do not install more conductors in a raceway than indicated on the drawings. A maximum of three branch circuits are to be installed in any one conduit, on 3 phase 4 wire system, unless specifically indicated on the drawings. No two branch circuits of the same phase are to be installed in the same conduit, unless specifically indicated on the drawings.

E. Conductors shall be tested to be continuous and free of short circuits and grounds.

F. Identication

1. Identify each control conductor at its terminal points with wrap around tape wire markers. I.D. to indicate terminal block and point designation, or other appropriate identifying indication. Identify all power conductors within terminal cabinets and pull boxes with circuit identification tag connected by nylon tie-wraps.

2. Group and lace with nylon tie straps all conductors within enclosures, i.e. panels, motor controllers, motor control centers, terminal cabinets, program instruments, and control cabinets.

3. Maintain phase rotation established at service equipment throughout the entire project.

G. Color code conductors

1. Color code all secondary service, feeder and branch circuit conductors. Control and signal system conductors need not be color-coded.

2. Coding shall be as follows:

   a. 208Y/120 volt three phase four wire wye system - Phase A, Black; Phase B, Red; Phase C, Blue; Neutral, White
   b. 480Y/277 volt three phase four wire system - Phase A, Brown; Phase B, Orange; Phase C, Yellow; Neutral, Gray with white tracer
   c. Grounding conductors shall be green or green traced.

3. Conductors No. 10 and smaller shall have solid color compound insulation or color coating.

H. Make splices in conductors only within junction boxes, wiring troughs and other enclosures as permitted by the National Electrical Code.

I. Terminate conductors No. 10 AWG and smaller specified to be stranded, with crimp type lug or stud. Direct termination of stranded conductors with crimp terminator to terminal screws, lugs, or other points is not permitted even if the terminal is rated for stranded conductors. Crimp terminal shall be the configuration type suitable for the terminal point.

J. Control, communications or signal conductors shall be installed in separate raceway systems from branch circuit or feeder raceway, unless indicated otherwise on the drawings.

K. Splices in conductors installed below grade are not permitted.

END OF SECTION

SECTION 32 31 13
CHAIN LINK FENCES AND GATES

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

A. Section Includes:

1. Chain-link fences.
2. Horizontal-slide gates.
3. Swing gates.

1.3 ACTION SUBMITTALS

A. Product Data: For each type of product.

1. Include construction details, material descriptions, dimensions of individual components and profiles, and finishes for the following:

a. Fence and gate posts, rails, and fittings.
b. Chain-link fabric, reinforcements, and attachments.
c. Accessories: Barbed wire.
d. Gates and hardware.

B. Shop Drawings: For each type of fence and gate assembly.

1. Include plans, elevations, sections, details, and attachments to other work.
2. Include accessories, hardware, gate operation, and operational clearances.

1.4 INFORMATIONAL SUBMITTALS

A. Product Certificates: For each type of chain-link fence and gate.

B. Product Test Reports: For framework strength according to ASTM F1043, for tests performed by manufacturer.

C. Field quality-control reports.

1.5 FIELD CONDITIONS

A. Field Measurements: Verify layout information for chain-link fences and gates shown on Drawings in relation to existing and proposed structures. Verify dimensions by field measurements.

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

A. Lightning Protection System: Maximum resistance-to-ground value of 25 ohms at each grounding location along fence under normal dry conditions.

2.2 CHAIN-LINK FENCE FABRIC

A. General: Provide fabric in one-piece heights measured between top and bottom of outer edge of selvage knuckle or twist according to "CLFMI Product Manual" and requirements indicated below:

1. Fabric Height: 6 feet or as indicated on Drawings].
2. Steel Wire for Fabric: Wire diameter of 0.148 inch.

    a. Mesh Size: 2 inches.

    b. Zinc-Coated Fabric: ASTM A392, Type II, Class 2, 2.0 oz./sq. ft.

    c. Coat selvage ends of metallic-coated fabric before the weaving process with manufacturer's standard clear protective coating.

3. Selvage: Knuckled at both selvages

2.3 FENCE FRAMEWORK

A. Posts and Rails: ASTM F1043 for framework, including rails, braces, and line; terminal; and corner posts. Provide members with minimum dimensions and wall thickness according to ASTM F1043 or ASTM F1083 based on the following:

1. Fence Height: 72 inches.

2. Heavy-Industrial-Strength Material: Group IA, round steel pipe, Schedule 40.

    a. Line Post: 2.375 inches in diameter.
    b. End, Corner, and Pull Posts: 2.875 inches in diameter.

3. Horizontal Framework Members: Intermediate, top, and bottom rails according to ASTM F1043.

    a. Top Rail: 1.66 inches in diameter.

4. Brace Rails: ASTM F1043.
5. Metallic Coating for Steel Framework:

a. Type A: Not less than minimum 2.0-oz./sq. ft. average zinc coating according to ASTM A123/A123M or 4.0-oz./sq. ft. zinc coating according to ASTM A653/A653M.

2.4 TENSION WIRE

A. Metallic-Coated Steel Wire: 0.177-inch diameter, marcelled tension wire according to ASTM A817 or ASTM A824, with the following metallic coating:
1. Type II: Zinc coated (galvanized) with the following minimum coating weight:
a. Matching chain-link fabric coating weight.

2.5 HORIZONTAL-SLIDE GATES

A. General: ASTM F1184 for gate posts and single sliding gate types.

1. Classification: Type II Cantilever Slide, Class 1 with external roller assemblies.

a. Gate Frame Width and Height:
1) Gate at East Side of Fuel Farm – 20 feet wide by 6 feet high

B. Pipe and Tubing:

1. Zinc-Coated Steel: Protective coating and finish to match fence framework.
2. Gate Posts: ASTM F1184. Provide round tubular steel posts.
3. Gate Frames and Bracing: Round tubular steel.

C. Frame Corner Construction: Welded.

D. Extended Gate Posts and Frame Members: Extend gate posts and frame end members above top of chain-link fabric at both ends of gate frame 12 inches as required to attach barbed wire assemblies.

E. Hardware:

1. Hangers, Roller Assemblies, and Stops: Fabricated from galvanized steel.
2. Latch: Permitting operation from both sides of gate with provision for padlocking accessible from both sides of gate.
3. Padlock: Provide padlock keyed to match existing locks

2.6 SWING GATES

A. General: ASTM F900-11 for gate posts and double swing gate types.

1. Gate Frame Width and Height – 18’ Clear opening, 6 feet high.

B. Pipe and Tubing:

1. Zinc-Coated Steel: Protective coating and finish to match fence framework.
2. Gate Posts: ASTM F900-11. Provide round tubular steel posts.
3. Gate Frames: Round tubular steel.

C. Frame Corner Construction: Welded.

D. Extended Gate Posts and Frame Members: Extend gate posts and frame end members above top of chain-link fabric at both ends of gate frame 12 inches as required to attach barbed wire assemblies.

E. Hardware:

1. Gate stops: suitable for setting in concrete.
2. Latch: Drop rod or plunger bar arranged to engage the gate stop, permitting operation from both sides of gate with provision for padlocking accessible from both sides of gate.
3. Padlock: Provide padlock keyed to match existing locks.
4. Gate keepers.

2.7 FITTINGS

A. Provide fittings according to ASTM F626.

B. Post Caps: Provide for each post.

1. Provide line post caps with loop to receive tension wire or top rail.

C. Rail and Brace Ends: For each gate, corner, pull, and end post.

D. Rail Fittings: Provide the following:

1. Top Rail Sleeves: Pressed-steel or round-steel tubing not less than 6 inches long.
2. Rail Clamps: Line and corner boulevard clamps for connecting intermediate and bottom rails to posts.

E. Tension and Brace Bands: Pressed steel.

F. Tension Bars: Steel, length not less than 2 inches shorter than full height of chain-link fabric. Provide one bar for each gate and end post, and two for each corner and pull post, unless fabric is integrally woven into post.

G. Truss Rod Assemblies: Steel, hot-dip galvanized after threading rod and turnbuckle or other means of adjustment.

H. Barbed Wire Arms: Pressed steel, with clips, slots, or other means for attaching strands of barbed wire, integral with post cap, for each post unless otherwise indicated, and as follows:

1. Provide line posts with arms that accommodate top rail or tension wire.
2. Provide corner arms at fence corner posts unless extended posts are indicated.
3. Single-Arm Type: Type I, slanted arm

I. Tie Wires, Clips, and Fasteners: According to ASTM F626.

1. Standard Round Wire Ties: For attaching chain-link fabric to posts, rails, and frames, according to the following:

a. Hot-Dip Galvanized Steel: 0.148-inch diameter wire; galvanized coating thickness matching coating thickness of chain-link fence fabric.

J. Finish:

1. Metallic Coating for Pressed Steel or Cast Iron: Not less than 1.2 oz./sq. ft. of zinc.

2.8 BARBED WIRE

A. Steel Barbed Wire: ASTM A121, two-strand barbed wire, 0.099-inch diameter line wire with 0.080-inch diameter, four-point round barbs spaced not more than 5 inches o.c.
1. Zinc Coating: Type Z, Class 3.

2.9 GROUT

A. Nonshrink, Nonmetallic Grout: Factory-packaged, nonstaining, noncorrosive, nongaseous grout complying with ASTM C1107/C1107M. Provide grout, recommended in writing by manufacturer, for exterior applications.

2.10 GROUNDING MATERIALS

A. Comply with requirements in Section 260526 "Grounding and Bonding for Electrical Systems."

B. Connectors and Grounding Rods: Listed and labeled for complying with UL 467.

1. Connectors for Below-Grade Use: Exothermic welded type.
2. Grounding Rods: Copper-clad steel, 5/8 by 96 inches.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine areas and conditions, with Installer present, for compliance with requirements for site clearing, earthwork, pavement work, and other conditions affecting performance of the Work.

1. Do not begin installation before final grading is completed unless otherwise permitted by Engineer.

B. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 PREPARATION

A. Stake locations of fence lines, gates, and terminal posts. Indicate locations of utilities, lawn sprinkler system, underground structures, benchmarks, and property monuments.

3.3 CHAIN-LINK FENCE INSTALLATION

A. Install chain-link fencing according to ASTM F567 and more stringent requirements specified.

1. Install fencing as depicted on the plans.

B. Post Excavation: Drill or hand-excavate holes for posts to diameters and spacings indicated, in firm, undisturbed soil.

C. Post Setting: Set posts in concrete at indicated spacing into firm, undisturbed soil.

1. Verify that posts are set plumb, aligned, and at correct height and spacing, and hold in position during setting with concrete or mechanical devices.
2. Concrete Fill: Place concrete around posts to dimensions indicated and vibrate or tamp for consolidation. Protect aboveground portion of posts from concrete splatter.

    a. Exposed Concrete: Place concrete flush with grade; shape and smooth to shed water.
    b. Concealed Concrete: Place top of concrete 2 inches below grade or as indicated on Drawings to allow covering with surface material.
    c. Posts Set into Holes in Concrete: Form or core drill holes not less than 4 inches deep and 3/4 inches larger than OD of post. Clean holes of loose material, insert posts, and fill annular space between post and concrete with nonshrink, nonmetallic grout, mixed and placed according to anchoring material manufacturer's written instructions. Finish anchorage joint to slope away from post to drain water.

D. Terminal Posts: Install terminal end, corner, and gate posts according to ASTM F567 and terminal pull posts at changes in horizontal or vertical alignment of 15 degrees or more. For runs exceeding 500 feet, space pull posts an equal distance between corner or end posts.

E. Line Posts: Space line posts uniformly at 10 feet o.c.

F. Post Bracing and Intermediate Rails: Install according to ASTM F567, maintaining plumb position and alignment of fence posts. Diagonally brace terminal posts to adjacent line posts with truss rods and turnbuckles. Install braces at end and gate posts and at both sides of corner and pull posts.

1. Locate horizontal braces at midheight of fabric 72 inches or higher, on fences with top rail, and at two-third fabric height on fences without top rail. Install so posts are plumb when diagonal rod is under proper tension.

G. Tension Wire: Install according to ASTM F567, maintaining plumb position and alignment of fence posts. Pull wire taut, without sags. Fasten fabric to tension wire with 0.120-inch diameter hog rings of same material and finish as fabric wire, spaced a maximum of 24 inches o.c. Install tension wire in locations indicated before stretching fabric. Provide horizontal tension wire at the following locations:

1. Extended along bottom of fence fabric. Install bottom tension wire within 6 inches of bottom of fabric and tie to each post with not less than same diameter and type of wire.

H. Top Rail: Install according to ASTM F567, maintaining plumb position and alignment of fence posts. Run rail continuously through line post caps, bending to radius for curved runs and terminating into rail end attached to posts or post caps fabricated to receive rail at terminal posts. Provide expansion couplings as recommended in writing by fencing manufacturer.

I. Intermediate Rails: Secure to posts with fittings.

J. Chain-Link Fabric: Apply fabric to outside of enclosing framework. Leave 2-inch bottom clearance between finish grade or surface and bottom selvage unless otherwise indicated. Pull fabric taut and tie to posts, rails, and tension wires. Anchor to framework so fabric remains under tension after pulling force is released.

K. Tension or Stretcher Bars: Thread through fabric and secure to end, corner, pull, and gate posts, with tension bands spaced not more than 15 inches o.c.

L. Tie Wires: Use wire of proper length to firmly secure fabric to line posts and rails. Attach wire at one end to chain-link fabric, wrap wire around post a minimum of 180 degrees, and attach other end to chain-link fabric according to ASTM F626. Bend ends of wire to minimize hazard to individuals and clothing.

1. Maximum Spacing: Tie fabric to line posts at 12 inches o.c. and to braces at 24 inches o.c.

M. Fasteners: Install nuts for tension bands and carriage bolts on the side of fence opposite the fabric side.

N. Barbed Wire: Install barbed wire uniformly spaced**,** angled toward security side of fence. Pull wire taut, install securely to extension arms, and secure to end post or terminal arms.

3.4 GATE INSTALLATION

A. Install gates according to manufacturer's written instructions, level, plumb, and secure for full opening without interference. Attach fabric as for fencing. Attach hardware using tamper-resistant or concealed means. Install ground-set items in concrete for anchorage. Adjust hardware for smooth operation.

3.5 GROUNDING AND BONDING

A. Comply with requirements in Plans.

B. Fence and Gate Grounding:

1. Ground for fence and fence posts shall be a separate system from ground for gate and gate posts.
2. Install ground rods and connections at maximum intervals as indicated.
3. Ground fence on each side of gates and other fence openings.

a. Bond metal gates to gate posts.
b. Bond across openings, with and without gates, except openings indicated as intentional fence discontinuities. Use No. 2 AWG wire and bury it at least 18 inches below finished grade.

C. Grounding Method: At each grounding location, drive a grounding rod vertically until the top is 6 inches below finished grade. Connect rod to fence with No. 6 AWG conductor. Connect conductor to each fence component at grounding location.

1. Make grounding connections to each barbed wire strand with wire-to-wire connectors designed for this purpose.
2. Make grounding connections to each barbed tape coil with connectors designed for this purpose.

D. Connections:

1. Make connections with clean, bare metal at points of contact.

2. Make aluminum-to-steel connections with stainless-steel separators and mechanical clamps.
3. Make aluminum-to-galvanized-steel connections with tin-plated copper jumpers and mechanical clamps.
4. Make above-grade ground connections with mechanical fasteners.
5. Make below-grade ground connections with exothermic welds.
6. Coat and seal connections having dissimilar metals with inert material to prevent future penetration of moisture to contact surfaces.

E. Bonding to Lightning Protection System: Ground fence and bond fence grounding conductor to lightning protection down conductor or lightning protection grounding conductor according to NFPA 780.

3.6 FIELD QUALITY CONTROL

A. Testing Agency: Engage a qualified testing agency to perform tests.

B. Grounding Tests: Comply with requirements in Plans.

C. Prepare test reports.

3.7 ADJUSTING

A. Gates: Adjust gates to operate smoothly, easily, and quietly, free of binding, warp, excessive deflection, distortion, nonalignment, misplacement, disruption, or malfunction, throughout entire operational range. Confirm that latches and locks engage accurately and securely without forcing or binding.

B. Lubricate hardware and other moving parts.

PART 4 - PAYMENT

4.1 BASIS OF PAYMENT

A. Fences and gates will not be paid for separately, but shall be included in the lump sum base bid item, and shall include furnishing all materials, labor, tools, and equipment to complete the work and no additional compensation will be allowed.

END OF SECTION 323113

SECTION 33 08 55
COMMISSIONING OF FUEL FACILITY SYSTEMS

PART 1 - GENERAL

1.01 SUMMARY/APPLICABILITY

A. This specification defines the requirements and procedures for startup and commissioning of the fuel systems, and the associated backup power system. It covers requirements for safety, scheduling and coordination, device testing, system flushing and cleaning, demonstration of indicated and specified system performance and final acceptance and reporting.

1.02 SUBMITTALS

A. Engineer of Record (EOR) approval is required for submittals. Submit the following in accordance with Section 01 33 00 SUBMITTAL PROCEDURES:

1. Preconstruction Submittals
    a. Commissioning Plan
2. Test Reports
    a. Control Valve Checklist
    b. Commissioning Report
3. Certificates Certification of Completion

1.03 SAFETY

A. Prior to any on-site commissioning activities, the following safety procedures shall be accomplished in all system areas to be commissioned under this specification section: testing/operation of emergency eyewash facilities (if applicable), placement of Contractor provided portable eyewash units within 100 feet or 10 seconds from the fueling point, verification of proper grounding throughout system, coordination with Fire Department and Operator personnel, placement of Contractor provided spill pads and containment booms, placement of Contractor provided fire extinguishers capable of extinguishing a fuel fire.

1. Ensure that all radios/devices within all Class I, Division 1 areas are intrinsically safe.

1.04 COMMISSIONING PLAN

A. The Contractor shall submit a detailed written plan for implementation of system commissioning. The commissioning plan shall specify a detailed plan incorporating in a sequenced manner for all work specified in PART 3 EXECUTION of this specification section. The plan shall be submitted to the Engineer of Record (EOR) for approval 30 calendar days prior to commencement of system commissioning. The plan shall include:

1. Personnel
    a. List of Contractor's personnel by trade, list of key personnel, list of safety equipment, list of miscellaneous equipment such as photo ionization detector (PID), two-way radios, and personnel transportation vehicles.
2. Performance Testing

a. Detailed equipment startup procedures and schedules to perform all system tests under each operating scenario in accordance with paragraph entitled "Performance Tests".

3. Test Forms

a. Develop all test forms required for documenting the system commissioning work. The format of the test forms shall follow the sequencing and terminology of the commissioning plan and shall furnish data grids and ample areas for test data recording.

4. Fuel

a. Quantities of fuel needed for all commissioning activities and fuel delivery schedules. Plan shall include requirements and schedules for Operator provided materials and equipment.

5. Contingency plans

a. Information on spill and fire contingencies, along with the required Fire Department involvement and approvals.

6. Coordination with Owner and Operator

a. Description of how Contractor shall implement system start-up in coordination with ongoing fueling operations. Plan shall incorporate all phasing and work restriction requirements of the Contract Documents.

1.05 CERTIFICATION OF COMPLETION

A. As a prerequisite to fuel system commissioning, the Contractor shall submit a Certificate of Completion that certifies all Work provided on the system, except for field painting, has been inspected and approved by the specified approving authorities. Further, the Contractor shall certify on this certificate that all specified checks and inspections have been successfully completed prior to commissioning. The Contractor shall give the EOR at least 15 calendar days' notice prior to commencement of system commissioning. The Contractor shall submit the Certificate of Completion to the EOR at least (7) calendar days prior to commencement of system commissioning. The EOR shall then be responsible for scheduling the Owner's Representatives for participation in the inspection, performance testing, and final approval activities. Any contractual deficiencies observed shall be corrected by the Contractor without cost to the Owner.

1.06 COMISSIONING REPORT

A. Contractor shall prepare a commissioning report that documents the execution of the approved commissioning plan. All items of work specified in the commissioning plan shall be carried out and reported in this report unless otherwise approved by the Engineer. Include as a part of this report verification letters of approved fuel storage tank hydrostatic tests and the piping hydrostatic tests, as generated under other specification sections. The commissioning report shall include the final settings of the control valves.

PART 2 - PRODUCTS

2.01 DESIGN CONDITIONS

A. Temporary flushing lines and equipment shall be equal in strength, stability, and materials to the associated permanent components.

2.02 CONTRACTOR PROVIDED MATERIALS AND EQUIPMENT

A. The Contractor shall provide all material, equipment and labor required for proper start-up of the system(s), except for that specified to be Owner furnished. Equipment shall include but not be limited to the following:

1. Temporary strainers
2. Pipe and spools
3. Flow meters
4. Pressure Gages
5. Temporary pumps
6. Temporary filtration

2.03 OWNER FURNISHED MATERIALS AND EQUIPMENT

A. The Owner will furnish the following materials, equipment and services used during the execution of the commissioning plan. Any damage caused by the Contractor's operations shall be repaired at no additional cost to the Owner.

1. Fuel
    a. The Owner will provide the fuel necessary for system testing. The Contractor shall notify the EOR a minimum of (30) days in advance of the requirements.
    b. Fuel will not be delivered to the system until the Contractor has satisfactorily completed all work and, in particular, the removal of preservatives and foreign matter from those portions coming in contact with the fuel valves, pumps, and other such equipment. Fuel delivered to the system shall remain the property of the Owner and the Contractor shall reimburse the Owner for shortages not attributable to normal handling losses. The Owner shall be reimbursed for fuel lost as a result of defective materials or workmanship.

PART 3 - EXECUTION

3.01 PRELIMINARY REQUIREMENTS:

A. All activities listed in paragraph "PART 3 EXECUTION" shall be performed sequentially in the order they are presented. Prior to any on-site commissioning activities, the Contractor shall ensure that all requirements of the paragraph entitled "Safety" are satisfied. Project shall be substantially complete and Contractor's work area shall be free of debris, trash and obstacles. Correct functioning of oil-water separator(s) (only if an OWS is included in the Scope of Work) shall be verified prior to receipt of fuel.

B. Perform the following activities prior to receipt of fuel

1. Electrical Preparations
    a. Prior to energizing the electrical equipment, verify that short-circuit links have been removed from current transformer and that secondary circuits have been connected. Verify all electrical transmitter connections and ensure proper calibration. Verify all electrical equipment meets Class I Division I requirements where required. Verify correct rotation of all motors prior to testing. Verify flow switches are electrically connected. Conduit explosion-proof seal-offs shall be poured after initial electrical checks but before fuel receipt.

2. Emergency Fuel Shutoff (EFSO) System Testing

   a. Prior to initial fuel receipt, verify that each EFSO station will de-latch all fuel pumps.

3. Storage Tanks

   a. Ensure approved performance of storage tank integrity testing, hydrostatic test, coating application/inspection per the applicable specifications and soak testing. Ensure that tank interior is clean and free of any fuel-contaminating debris. Verify operation of tank level alarms. Ensure that certified strapping charts for all tanks are available for start-up personnel.

4. Piping System

   a. Ensure that all piping weld integrity and coating inspections have been performed per the applicable specifications. Include verification of approved test results for information in the commissioning report. Evacuate all accumulated water from piping low point drains, valve cavities, and equipment drains. Verify all bolted connections are tightness tested to required torque using a calibrated torque wrench. Verify that all pressure gauges are properly located and installed. Ensure that pipe marking and identification is provided as specified. Ensure that piping system thermal relief provisions are installed and operating as designed.

3.02 INITIAL FUEL RECEIPT

A. Storage Tanks

   1. Receipt flow rate into an empty storage tank shall not exceed 3 feet per second (FPS), as measured in the main receipt piping, until outlet of tank fill tube is submerged.

B. Filter Vessels

   1. Filter separators shall be slowly filled at 1/30th of their rated flow rate

C. Fuel Receipt by Transport Truck

   1. Coordinate with Owner’s personnel to schedule quantity of trucks required. Contractor's personnel shall be positioned at each unloading island, at the pump area and at the receipt tank, all in radio contact.

   2. Contractor shall provide a written summary of truck receipt procedures to the Owner’s Representative. If truck unloading system is newly constructed, perform initial receipt and testing prior to performance testing.

3.03 CONTROL VALVE ADJUSTMENT

A. All control valve settings shall be checked and field adjusted from the factory settings at start-up as necessary to provide a smooth operation. Control valves shall only be adjusted by Manufacturer-trained Technicians.

3.04 EQUIPMENT TESTS

A. After completion of control valve and electrical component adjustments, the equipment tests and performance tests specified hereinafter shall be performed. Both the mechanical and electrical components shall be adjusted concurrently. Tests will be witnessed by the Owner’s representatives.

B. Emergency Fuel Shutoff System

1. With one fueling pump operating, test each EFSO pushbutton station to verify that the pump stops. Repeat this procedure for each fueling pump and EFSO pushbutton station.

3.05 PERFORMANCE TESTS

A. During performance testing, the Contractor shall demonstrate that all portions of the system are operating as designed and specified. Tests shall be performed under all operating scenarios. Record required data necessary to prepare reports specified in paragraph entitled "Commissioning Report".

B. Fuel Loading and Receipt Systems

1. Demonstrate the following features:

a. Static and continuity ground verification system
b. Manual start/stop push button control
c. Fuel load/offload pump operation
d. Filter/separator water detection probe operation and subsequent pump shutdown
e. Pump shutdown upon no-flow/empty off-loading tanker condition signal from flow switch
f. Loading meter operation and communication of transaction data with the Owner’s cloud-based
g. Loading control valve adjustment and operation
h. Scully system Overfill and Grounding verification
i. Deadman Switch Operation to close loading control valve
j. Operation of product recovery tank(s)

C. Storage Tank Systems

1. Demonstrate the following features:

a. Overfill prevention valve closure upon tank independent high-high level condition
b. Independent high-level alarm operation and actuation
c. Tank leak detection system performance
d. Tank clock gauging system operation and clock gauge alarm operation on high level

D. Certified strapping charts shall be provided by the Contractor. Demonstrate all other tank features and functions per the applicable specifications.

E. Satisfactory Performance

1. In the event a portion of the system or any piece of equipment fails to meet the test, the Contractor shall make the necessary repairs or adjustments and repeat the Performance Test until satisfactory performance is obtained. Any component found not to be working as specified shall be repaired/replaced by the Contractor at no additional cost to the Owner. The determination of satisfactory performance shall be made by the Owner’s representatives. The system shall be filled with fuel and shall be operable and leak-free prior to acceptance. The Contractor shall be responsible for any leaks in the new or modified portions of the system. Anything wet with fuel is considered to be leaking.

3.06 TRAINING / INSTRUCTION FOR OWNER’S PERSONNEL

A. The contracting authority should provide one or two key personnel from their "operations" and "maintenance" departments to participate in all phases of system commissioning. The Contractor will be responsible for coordinating the involvement and training of these individuals during the startup process, including hands-on familiarization and adjustment of devices, valves, and components.

3.07 PROJECT CLOSEOUT

A. Ensure that As-Built drawings, equipment warranty documentation, and other project closeout activities are completed per the requirements of the applicable specifications.

END OF SECTION

SECTION 33 52 43.11
AVIATION AND MOTOR FUEL SYSTEM GENERAL PROVISIONS

PART 1 - GENERAL

1.01 SUMMARY

A. Work in this Section includes furnishing all materials, labor and supervision necessary for the new Aircraft and Motor Fuel Systems.

B. The work shall include all pipe, fittings, valves, appurtenances, instrumentation, and activities as specified herein and shown on the drawings. All testing, inspection and flushing shall be provided as specified to provide a complete and operational system.

C. The General Provisions described herein, together with the conditions of the Contract, the General Conditions, Supplementary Conditions and Division 01, apply to the work in Division 33 – Utilities and associated fuel system Work. This Section is hereby made a part of all other Sections of Division 33 - as if repeated in each.

D. All licenses that are required by governing authorities for the performance of work shall be procured by and paid by the Contractor. See Divisions 00 and 01 for related requirements.

E. The Work will be completed as scheduled and stipulated by the Contract Documents, including Div 00 and 01. Advanced planning and time-constrained construction activities are required.

F. No connection to existing fuel systems is required, but the coordination with Demolition and Construction Phases are mandatory and the coordination of work activities shall be harmonious and cooperative.

1.02 REFERENCES

A. Refer to each individual section in this division for a list of applicable references from each of the following organizations:

1. American Petroleum Institute (API)
2. Air transport Association (A4A/ATA)
3. National Fire Protection Association (NFPA)
4. Underwriters Laboratories (UL)
5. American Society of Mechanical Engineers (ASME)
6. American Society for Testing and Materials (ASTM)
7. Factory Mutual Engineering Division (FM)
8. Industrial Risk Insurance (IRI)
9. Military Specifications (MIL)
10. Petroleum Equipment Industry (PEI)
11. Federal Aviation Authority (FAA)

1.03 DEFINITIONS

A. “Piping” includes in addition to pipe, all fittings, valves, sleeves, hangers, and other supports and accessories related to such piping.

B. The words “furnish and install”, “provide”, “furnish”, and “install” are used to mean the Contractor shall furnish and completely install the system, service, equipment, or material named along with other associated devices, equipment, material, wiring, piping, etc. as required. System shall be a complete operating installation, and shall conform to the codes, standards and guidelines applicable to this type of project.

C. It is the intent of the specifications and drawings to call for finished work, tested and ready for operation.

1. All apparatus, appliances, materials, or work not shown on drawings but mentioned in specifications, or vice versa, and/or all incidental accessories necessary to make work complete and ready for operation, even though not specified or shown on drawings, shall be furnished and installed without increase in contract price.

2. Should there be discrepancies or questions of intent, refer matter to the Engineer in writing for a decision before ordering any equipment or materials or before starting any related work.

1.04 COMPLIANCE SUBMITTALS

A. Compliance submittals shall be processed in accordance with Division 01. Submittals are required for all material specified in this Division. If material or equipment is shown on the drawings to be included in this project but is not specified, the Contractor shall bring this to the immediate attention of the Engineer. Submittals are required for all material and equipment incorporated into this project whether specified or not.

B. The Contractor’s attention is called to the Engineer’s review of Compliance Submittals. This review shall be completed and the submittal returned to the Contractor before starting installation or fabrication.

C. The Contractor’s submission of a compliance submittal constitutes that he has either verified and coordinated all dimensional data, quantities, field conditions, catalog data, and compliance with the specification or he assumes full responsibility for doing so.

D. Compliance Submittals shall include all components and units of fabrication for the Fuel System Improvements specified.

E. Compliance Submittals shall be made for construction procedures as specified in individual Sections, and include the following at a minimum:

1. Flushing and swabbing

2. Cutting and tie-in processes

3. Testing and performance adjustments to new controls

4. Overall phasing plans that coordinate fuel system needs, regulations, etc., with the fuel system assets that will be taken out of service to make specified improvements.

F. Submittal Formats are as follows:

1. Product Information: Submit manufacturer’s data sheets identifying equipment size, descriptions, materials, ratings, etc.

2. Drawings: Submit drawings which graphically show relationship of various components of the work, schematic diagrams of systems, details of fabrication, layouts of particular elements, connections, and other relational aspects of the work.

3. Instructions: Preprinted material describing installation of a product, system or material, including special notices and material safety data sheet, if any, concerning impedance, hazards and safety precautions.
4. Statements: A document required of the Contractor, or through the Contractor, from a supplier, installer, manufacture, or other lower tier Contractor. The purpose of which is to confirm the quality or orderly progression of a portion of the work by documenting procedures, acceptability of methods or personnel, qualifications or other verifications of quality.
5. Reports: Reports of inspections or tests, including analysis and interpretation of test results. Each report shall be properly identified. Test methods used shall be identified and test results shall be recorded.
6. Certificates: Statement signed by an official authorized to certify on behalf of the manufacturer of a product, system or material, attesting that the product, system or material meets specified requirements. The statement must be dated after the award of this contract, must state the Contractor's name and address, must name the project and location, and must list the specific requirements that are being certified.
7. Records: Documentation to record compliance with technical or administrative requirements.
8. Submittal Review Action: See Division 01.

1.05 QUALITY ASSURANCE

A. Materials and equipment shall be new, unused, and shall bear manufacture's name, model number, and other identification marking unless material removed during demolition is found to be suitable for reuse as specified elsewhere.

B. Materials and equipment shall be standard products of manufacturer(s) regularly engaged in the production of required type of material or equipment for at least 5 years (unless specifically exempted by Engineer) and shall be manufacturer's latest design having published properties.

C. If more than one unit of the same type of equipment is required, (i.e., control valves, manual valves, etc.) they shall be products of a single manufacturer.

D. All equipment, materials, components, coatings, and accessories provided shall be suitable for use within an aviation Jet-A or Avgas fuel system or Diesel or Gasoline Motor Vehicle fuel system. Maximum operating condition shall be 275 psig, with a temperature range of -20°F to 120°F and specific gravity related to each fuel used. Buna-N elastomers shall not be used in Avgas and Mogas systems.

E. The Contractor is responsible for protecting all equipment and material from loss or damage until the system is completed and accepted by the Owner.

F. The Contractor shall be responsible for coordinating with the manufacturer for installation of the equipment furnished under this contract.

G. The Contractor shall be responsible for warranty work required and shall coordinate with the manufacturer of the equipment to accomplish warranty work including any labor and additional cost for such warranty work. Note that the warranty period shall extend for one year after substantial completion as agreed to by the Owner.

H. The equipment manufacturer shall provide the Contractor with installation manuals and instructions. The Contractor shall receive and install this equipment for a complete

furnished and installed installation including all accessories as specified within these specifications and as shown on drawings.

I. The Contractor shall check equipment delivered to job site by the equipment supplier against approved Compliance Submittals or other required documentation. The Contractor shall report all discrepancies, shortages, or lack of data to the Owner and equipment supplier for adjustments within one week after equipment is received. If such report is not made within one week, it shall be assumed no discrepancies, shortages, or lack of data has been found.

J. Contractor shall provide the following for all equipment furnished:

1. All rough-ins for equipment and accessories
2. Installation of loose trim provided with equipment by the equipment supplier
3. Furnish and install all piping connections, valves, unions, control valves, drains, and other accessories as indicated on the plans and as specified here within these documents

K. The products of specific manufacturers have been used as the basis of design. Any changes to the structure, piping, instrumentation, controls, and electrical connections that result from the use of other manufacturers shall be coordinated with all other trades by the Contractor and approved in writing on letterhead by the Engineer before the ordering of the equipment from the manufacturer. Any resultant modifications required shall be performed without incurring additions to the contract price.

L. The bid shall be based only on products specified. The Contractor shall verify delivery dates for timeliness before submitting his bid. Desired product substitutions shall be brought to the Engineer's attention prior to bidding. No consideration shall be given to substitutions after bids are received.

M. Unless this Contractor states in writing at the time of pricing any and all exclusions to these specifications or drawings in his bid proposal, this Contractor shall furnish and install at the job site the equipment, material, labor and services as specified herein and shown on the drawings for the amount of his bid.

1.06 DRAWINGS

A. Drawings are diagrammatic and indicate the general arrangement of systems and work included in the contract. Drawings are not to be scaled. All drawings and details shall be examined and coordinated by the Contractor to establish exact location of piping and equipment. Where conflicts occur, the Contractor shall inform the Engineer immediately.

B. The Contractor shall follow all contract drawings in laying out work and shall check shop drawings of other trades to verify spaces in which work will be installed.

1.07 MAINTENANCE MANUALS

A. In addition to the requirements specified in the General Conditions, at the project's completion, the Contractor shall submit a complete system Operating and Maintenance Manual (O&M). The manual at a minimum shall include the following:

1. The manual shall be composed of typed instruction sheets with large drawing sheets (not reduced) folded in with reinforced margin. It shall have a post binder system so that the sheets can be easily substituted and shall have a hard cover.

2. The manual shall be organized into systems and shall contain the manufacturer's complete detailed operating and maintenance instructions with data sheets for each piece of equipment furnished under this project.
3. The Contractor shall include a recommended spare parts list for each major piece of equipment furnished for the project including but not limited to:
   a. Fuel Storage Tank Devices
   b. Control Valves
   c. Manual Valves
   d. Filters and Relaxation Chambers
   e. Pumps, Motors and Started
   f. Meter and Electronic Meter Registers
   g. Fuel Level Monitoring system devices and Panels
4. Provide a comprehensive list of maintenance procedures for preventative maintenance and troubleshooting; repair and reassembly, aligning and adjusting, and disassembly.

1.08 NAMEPLATES

A. All major equipment items shall have a permanent, stamped metal, nameplate. The nameplate shall be permanently attached to the equipment in a manner such that it does not hinder the operation of the equipment. All nameplates shall be protected from overspray during field painting operations. Nameplates shall generally include the applicable items in the following list:

1. Manufacturer's Size and Type
2. Serial Number
3. Design Capacity
4. Design Pressure
5. Design Temperature
6. Code Conformance

1.09 CODE REQUIREMENTS AND PERMITS

A. All work indicated on the contract drawings and herein specified shall conform with all applicable codes, environmental regulations or laws of the State in which the work is performed and any other governmental bodies having jurisdiction and shall be installed to the satisfaction of the inspecting authorities.

B. Any deviations from the contract documents or specifications required for conformance with the applicable codes or laws shall be made without change in contract price, but not until such deviations have been brought to the attention of, and approved in writing, by the Engineer.

C. The applicable codes, regulations and laws shall govern the minimum requirements only. Where the drawings or specifications call for materials, construction limitations, or other similar requirements in excess of those requirements, the drawings and specifications shall be followed.

D. The Contractor shall obtain all permits.

E. Contractor shall obtain all licenses, and shall pay all fees and taxes and give all notices bearing on the conduct of the work as drawn and specified.

F. Contractor shall obtain all certificates of occupancy, compliance, approval, or acceptance from all authorities having jurisdiction over the work. Obtain and deliver these to the Owner.

G. All work indicated on the drawings and herein specified shall conform with all applicable standards of the National Fire Protection Association, American Petroleum Institute, American National Standards Institute and American Society for Testing and Materials and the Owner's and/or airlines' Fuel Quality Representatives.

H. All work indicated on the drawings, and herein specified, or tasks required in the performance of the work but not specifically indicated in the drawing or specifications, shall conform with the applicable requirements of the Occupational Safety and Health Administration (OSHA) as provided in 29 CFR. Applicable requirements include, but are not limited to, Part 1910 – Occupational Safety and Health Standards and Part 1926 – Safety and Health Regulations for Construction.

I. All equipment, materials, and specialties shall be installed and connected in accordance with the best engineering practice and standards for this type of work. Unless otherwise specified or shown on the drawings, the recommendations and instructions of the manufacturer shall be followed for installing the work.

J. The Contractor shall promptly notify the Engineer in writing, of any instances in the specifications or on the drawings that are in conflict with any of the aforementioned authorities so that any required changes shall be adjusted before the contract is awarded. If the Contractor performs any work contrary to such laws, rules, regulations or recommendations, without notice, he shall bear all cost arising therefrom.

PART 2 - MATERIALS – NOT USED

PART 3 - EXECUTION

3.01 GENERAL INSTALLATION

A. Contractor shall be responsible for the safety and protection from loss or damage of all equipment and material received until all the work under this contract is complete and the Contractor has received final acceptance. Protect all equipment and material during storage and prior to start-up, which shall include the coverings of all openings, protection against rust and other damage, etc.

B. Contractor shall ensure that all equipment installed as part of this contract shall be properly aligned, adjusted and lubricated before final acceptance.

C. Contractor shall spot paint all equipment where the shop paint has been damaged or flaked off.

D. Furnish all bolts, studs, nuts and gaskets for makeup of all connections to the equipment and replace all gaskets, bolts and fasteners damaged or as directed during the flushing process.

E. All connections to equipment shall be made with socket welds, unions or flanges.

3.02 REQUIREMENTS

A. Mechanical and electrical designs are based on the requirements for the specified manufacturers listed in the equipment specification. Conduit sizes are selected on the basis of specified equipment. Increased manufacturers requirements necessitating

piping changes, additional power conductors, controls, foundations, etc., or any changes required to accommodate any alternate or substitute manufacturer's equipment, other than as shown on drawings shall be provided without any increase in contract price by Contractor.

B. Manufacturers, where specifically called for, must provide factory tests, unit installation observations, unit start-up and tests, etc., as specified. Signed reports shall be submitted to the Engineer upon completion of these services. Subletting of these services will not be permitted. Compliance Submittals shall be accompanied with a letter of certification by the manufacturer that the specified services shall be provided. Failure to do so shall be cause to reject the Compliance Submittals.

C. The contract drawings are in part schematic, intended to convey the scope of work and indicate the general layout, design, and arrangement. The Contractor shall follow these drawings in the layout of his work and shall consult general construction drawings, electrical drawings, and all other drawings for this project. Contractor shall verify all existing site conditions to determine all conditions affecting the work shown or specified. The contract drawings are not to be scaled and the Contractor shall verify areas in which the work is to be installed.

D. Follow drawings in laying out work, check drawings of other trades to verify spaces in which work will be installed, and maintain maximum space conditions at all points. Where space conditions appear inadequate, Engineer shall be notified before proceeding with installation.

E. All work shall be performed by trained personnel of the particular trade involved and shall be done in neat and workmanlike manner as approved by the Engineer.

1. Work shall be performed in cooperation with other trades and scheduled to allow timely and efficient completion of project.

2. Furnish other trades advance information on locations and sizes of frames, boxes, sleeves and openings needed for work. Also furnish information and shop drawings necessary to permit other trades affected to install their work properly without delay.

3. Where there is evidence that work of one trade will interfere with work of other trades, all trades shall assist in working out space conditions to make satisfactory adjustments.

F. Work installed before coordinating with other trades causing interference with work of such other trades shall be changed to correct such condition without increase in contract price and as directed by Engineer.

G. Where specific details and dimensions are not shown on the drawings, the Contractor shall take measurements and make layouts as required for the proper installation of the work and for coordination with all other work on the project. In case of any discrepancies between the drawings and the specifications, it shall be assumed by the signing of the Contract that the higher cost (if any difference in costs) is included in the contract price. The Contractor shall perform the work in accordance with the drawings or with the specifications, as determined and approved by the Engineer.

H. The Contractor shall be responsible for a scheduled sequence in performing the work so that it will not interfere with the Owner's operation. Before any work is started, the Contractor shall consult with the Engineer and Owner and arrange a satisfactory schedule.

1. Make temporary alterations as required to execute work so that all operations and services are maintained with the minimum possible interruption.
2. Temporary shut-downs shall be segregated and shall be of the shortest possible duration. All facilities shall be kept in continuous operation unless Owner grants specific written permission to the contrary.

I. It is the responsibility of the Contractor to monitor the construction area for the presence of flammable vapors and to assure the proper construction methods and equipment is used if hazardous conditions exist.

J. The Contractor shall review the Fuel System Operator's SPCC plan (to be developed and provided post-bid before commissioning). The Contractor shall train their personnel on the appropriate spill prevention, control, and response measures outlined in the plan as they pertain to the current Work. The Fuel System Operator's SPCC plan shall be available on site during the Work.

1. The Contractor shall ensure that spill response procedures have been developed with the Owner to address a potential release. These procedures shall detail initial response actions, availability of spill response kits onsite, and an emergency contact list including appropriate regulatory agencies. These procedures shall be available in written format at the site. In addition, the Contractor shall ensure that all personnel have been trained and visitors have been briefed on appropriate spill response procedures.

3.03 EXISTING CONDITIONS

A. Each bidder shall inspect the site as required for knowledge of existing conditions. Failure to obtain such knowledge shall not relieve the successful bidder of the responsibility to meet existing conditions in performing the work under the contract.

B. Where new work cannot be installed without changes in existing plant, facility, or systems or where it is indicated on drawings to re-work an existing installation, this contract shall include alterations to existing work as required to install new work. Additions to the contract cost will not be allowed because of the Contractor's failure to inspect existing conditions.

C. Existing conditions indicated on the drawings are taken from the best information available on previous contract drawings and from visual site inspection. They are not to be construed as "As Built" conditions, but are to indicate the intent of this work. It shall be the responsibility of the Contractor to verify all existing conditions at the project site and to perform the work as required to meet the existing conditions and the intent of this work indicated.

D. Unless specified otherwise, all existing material and equipment shown or required to be removed from existing construction and not shown to be reused or turned over to the Owner shall become the property of the Contractor and shall be promptly removed from the site.

E. Any existing material or equipment which is to be reused or is to remain in place and which is damaged by this Contractor in performing the contract work shall be repaired to the satisfaction of the Owner or shall be replaced with new equipment and material.

3.04 STORING MATERIALS

A. Unless otherwise arranged for by the Contractor, buildings of the Owner shall not be used for Contractor storage or job office purposes. Open or exposed space for storage of material and location of temporary job facilities will be allocated to the Contractor. The

Contractor, at his own expense, shall provide any temporary structures such as trailers and sheds, as may be required for this purpose.

3.05 CUTTING AND PATCHING

A. The responsibility for the cutting of existing masonry and concrete which is required for the installation of new work shall be by the Contractor. The Contractor shall coordinate with the Owner before any cutting and obtain approval from the Engineer and the Owner prior to any cutting.

B. Cutting shall be done with extreme care and in such a manner that the strength of the structure will not be endangered. Wherever possible, openings in concrete or masonry construction shall be by concrete saw or rotary core drill. Openings in any construction shall be cut the minimum size required for the installation of the work.

C. Where openings or holes are cut in existing construction and the cutting breaks existing electrical circuitry, control circuitry, communications, conduit, or wiring, then it shall be the responsibility of the Contractor to have the circuitry, conduit, and rewiring re-routed as required and as approved by the Owner. Temporary completion shall be provided where necessary before the permanent re-routing and completion work is finished. All costs for this work shall be the responsibility of the Contractor and no additions will be allowed to the contract price.

D. Where existing work is removed from openings in existing construction and the opening is not to be reused for new work, the opening shall be filled and patched to match existing adjacent construction.

3.06 BASES, FOUNDATIONS, SUPPORTS, AND ATTACHMENTS

A. The Contractor shall provide all structural steel, concrete, and materials necessary to properly support and anchor equipment and lines provided under this contract.

B. All equipment and materials shall be securely attached in an approved manner. Attachments shall be of a strong and durable nature and suitable for the service required.

C. Concrete bases shall be provided where shown on the drawings. Equipment which is to be grouted in place shall be grouted with non-shrink grout.

D. All equipment shall be mounted, aligned, adjusted, and serviced in accordance with manufacturer’s recommendations before system testing and final acceptance of the system.

3.07 ELECTRICAL COORDINATION

A. All electrical products and their installation shall conform unless otherwise specifically noted, to applicable standards of the National Electrical Manufacturers Association, NFPA 70, Division 26 of these specifications, and shall also be listed by Underwriter’s Laboratories, Inc. and/or other agencies, as required.

3.08 TESTING LABORATORY SERVICES:

A. The Contractor shall secure the services of an independent testing laboratory approved by the Engineer and Owner to perform all testing, witnessing and certification of materials and fuel quality analysis. This applies to coating integrity, fuel acceptability, pressure tests and weld examinations.

B. The cost for all laboratory services will be the responsibility of the Contractor.

C. The laboratory shall:

1. Cooperate with the Engineer, Owner and Contractor; and provide qualified personnel promptly on notice.
2. Perform specified inspections, sampling and testing of materials and methods of construction:
   a. Comply with specified standards; ASTM, other recognized authorities and as specified.
   b. Ascertain compliance with requirements of contract documents.
3. Promptly notify the Engineer, Owner and Contractor of irregularities or deficiencies of work, which are observed during performance of services.
4. Promptly submit 2 copies of reports of inspections and test to the Engineer including:
   a. Date Issued
   b. Project Title and Number
   c. Testing Laboratory Name and Address
   d. Name and Signature of Inspector
   e. Date of Inspection or Sampling
   f. Record of Temperature and Weather
   g. Date of Test
   h. Identification of Product and Specification Section
   i. Location in Project
   j. Type of Inspection or Test
   k. Observations Regarding Compliance with Contract Documents
5. Perform additional pre-approved services as required by the Engineer, Owner and Contractor.
6. The laboratory is not authorized to:
   a. Release, revoke, alter, or enlarge on, requirements of contract documents
   b. Approve or accept any portion of work
   c. Perform any duties of the Contractor

D. The Contractor shall:

1. Coordinate laboratory services, cooperate with laboratory personnel, provide access to project and to manufacturer’s operations.
2. Furnish to laboratory preliminary representative samples of materials to be tested, in required quantities.
3. Furnish labor and facilities:
   a. To provide access to work to be tested
   b. To obtain and handle samples at the site
   c. To facilitate inspections and tests
   d. For laboratory’s use for storage of test samples
4. Arrange with laboratory and pay for pre-approved additional samples and tests required for Contractor’s convenience.
5. The Owner shall reserve the right to request the Contractor to obtain the services of a separate, equally qualified independent testing laboratory, to perform additional inspections, sampling and testing required when initial test indicate work does not comply with contract documents. The Contractor shall pay the costs of such retesting.

3.09 WARRANTY BY CONTRACTOR

A. Warrant all systems, equipment, materials and components installed under these specifications for a period of not less than one (1) year from time of the Project's Substantial Completion.

END OF SECTION

SECTION 33 52 43.13
AVIATION FUEL SYSTEM EXCAVATION BEDDING AND BACKFILL

PART 1 - GENERAL

1.01 SUMMARY

A. This Section applies to underground piping and electrical work and includes the following.

1. Excavating and backfilling for underground contact water drainage piping and appurtenances.
2. Pipe bedding.
3. Flowable Fill.
4. Geotextiles.

B. Related Work Specified Elsewhere:

1. Divisions 00 and 01 apply to all Sections of the Project Manual.
2. Division 33 Sections are particularly complimentary.

1.02 REFERENCES

A. American Society for Testing and Materials (ASTM)

1. C31 – Making and Curing Concrete Test Specimens in the Field.
2. C33 – Standard Specification for Concrete Aggregates.
3. C39 – Compressive Strength on Cylindrical Concrete Specimens.
4. C88 – Soundness of Aggregates by Use of Sodium Sulfate or Magnesium Sulfate.
5. C109 – Test Method for Compressive Strength of Hydraulic Cement Mortars (Using 2 – inch or (50-mm) Cable Specimens).
6. C117 –Materials Finer than 75 μm (No. 200) Sieve in Mineral Aggregates by Washing.
7. C131 – Resistance to Degradation of Small-Size Coarse Aggregate by Abrasion and Impact in the Los Angeles Machine.
8. C136 –Sieve Analysis of Fine and Coarse Aggregates.
9. C144 – Aggregate for Masonry Mortar.
10. C150 – Portland Cement.
11. C618 – Coal Fly Ash and Raw or Calcined Natural Pozzolans for Use as a Mineral Admixture in Concrete.
12. D698 – Laboratory Compaction Characteristics of Soil Using Standard Effort (12,400 ft – Lbf/ft^3 (600 kN-m/m^3)).
13. D1241 – Materials for Soil-Aggregate Subbase, Base and Surface Courses.
14. D1556 – Density and Unit Weight of Soil in Place by the Sand-Cone Method.

15. D1557 – Laboratory Compaction Characteristics of Soil Using Modified Effort (56,000 ft. lbf/ft^3 (2700 kN-m/mm^3).
16. D2487 – Classification of Soils for Engineering Purposes.
17. D2922 – Density of Soil and Soil-Aggregate in Place by Nuclear Methods (Shallow Depth).
18. D3017 – Water Content of Soil and Rock in Place by Nuclear Method (Shallow Depth).
19. D4253 – Maximum Index Density and Unit Weight of Soils Using a Vibratory Table.
20. D4254 – Minimum Index Density and Unit Weight of Soils and Calculation of Relative Density.
21. D4318 – Liquid Limit, Plastic Limit, and Plasticity Index of Soils.
22. D4429 – CBR (California Bearing Ration) of Soils in Place.
23. D4491 – Water Permeability of Geotextiles by Permittivity.
24. D4533 – Trapezoid Tearing Strength of Geotextiles.
25. D4546 – One-dimensional Swell or Settlement Potential of Cohesive Soils.
26. D4632 – Grab Breaking Load and Elongation of Geotextiles.
27. D4751 – Determining the Apparent Opening Size of a Geotextile.
28. D4832 – Preparation and Testing of Controlled Low Strength Material
29. D4833 – Index Puncture Resistance of Geotextiles, Geomembranes, and Related Products.

B. Occupational Safety and Health Administration (OSHA):
   1. 29 CFR Part 1926 – Safety and Health Regulations for Construction.

1.03 SUBMITTALS:

A. Submit as specified in DIVISION 01.

B. Includes, but not limited to, the following:
   1. Test results from laboratory testing of proposed borrow materials.
   2. Erosion and dust control plan.
   3. Dewatering plan
   4. Compaction equipment to be used for fill, trench backfill, and other backfill operations.
   5. Warning tape data and sample.
   6. Pipe bedding and aggregate materials data and tests.
   7. Flowable fill.
   8. Geotextile data and samples.

C. Where selecting an option for excavation, trenching, and shoring design from “OSHA Part 1926,” submit (For information only and not for Engineer approval)

copies of design calculations and notes for sloping, benching, support systems, shield systems, and other protective systems approved by the Responsible person or Contractors Registered Professional Engineer.

D. Provide one set of photographs to the Engineer of existing structures and site improvements on and adjacent to site.

1.04 QUALITY ASSURANCE

A. Tests of all Contractor-secured materials and products being submitted for approval to determine conformance with all requirements of these specifications including borrow materials (both on-or off-site) proposed for use, shall be performed by an independent, testing laboratory retained and compensated by the Contractor.

B. As materials are incorporated into the Project, on-site and off-site quality control tests will be performed during construction to determine conformance with Drawings and Specifications by an independent testing laboratory retained and compensated by the Owner. Frequency of on-site and off-site testing is specified in PART 3.

1.05 PROJECT/SITE CONDITIONS

A. Lines and grades shall be as indicated on the Contract Documents.

B. Carefully maintain and relocate as necessary all reference points and replace as directed by the Owner if disturbed or destroyed.

C. Temporary Erosion, Dust and Sediment Controls: This work shall consist of furnishing, installing, and constructing temporary measures to control erosion and minimize the siltation of intermittent streams as well as prevent siltation of open trenches or other excavations.

1. Temporary erosion and sediment control facilities (i.e., silt fences, sediment traps, or other measures) shall be constructed in compliance with local, state, federal, and jurisdictional agency regulations.

2. Maintain all erosion control facilities and replace when damaged.

D. Disposition of Utilities

1. Adequately protect from damage all existing utilities and remove or relocate only as indicated, specified, or directed.

2. Report inactive and abandoned utilities encountered in excavating and grading operations to the Engineer. Remove, plug, or cap as directed by the Engineer.

3. Provide a minimum of 72-hours' notice to the Engineer and the affected Utility and receive written notice to proceed before interrupting any utility.

E. New spot and contour elevations shown on the contract drawings are finished grade in unpaved areas and top of pavement in paved areas.

F. Geotechnical information is available for this project and can be obtained from the Engineer. Stockpiling of topsoil and other excavated materials will be permitted within the project limits at a location that Contractor coordinates through the Resident Engineer and Owner's Representative.

PART 2 - PRODUCTS

2.01 MATERIALS DEFINED

A. Materials suitable for use in backfill and fill include material that is free of debris, roots, organic matter, and landfill matter and which is free of stone having any dimension greater than ½ the specified layer thickness. Materials shall not exhibit characteristics of high shrink-swell potential as determined from Atterberg limit tests (ASTM D4318) and/or swell/pressure tests (ASTM D4546). For soils used below structural elements, such as footings, slabs, pavements, and mats, that portion of material passing the No. 40 sieve shall have a liquid limit not exceeding 40 and a plasticity index not exceeding 25 when tested in accordance with D4318.

1. When backfill and fill source material is stratified or exists as segregated deposits of material which individually are and are not suitable fill as specified, the Contractor will be allowed to mechanically mix the soil material and use it as fill if the blended material meets the specified requirements for suitable fill and backfill material. Mixing or other conditioning of soil material necessary to make it conform to the specified requirements for fill shall be done at no additional cost to the owner.

2. Conforming to the following:
   a. Soluble Chlorides < 0.02%
   b. Sulfate Content < 0.2%
   c. Sodium Sulfate Content < 0.2%
   d. Percent Swell < 4%

B. Materials suitable for backfill of utility trenches and structures shall be as specified for backfill and fill except that no stones or particles may exceed 50 mm (2 inches).

C. Cohesionless materials include gravels, gravel-sand mixtures, sands, and gravelly sands generally exclusive of clayey and silty material. Cohesionless materials are free-draining materials for which impact compaction will not produce a well-defined moisture-density relationship curve and for which the maximum density by impact methods will generally be less than by vibratory methods. Generally, less than 15% by dry weight of soil particles pass a No. 200 sieve. Cohesionless materials are typically classified by ASTM D2487 as GW, GP, SW, and SP. Materials classified as GM and SM will be identified as cohesionless when fines have a plasticity index of zero.

D. Cohesive materials include silts and clays generally exclusive of sands and gravel and are materials for which impact compaction will produce a well-defined moisture-density relationship curve. Cohesive materials are typically classified by ASTM D2487 as GC, SC, ML, CL, MH, and CH. Material classified as GM and SM will be considered cohesive when the fines have a plasticity index greater than zero.

E. Rock is defined as solid, homogeneous, interlocking crystalline material with firmly cemented, laminated, of foliated masses or conglomerate deposits, none of which can be removed without systematic drilling and blasting, or the use of machine mounted hydraulic or pneumatic rock breakers. Rock also includes large boulders, buried masonry, or concrete other than pavement, exceeding 1 cubic yard(s). Material indicated in the soil boring logs as having a standard penetration resistance as determined by ASTM D1586 greater than 600 blows per foot is arbitrarily defined herein as “Rock”. Removal of “hard material” will not be considered rock excavation because of drilling and blasting that is performed merely to increase production.

F. Hard material is defined as weathered rock, dense consolidated deposits or conglomerate materials, (excluding manmade materials such as concrete) which

usually require the use of heavy excavation equipment with ripper teeth or large excavators for removal. (Material indicated in the soil boring logs as having a standard penetration resistance as determined by ASTM D1586 between 60 and 600 blows per foot is arbitrarily defined herein as “Hard Material”.) Hard material shall not be considered as rock and excavation of hard material shall not be cause for a claim for additional compensation regardless of hardness or difficulty in removing.

G. Rock that is not rippable is classified as unforeseen conditions, but if encountered shall be excavated, measured and paid for by the quantity of cubic yards.

H. Waste material includes excess usable materials and materials unsuitable for use in the Work.

I. Borrow materials includes the following:

1. Acceptable fill materials, granular materials, and topsoil obtained from locations arranged for by Contractor and required when sufficient suitable materials are not obtained from excavation and trenching.

2. Obtaining, excavating, handling, and final placement of materials.

2.02 GRANULAR MATERIAL

A. Pipe Bedding Material shall be clean, natural sand conforming to ASTM C144 (masonry aggregate), or ASTM C33 (fine concrete aggregate) with 100% passing the No. 4 sieve. Neither shall have more than 5% by weight passing the No. 200 sieve.

Sieve	ASTM C33 Percent Passing	ASTM C144 Percent Passing
3/8-in.	---	---
No. 4	95-100	100
No. 8	80 to 100	95 to 100
No. 16	50 to 85	70 to 100
No. 30	25 to 60	40 to 75
No. 50	10 to 30	10 to 35
No. 100	2 to 10	2 to 15
No. 200	---	0 to 5

B. Crushed rock bedding shall be crushed stone or crushed gravel conforming to ASTM C33 coarse aggregate, size No. 57 or 67.

ASTM C33 Sieve	Size No. 57 Percent Passing	Size No. 67 Percent Passing
1-1/2-inch	100	---
1 inch	95 to 100	100
3/4- inch	---	90 to 100
1/2-inch	25 to 60	---
3/8-inch	---	20 to 55
No. 4	0 to 10	0 to 10

No. 8	0 to 5	0 to 5

C. Under-tank bedding material for underground tanks or oil-water separator shall be clean, natural sand conforming to ASTM C144 (masonry aggregate), or ASTM C33 (fine concrete aggregate) with 100% passing the No. 4 sieve. Neither shall have more than 5% by weight passing the No. 200 sieve. The sand material shall have less than 300 ppm chlorides, less than 1000 ppm sulfates and have a PH of 6.5 to 8. The sand material shall have an electrical resistivity of 10,000 ohm-cm or greater.

D. Granular material for trench stabilization shall conform to requirements of crushed rock bedding.

E. Pea gravel bedding shall be smooth, uncrushed aggregate material conforming to ASTM C33 coarse aggregate size No. 8. Pea Gravel may be used as bedding material around all buried tanks and other locations indicated.

ASTM C33 Sieve	**Size No. 8 Percent Passing**
1/2-inch	100
3/8-inch	85 to 100
No. 4	10 to 30
No. 8	0 to 10
No. 16	0 to 10

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2.03 CRUSHED ROCK BASE AND SUBBASE

A. Aggregate shall be crushed stone or crushed gravel, free from lumps or balls of clay, dirt, or other objectionable matter and reasonably free from thin and elongated pieces or dirt. Aggregates shall consist of angular fragments, durable and sound, and shall be reasonably uniform in density and quality.

B. Percentage of wear shall not exceed 50 after 500 revolutions as determined by ASTM C131.

C. Aggregate shall contain 75% by weight of pieces with two or more fractured surfaces if material is crushed gravel.

D. Portion of aggregate passing No. 40 sieve shall be as follows:

1. Liquid Limit: Not more than 25 determined by ASTM D4318.
2. Plastic Index: Not more than 6 determined by ASTM D4318.

E. Gradation shall not vary from the low limit on one sieve to high limit on an adjacent sieve. Test by ASTM C136 and C117, and conform to ASTM D1241, gradation A or B as follows:

Percent By Weight
Passing Square-Mesh Sieve

Sieve Designation	Gradation A	Gradation B
2-inch (50-millimeters)…..	100	100
1-inch (25-millimeters)…..	---	75-95
3/ 8-inch (9.5-millimeters).	30-65	40-75
No. 4 (4.75- millimeters)…	25-55	30-60
No. 10 (2.0- millimeters)…	15-40	20-45
No. 40 (425- millimeters)…	8-20	15-30
No. 200 (75-micrometers)..	2-8	5-15

2.04 CEMENT TREATED BASE

A.

Percent by Weight Passing Square-Mesh Sieve	
Sieve No.	21A
2-inch	100
1-inch	94-100
3/8-inch	63-72
No. 10	32-41
No. 40	24-24
No. 200	6-12

2.05 FLOWABLE FILL

A. Flowable fill, also known as Controlled Low Strength Materials (CLSM), may be used in place of other pipe bedding materials with Engineer's approval.

B. A flowable fill design mix shall be developed by an independent testing laboratory retained and paid by the Contractor. Mix shall consist of sand conforming to ASTM C33 or C144, fly ash conforming to ASTM C618, Portland cement conforming to ASTM C150 or other materials approved by the engineer and have a 28 day compressive strength of not less than 25 psi or more than 150 psi. The objective of this material is to provide a flowable material that will completely fill spaces around pipe and structures and develop adequate strength to support loads while remaining easily excavatable. Mixes that produce 28 day compressive strengths consistently above 150 psi are unacceptable. Slump at time of placement shall not exceed 7 inch. In general, the water content in the mix should not be so high that it hydraulically inhibits consolidation of the material.

C. Flowable fill material conforming to FAA P-152 Class 1 (50-150 psi) is acceptable in lieu of developing and producing a mix under this specification section, except that no aggregate material may be used that exceeds the gradations for sand and fine aggregate specified in the preceding paragraph B.

2.06 BENTONITE SEALING MATERIAL

A. Bentonite supplied as a soil sealant shall be high-swelling sodium Montmorillonite clay referred to as Wyoming Bentonite or sodium Bentonite. The Bentonite shall be Enviroplug-8 as manufactured by WyoBen, Inc., Billings, Montana, or an approved equal.

B. High swelling is defined as the ability of 2 grams of the base Bentonite, when mechanically reduced to a minus 100 mesh, to swell in water to an apparent volume of 16 cc or more when added a little at a time to 100 cc of distilled water contained in a graduated cylinder.

C. The colloid content of the Bentonite shall exceed 75% and is measured by evaporating and weighing the suspended potion from a 2% distilled water solution after 24 hours of sedimentation.

D. Dry fines of the soil sealant shall be:

1. 97% minimum passing 4 mesh.

2. 1% maximum passing 200 mesh.

2.07 BACKFILL AND FILL MATERIAL

A. Material shall be free of roots or other organic matter, refuse, debris, ashes, cinders, frozen earth, or other unsuitable material.

B. Use suitable material sufficiently friable to provide a dense mass free of voids and capable of specified compaction.

C. Do not use material containing gravel, stones, or shale particles greater in dimension than specified.

D. Moisture content shall be that required to obtain specified compaction of the soil.

E. Perform any wetting or drying of the material as required to obtain the specified density when compacted.

2.08 WARNING TAPES FOR UNDERGROUND UTILITIES

A. Warning Tape shall be installed for the purposes of early warning and identification of buried piping during future trenching or excavation.

B. Tape shall be plastic, acid- and alkali-resistant polyethylene film, at least 6 inches in width and 4 mils thick, of the color indicated, and continuously inscribed with at least 1-inch-high, black lettering, indicating type of buried line installed:

1. “BURIED DRAIN LINE BELOW,” green tape.

2. “BURIED ELECTRIC LINE BELOW,” red tape.

3. “BURIED TELEPHONE/COMMUNICATIONS LINE BELOW,” orange tape.

C. Use detectable warning tape above all nonmetallic piping. Tape shall be manufactured with protected integral wire, foil backing, or other means of enabling detection up to and including 36” depths.

2.09 GEOTEXTILES

A. Geotextile fabrics for segregation of pipe bedding from adjacent soils shall be nonwoven fabric as follows:

1. Apparent opening size (AOS) (ASTM D4751). 70-120 sieve

2. Puncture strength (ASTM D4833): ≥100 pounds

3. Grab strength (ASTM D4632): ≥100 pounds

4. Trapezoidal tear strength (ASTM D4533): ≥75 pounds

5. Minimum average weight ≥7.0 ounce per square yard.

6. Fabric around pipelines and tanks containing petroleum products shall be polyester.

7. For pipelines carrying nonpetroleum products, material shall be polypropylene or polyester.
8. Manufacturer shall certify that fabric is designed for filtration.
9. Fabric placed under granular slope protection shall be as specified above except that fabric shall be nonwoven.

B. Geotextile fabrics for use under pavements shall be woven or nonwoven material as follows:

1. Mullen Burst (ASTM D3787): ≥600 psi
2. Puncture Strength (ASTM D4833): ≥120 psi
3. Trapezoidal Tear Strength (ASTM D4533): ≥110 pounds

C. Geotextile fabric for use in silt fence shall be woven polypropylene recommended by the manufacturer for use as silt fence (curtain) and have the following values:

1. Mullen Burst ASTM D3786 ≥ 250
2. Permittivity ≥ 30 gal/min./ft.^{2}

PART 3 - EXECUTION

3.01 SITE PREPARATION

A. Clearing and Grubbing:

1. Clear and grub all areas where earthwork is to be performed and any other areas beyond the earthwork limits where indicated. Much of the site has been cleared already, but not the entire site. See the Phase Reference Plans for more information.
2. Clearing includes clearing and grubbing of vegetation, existing paving, or other material found on or above the existing ground surface inside the clearing limits.
3. Conduct work in a manner to prevent damage to property and to provide for the safety of employees and others.
4. Keep operations within construction limits indicated.
5. Grubbing includes the removal and disposal of all roots or organics where new roads are to be placed and when the excavated material is to be used as fill.
6. Backfill all excavated depressions with approved material and grade to drain.
7. Dispose of debris from clearing and grubbing as specified for waste.

B. Stripping

1. Remove topsoil from areas within limits of excavation, trenching, and borrow areas designated to receive compacted fill.
2. Scrape areas clean of all brush, grass weeds, roots, and other unsuitable material.
3. Strip to depth of approximately 6 inches or to a sufficient depth to remove excessive roots in heavy vegetation or brush and as required to segregate topsoil.

4. Stockpile topsoil in areas where it will not interfere with construction operations or existing facilities. Stockpiled topsoil shall be reasonable free of subsoil, debris, and stones larger than 2 inches in diameter.
5. Remove waste from the site.

3.02 EXCAVATION AND TRENCHING

A. Sheeting, Shoring and Sloping:

1. Soil is very granular and generally requires that trenches be sloped for stability with few exceptions. Trench-boxes (or other compliant means or methods) will be required for deeper utility installations and where resulting slopes from excavation or trenching endanger people or in-place or proposed structures or utilities.
2. Provide materials on site prior to start of excavation. Adjust spacing and arrangement as required by conditions encountered.
3. Remove sheeting and bracing as backfill progresses. Fill voids left after withdrawal with sand or other approved fill material.
4. The Contractor is entirely responsible for excavation means, methods and safety, including compliance with OSHA 29 CFR Part 1926 – Safety and Health Regulations for Construction. Excavation and trench details shown on the drawings have been provided for the sole purpose of addressing design issues related to the intended short and long term performance of the respective structures and utilities and conveying these requirements to the contractor. The presence of these details shall not be construed to mean or imply that site soils have been classified in accordance with OSHA safety requirements or that the engineer has designed or taken responsibility for design of systems related to excavation safety.
5. Existing infrastructure, ongoing Owner or Operator operations and project work limits will preclude some traditional trenching methods such as sloped sides and require others such as sheeting, shoring, trench boxes or others. The Contractor is free to select and use any method or combination of methods that facilitate the work, and adequately protects workers and existing infrastructure to remain in service.

B. Explosives: Blasting shall not be permitted.

C. Excavation for Structures:

1. See structural specs for additional requirements.
2. Excavate area adequately to permit efficient erection and removal of forms without impacting nearby equipment.
3. Shore all excavations deeper than 24 inches within 10 feet of any operating tank. Do not slope back any trenches within 10 feet of an operating tank.
4. Trim to neat lines where details call for concrete to be deposited against earth.
5. Excavate by hand in areas noted and where space and access will not permit use of machines.
6. Notify Resident Engineer immediately when excavation has reached the depth indicated.

7. Restore bottom of excavation to proper elevation with compacted fill in areas over-excavated. If trench bottom is soft, replace over-excavated material with compacted crushed rock. Payment shall be negotiated with Owner for authorized replacement of unsuitable materials. Correct at no additional cost to Owner when trench is over-excavated without authority or to stabilize bottom rendered unsuitable through negligence or improper operations.

D. Trenching for Underground Utilities

1. Side Walls:
   a. Make sloped or use trench boxes within specified (or necessary) trench width limits below a plane 12 inches above top of pipe.
   b. Make vertical, sloped or stepped as required for stability, above a plane 12 inches above top of pipe.
   c. Always excavate without undercutting.
   d. Take measures to avoid impacts to Phases relevant infrastructure during excavations

2. Trench Depth
   a. Excavate to depth indicated on plans and sufficient to provide the minimum bedding requirements for the pipe being placed. If utility depth is not indicated on plans or profiles, the following depths shall be used as typical minimums from top-of-pipe to finish grade. If local codes require greater cover depths, the local code depth for the specific utility shall be used. Shallower depths may be use when required to match existing utilities at tie-ins or special conditions approved by the Engineer.
   b. Depth of utility to surface grade unless otherwise shown.
      1) Electric conduits and ductbanks …. 36 inches
      2) Contact Water drain lines…….. 36 inches or as specified
   c. Do not exceed depths indicated on the plans where conditions of the trench bottoms are satisfactory.
   d. Increase depth of bury as necessary to remove unsuitable supporting materials as directed by the Engineer and the Owner’s Representative.

3. Trench Bottom
   a. Protect and maintain when suitable natural materials are encountered.
   b. Remove rock fragments and materials when over-excavated. Payment shall be negotiated with Owner for authorized replacement of unsuitable materials.
   c. It is noted that the granular soils at the airport may not sustain a vertical trench wall unless the trench is very shallow. See Civil and Structural notes.
   d. Correct at no additional cost to Owner when trench is over-excavated without authorization or to stabilize bottom rendered unsuitable through negligence or improper operations.

4. Trench Width
   a. Excavate trench to a width, which will permit satisfactory jointing of the pipe and thorough tamping of bedding.
   b. If soils will permit a vertical trench, do not exceed following trench widths:
      1) Below a plane 12 inches above top of pipe.

Nominal Pipe Size	Trench Width Minimum	Maximum
Less than 24 inches	Pipe OD + 1.50 foot	Pipe OD + 2 feet
24 inches and larger	Pipe OD + 2 feet	Pipe OD + 3 feet

2) Above plane defined in (1), as determined by Contractor means and methods.
3) Maximum trench width limitations shall apply in all areas more than 5 feet from manhole or structure walls.
4) Maximum width shall be as near the minimum specified as can be controlled by construction equipment and methods utilized.

5. Fill Areas: Perform trenching only after compacted fill has reached an elevation of not less than one foot above the top of the pipe.
6. Limit maximum length of open trench to 50 feet in advance and to 50 feet behind pipe installation.
7. When appropriate and of practical use, protect open trenches with supported steel plate, movable concrete barriers, wood beam barricades, fencing or other approved method as approved by the Engineer.

E. Surface water and trenches:

1. Contractor shall take every precaution to control grading around excavations to prevent surface water from flowing into excavations.
2. Drain or pump as required to continuously maintain all excavations and trenches free of water or mud from any source and discharge to approved drains or drainage channels. Commence when water first appears and continue until work is complete to the extent that no damage will result from hydrostatic pressure, flotation or other causes.
3. Remove subgrade material rendered unsuitable by excessive wetting or siltation and replace with approved backfill material.

3.03 SUBGRADE PREPARATION

A. General

1. Excavate or backfill as required to construct subgrades to the elevations and grades indicated.
2. Prepare pipe support foundation subgrades as specified below.
3. Remove all unsuitable material and replace with acceptable fill material. Perform all wetting, drying, shaping, and compacting required to prepare the subgrade.

B. Subgrade for Fills: Roughen by mechanical disc or scarifying and wet or dry top 6 inches as required to bond with fill.

C. Subgrade for areas to receive crushed rock base course, pavement, structures and concrete slabs:

1. Extend subgrade, where possible, the full width of the pavement, structure, or concrete slab, plus 1 foot in each direction.
2. Scarify the top 6 inches of subgrades in excavation areas and re-compact.
   a. Compact cohesive and cohesionless soil subgrades to a minimum of 95% of maximum density at optimum moisture content as determined by ASTM D1557.
   b. Moisture content for cohesive and cohesionless materials shall not be more than 3% above or 2% below optimum during compaction. Stricter limits may be required to meet specified density. Less restrictive limits may be used when specified density requirements are achieved.

D. Subgrade for Structures

1. For subgrades in fill, compact to density specified for fill.
2. For normal subgrades, not constructed in fill, above the water table and not subject to saturation, compact subgrade as specified for fill.
3. For saturated subgrades in well-draining soil near or below the water table, dewater soil and compact top 6 inches as specified for fill, but not less than the density of undisturbed soil at the same location and depth.
4. For saturated subgrades in poor draining soil near or below the water table, dewater soil and compact to density of undisturbed soil at the same location and depth. If soil shows signs of liquefying or compaction efforts cause soil to loose density or bearing capacity as compared to in-situ material, notify engineer and proceed as directed.

3.04 CRUSHED ROCK BASE AND SUBBASE

A. Placement and Compaction:

1. Place material without segregation of sizes and spread from spreader boxes or moving vehicles equipped to spread material in layers of uniform thickness.
2. Compact in layers no less than 3 inches or more than 7 inches thick.
3. Roll to specified compaction requirements throughout full depth of layer with tamping rollers, power rollers, rubber-tired rollers, or combination.
4. Shape and smooth by blading.
5. Hand-tamp in places not accessible to rolling equipment.
6. Aerate by blade graders, harrows, or other approved equipment when mixture is excessively moistened by rain.

B. Degree of Compaction:

1. Base compaction on weight per cubic foot of material passing 3/4-inch sieve and compact to at least 95% of maximum dry density at optimum moisture.
2. Determine and control compaction in accordance with ASTM D1557.

C. Smoothness Test:

1. Surface shall show no deviation in excess of 3/8-inch in any 10 feet when tested with a 10-foot straightedge applied parallel with and at right angles to the centerlines of the paved area.

2. Correct any deviation in excess of this amount by loosening, adding or removing material, reshaping, watering, and compacting as directed by Engineer.

D. Maintain finished base course in a condition satisfactory to Engineer until pavement is placed upon it.

3.05 CEMENT TREATED BASE

A. Not used

3.06 FILL AND BACKFILL

A. General Fill and Backfill:

1. Construct to the depths, contours, and elevations indicated and as specified, using suitable approved material from excavation and borrow areas.
   a. Place materials in compacted lifts not exceeding 8 inches.
   b. Place only on subgrades approved by the Engineer.
   c. Do not place snow, ice or frozen earth in fill and do not place fill on a frozen surface.
   d. Remove all debris from excavation prior to placement.
   e. Compact cohesive and cohesionless soil to a minimum of 95% of maximum density at optimum moisture content as determined by ASTM D1557 as noted in the geotechnical report.
   f. Moisture content shall not be more than 3% above or 2% below optimum during compaction. Stricter limits may be required to meet specified density. Less restrictive limits may be used when specified density requirements are achieved. Obtain compaction by the controlled movement of approved compaction equipment during the placing and grading of layers.

B. Backfilling: Backfill for structures and trenches shall be as specified for general fill and backfill with the following additional provisions.

1. Structures:
   a. Backfill only after concrete has attained 70% design strength.
   b. Backfill adjacent to structures only after a significant portion of the structure has been built to resist the imposed load.
   c. Perform backfilling simultaneously on all sides of structures.
   d. Exercise extreme care in the use of heavy equipment in areas adjacent to structures. Equipment operated within 10 feet of any wall shall not exceed 20,000 pounds gross weight.
   e. Material above a 45-degree plane intersecting the footing shall not include rock fragments incapable of passing a 2-inch screen, and no shale whether disintegrated or not.

2. Trenches: Backfill for trenches shall be as specified for general fill and backfill and with the following additional provisions:
   a. Complete promptly upon completion of pipe embedment and approval to proceed.
   b. Use hand methods to a plane 12 inches above top of pipe.
   c. Mechanical methods shall be acceptable where hand backfill is not required.
   d. Compact backfill in compacted lifts not exceeding 8 inches.

e. Until compacted depth over utility exceeds 3 feet, do not drop fill material over 5 feet.

C. Pipe Bedding Material:

1. Place pipe bedding as indicated using bedding material specified.

2. Consolidation or compaction by flooding or jetting methods will not be permitted.

3. Place pipe bedding material as follows:
   a. With level bottom layer at proper grade to receive and uniformly support pipe barrel throughout its length.
   b. Add second layer simultaneously to both sides of the pipe with care to avoid displacement.
   c. Complete promptly after placement of pipe.

4. Compact Pipe Bedding Material as follows:

   a. In lifts not exceeding 12 inches of loose material.
   b. Rod, spade, or use pneumatic or vibratory equipment.
      1) Throughout depth of embedment.
   c. Pipe bedding adjacent to coated steel pipe shall be compacted using sound mechanical methods acceptable to the Engineer that thoroughly compact the bedding material to a condition that is firm and tight without damaging pipe coatings. Compaction acceptance will be based on visual observation of the bedding placement and compaction operation, and the ability of the procedure to provide in-place bedding that is tight and does not show signs of additional consolidation when walked on. Density testing will not be performed on pipe bedding adjacent to coated piping.

D. Flowable Fill

1. Place in trench after pipe or structure is installed and approved for backfill.

2. Place in manner that prevents lateral or vertical displacement of pipe or structures. Pipelines with exterior protective coating or which are protected by a cathodic protection system shall not be restrained by straps or wires which will damage coatings or concentrate corrosion.

3. Material shall be placed within 2 hours of mixing with water. Placement shall conform to ACI and other typical procedures and practices used to place concrete, including Cold and Hot whether practices.

4. Backfill may proceed on top of flowable fill after it is sufficiently set to support foot traffic without deformation.

5. When using around fiberglass pits, reinforce with number 4 bar at 12 inch centers and place flowable fill in 24 inch lifts or stabilize the pit internally as approved by the Resident Engineer and the Engineer.

3.07 WASTE MATERIALS

A. Remove unsuitable materials from Work area as excavated.

B. Demolished or excavated materials such as asphalt, concrete, and others which are unsuitable for reuse in the Project (as determined by the Engineer) shall become property of Contractor and be disposed of off-site at locations arranged for and paid for by the Contractor.

3.08 GEOTEXTILES

A. Install in accordance with manufacturers recommendations on approved subgrades and as specified herein.

B. Supply material in widths required to minimize seams and laps.

C. Secure material in place on slopes, trench walls and other surfaces where needed to prevent displacement by wind or construction operations. Use pins recommended or supplied by fabric manufacturer.

D. Subgrades shall be free of sharp objects or debris.

E. Fabric used for segregation and drainage such as in trenches, around tanks and under slope protection shall have a minimum of 6 inches of overlap. Fabric use for reinforcement under pavement shall have a minimum of 18 inches of overlap unless otherwise recommended by the fabric manufacturer.

3.09 ON-SITE TESTING

A. Contractor shall retain and compensate an independent testing lab to perform the following tests. Contractor shall provide testing laboratory access to work which is to be tested and include in his bid, all costs for delays associated with the performance of the described testing by the CONTRACTOR'S testing lab. Contractor is responsible for notifying the owner's representative no less than 24 hours before work is expected to be ready for testing.

B. The method of in-place compaction testing including density and moisture content will be as follows:

1. Density: ASTM D2922 (Nuclear Density) and ASTM D1556 (Sand Cone Density).
2. Moisture Content: ASTM D3017 (Nuclear Moisture).

C. A representative frequency of in-place compaction tests including density and moisture content shall be as follow:

1. At least one test per lift for every 100 linear feet or less of backfill placed in trenches.
2. At least one test for every 500 square feet where subgrade preparation for paved areas is being performed.
3. At least one test for every 200 square feet but not less than one test per lift in fill around structures and tanks.
4. At least one test when the Engineer suspects the moisture content or effectiveness of compaction is not acceptable.
5. In place density may be tested by ASTM D2922 (nuclear) or by ASTM D1556 (sand cone), but at least one ASTM D1556 test shall be performed for every 10 ASTM D2922 tests or portion thereof.
6. At least one soil bearing capacity test below each concrete structure.

D. Fill failing to meet required densities or moisture contents shall be scarified and recompacted as necessary to achieve specified results at no additional cost to Owner.

E. Removal of in-place material and replacement with approved new material will be required if scarifying and recompacting do not produce the required densities.

F. Perform at least one ASTM D2487 (Classification of Soil) and one ASTM D1557 [D698] (Compaction) test on each soil type used in fill or backfill operations during construction.

1. Each sample shall be taken from trenches or other excavations as directed by the Engineer and should be generally representative of distinguishably differing materials encountered and use for backfill or fill.

2. Perform one set of tests at the beginning of excavation and one additional set of tests when material properties vary (wetter, dryer, more granular, or other conditions) from the material initially tested.

3. Additional tests shall be performed when directed by the Engineer.

G. Perform at least one ASTM D1557 [ASTM D698] (Compaction) test for every 2500 cubic yards of material placed.

H. Flowable Fill:

1. Make and test one set of four cylinder specimens in accordance with ASTM D4832 for every 100 cubic yards of material placed but not less than one set for each day's pour.

3.10 MAINTENANCE AND CLEANUP

A. Protect newly graded areas from actions of the elements.

B. Settling or erosion occurring shall be filled and repaired and grades reestablished to the required elevations and slopes.

C. Keep paved areas clean. Promptly remove rock or dirt dropped upon paved surfaces by sweeping, washing, or other methods acceptable to the Engineer.

END OF SECTION

SECTION 33 52 43.14
AVIATION AND MOTOR FUEL SYSTEM PIPE, FITTINGS AND INSTALLATION

PART 1 - GENERAL

1.01 SUMMARY

A. This Section describes and provides for the furnishing, installing and testing of pipe and piping components for the aviation and motor fuel systems.

1.02 RELATED SECTIONS

A. Divisions 00 and 01 apply to all Sections of the Project Manual

B. Division 33 Sections are particularly complimentary.

1.03 UNIT PRICES

A. Not used for this Section.

1.04 REFERENCES

A. American Society for Testing and Materials (ASTM):

1. A182 - Standard Specification for Forged or Rolled Alloy and Stainless Steel Pipe Flanges, Forged Fittings, and Valves and Parts for High-Temperature Service
2. A193 - Alloy-Steel and Stainless-Steel Bolting Materials for High-Temperature Service.
3. A194 - Carbon and Alloy Steel Nuts for Bolts for High Pressure and High Temperature Service.
4. A312 - Standard Specification for Seamless, Welded, and Heavily Cold Worked Austenitic Stainless Steel Pipes
5. A358 - Standard Specification for Electric-Fusion-Welded Austenitic Chromium-Nickel Stainless Steel Pipe for High-Temperature Service and General Applications
6. A403 - Standard Specification for Wrought Austenitic Stainless Steel Piping Fittings
7. D910 - Standard Specification for Aviation Gasolines
8. D1655.- Standard Specification for Aviation Turbine Fuels

B. American Society of Mechanical Engineers (ASME)

1. B1.20.1 – Pipe Threads, General Purpose
2. B16.5 - Pipe Flanges and Flanged Fittings.
3. B16.9 – Factory Made Wrought Steel Butt Welding Fittings.
4. B16.9 - Factory Made Wrought Steel Butt Welding Fittings.
5. B16.11 - Forged Steel Fittings, Socket Welding and Threaded.
6. B16.25 - Buttwelded Ends.
7. B31.1 - Power Piping.
8. B31.3 - Chemical Plant and Petroleum Refinery Piping.

C. American Petroleum Institute (API):

1. RP 1110 – Pressure Testing of Liquid Petroleum Pipelines.
2. Spec 5L - Line Pipe.
3. Std. 601.21 - Metallic Gaskets for Piping, Double-Jacketed Corrugated and Spiral Wound.

D. Federal Specifications (FS) QQ-P-416 - Plating, Cadmium.

E. National Electrical Manufacturer's Association (NEMA).

1.05 DEFINITIONS

A. Unless otherwise specified, the working pressure ratings as used in these specifications for valves, fittings, unions, and other piping specialties refer to pressure ratings in pounds per square inch above atmosphere (PSIG) in accordance with applicable ASME Standards.

B. The word 'domestic' shall mean manufactured in the United States of America. All materials provided under this Section shall be domestic.

C. The use of the word "piping" shall be interpreted to include all pipe, valves, fittings, flanges, supports, or accessories for any particular portion of the work, or system to which the word "piping" is applied.

1.06 SUBMITTALS

A. General: Compliance Submittals shall be in accordance with Division 01 and this Section.

B. Product Information: Submit manufacturer's data sheets identifying equipment size, materials, pressure ratings, etc.

1. Piping
2. Fittings
3. Flanges and Gaskets
4. Bolts, Nuts and Washers
5. Valves
6. Supports

C. Reports

1. Radiograph Test Reports

D. Certificates

1. Pipe
2. Fittings
3. Flanges and Gaskets
4. Bolts, Nuts and Washers
5. Welder Performance Qualification (WPQ)
6. Welding Procedure Specifications (WPS)
7. Piping System Installation

E. Records

1. Procedure Qualification Records (PQR)

1.07 QUALITY ASSURANCE

A. All pipe and piping materials shall be provided by a manufacturer and fabricator approved by the Engineer.

B. No foreign materials or components, supplied as part of this Section, shall be utilized. The use of the words “domestic materials” or “no foreign materials” shall mean all materials shall be of U.S. origin. The Contractor shall certify this condition in the compliance submittals. If at any time, the Owner or Engineer determines that any flanges, fittings, bolts or nuts are not of U.S. origin, the Owner shall be entitled to replace the components without need for individual testing for conformance to technical specifications. Contractor shall be responsible for all costs associated with such replacement.

C. Welding operations, qualification of welders and welding procedures shall comply with ASME B31.3 and the ASME Boiler and Pressure Vessel Code, Section I and Section IX. Certified copies of the welding procedure, the procedure qualification, and the welder, qualification certification must be submitted prior to beginning any welding operations.

D. Welders for all base metals must be qualified to position 6G of ASME B31.3, tested on the type of pipe used in this project, and must have been qualified within the six months preceding this project or the welder shall be re-qualified.

E. Contractor is responsible for all costs associated with procedure and welder qualifications.

F. Certified copies of the quality control procedures and results of the internal pipe coating application shall be submitted.

G. The installation shall include all necessary materials, coating, supports, controls, valves and fittings, hereinafter described or called for on the Contract Drawings accompanying these specifications, or as necessary to make the installation complete.

H. The drawings and specifications shall be considered complementary, one to the other, so that materials and labor indicated, or called for, or implied by the one and not the other, shall be supplied and installed as though specifically called for by both.

I. All materials and equipment provided under these specifications shall be new, unused products of manufacturers regularly engaged in production of such equipment for a minimum of 5 years. All products shall conform to the applicable code or standard for its manufacturing, fabricating and installation.

PART 2 - MATERIALS

2.01 AVIATION AND MOTOR FUEL SYSTEM PIPING MATERIALS

A. Uncoated stainless steel shall be used for all fuel service.

B. The piping system Work includes above ground and below ground piping. Unless noted otherwise, piping shall be of single wall construction when installed above ground. Welded joints shall conform to the standards set forth in the ASME B31.3 Code for Petroleum Refinery Piping.

C. Threaded joints are allowed for above-ground small bore piping that has no internal pressure such as downstream of a vent or atmospheric drain piping. Threaded joints shall be American Standard for Pipe Threads, ASME B1.20.1. All burrs shall be removed. Pipe ends shall be reamed out to size of bore and all chips shall be removed. Teflon pipe thread sealant shall be used on the male threads only and shall not extend past the end of the pipe.

D. Single or double-walled underground threaded joints that are called for on the plans shall only include atmospheric vent and drain lines. These joints shall all be air tested before installed onto tanks in accordance with the testing section. If the joint is not tested, the Resident engineer shall witness the entire installation and the exterior coating of the joint for acceptance.

E. Furnish and install flanges where shown and at connections to all equipment. Flanged connections are only allowed above ground or within pits/vaults.

F. Unless otherwise specified herein or stipulated on the Drawings, all flanges shall be matched on piping, valve or equipment as to size, and shall be constructed from materials equivalent to the piping. Flanges shall be raised face unless the existing equipment being connected to is flat face. Identify any flat-face flanges to the Engineer before ordering and installing any such equipment. If accepted by the Engineer, any and all flat-face joints shall be witnessed by the Resident Engineer prior to bolt-up.

G. Pipe fittings shall be of standard manufacture of materials, weight, and quality corresponding to the pipe with which they are used.

H. Fittings such as elbows, tees, reducers and caps shall be used for all changes in piping direction, intersections, size changes and end closures unless otherwise stipulated on the Drawings or specified herein.

I. The manufacturer or supplier of the piping materials shall provide a certificate of the inspection, stating origin of manufacture and that all material has been manufactured, sampled, tested and inspected in accordance with the specified ASTM, API and other identified specification and has found to meet those requirements.

J. All pipe shall be stamped with specification and grade and country of origin. Shop coated pipe shall have specification and grade stenciled on the coating.

K. Galvanized piping is not allowed in the aircraft fueling system.

2.02 PIPING SPECIFICATIONS

A. The following table is provided to indicate the basic design conditions of the components within this section of the specification:

SERVICE	SYMBOL	PRESSURE	TEMPERATURE	SPECIFIC GRAVITY
Jet Fuel	JF	275 psig	-20 to 110°F	0.81±0.01
Leak Detection	LD	275 psig	-20 to 110°F	0.81±0.01
Drain (downstream)	D	30 psig	-20 to 110°F	0.81±0.01
Vent (downstream)	V	0 psig	-20 to 110°F	0.81±0.01

B. The following table is provided to indicate the various materials of construction for the design service required by this specification:

ITEM	2" AND SMALLER	2 1/2" AND LARGER
Carrier Pipe:	ASTM A312 Seamless Type 304L for threaded and Sch. 80 for welded pipe	ASTM A312 Grade 304L, Class 1 Sch. 40
Note: Where applicable, use double random lengths to minimize the number of welds required		

ITEM	2" AND SMALLER	2 1/2" AND LARGER
Fittings:	Stainless Steel Type ASTM A403 Class WP Grade 304L Socket Weld per ASTM A403 and ASME B16.11	Butt – Weld End preparation to ASTM A403, Class WP, Type 304L, seamless or welded and ASME B16.9 of the same minimum wall thickness as the adjoining pipe.
Note: Atmospheric pressure small-bore piping may be threaded. Socket welded small bore piping is required in buried Work. Threaded connections are only allowed above ground or within pits/vaults.		

ITEM	2" AND SMALLER	2 1/2" AND LARGER
Flanges:	150lb. ASME B16.5 Stainless Steel ASTM A182 Slip-on	150lb. ASME B16.5 Stainless Steel ASTM A182 Weld Neck Raised-Face
Note: Flange face and ASME rating to be compatible with corresponding component.		

ITEM	2" AND SMALLER	2 1/2" AND LARGER
Gaskets:	ASTM B16.21, composition ring, using Buna-N, PTFE, or a protein and glycerin binder, 0.125 inch thick	ASTM B16.21, composition ring, using Buna-N, PTFE, or a protein and glycerin binder, 0.125 inch thick
Note: Gaskets to be 1/8" in thickness - ring style for R.F. flanges Note: Bushings shall not be used except as noted or otherwise detailed in the Contract Documents.		

ITEM	2" AND SMALLER	2 1/2" AND LARGER
Bolts:	Stainless Steel Machine Bolts ASTM A193, Grade 8	Stainless Steel, Machine Bolts ASTM A193, Grade 8
Note: Studs may be used for corresponding equipment.		

ITEM	2" AND SMALLER	2 1/2" AND LARGER
Nuts:	Nuts to be heavy hexagon ASTM A194, Grade 8 Stainless Steel	Nuts to be heavy hexagon ASTM A194, Grade 8 Stainless Steel
Note: Nuts shall be properly torqued to manufacturer's recommendations.		

C. Avgas Fuel shall match the Jet Fuel Specification except that the Avgas fuel has a specific gravity of 0.72 and all elastomers shall be Viton.

D. Unleaded fuel system elastomers shall be Viton.

E. Welded elbows shall be long radius unless otherwise shown.

F. Changes in direction of pipe of other than 45 degrees or 90 degrees shall be made as follows

1. With long radius fittings cut to proper angle and shop beveled.
2. Or, at the option of the Contractor, with long radius pipe bends. Pipe roundness shall be maintained to ANSI and industry tolerance for straight pipe lengths. Submit shop drawings of all bends and bending procedures for approval.
3. Field conditions that may lend themselves to implementing bends of 10 degrees or less shall be accomplished using miter joints. Identify any such condition to the Resident Engineer prior to fit-up and tacking.

G. Tee Connections

1. Branch connections may be used in lieu of butt-welding tees for sizes below 3" only, and only above ground or within pits/vaults. Branch connections shall not be used in direct buried piping unless otherwise indicated by the Contract Drawings.
2. Branch connections for all shall be weldolets, sockolets, socket-welded nipolets, or socket-welded weldolets, as manufactured by Bonney Forge or equal.
3. Material shall be ASTM A105, Grade 2, standard weight steel, and shall conform to ASME B16.11 for all.
4. Use for all vent and instrument connections.

H. Fittings for threaded fuel piping

1. 3,000 pound forged steel conforming to ASME B16.11.
2. Threads of threaded jointed piping shall be full, clean, sharp, and true.
3. Bushings shall not be used except as noted on the drawings.

2.03 TESTING EQUIPMENT

A. The Contractor shall provide all necessary devices to test the completed leak detection piping system. Items shall include but, not be limited to the following:

1. Air compressors
   a. Air compressors shall be equipped with condensate dryer system and filter capable of generating oil-free air at -20° F dew point.
   b. Air compressors shall have sufficient capacity to bring the system pressure in a maximum of 60 minutes.
2. Pressure and temperature recorders
   a. Provide certified and calibrated test instruments capable of recording direct temperature, pressure and time in the same scale and chart.
   b. Submit data for test instruments and certificates of calibration.
3. Temporary piping
   a. Provide all piping, fittings, valves, gauges and equipment required for inspection and testing.

B. Testing requirements shall be as specified in Section 33 52 43.43 AVIATION FUEL SYSTEM INSPECTION, TESTING AND FLUSHING.

2.04 HYDROSTATIC TESTING MEDIUM

A. The Contractor shall perform hydrostatic testing of the new pipe, but not the existing piping it is connected to (if applicable). The Fuel System Operator, via the Owner will provide the Jet A fuel required for the hydrostatic testing. The fuel shall meet ASTM D1665, latest revision specification for Jet A Type Aviation Turbine Fuel. Testing requirements shall be as specified in Section 33 52 43.43 AVIATION FUEL SYSTEM INSPECTION, TESTING AND FLUSHING.

PART 3 - EXECUTION

3.01 CLEAN PIPING REQUIREMENTS

A. **The importance of keeping the interior of all piping systems clean during construction is critical to system operations.** The Contractor is required to keep the interior of the carrier piping clean from 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 correct this condition to the Engineer's satisfaction with all necessary material, labor and equipment for cleaning being furnished at the Contractor's expense. The following MINIMUM measures shall be taken to assure cleanliness of the system:

1. The pipe and fittings shall be delivered to the job site sealed. The seals shall not to be removed until the pipe is incorporated into the fabrication of new system piping. After each day's work, the open ends of all pipe being installed shall be sealed closed with an expansion type weatherproof and watertight seal manufactured for this purpose.
2. Trenches present high risk of piping contamination and foreign material collection including storm water and groundwater. Every measure shall be taken by the Contractor to ensure that the solution lines are kept clean and dry during trench installation.
3. All fittings and valves shall be kept in a covered dry storage area until installation.
4. Pipe shall not be installed or stored in areas or ditches containing water or mud.
5. At openings for branches in piping, all material that falls into the pipe must be removed before welding in the branch fittings.

3.02 HANDLING PIPE

A. The shipment, delivery, and installation of all pipe and accessories shall be handled in such manner as to ensure a sound undamaged condition. Particular care shall be taken not to damage pipe coating when storing pipe. No other pipe or materials of any kind shall be placed inside a pipe or fitting after the coating has been applied.

B. Perform the hauling of pipe and other materials in such a manner as to prevent damage to pipe and material. If damage is sustained, Contractor shall be responsible for repair or replacement cost.

3.03 FABRICATION AND INSTALLATION

A. All piping materials, fabrication, installation and application shall be in compliance with the latest requirements of the code for Petroleum Refinery Piping ASME B31.3, and all state and local regulations when applicable.

B. All temporary piping required for construction, testing, flushing and start-up shall be furnished by the Contractor. Such piping shall remain the property of the Contractor; and it shall be his responsibility to dismantle and remove it from the premises when no longer required.

C. End Preparation: The base metals for all butt-welding pipe joints shall be prepared to provide for proper "fit-up" in accordance with ASME B16.25. Ends shall be prepared by machining or flame cutting. Hand flame cutting is only allowed subject to approval by the Engineer and only where the use of machine or automatic machine flame cutting is impractical. Hand flame cuttings shall be ground smooth. No welded joint shall be made where either flame cut or machine cut ends provide a spacing between the pipe so large that more than one stringer bead is required to completely close the pipe. Where flame cutting by hand is employed, the included angle or bevel at the end of the pipe shall be not less than plus or minus 5 degrees from that which is required elsewhere in these specifications for machine cut beveled ends. Pipe end for socket welding shall be reamed for the full inside diameter to remove all burrs and obstructions.

D. All pipe shall follow the routes shown on the drawings and shall be placed accurately to measurements indicated or established from the work. Pipe shall be placed clear of equipment, and other work. Changes in direction shall be made by use of fittings for standard angles and by trimmed fittings for angles other than standard. Reference earlier paragraphs in this section.

E. Proper pipe joint alignment and separation shall be accomplished without the use of backing rings.

F. Weld spatter shall be removed around welds leaving a smooth clean surface.

G. Pipe shall be fabricated to measurements established on the job and shall be carefully worked into place without springing or forcing.

H. Flanges and unions shall not be placed in a location that will be inaccessible after completion of the work.

I. All piping and equipment shall be properly supported and guided. Anchors shall be provided where shown and where required to absorb or transmit thrust and eliminate vibration or pulsation.

J. Changes in pipe size shall be made with reducing fittings. The Contractor shall pay special attention to the type of reducer, and its orientation, shown on the Contract Drawings. Bushings shall not be used unless otherwise shown.

K. Flanged joints shall be accurately centered and aligned prior to installation of bolts so as to prevent mechanical pre-stressing of the flanges, pipe and equipment.

L. For Buried Piping, refer to other Sections under Division 33.

M. Install pipe so as to be clear of contacts with other pipes, pipe sleeves, casings, reinforcing steel, conduits, cables, or other metallic structures. Minimum separation from non-metallic utilities is 12” and from metallic utilities is 24”. Should uncovered field conditions result in clearances less than this, bring to the attention of the Engineer for resolution prior to installing the new piping.

N. Verify all measurements before commencing work. Submit discrepancies for clarification before proceeding.

O. Arrange all piping with proper slopes as directed or level if no slope is stipulated or elevations are not stipulated Piping to be free of sags, traps, or pockets unless otherwise specifically shown.

P. Provide high point vents, pump outs, and low point drains as required and indicated on the drawings.

3.04 WELDING

A. Qualifications of welders shall be done by Contractor in accordance with ASME B31.3, Petroleum Refinery Piping, and may be done on the project site, witnessed by the Engineer, but in any case, shall be done before being allowed to make construction welds. Certified test results for each welder employed by the Contractor shall be kept in the Contractor's field office for inspection by the Engineer.

B. Performance test records of welders issued by a previous employer, in lieu of qualification tests conducted by the Contractor, will not be acceptable. The Contractor shall assume the costs for all tests.

C. Welding and fabrication shall be accomplished in accordance with ASME B31.3 latest edition. Before welding, the piping or other equipment shall be carefully lined up so that no part is offset; flanges and branches shall be set square and true. This alignment must be preserved during the welding operation. If tack welds are used, they must be of the same quality and made by the said procedure as the completed weld. Backing rings shall not be used. No weld metal shall project within the pipe so as to restrict its area or cause danger of its loosening and falling into the pipe. The piping shall not be split, bent, flattened or otherwise injured before, during or after installation. During erection, care shall be taken to remove all dirt, scale and other foreign matter from inside the piping before tying in sections, valves, equipment or fittings.

D. All welded joints shall be made as recommended by the standards of the American Welding Society and B31.3. The welding shall ensure complete penetration of the deposited metal with the base metal. The filler shall be suitable for use with the base metal. Mitered joints shall not be used except where specifically allowed in this specification or on the Drawings.

E. All manual welds shall be made using downhill welding procedure. Shop welds utilizing machine-welding procedures do not have to qualify to the downhill requirement. Machine-welding procedures must be qualified and submitted to the Engineer.

F. Inspection and Repair

1. Aboveground welds (10%) and all below ground welds (100%) shall be radiographed in accordance with these specifications. All socket welds and fillet welds shall be 100% inspected with magnetic particle testing.

2. Any weld that is determined to be defective by the testing laboratory shall be repaired in accordance with ASME B31.3. The Contractor shall be responsible for all costs associated with the weld repair.

G. Qualifications and Approval

1. Welding procedures that are intended to be used on the job shall be submitted for approval. The Contractor shall be responsible to assure that all welding procedures, welders, and welding operators have been qualified in accordance with applicable code requirements before work is started. Shop and field procedures shall be

submitted to the Engineer for approval. The procedure specifications shall be as follows:

a. Include copies of the qualification test records as evidence that the procedures have been qualified in accordance with the latest revisions of the following code:
   1) ASME B31.3 - Chemical Plant and Petroleum Refinery Piping.
b. Developed for the conditions of this Contract and be complete and specific, and if necessary, differentiate between shop and field welding.
c. Welder Performance Qualification Test Certificates
   1) Furnish welder performance qualification test certificates prior to starting work for position 6G for the pipe being installed as part of this project made in strict compliance with the above code.
   2) Submit qualification test records for each welder on the project and keep record files.

2. Costs: Costs incident to procedure and welders qualification tests shall be the responsibility of the Contractor.

H. Each welder shall identify each of his welds with a specific code or identifier. The Contractor shall keep an as built fabrication drawing on the site that identifies the location of each weld made and also indicates the welder who made the weld. The weld shall be made with a “low stress” steel stamp or permanent ink marking.

I. The Owner reserves the right to place welding inspectors (at the Owner’s cost) in the shop where off site welding is taking place.

3.05 INDIVIDUAL WELD INTEGRITY TESTING

A. All butt welds for field and shop fabricated piping for either temporary or permanent installation (including those welds within a pit/vault) shall be 10% (percent) radiographed. All socket welds for field and shop fabricated piping, shall be 100 percent magnetic particle inspected.

B. All fillet welds on hot tap weldolets shall be magnetic particle tested.

C. Piping where factory welds have been performed, must also be radiographed or tested by an approved testing laboratory with results provided to the Contractor upon delivery and receipt of the piping. Forward results of the testing to the Owner and Engineer.

D. All weld integrity-testing costs, including test reports and interpretation, are the responsibility of the Contractor. An independent testing laboratory employed by the Contractor, and subject to approval by the Owner and Engineer, shall perform the weld integrity testing. All testing shall be performed in accordance with ASME B31.3.

E. One film negative of each radiograph shall be made. Each negative shall be identified as to location. Negatives shall be turned over to the Owner at the end of the project. An expert interpretation by a recognized testing laboratory shall be submitted in report form for every weld to the Owner and the Engineer throughout the progress of the work. The report shall show date of test, location, area, film number, weld number and other pertinent information.

F. Permanent radiographic identification stamps shall be located on the piping near the welds.

G. The Independent Laboratory making the tests shall interpret test results and any defects found shall be repaired by the Contractor and a new radiograph taken of the

repair. The cost for inspection of defective welds shall be the responsibility of the Contractor at no cost to the Owner.

H. The Contractor shall coordinate the weld integrity testing with the testing lab, making certain that adequate notices are given that the welds are available for testing.

I. Failure rates: Should a pattern of failure exist in any one welder's work, at the sole discretion of the Resident Engineer and Owner's Representative, the welds of the welder shall be 100% examined at Contractor's expense.

J. Backfilling of the piping shall not commence until tests have been approved by the Engineer and pressure tests have been completed. See also the testing section for more requirements.

3.06 IN-SERVICE PRESSURE TESTING OF SELECTED PIPING JOINTS

A. General: This approach to piping integrity shall be used where certain tie-in joints cannot be pressure tested with the rest of the piping system. Contractor shall set up a visual in-service exam with the Resident Engineer in advance to accomplish and document this test in accordance with the requirements of B31.3.

B. During the testing period, if a leak develops, the Contractor shall abort the test, repair the defect and restart the test from the beginning.

3.07 PIPE HANGERS AND SUPPORTS

A. Pipe hangers and supports shall meet or exceed the requirements of ASME B31.3 and shall be types as given for MSS Standard Practice SP-58 and SP-69 unless otherwise shown on the plans.

B. Pipe hanger and supports shall be of the types listed in Table 1 "Hanger and Support Selection," MSS Standard Practice SP-69. The following figure types given in Fig. 1 will be acceptable: Types 2, 24, 35, 37, 38, 44 and 46.

C. The design, selection, spacing and application of pipe hangers, supports and anchors shall be in accordance with the codes and standards specified except the ASME B31.3 shall take precedence over the MSS SP-69 and SP-58 standards. Spacing shall not exceed distances shown on the Drawings.

D. Not all supports are shown. Furnish and install all rigid supports, whether or not they are shown and detailed, but are required to adequately support the piping systems. Include all necessary structural steel, brackets, concrete inserts, etc., which are required to properly support the piping systems.

E. Install piping and provide necessary support and anchors to prevent forces from being imposed on equipment that would exceed the limits specified by the equipment manufacturer.

F. Provide complete assemblies that are rated for a minimum of 200% of the applied load.

G. Provide galvanized concrete inserts and shop- or field- fabricated galvanized brackets, j-bolts or structural steel shapes where necessary to meet field conditions.

H. Observe the flushing system in operation and make adjustments as necessary to support the system under dynamic loads.

I. Expansion bolts shall be self-drilling anchors, or insert type. Power driven fasteners shall not be used.

J. Fabricate anchors welded to the pressure barrier from the same materials as the pipe and fasten securely to structure at points of adequate structural strength.

K. Support locations configuration and orientation shall be identified and submitted to the Engineer prior to beginning installation.

3.08 SAFETY PRECAUTIONS AND FUEL SYSTEM MODIFICATIONS

A. Safety procedures are the responsibility of the Contractor. All operations in the construction area that involve open flames or the possibility of arcing or sparking shall be conducted in a "Gas-Free" condition.

B. It shall be the responsibility of the Contractor to monitor the use and suitability of the equipment and procedures on the job and maintain a safe "Gas-free" condition when necessary during construction.

C. Prior to commencing any phase of the work requiring a gas-free condition, the Contractor shall make the following minimum provisions:

1. Empty pipes containing fuel and purge all vapors.
2. Isolate, blank off, and adequately ventilate open piping sections so that no part of the pipe containing fuel or vapors is exposed.
3. Inspect for, and confirm that there are no open pools of fuel, or soil contaminated to a combustible limit, in the area of the work.
4. Drain and ventilate storage tanks prior to working on the tanks or tank connections.

D. Utilize a combustible gas analyzer or similar device to make certain that concentrations of combustible gas do not exist in the construction area when performing these operations.

E. Perform all safety precautions as required to assure that the work is conducted in a safe manner and to conform to applicable codes.

END OF SECTION

SECTION 33 52 43.16
FUEL SYSTEM VALVES

PART 1 - GENERAL

1.01 SUMMARY

A. This Section of the Project Manual includes general valves for use in isolating various segments of the Jet Fuel, Avgas, Gasoline and Diesel systems. General valves for fuel systems specified in this Section include the following:

1. Needle Valves
2. Ball Valves
3. Butterfly Valves
4. Check Valves
5. Pressure/Thermal Relief Valves
6. Anti-Siphon Valves
7. Anti-Siphon Check Valves
8. Fusible Link Valves

B. All carbon steel, cast steel and ductile iron valves and equipment shall be externally coated, see Specification Section 09 97 13.51 for coating specification.

1.02 RELATED SECTIONS

A. Divisions 00 and 01 apply to all Sections of the Project Manual.

B. Refer to other Sections under Division 33.

1.03 REFERENCES

A. American Petroleum Institute (API)

1. 6D – Specification for Pipeline Valves
2. 6FA – Specification for Fire Test for Valves
3. 607 – Fire Test for Soft-Seated Quarter-Turn Valves
4. 609 – Butterfly Valves: Lug-type

B. American Society of Mechanical Engineers

1. 16.34 – Valves – Flanged, Threaded, and Welding End.

C. Underwriters Laboratory (UL)

D. Oil Companies Materials Association (OCMA)

E. American Society of Mechanical Engineers (ASME)

F. Factory Mutual (FM)

1.04 SUBMITTALS

A. Submit Compliance Submittals in accordance with Division 01 and Division 33 on all valves and their accessories, indicating the make, model, type, material, size, and pressure rating.

1.05 QUALITY ASSURANCE

A. No foreign made equipment, fittings, bolts, or any other accessory may be used in this work. All such items shall be American made, manufactured in the United States of America. If any foreign items are found within the work supplied under this contract, the Contractor shall remove and replace them with American made items at no additional charge to the Owner.

B. The valve manufacturers shall have products in satisfactory use in similar applications for a minimum of five years.

PART 2 - MATERIALS

2.01 NEEDLE VALVES- THREADED

A. Valves shall be roddable, zinc-nickel plated carbon steel bodied with a 6,000 psig pressure rating @ 200ºF, threaded with a soft seat and ½-inch male x female NPT threaded connections.

B. Valve body shall have an integrated block and bleed design with a 0.090-inch bleed port located on the bottom that is controlled by a ¼”-20 UNF-2A bleed screw.

C. Valve shall have a replaceable Acetal seat and straight through porting

D. The valve’s stem shall be 316 SS with rolled threads, FKM o-ring seal and PTFE back-up ring below the stem threads to protect from corrosion and galling

E. Valve shall have one piece bonnet with metal-on-metal seal to the valve body

F. This valve is used under all gauges and for tubing connections to the pressure boundary where specified. Handle material shall match the valve material.

G. Valve shall be NoShok Model 704-MFC or approved equal.

2.02 BALL VALVES – SOCKET WELDED

A. The valve shall be of three-piece construction, allowing for replacement of all seats and seals without removing the valve from adjacent piping. The valve shall be capable of not less than 400 psi W.O.G. pressure, and shall have a working temperature range of at least -40°F to 300°F.

B. Valves shall consist of carbon steel for Fuel systems, three-section assembly with replaceable primary and secondary body seals of Teflon (RPTFE) and Graphoil, respectively. The ball and stem shall be 316 Stainless Steel. The replaceable ball seat and stem packing shall be constructed of Teflon.

C. Valves shall have a lever type handle with vinyl grip and a 90-degree stop on the extended stem. Handle shall be carbon steel suitable for padlocking.

D. Valves shall have a “fire safe” rating per API 607.

E. Where indicated on the Drawings, valves shall be equipped with spring return devices in the actuator as part of the manufacturer’s complete assembly.

F. All valves shall have socket welded end connections for Schedule 80 pipe.

G. Valves shall be manufactured by Flow-Tek, Triad HR-2-2-xx-3-R-R-L. Apollo or approved equal.

H. Provide spring return model valves when called out on the plans. Spring return valves shall have a 2000 psig pressure rating.

2.03 BALL VALVES – THREADED, LOCKING AND QUARTER TURN

A. The valve shall be two-piece construction. The valve bodies shall consist of carbon steel for Fuel systems. The valve shall be capable of not less than 2000 psig CWP up to 1" and 1500 psig CWP for 1-1/2" sizes. Valves shall have a vacuum service rating of 29" Hg. Valves shall have a working temperature range of at least -40°F to 300°F.

B. Valves shall consist of stainless steel, seats shall be of Teflon (RPTFE) and stem packing of Teflon MPTFE. The ball and stem shall be 316 Stainless Steel. The replaceable ball seat and stem packing shall be constructed of Teflon.

C. Valves shall have a lever type handle with vinyl grip and a 90-degree stop on the extended stem. Handle shall be carbon steel suitable for padlocking unless spring return is specified.

D. Where indicated on the Drawings, valves shall be equipped with spring return devices in the actuator as part of the manufacturer's complete assembly.

E. Valves shall be manufactured by Flow-Tek, Apollo or approved equal.

2.04 BALL VALVES – FLANGED 150 CLASS SERVICE

A. Valves 2" and larger shall be flanged, non-lubricated, double seated, ball type that conforms to API Spec 6D and fire safe certified to API 607. The valve bodies shall consist of carbon steel for Fuel systems. Valve shall operate from fully open to fully closed with 90-degree rotation of the ball. Valve shall be capable of 2-way shutoff. Valve ball shall be constructed of carbon steel, provide full bore type. Provide valves with worm gear operators, except valves 6 inches and smaller may be lever operated with a minimum 10 adjustable positions between fully opened and fully closed.

B. Valves shall be Flow-Tek F15 or approved equal.

2.05 BUTTERFLY VALVES – BI-DIRECTIONAL

A. Butterfly valves shall be used for bi-direction bubble-tight shut-off of flow within the system. Valves shall be mounted between ANSI Class 150 flanges with rated working pressure of the valve to be not less than 275 psi.

B. The valves shall have a carbon steel ASTM, A216 full lug body for fuel systems, drilled and tapped lugs, 316 ASTM stainless steel disc, stainless steel stem, and 316 stainless steel seat with TFE insert material. The operator shall be a spring loaded 10-position manual operator with locking device for valves 4" or smaller and a self-locking worm-gear operator for valves 6" or larger. Valves shall have a "fire safe" rating per OCMA and/or API 607.

C. Valves shall be WKM "Dynacentric", Posi-Seal "Phoenix III", FlowSeal "Fire-Flow", or approved equal.

2.06 CHECK VALVES – FLANGED 150 CLASS SERVICE

A. Check valves shall be used to limit flow to one direction in the system. Valves shall be bubble-tight spring-loaded, non-slamming, silent closing type rated for not less than 285 psi working pressure at 100°F.

B. The valves shall be manufactured with renewable seat and disc. Disc shall be guided at both ends, body shall be carbon steel with stainless steel trim for fuel systems.

Valves 2” and smaller shall have screwed ends and valves 2 1/2” and larger shall be lugged style (not wafer style) suitable for installation between ANSI Class 150 raised face flanges.

C. Valves shall be Mueller Steam Specialty Co. “101M-DT”, Crane Duo-check or approved equal.

2.07 CHECK VALVES – THREADED

A. Check valves less than 2” shall be threaded and used to limit flow to one direction in the system. Valves shall be center-guiding, silent shut-off check valves.

B. Valve body, disc, stem and spring shall be stainless steel, and the seat shall be Viton.

C. WOG: 720-psi at 100^{o}F

D. Seat material temperature rating: -40 ^{o}F to 400 ^{o}F

E. Valves shall be Titan CS80-SS, or approved equal.

2.08 CHECK VALVES – DOWNSTREAM OF AIR ELIMINATORS

A. Downstream of each air eliminator shall be a check valve, which conforms to the following:

B. Valve shall be all stainless-steel construction with threaded MNPT connections and Viton seal,

C. Valves shall be GTP-2916-10 or approved equal.

2.09 PRESSURE/THERMAL RELIEF VALVES

A. Pressure and temperature relief valves shall be used to relieve pressure increases within the piping system due to thermal changes in the piping system. The valves shall be designed, constructed, and rated to ASME Code. Valves shall relive at pressure indicated on drawings.

B. The valve body shall be of carbon steel construction with 3/4” flanged inlet and 1” flanged outlet for fuel systems. Extend discharge piping full size and as indicated on the drawings.

C. Inlet side of valve body shall be equipped from the manufacturer with a ¼-inch ISO B coupling. Contractor shall provide a 1-inch raised face flushing ring with a ¼-inch FNPT port with a ¼-inch ISO B coupling. Provide dust caps for all ISO B couplings.

D. Valves shall be Taylor Valve Technology 8250 Series, Kunkle 171, Consolidated “1982”, Hydroseal, or approved equal.

2.10 ANTI-SIPHON VALVES

A. Anti-siphon valves are used to help prevent the accidental siphoning of a product from a tank in the event of a leak downstream below the liquid level.

B. Valve shall be normally closed, compatible in suction and pressurizes systems.

C. Valve shall have integrated thermal expansion relief set at +/- 25 psig.

D. Valve cap and spring shall be stainless steel, plunger shall be stainless steel with Viton disc.

E. Valve shall be Morrison Bros. Co. model 912-100500 AV.

2.11 FUSIBLE LINK – EXTERNAL EMERGERNCY VALVE

A. Fusible Link External Emergency Valve is designed to stop product flow in the event of a fire.

B. Valve body shall be of ductile iron construction with ANSI class 150# flanged ends.

C. Valve gaskets shall be Teflon (TFE), poppet and lever arm shall be ductile iron, O-ring shall be Teflon encapsulated fluorocarbon elastomer, spring shall be 302 SS, seal nut and plunger shall be 303 SS, handle shall be brass, fulcrum shaft shall be 303 SS, groove pin shall be steel, hold open hook shall be SS.

D. Valve shall have a cold, non-shock maximum operating pressure of 250 psig.

E. Fusible link shall be set to actuate valve at 165 ^{O}F, and UL listed.

F. Valve shall be Morrison Bros. Co. Model 346FDI0-__00 AV, or approved equal.

PART 3 - EXECUTION

3.01 INSTALLATION

A. For any one type of valve, the valves shall be of the same Manufacturer throughout, unless not possible. Manufacturer's name and pressure rating shall be located on a permanent nameplate on outside of valve.

B. Valves shall be installed in accordance with manufacturer's recommendations and as indicated on the plans.

C. Each valve shall be installed in an easily accessible location such that valve operator shall not have to interfere with adjacent equipment for operation and maintenance. Provide spool piping, whether indicated on the drawings or not, if required for proper movement of valve operator and disc.

D. A union connection shall be installed within two feet of each screw end valve. Valves and specialty items shall be rated for not less than the system pressure.

E. Replace any and all valves that prove defective during system testing.

F. Disassemble the three section ball valves during the socket welding procedure to prevent the heat from warping the seals, ball seat, and stem packing.

G. Install all butterfly valves with valve shaft in the horizontal position unless specifically noted otherwise on the plans.

END OF SECTION

SECTION 33 52 43.17
AVIATION FUEL SYSTEM CONTROL VALVES

PART 1 - GENERAL

1.01 SCOPE

A. Control valves specified in this Section include the following:

1. Tank Overfill Prevention Float Operated Control Valve
2. Backpressure Control Valve

B. All carbon steel, cast steel and ductile iron valves and equipment shall be externally coated, see Specification Section 09 97 13.51 for coating specification.

1. Control valve pilot systems and tubing shall not be coated.
2. Control valve nameplates shall not be coated.

1.02 REFERENCES

American National Standard Institute - (ANSI)

National Electrical Manufactures Association - (NEMA)

1.03 RELATED SECTIONS

A. Divisions 00 and 01 apply to all Sections of the Project Manual

B. See also Aviation Fuel System General Provisions, 33 52 43.11

C. See also Aviation Fuel System Controls, 33 52 43.42

D. For electrical elements, see also Division 26

1.04 QUALITY ASSURANCE

A. Contractor shall inspect and clean the valve upon arrival and ensure that the valve stays sealed from contamination of any sort until prepared for immediate installation.

B. Contractor shall hire Cla-Val to adjust and certify the operation of the valves.

C. Contractor shall not flush through the valve, but shall spool through instead.

1.05 GENERAL

A. Control valves shall be as manufactured by Cla-Val.

B. Control valves shall be single-seated globe type, diaphragm actuated, hydraulically operated valves. Valves shall consist of 3 major components: the valve body, valve cover, and diaphragm assembly. The diaphragm assembly shall be the only moving part. In the event of diaphragm failure, valve shall fail closed against flow, unless otherwise indicated. The main valve shall be drip-tight when closed. Each valve shall have an external indicator to show the position of the valve disc at all times. Control valves shall be shipped from the factory as a complete assembly with all pilot controls and pilot auxiliary piping properly installed on the main valve. Materials which come in contact with the fuel shall be resistant to the effects of and not harmful to aircraft engine fuel and shall be stainless steel, or electroless nickel plated ductile iron unless noted otherwise. High level shut-off valve bodies shall be electroless nickel plated ductile iron. Materials for

control valves, and items to be mounted on the valves shall be as listed in the following paragraphs.

C. Bodies, Bonnets, and Covers

1. Shall be constructed of one of the following materials:

   a. Ductile Iron conforming to ASTM A536, with internally electroless nickel plated.
   b. Bodies shall have flanged inlet and outlet connections, Class 150 conforming to ANSI B16.42. Valve shall have a screwed bottom drain plug.

2. Valve Seats

   a. Valve seats shall be stainless steel in accordance with ASTM A743/A743M.
   b. It shall be possible to remove the valve seat while the valve is connected in the line.
   c. Valve seat and upper stem bearing shall be removable and screwed in the body and/or cover.
   d. The lower stem bearing must be concentrically contained in the valve seat and shall be exposed to flow on all sides.
   e. The diameter of the valve seat shall be the same size as the inlet and/or outlet flanges of the main valve.

3. Valve Discs

   a. Valve discs shall contain a resilient, fluoroelastomer (FKM), commonly referred to as Viton disc conforming to SAE AMS 3216 having a rectangular cross section, contained on 3.5 sides by a disc retainer and a disc guide, forming a drip tight seal against the seat.
   b. The disc shall be usable on either side.
   c. The disc guide shall be the contoured type capable of holding disc firmly in place during high differential pressure conditions that may develop across the seating surface.
   d. The disc retainer shall be capable of withstanding rapid closing shocks.

4. Diaphragm Assembly

   a. Diaphragm Assembly shall form a sealed chamber in the upper portion of the valve, separating the operating fluid from the line pressure. The diaphragm assembly shall contain a valve stem which is fully guided at both ends by a bearing in the valve cover and an integral bearing in the valve seat.
   b. Valve body and cover shall be sealed by the diaphragm. Valve stem shall be stainless steel.
   c. The bearing material shall be compatible with the fuel specified and shall not contain zinc coated metals, brass, bronze, or other copper bearing alloys.
   d. The diaphragm shall be of a nonwicking material or design, with a minimum of 2 layers of nylon fabric bonded with a minimum of 3 layers of synthetic rubber (valves 2-1/2 inches and smaller one layer of nylon fabric). The edge area of the center hole for the valve stem shall be sealed by vulcanization. Materials to be resistant to aromatics of up to 50 percent in accordance with ASTM D2000 (SAE J200). The diaphragm must have a MULLINS-burst rating according to ASTM D751 of a minimum of 600 psi per layer of nylon fabric. All diaphragm

sizes must be cycle tested to a minimum of 100,000 cycles, by alternately applying pressure under the diaphragm (main valve pressure) and above the diaphragm (cover chamber pressure). That test shall be certified by the manufacturer. The diaphragm shall not be used as a seating surface. The diaphragm must be fully supported by the body and cover in either the open or closed position.

5. Bolts, Screws and Nuts

    a. For Ductile Iron, and Cast Steel Body Valves.
    b. Bolts and Screws, cadmium plated steel in accordance with SAE J429, Grade 5.
    c. Nuts, Teflon coated steel, Grade 2 H.

6. For Stainless Steel Body Valves.

    a. Bolts, Screws and Nuts, ASTM A320/A320M, Grade B8M C.1.1.

7. Pilot Control System and Auxiliary Piping

    a. Pilot Control System and auxiliary piping shall be stainless steel, seamless, fully annealed tubing conforming to ASTM A269/A269M, Grade TP316, Rockwell hardness B80 or less. Wall thickness for 1/2-inch tubing to be 0.049-inch. Threaded connections shall be used in pilot system piping and shall be o-ring type with FKM O-rings. Tubing connections shall not be welded.

8. Pilot Valves

    a. Pilot valves shall have stainless steel bodies conforming to ASTM A743/A743M with stainless steel internal working parts. Disc and diaphragm assemblies shall be as specified herein before. The setting of adjustable type pressure operated pilot valves shall be easily adjusted by means of a single adjusting screw. The adjusting screw shall be protected by a threaded cap drilled to accommodate a lead-seal wire and a lock nut shall be provided on the adjusting screw to lock it in position at the desired setting. The lead seal wire shall be installed after final acceptance of the system. Spare wire seals and the "embossing" tool will be turned over to the Contracting Officer for the LFM shop.

9. Serviceability of Main Valve Internal Part

    a. Main valve movable parts including strainers, valve seat, stem bearings, and control system shall be replaceable without removing the main valve from the line. All nonmetallic parts shall be replaceable.

D. Total Lengths

The total valve length does not include the orifice plate flange (when used). If the control valve being supplied has the orifice plate built into its flange, the spacer provided shall bring the valve face-to-face dimension equal to those listed below plus 0.0875 inch. The lengths of the valves shall be equal for the following materials: cast stainless steel, and cast steel

PART 2 - PRODUCTS

A. Individual control valve operational requirements

1. Operation, performance, and special features of the individual control valves shall be as specified herein.

2.01 TANK FLOAT ACTUATED HIGH LEVEL SHUT-OFF VALVE

A. The tank overfill prevention valve shall be a float operated valve, non-modulating to control the liquid level in the tanks. The valve shall open fully when the liquid level reaches a pre-set low point and close drip-tight when the level reaches a preset high point based on the mechanical float settings.

B. Valve shall be as manufactured by Cla-Val, Model 129-26 Mechanical Float Valve, with an in-tank CFM2 Modulating Float Control and X77 Manual Float Tester (or as recommended by manufacturer).

C. Valve shall be hydraulically operated, in-tank float pilot controlled, diaphragm actuated control valve. The float shall position the pilot control to close the main valve when the float contacts the upper stop level. The high and low liquid levels shall be adjusted by positioning the stop collars on the float rod. The float mechanism shall be Cla-Val Model CF2M Modulating Float Control, with a X77 Remote Manual Float Tester.

D. Valve body shall be ductile iron with internal ENP coating with flanged ends conforming to ANSI B16.5 class 150#, suitable for a maximum pressure of 250 psig.

E. Valve shall have the following components:

1. 100-34 Hytrol (Reverse Flow)
2. X47A Ejector
3. Bell Reducer
4. CFM2 Float Control
5. X101 Valve Position Indicator
6. X46A Flow Clean Strainer
7. CK2 Cock (Isolation Valve)
8. ~~CV Flow Control (Closing)~~
9. 81-01 Check Valve
10. CV Speed Control (Opening)
11. Valve shall be supplied with a differential pressure control pilot to maintain +/- 7-psi differential across the valve to ensure timely closure upon a high level event.

F. Valve materials

1. Body and cover shall be ductile iron ASTM A536, with internal ENP coating.
2. Valve trim shall be 303 stainless steel
3. Elastomers shall be Buna-N for Jet-A system and Viton for Avgas system.

2.02 TRUCK FILL STAND CONTROL VALVE

A. Combined pressure reducing and solenoid-controlled fuel shut-off control valve shall be used on the refueler loading rack to provide means of deadman control via the Scully system and pressure reducing control.

B. Valve shall be as manufactured by Cla-Val, Model 94-45 Combination Pressure Reducing and Solenoid Shutoff Valve (or as recommended by manufacturer).

C. Valve shall be hydraulically operated, pilot controlled, diaphragm actuated control valve. Valve body shall be ductile iron with internal ENP coating with flanged ends conforming to ANSI B16.5 class 150#, suitable for a maximum pressure of 250 psig.

D. Valve shall have the following components:

1. 100-34 Hytrol (Reverse Flow)
2. CRD Pressure Reducing Control
3. X47A Ejector
4. CS3XM Solenoid Control
5. 100-01 Hytrol (Reverse Flow)
6. X101 Valve Position Indicator
7. X46A Flow Clean Strainer
8. CK2 Cock (Isolation Valve)
9. CV Flow Control (Closing)
10. ~~Check Feature with Cock~~
11. CV Flow Control (Opening)

E. Valve materials

1. Body and cover shall be ductile iron ASTM A536, with internal ENP coating.
2. Valve trim shall be 303 stainless steel
3. Elastomers shall be Buna-N for Jet-A system and Viton for Avgas system.

F. Solenoid Control Feature

1. Solenoid control is a direct acting, 3-way solenoid control that changes position when the coil is de-energized for energized. This applies or relieves pressure in the cover chamber of the auxiliary hytro, providing the operation as follows.
   a. The solenoid when de-energized keeps the Hytrol closed which keeps the main valve normally.
   b. When energized, the solenoid will open the Hytrol position which will cause the main valve to open.
2. The solenoid control shall have a manual actuator which will be used to operate the solenoid without electrical power.
3. The deadman shall be electronically connected through the Scully unit and electrically connected from the Scully unit to the control valve solenoid. The main control valve shall open via solenoid control when the deadman control lever is pressed and shall close the valve when the lever is released.
4. Solenoids for operation of the pilot valves shall be housed in an explosion-proof case suitable for Class I, Division 1, Group D with maximum temperature rating of 419 degrees F, hazardous locations as defined in NFPA 70. Solenoids shall operate on 120 volts, 60 Hz, single phase, alternating current.

G. Pressure Reducing Feature

1. The pressure reducing control shall be a normally open control that senses main valve outlet pressure changes. An increase in outlet pressure shall close control and a decrease in outlet pressure shall open control causing the main valve to modulate (opens and closes) maintaining a constant outlet pressure.

H. Valve shall limit the surge pressure on the bottom loader of a tank truck to a maximum of 85 psig when filling at 300 GPM with a tank truck valve closure of 0.5 second.

I. Opening Speed Control

1. Valve shall control the opening speed of the main valve. The control shall be adjustable with a range of 2 to 30 seconds. Factory set at 10 seconds.

J. Strainer

1. A 40-mesh stainless steel wire, self-cleaning strainer shall be provided in the pilot valve supply piping.

2.03 BACK PRESSURE CONTROL VALVE

A. The back-pressure control valve shall be normally closed and respond to inlet pressure changes. An increase in the inlet pressure above the valve's specified set-point (see P&ID) will open the valve's pressure relief control pilot, thereby relieving pressure from the main valve cover causing the main valve to close. Whereas, a pressure decrease below the set-point will close the valve's pressure relief control pilot, thereby pressurizing the cover of the main valve causing the main valve to close.

B. Valve shall be as manufactured by Cla-Val, Model 50-48 Back Pressure and Check Valve (or as recommended by manufacturer).

C. Valve shall be hydraulically operated, pressure relief pilot controlled, diaphragm actuated control valve that controls the upstream pressure.

D. Valve body shall be ductile iron with internal ENP coating with flanged ends conforming to ANSI B16.5 class 150#, suitable for a maximum pressure of 250 psig.

E. Valve shall have the following components:

1. 100-34 Hytrol (Reverse Flow)
2. CRL/CRL60 Pressure Relief Control
3. X44A Strainer & Orifice
4. X101 Valve Position Indicator
5. CK2 Cock (Isolation Valve)
6. CV Flow Control (Closing)
7. 81-01 Check Valve with Cock
8. ~~CV Speed Control (Opening)~~

F. Valve materials

1. Body and cover shall be ductile iron ASTM A536, with internal ENP coating.
2. Valve trim shall be 303 stainless steel
3. Elastomers shall be Buna-N for Jet-A system and Viton for Avgas system.

G. Quick Closure check valve tubing sized at ¾ inch diameter.

H. Opening and Closing Speed Control

1. Valves shall control the opening and closing speed of the main valve. The control shall be adjustable with a range of 2 to 30 seconds. Factory set at 5 seconds.

I. Strainer

1. A 40-mesh stainless steel wire, self-cleaning strainer shall be provided in the pilot valve supply piping.

PART 3 - EXECUTION

3.01 MANUFACTURER'S SERVICE ENGINEER

A. Furnish the services of an experienced service engineer for a minimum of two days on the jobsite to verify proper installation and assist in start-up, check-out and calibration for each tank.

B. Allow for two separate trips to the jobsite by Cla-Val. If the technician arrives and finds that the installation is incorrect, and is forced to schedule another trip, all costs are the responsibility of Contractor.

END OF SECTION

SECTION 33 52 43.19
FACTORY FABRICATED FUEL STORAGE TANKS AND TANK ACCESSORIES

PART 1 - GENERAL

1.01 SUMMARY

A. This section defines the requirements for factory-fabricated fuel storage tanks.

B. The layout of the submitted tanks shall match those specified within the FT-plans. If the Tank Manufacturer deems in necessary to change the layout, then the Contractor shall notify the Engineer of such change and submit the change to the Engineer for review and approval.

C. The Contractor shall coordinate the locations of the submitted tank saddles with the foundation(s). If different than proposed, then the Contractor shall notify the Engineer.

D. Contractor shall coordinate the tank and catwalk system to ensure a compliant and complete system, which confirms to the Contract Documents.

1.02 REFERENCES

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

AMERICAN PETROLEUM INSTITUTE (API)

API MPMS 2.2E	(2004; Errata 2009; R 2009) Petroleum and Liquid Petroleum Products - Calibration of Horizontal Cylindrical Tanks - Part 1: Manual Methods
API RP 2003	(2008; 7th Ed) Protection Against Ignitions Arising out of Static, Lightning, and Stray Currents
API RP 540	(1999; R 2004) Electrical Installations in Petroleum Processing Plants

ASTM INTERNATIONAL (ASTM)

ASTM A193/A193M	(2014a) Standard Specification for Alloy-Steel and Stainless-Steel Bolting Materials for High-Temperature Service and Other Special Purpose Applications
ASTM A194/A194M	(2014a) Standard Specification for Carbon and Alloy Steel Nuts for Bolts for High-Pressure or High-Temperature Service, or Both
ASTM A307	(2014) Standard Specification for Carbon Steel Bolts and Studs, 60 000 PSI Tensile Strength
ASTM A563	(2007a; R2014) Standard Specification for Carbon and Alloy Steel Nut
ASTM D3308	(2012) PTFE Resin Skived Tape
ASTM F844	(2007a; R 2013) Washers, Steel, Plain (Flat), Unhardened for General Use

INSTITUTE OF ELECTRICAL AND ELECTRONICS ENGINEERS (IEEE)

IEEE 1100	(2005) Emerald Book IEEE Recommended Practice for Powering and Grounding Electronic Equipment
IEEE 142	(2007; Errata 2014) Recommended Practice for Grounding of Industrial and Commercial Power Systems - IEEE Green Book

NATIONAL ELECTRICAL MANUFACTURERS ASSOCIATION (NEMA)

NEMA 250	(2014) Enclosures for Electrical Equipment (1000 Volts Maximum)

NATIONAL FIRE PROTECTION ASSOCIATION (NFPA)

NFPA 30	(2015) Flammable and Combustible Liquids Code
NFPA 30A	(2015) Code for Motor Fuel Dispensing Facilities and Repair Garages
NFPA 407	(2012; TIA 11-1) Standard for Aircraft Fuel Servicing
NFPA 70	Latest edition
NFPA 77	(2014) Recommended Practice on Static Electricity
NFPA 780	(2014) Standard for the Installation of Lightning Protection Systems

STEEL TANK INSTITUTE (STI)

STI 700-50-5007	(2010) Installation Instructions for Shop Fabricated Aboveground Tanks for Flammable, Combustible Liquids

UNDERWRITERS LABORATORIES (UL)

UL 142	(Tenth Edition, 2019) Steel Aboveground Tanks for Flammable and Combustible Liquids

1.03 SUBMITTALS

A. Submit the following Shop Drawings and Product Data in accordance with Section 01 33 00 SUBMITTAL PROCEDURES:

1. Tank Grounding and Bonding
2. Aboveground Storage Tanks
3. Tank Protective Coatings
4. Aboveground Storage Tank Tightness Tests
5. Tank Manufacturer's Tests
6. Tank Fill Tests Certificates
7. Tank Registrations
8. Independent Hi Level Shut Off Valve
9. Tank Gauging
    a. Analog Clock gauges and alarm boxes

b. Magnetostictive Level Probes and Alarm Panel

10. Gauge Hatch
11. Tank Vents
    a. Normal vent
    b. Emergency vents (Primary and Secondary)
12. Floating Suction Assembly, with buoyancy calculations
13. Manual Water Draw-Off Hand Pump
14. Tank and Equipment Manufacturer's Installation Instructions
15. Equipment Operation and Maintenance Manuals
16. Test Reports

1.04 QUALITY ASSURANCE

A. Contractor Qualifications

1. Each installation Contractor shall have successfully completed at least 3 projects of the same scope, and the same size or larger within the last 6 years, and demonstrated specific installation experience in regard to the specific system installation to be performed. Each installation Contractor shall have taken, if applicable, manufacturer's training courses on the installation of storage tanks and shall meet all applicable licensing requirements in the state.

B. Regulatory Requirements

1. Permitting
    a. Obtain necessary permits in conjunction with the installation of aboveground storage tanks as required by federal, state, or local authority.
2. Registration
    a. Obtain and complete all required tank registration forms required by federal, state, and local authorities. Submit all tank registration forms to the proper regulatory agencies within 30 days after contract award.
3. Licensed Personnel
    a. Tank installers shall be licensed/certified by the state when the state requires licensed installers.

1.05 DELIVERY, STORAGE, AND HANDLING

A. Handle, store, and protect equipment and materials to prevent damage before and during installation in accordance with the manufacturer's recommendations, and as approved by the Owner’s Representative. Replace damaged or defective items.

1.06 PROJECT/SITE CONDITIONS

A. Exposed moving parts, parts that produce high operating temperatures and pressures, parts that may be electrically energized, and parts that may be a hazard to operating personnel shall be insulated, fully enclosed, guarded, or fitted with other types of safety devices. Install safety devices so that proper operation of equipment is not impaired.

PART 2 - PRODUCTS

2.01 MATERIALS AND EQUIPMENT

A. General

1. Provide materials and equipment that are standard products of a manufacturer regularly engaged in the manufacturing UL142 fuel storage tanks.

2. Provide materials and equipment that have been in satisfactory commercial or industrial use for a minimum of 15 years prior to bid opening. The 15-year period shall include applications of the equipment and materials under similar circumstances and of similar size. Provide materials and equipment that have been for sale on the commercial market through advertisements, manufacturers' catalogs, or brochures during the 15-year period.

B. Nameplates

1. Attach nameplates to all specified equipment defined herein. List on each nameplate the manufacturer's name, address, component type or style, model or serial number, catalog number, capacity or size, and the system that is controlled. Construct plates of stainless steel. Install nameplates in prominent locations with nonferrous screws, nonferrous bolts, or permanent adhesive. Minimum size of nameplates shall be 1-inch x 2.5 inches. Lettering shall be the normal block style with a minimum 0.25-inch height. Accurately align all lettering on nameplates.

C. Electrical Work

1. Grounding and Bonding - Grounding and bonding - shall be in accordance with NFPA 70, NFPA 77, NFPA 407, NFPA 780, API RP 540, API RP 2003, IEEE 142, and IEEE 1100. Provide jumpers to overcome the insulating effects of gaskets, paints, or nonmetallic components.

D. Aboveground Storage Tanks

1. Single-Walled UL142 Steel Tanks

   a. Provide a factory-assembled steel single-walled tank unit assembly in accordance with NFPA 30 and be designed and manufactured for a horizontal cylindrical installation for Jet-A fuel. Storage tank shall be factory-welded, steel with shell seams of continuous lap weld construction and shall conform to UL 142. Tank assembly shall be mounted on the tank manufacturer's standard UL listed support skids that elevates the tank assembly above the underlying concrete support structure, see FT plans. Tank assembly shall have lifting lugs that allow tank relocation.
   b. Provide tanks with the external stair and catwalk assemblies as shown on the drawings and constructed in accordance with the manufacturer’s construction methods. The stair and catwalk assemblies shall be designed and constructed by the tank manufacturer in accordance with the configuration shown on the drawings and shall be constructed of galvanized structural steel with galvanized steel, non-slip grating and shall allow personnel access to the top of the tank system. All catwalk and stair assemblies shall be OSHA compliant, including but not limited to, stair tread height and width, handrail and mid-rail installations and toe board installations.
   c. Approved Manufacturer: Tank shall be manufactured by Highland Tank, or Modern Welding, or other approved UL certified tank fabricators

E. Tank Anchors

a. See Structural Plans.

F. Tank Protective Coatings

1. Interior Surfaces

a. Surface Preparation: Grit blast - SSPC-SP-6 White Blast.
b. The tank interior coatings shall be a two (2) coat system of epoxy novolac phenolic paint and be applied in accordance with the manufacturer's instruction and procedure and shall be approved by the manufacturer's representative. Surfaces to be coated include entire tank interior and all surfaces of equipment and piping within the tank. The total dry film thickness of the paint shall be within the range recommended by the manufacturer.
c. Acceptable products include Phenicon HS by Sherwin Williams or approved equal

2. Exterior Surfaces, Aboveground Tank

a. Surface Preparation: Grit blast - SSPC-SP-6 White Blast.
b. The exterior coating system shall be a factory applied three coat epoxy and polyurethane system. Surfaces to be coated include the exterior of storage tanks, aboveground steel piping, flanges, fittings, nuts, bolts, washers, valves, and piping components. The epoxy primer coat shall be a zinc rich epoxy polyamide, (Formula 159, Type III). The epoxy intermediate coat shall be epoxy polyamide, (Formula 152, Type IV, White (tinted). The top coat shall be a polyurethane top coat, Type II (White, FED-STD-595 color number 17925). All primer, intermediate and topcoat materials shall be manufactured by one manufacturer.

3. Submit all tank coating to Engineer for review and approval.

G. Tank Components

1. Tank Manways

a. Tank manways shall have an internal diameter of 36 inches and 24 inches as shown on the drawings. Provide each manway with a matching flanged watertight manway cover. Manway covers shall be UL listed, be constructed of pressed, mild steel as stipulated on the plans, and include a UL listed gasket. "DANGER – CONFINED SPACE" placards as shown on the drawings shall be installed on or near the tank manways.

2. Tank Piping Penetrations

a. Provide a welded-in-place double tapered National Pipe Thread (NPT) couplings sized at a minimum of 4-inches or welded flanges for each tank piping connection in accordance with the contract drawings.

3. Tank Striker/Impact Plates

a. Provide an interior striker/impact plate under each tank manway, pipe connection and spare bung. Each plate shall be a minimum of 1/4 inch in thickness, be larger in diameter than the tank penetration, beveled on each side, fit the curvature of the tank bottom, and be completely coated in the same fashion as the interior tank bottom coating. Each plate shall be welded to the tank bottom at the factory (full circumference connection).

4. Tank Ladder

    a. Provide interior tank ladder constructed of stainless steel. The two stringers shall be a minimum 3/8-inch-thick and a minimum 2 inches wide. The rungs shall be a minimum 3/4-inch rod on 12 inches centers. Members of the ladder shall be securely affixed. Ladder shall be of sufficient length to extend from the bottom of the tank to the top surface of the tank. Ladder shall be rigidly connected to the tank bottom in accordance with the tank manufacturer's standard. Ladder shall be connected to the top of the tank with pipe guides or slip bars to accommodate expansion of the two stringers.

H. Tank Accessory Equipment

1. Manual Gauge Hatch Assembly

    a. Provide a Manual Gauge Hatch assembly for each tank. The assembly shall include a bronze top-seal type adapter with a corresponding locking type cap (adapter and cap both externally-mounted to the top of the tank) and a coated steel or aluminum pipe mounted internal to the tank. The pipe shall be a minimum 3 inches in size and extend downward through the top of the tank to within 3 inches of the tank bottom. For steel pipe, coat the pipe in the same fashion as the interior tank coating.

2. Floating Suction Assembly

    a. Provide a floating suction assembly for Jet-A tanks as shown on the Contract Drawings. The floating suction piping shall be schedule 10 aluminum piping with 150 lb. flanges. Flange hardware shall be stainless steel.
    b. The floating suction arm and assembly shall be sized as to not interfere with any of the other tank equipment. Do not size the arm such that it will rise to an angle greater than 45 degrees and restrict its movement using an adjustable tether.
    c. Provide a suction baffle assembly (anti-vortex assembly)
    d. Provide a single fixed float assembly with aluminum floats that are leak tested prior to installation. Contractor shall submit floating suction buoyancy calculations for Engineer’s review and approval.
    e. Provide an inspection cable assembly and connect the cable to a Kamlock Cap on a tank opening mounted on top of the tank as shown.
    f. Floating suction assembly shall be aligned such that the intake rises up and down along the centerline of the tank.

3. Inlet Diffuser

    a. The threaded diffuser shall be designed for installation at the bottom of the inlet drop tube to reduce turbulence and vapor loss during the filling operation.
    b. Materials of Construction
        1) Body: aluminum
    c. Diffuser shall be Morrison Bros. 539AT or approved equal.

4. Tank Emergency Vents

    a. Emergency vents shall be the normally-closed, UL listed type that vents outward and upward unless shown or approved otherwise. Vents shall conform with NFPA 30. Provide vents with the cubic feet per minute (cfm) rating permanently labeled on the vent's exterior.

5. Tank Atmospheric Vent

    a. Atmospheric vent for the Jet-A Tank shall consist of a steel pipe the same size as the tank fill and/or suction pipe (whichever is larger, at a minimum) with an open vent cap. The vent shall be of aluminum body and with 40-mesh SS wire vent screen and, mounted a minimum of 12 feet above grade in accordance with NFPA 30.
    b. The Jet-a vent shall be of gooseneck design, Shand & Jurs 94240-03-01, or approved equal.

6. Water Draw-Off Hand Pump

    a. Provide a manual style hand pump for water draw-off from the low point in the tank mounted as shown on the Contract drawings. The pump shall be rated for a minimum of 10 gallons at 100 hand pumps.
    b. Pump and all accessories shall be compatible with Jet-A.
    c. Pump suction shall be minimum of 10’ of lift
    d. Hand pump shall Fill-Rite FR150 Series 5200, or approved equal

7. Manual Tank Gauging

    a. Stick Gauge
        1) For each tank, provide 1 wooden stick gauge. Gauge length shall allow the measurement of the entire level of fuel in the corresponding tank. Gauges shall be compatible with the fuel to be measured (no swelling or damage from fuel contact). Provide gauge with non-sparking caps on each end. Mark gauges in feet and inches. The smallest unit of measure on the gauge shall be 1/16 inch.
    b. Tank Strapping Table
        1) Furnish (2) API MPMS 2.2E certified strapping tables (calibration charts) for the new tanks. Tables shall indicate the liquid contents in gallons for each 1/16 inch of tank depth. Provide an electronic media file of each strapping table.

8. Analog Tank Clock Gauge

    a. Clock Gauge shall be the level sensing, mechanical float actuated type that provides the tank level readout in a sealed dial gauge box.
    b. Level shall be displayed in feet (hour hand [short hand]) and inches (minute hand [long hand]) and shall be accurate to plus or minus 1/8 inch over the full range of a tank's height.
    c. Gauge shall have vapor tight seals to prevent condensation from fogging the viewing glass
    d. Provide battery powered alarm box with both visual and audible alarms. The alarm box shall have a single channel consisting of normally open contacts with the alarm activation level set as indicated in the drawings.
    e. Clock Gauge shall be Morrison Bros 818 and Alarm Box shall be Morrison Bros 918S, or approved equal

9. Magnetostictive Level Probe and Alarm Panel

    a. See Specification Section 33 52 43.41

I. Tank Accessory Equipment Finishes

1. Factory Coating

a. Unless otherwise specified, provide equipment and components fabricated from ferrous metal with the manufacturer's standard factory finish. For equipment and component surfaces subject to temperatures above 120 degrees F, the factory coating shall be appropriately designed for the temperature service.

PART 3 - EXECUTION

3.01 INSTALLATION

A. General

1. Install work so that parts requiring periodic inspection, operation, maintenance, and repair are readily accessible. Handle storage tanks with extreme care to prevent damage during placement and install in accordance with the manufacturer's installation instructions and NFPA 30, as applicable. Inspect the exterior surface of each tank for obvious visual damage prior to and during the placement of each storage tank. Repair surface damage to a storage tank according to manufacturer's requirements before proceeding with the system installation. Provide the termination of fill lines within a tank with an anti-splash deflector. Provide nylon dielectric bushings on threaded pipe connections to a steel tank.

B. Equipment

1. Properly level, align, and secure equipment in place in accordance with manufacturer's instructions and the contract drawings. Provide supports for equipment, appurtenances, and pipe as required. Install anchors, bolts, nuts, washers, and screws where required for securing the work in place. Sizes, types, and spacings of anchors and bolts not indicated or specified shall be as required by the tank manufacturer for proper installation.

C. Field Quality Control

1. Aboveground Storage Tank Tightness Tests

a. Perform tightness tests on each aboveground storage tank prior to making piping connections. Perform testing in accordance with STI 700-50-5007 except as modified herein. Gauges used to monitor the tests shall have a scale with a maximum limit of 10 psig. Repair leaks discovered during the tightness tests in accordance with tank manufacturer's instructions. Following any repair, re-test the tank until the tank successfully passes the testing requirements of this paragraph.

2. Tank Manufacturer's Tests

a. In addition to the tests required herein, perform any additional tests (i.e., leak tests, cathodic protection verification tests, etc.) on each storage tank that is required by the tank manufacturer's written test procedures. Manufacturer's tests that are redundant to tests already required by this specification will only be performed once per tank. Repair all leaks discovered during the tests in accordance with manufacturer's instructions. Following tank repairs, re-test the tank until the tank successfully passes the manufacturer's testing requirements.

3. System Commissioning

a. System commissioning shall conform to Section 33 52 43.43 Aviation Fuel System Inspection, Testing and Flushing.

D. Demonstrations

1. Conduct a training session for designated Fuel Facility Operator's personnel in the operation and maintenance procedures related to the equipment/systems specified herein. Include pertinent safety operational procedures in the session as well as physical demonstrations of the routine maintenance operations. Furnish instructors who are familiar with the installation/equipment/systems, both operational and practical theories, and associated routine maintenance procedures. The training session shall consist of a total of 4 hours of normal working time and shall start after the system is functionally completed, but prior to final system acceptance. Submit a written request, at least 14 working days prior to the proposed training date, scheduling a proposed date for conducting the onsite training.

2. Tank Fill Tests

a. Tank fill tests shall not be performed until after the flushing, cleaning, and adjusting requirements defined in Section 33 52 43.43 Aviation Fuel gsSystem Inspection, Testing and Flushing. For the tank fill tests, initially fill each storage tank with fuel in order to verify the tank level alarm system operates properly and the tank overfill protection device functions as designed. Stop filling each tank immediately once the overfill devices operate. Do not overfill any storage tank more than the 98 percent level. Correct and retest any problems with the level alarm system or the overfill device until each operate as specified herein. During the tests, verify that all tank gauges are calibrated and operating appropriately.

E. Field Painting

1. Steel surfaces not otherwise specified shall be field painted with an epoxy paint coating. Do not paint stainless steel and aluminum surfaces. Do not coat equipment or components provided with a complete factory coating. Prior to any field painting, clean surfaces to remove dust, dirt, rust, oil, and grease.

END OF SECTION

SECTION 33 52 43.21
AVIATION FUEL SYSTEM FILTRATION AND RELAXATION

PART 1 - GENERAL

1.01 DESCRIPTION

A. This Section pertains to the new unloading/loading filter separators and relaxation chambers to be installed within the Fuel Storage Facility.

B. Refer to FM1.03 Filter Separator & Relaxation Chamber Schedule for required flow ratse, and basis of design make and model numbers.

C. Appurtenances to the vessels are specified herein.

D. All equipment shall conform with the requirements of this Section and be completely compatible with the liquid being handled – Jet-A.

1.02 RELATED DOCUMENTS

A. American Society for Testing and Materials (ASTM)

B. Air Transport Association, Specification 103 (ATA103)

C. American National Standards Institute (ANSI)

D. American Society of Mechanical Engineers (ASME)

E. Energy Institute (EI)

1. EI Standard 1541, Requirements for Internal Protective Coating Systems Used in Aviation Fuel Handling Systems
2. EI Specification 1581, Specifications and Laboratory Qualification Procedures for Aviation Fuel Filter/Water Separators
3. EI Specification 1596, Design and Construction of Aviation Fuel Filter Vessels

1.03 QUALITY ASSURANCE

A. If the equipment being supplied is not to be installed by the Contractor's workforce, the equipment shall be installed by a company regularly engaged in the installation of aviation filtration equipment with at least 15 years of experience installing this equipment at active fueling facilities.

B. Acceptable manufacturers for the specified vessels and cartridges shall include:

1. Peco/Facet
2. Parker/Velcon

PART 2 - MATERIALS

2.01 FILTER SEPARATORS

A. Temporary flushing filters shall be supplied the same type of filter as that supplied for the permanent filter. Both filters shall be horizontal configuration, Facet or Velcon, API 1581 5th edition or later, rated for at least 10 feet per second.

B. The filter separator shall be Facet "Series HCS-C" or Velcon "HV Series" or approved equal. The unit shall be of the horizontal design capable of removing free and

entrained water and solid contaminants in conformance to API 1581 Fifth Edition, Category C requirements with two-stage coalescer and separator cartridges at the flow rates specified by the Engineer of Record.

C. Vessel shall comply with EI 1596, most current version.

D. Vessel shall be designed and fabricated of carbon steel in accordance with Section VIII of the ASME Code stamped for 150 psig maximum working pressure with a pressure relief valve set in accordance with the drawings.

E. Head closure shall be removable for access to cartridge elements. The assembly shall include swing-type, cadmium-plated eye bolts attached to the shell compatible with slotted bolt clips attached to the head.

F. All wettable surfaces and components inside the vessel shall be epoxy coated conforming to EI-1541 or more current version to a dry film thickness of 6 mils.

G. All valves supplied with the vessel shall be configured to match the requirements indicated on the plans including locking devices and spring return handles where called for.

H. Coalescer cartridges shall be inside/outside flow. Separator cartridges shall be outside/inside flow. Cartridge shall be screw mounted style. Cartridge removal will be from the end of the vessel.

I. Piping connections shall be made with 150-pound ANSI raised-face weld-neck flanges. Inlet and outlet connections shall be supplied with Gammon Kit No. 7T millipore test taps on the side.

J. Provide (1) 2-inch vessel bottom drain connection and (1) 3/4-inch sample/drain connections on bottom sump.

K. Water detection shall be by flange float control pilot, see Specification Section 33 52 43.17 Aviation Fuel System Control Valves.

L. Automatic Air Eliminator

1. Air vent shall have a two-piece T-316 stainless steel body, with a stainless steel fixed pivot ball float and viton seals.
2. Piping connections shall be 3/4-inch unless noted otherwise in the drawings
3. Maximum allowable pressure of 250-psi @ 450^{o}F
4. Minimum Specific Gravity of 0.49
5. 5/64” orifice suitable for a maximum working pressure of 133-psi
6. The air vents shall be Armstrong 21-AR, or an approved equal
7. Non repairable air vents such as the Armstrong 11-AV shall not be permitted.

M. Provide Gammon Technical Products GTP-534 PB (three-way test valve), 0-30, direct reading differential pressure gauge assembly or similar as manufactured by Schultz. The assembly shall be complete with a top-mounted line pressure gauge, dampeners, valves, and stainless-steel tubing and fittings. If the unit is not mounted at the factory, the assembly shall be shipped lose for mounting on brackets provided by the vessel manufacturer.

N. Provide 4-inch clean-out connections that shall be flanged and bolted.

O. The Contractor shall provide one extra set of filter media for each vessel after flushing and turnover.

P. Pressure relief valve shall be supplied by Taylor Valve Series 8200 (see P&ID for pressure relief set-point). Provide a testing arrangement as indicated on the plans. Valve shall be flanged ¾" x 1-inch steel with stainless steel internals.

2.02 RELAXATION CHAMBERS

A. The relaxation chamber shall be Facet "Series HRC-C" or, Velcon "HR Series" or approved equal. The unit shall be of vertical design sized as shown on the drawings.

B. Vessels shall be designed and fabricated of carbon steel in accordance with Section VIII of the ASME Code stamped for 150 psig maximum working pressure with a pressure relief valve set at pressures indicated on the drawings.

C. All wettable surfaces and components inside the vessel shall be epoxy coated conforming to EI-1541 or more current version to a dry film thickness of 6 mils.

D. Piping connections shall be made with 150-pound ANSI raised-face weld-neck flanges.

E. Provide 4-inch clean-out connections to match those supplied on the F/S vessel.

F. Pressure relief valve shall be supplied by Taylor Valve Series 8200 set at pressures indicated on the drawings. Provide a testing arrangement as indicated on the plans. Valve shall be 1 inch steel with stainless steel internals.

G. Automatic Air Eliminator

1. Air vent shall be constructed of stainless-steel welded body and caps, which shall be permanent sealed and tamperproof with no gaskets.
2. Air vent shall have a single free floating lever with a high leverage elliptical float
3. Piping connections shall be 3/4-inch unless noted otherwise in the drawings
4. Air vent shall be rated for a maximum operating pressure of 600-psig at 100^{o}F
5. Air vents shall have a downstream check valve as manufactured by Gammon or Shultz. A 1-inch manual air vent shall be provided between the air eliminator and the vessel with nipple and threaded cap.
6. The air vents shall be Armstrong AV-11, or an approved equal
7. A Gammon Technical Products GTP-1294 check valve shall be installed above the air eliminator. A manual air vent shall be provided between the air eliminator and the vessel.

H. Provide (1) 2-inch vessel bottom drain connection.

PART 3 - EXECUTION

3.01 MANUFACTURER'S SERVICE ENGINEER

A. Vessels shall be of the same manufacturer.

B. Furnish the services of an experienced service engineer for a minimum of two days on the jobsite to provide the following:

1. Certify proper installation.
2. Assist in start-up, check-out and calibration.

3. Allow for two separate trips to the jobsite if required by the construction schedule.

END OF SECTION

SECTION 33 52 43.22
FUEL PUMPING AND DISPENSING EQUIPMENT

PART 1 - GENERAL

1.01 REFERENCES

A. Refer to FM1.03 Pump Schedule for required flow rates, pressure, horsepower, RPM, and basis of design make and model.

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

AMERICAN BEARING MANUFACTURERS ASSOCIATION (ABMA)

ABMA 7 (1995; Stabilized (S) 2013)	Shaft and Housing Fits for Metric Radial Ball and Roller Bearings (Except Tapered Roller Bearings) Conforming to Basic Boundary Plan

AMERICAN PETROLEUM INSTITUTE (API)

API STD 682	(2014) Pumps Shaft Sealing Systems for Centrifugal and Rotary Pumps
API Std 610	(2010; Errata 2011) Centrifugal Pumps for Petroleum, Petrochemical, and Natural Gas Industries

ASME INTERNATIONAL (ASME)

ASME B31.3	(2014) Process Piping
ASME B16.5	(2013) Pipe Flanges and Flanged Fittings: NPS 1/2 Through NPS 24 Metric/Inch Standard
ASME BPVC SEC IX	(2010) BPVC Section IX-Welding and Brazing Qualifications
ASME BPVC SEC VIII D1	(2015) BPVC Section VIII-Rules for Construction of Pressure Vessels Division 1

HYDRAULIC INSTITUTE (HI)

HI M100	(2009) HI Pump Standards Set

INSTITUTE OF ELECTRICAL AND ELECTRONICS ENGINEERS (IEEE)

IEEE 1100	(2005) Emerald Book IEEE Recommended Practice for Powering and Grounding Electronic Equipment

IEEE 142	(2007; Errata 2014) Recommended Practice for Grounding of Industrial and Commercial Power Systems - IEEE Green Book

NATIONAL ELECTRICAL MANUFACTURERS ASSOCIATION (NEMA)

NEMA 250	(2014) Enclosures for Electrical Equipment (1000 Volts Maximum)
NEMA MG 1	(2014) Motors and Generators
NEMA MG 11	(1977; R 2012) Energy Management Guide for Selection and Use of Single Phase Motors

NATIONAL FIRE PROTECTION ASSOCIATION (NFPA)

NFPA 30	(2015) Flammable and Combustible Liquids Code
NFPA 407	(2012; TIA 11-1) Standard for Aircraft Fuel Servicing
NFPA 70	(2014; AMD 1 2013; Errata 1 2013; AMD 2 2013; Errata 2 2013; AMD 3 2014; Errata 3-4 2014; AMD 4-6 2014) National Electrical Code
NFPA 77	(2014) Recommended Practice on Static Electricity
NFPA 780	(2014) Standard for the Installation of Lightning Protection Systems

SOCIETY OF AUTOMOTIVE ENGINEERS INTERNATIONAL (SAE)

SAE AMS3275	(2009; Rev C) Sheet, Acrylonitrile Butadiene (NBR) Rubber and Non-Asbestos Fiber Fuel and Oil Resistant

U.S. GENERAL SERVICES ADMINISTRATION (GSA)

CID A-A-50696	(2014; Rev B) Reels, Static Discharge, Grounding, 50 and 75 Foot Cable Lengths
CID A-A-59326	(Rev D) General Specification For Coupling Halves, Quick-Disconnect, Cam-Locking Type

UNDERWRITERS LABORATORIES (UL)

UL 842	(2007; Reprint Aug 2014) Standard for Valves for Flammable Fluids
UL 87	(2001; Reprint Jun 2008) UL Standard for

	Safety Power-Operated Dispensing Devices for Petroleum Products
UL 87A	(2015) UL Standard for Safety Power-Operated Dispensing Devices for Gasoline and Gasoline/Ethanol Blends with Nominal Ethanol Concentrations up to 85 Percent (E0 – E85)
UL 913	(2013) UL Standard for Safety Intrinsically Safe Apparatus and Associated Apparatus for Use in Class I, II, and III, Division 1, Hazardous (Classified) Locations

1.02 SYSTEM DESCRIPTION

A. Equipment specified herein shall be designed to handle a working pressure of 275 psig at 100 degrees F. Equipment specified herein shall be compatible with the fuel to be handled.

1.03 SUBMITTALS

A. Submit the following in accordance with Section 01 33 00 SUBMITTAL PROCEDURES:

1. Shop Drawings
    a. Jet-a Pumps
    b. Motor Fuel Dispensers
2. Product Data
    a. Jet-a Pumps
    b. Motor Fuel Dispensers
3. Test Reports
    a. Certified Pump Test Curves
4. Certificates
    a. Demonstrations
5. Operation and Maintenance Data
    a. Fueling Pump Installation, Operations and Maintenance Manuals

1.04 QUALITY ASSURANCE

A. Material and Equipment Qualifications

1. Provide materials and equipment that are standard products of a manufacturer regularly engaged in the manufacturing of such products, that are of a similar material, design and workmanship. Materials and equipment shall have been in satisfactory commercial or industrial use for a minimum two years prior to bid opening. The two-year period shall include applications of the equipment and materials under similar circumstances and of similar size. Materials and equipment shall have been for sale on the commercial market through advertisements, manufacturers' catalogs, or brochures during the two-year period.

B. Nameplates

1. Attach nameplates to all specified equipment, thermometers, gauges, and valves defined herein. List on each nameplate the manufacturer's name, address, component type or style, model or serial number, catalog number, capacity or size, and the system that is controlled. Construct plates of stainless steel. Install nameplates in prominent locations with nonferrous screws, nonferrous bolts, or permanent adhesive. Minimum size of nameplates shall be 1 by 2-1/2 inches. Lettering shall be the normal block style with a minimum 1/4-inch height. Accurately align all lettering on nameplates.

1.05 DELIVERY, STORAGE, AND HANDLING

A. Handle, store, and protect equipment and materials to prevent damage before and during installation in accordance with the manufacturer's recommendations, and as approved by the Owner’s Representative. Replace damaged or defective items.

PART 2 - PRODUCTS

2.01 MATERIALS

A. Internal parts and components of equipment that could be exposed to fuel during system operation shall not be constructed of zinc coated (galvanized) metal, brass, bronze, or other copper bearing alloys.

2.02 ELECTRICAL WORK

A. General

1. Provide motors, motor starters, controllers, integral disconnects, contactors, controls, and control wiring with their respective pieces of equipment. Provide electrical equipment, including motors and wiring, as specified in electrical sections of these specifications. Provide switches and devices necessary for controlling and protecting electrical equipment. Provide motor starters complete with thermal overload protection and other necessary appurtenances. Controllers and contactors shall have a maximum of 120-volt control circuits and shall have auxiliary contacts for use with the controls provided. For packaged equipment, the manufacturer shall provide controllers including the required monitors and timed restart.

B. Motors

1. For Jet-A pumps, provide polyphase, squirrel-cage medium induction motors that meet the efficiency ratings for premium efficiency motors in accordance with NEMA MG 1. Provide motors of sufficient size to drive the load at the specified capacity without exceeding the nameplate rating of the motor when operating at proper electrical system voltage. Motors shall be rated for continuous duty with the enclosure specified. Motor duty requirements shall allow for maximum frequency start-stop operation and minimum encountered interval between start and stop. Motor torque shall be capable of accelerating the connected load within 20 seconds with 80 percent of the rated voltage maintained at motor terminals during one starting period. Motor bearings shall be fitted with grease supply fittings and grease relief to outside of the enclosure.

2. Motors shall be furnished by the pump manufacturer and shall be suitable for the environment and operating conditions to which it will be subjected and be provided with anti-reversing ratchet. Provide space heaters suitable for operation on 460 or 120 volts as indicated on the drawings within the motor enclosure to prevent moisture condensation after shut-down. Motor shall be UL listed for use in Class 1, Division 1, Group D hazardous areas, and shall have a maximum temperature rating of "T2D216 degrees C 419 degrees F " as defined by NFPA 70. The motor nameplate shall include

the temperature rating of the motor and locked-rotor indicating code letters in accordance with NFPA 70, Table 430-7(b).

C. Voltage rating shall be 240 volts, 3-phase, 60Hz. Motor nominal speed shall match pump. Motors shall be capable of delivering rated horsepower output successfully and continuously under conditions of voltage variations of 10 percent above or below rated voltage.

D. Pump manufacturer shall assure the specified output and proper operation of the pump without being overloaded at unity service factor when operating at any point on the pump performance curve based on the future potential of a 5 percent head increase. In addition to having sufficient horsepower-output rating at rated speed, motor shall have performance characteristics which will allow, without injurious overheating of the motor, accelerating the load from standstill to rated speed under conditions of 10 starts per hour. Attention is specifically directed to the fact that thermal characteristics of motors with regard to capability for accelerating the load may vary greatly from motor manufacturer to motor manufacturer, notwithstanding that the horsepower rating may be the same. It is the pump manufacturer's responsibility to provide motors with adequate thermal starting characteristics as well as adequate rated-speed operating characteristics. Service factors shall conform with NEMA standards; however, service factors are only applicable at rated nameplate voltage and frequency. Since all system voltages are subject to variation, service factors above unity shall not be applied in sizing motor.

E. Pump motor shall be furnished with lifting lugs on the motor casing.

F. Underground Wiring

1. Enclose underground electrical wiring in PVC coated conduit. Dielectrically isolate conduit at any steel storage tank connection.

G. Grounding and Bonding

1. Grounding and bonding shall be in accordance with NFPA 70, NFPA 77, NFPA 407, NFPA 780, API RP 540, API RP 2003, IEEE 142, and IEEE 1100. Provide jumpers to overcome the insulating effects of gaskets, paints, or nonmetallic components.

2.03 JET-A PUMPS

A. Refer to Pump Schedule on drawing FM1.03.

B. Capacity

1. Capacity shall be as listed on the drawings. Overall efficiency at design conditions of pump and driver, connected, shall be minimum of 60 percent. Pump head capacity shall be continually rising and shall be free of dips and valleys from design point to shut-off head. Pump shut-off head shall have a 10 to 20 percent head rise to shut off. Pumps shall not overheat or be damaged in any way while operating continuously at a minimum flow condition of 50 percent required capacity and continuously at a maximum flow condition of 125 percent required capacity.

C. General Requirements

1. The pump motors for this service shall run at a nominal 1800 or 3600 rpm and shall include a gear reducer to reduce the pump’s shaft speed to meet the specified flow rate and pressure. Pumps shall be self-priming sliding vane pumps with internal bypass pressure relief valve, horizontally mounted, with side suction and top discharge as per the drawings. All parts shall be factory inspected so that parts are interchangeable. Pumps and motors shall be furnished as complete units as herein specified.

Pump assembly shall be statically and dynamically balanced for all flow rates from no flow to 120 percent of design flow.

2. The pump shall require no more than 7.5-feet of net positive suction head (NPSHR) when it is operated with fuel at a capacity of 300-gpm for Jet-A at the specified head and speed. A hydrocarbon reduction or correction factor shall not be used.
3. Provide FKM O-rings for both Jet pumps.
4. Provide internal bypass spring with adjustable setting from 45-200 PSI, factory set at 70-psid
5. Flange ratings shall be class 150-pound per ASME B16.5.The pump casing shall be ductile iron and shall be designed for maximum working pressure of 175-psig.
6. Pump vane shall have a symmetrical bearing support, which shall support the shaft load on both sides.
7. Stationary Seat / Mating Ring shall be Hardened Steel and rotating Seal Face shall be Carbon.

D. Service Nameplate

1. A pump service nameplate, of type 18-8 stainless steel or monel, attached by stainless steel pins at an accessible point on the pump, shall be furnished in addition to the identification nameplate. The pump service nameplate shall be stamped with the following information:
   a. Manufacturer's name Serial number of pumps
   b. Capacity, gpm
   c. Pumping head, ft.
   d. Maximum specific gravity of fluid to be pumped
   e. Revolutions per minute
   f. Gear reduction
   g. Horsepower of driver

E. Identification Nameplate

1. A pump identification nameplate of Type 18-8 stainless steel or monel shall be provided and securely attached by stainless steel pins to a conspicuous place on the pump head. Tagging in letters 6 mm 1/4-inch high shall bear the equipment number as shown on the drawings.

F. Exterior Primer Coat

1. Exterior surfaces of the baseplate shall be primed by the manufacturer. Coating shall be applied meeting requirements of SSPC PA 1. Surface cleaning shall meet requirements of SSPC SP 10/NACE No. 2. Metal primer shall be zinc rich epoxy polyamide paint. Dry film thickness shall be 2 to 4 mils.

G. Exterior Topcoat Manufacturer's standard exterior topcoat shall be applied at factory to the base plate.

H. Manufacturer: These sliding vane pumps shall be Blackmer GNX4A for Jet-A, no alternatives shall be considered.

2.04 GASOLINE AND DIESEL DUAL PRODUCT DISPENSER

A. See drawing FM4.04 for dispenser detail and specifications.

PART 3 - .EXECUTION

3.01 INSTALLATION

A. Installation, workmanship, fabrication, assembly, erection, examination, inspection, and testing shall be in accordance with ASME B31.3 and NFPA 30, except as modified herein. Safety rules as specified in NFPA 30 and NFPA 407 shall be strictly observed. When work is not in progress, securely close open ends of pipe and fittings with expansion plugs so that water, earth, or other substances cannot enter the pipe or fittings.

B. All equipment shall be installed in accordance with the manufacturers recommended installation manual.

C. Equipment

1. Properly level, align, and secure equipment in place in accordance with manufacturer's instructions. Provide supports for equipment, appurtenances, and pipe as required. Install anchors, bolts, nuts, washers, and screws where required for securing the work in place. Sizes, types, and spacings of anchors and bolts not indicated or specified shall be as required for proper installation.

3.02 SYSTEM COMMISSIONING

A. System commissioning shall conform to Section 33 52 43.43 Aviation Fuel System Inspection, Testing and Flushing.

3.03 DEMONSTRATIONS

A. Conduct a training session for designated personnel in the operation and maintenance procedures related to the equipment/systems specified herein. Include pertinent safety operational procedures in the session as well as physical demonstrations of the routine maintenance operations. Furnish instructors who are familiar with the installation/equipment/ systems, both operational and practical theories, and associated routine maintenance procedures. The training session shall consist of a total of 2 hours of normal working time and shall start after the system is functionally completed, but prior to final system acceptance. Submit a letter, at least 14 working days prior to the proposed training date, scheduling a proposed date for conducting the on-site training.

END OF SECTION

SECTION 33 52 43.24
AVIATION FUEL SYSTEM PIPING SPECIALTIES

PART 1 - GENERAL

1.01 DESCRIPTION

A. Aviation fuel system piping specialties relates to all aviation fuel system work.

B. This Section includes piping specialty items that are not considered general piping materials, but that are elements in and appurtenant to the aviation fuel system piping system.

C. The Contractor shall provide the necessary labor and materials to install the items specified herein, and as indicated on the Contract Drawings.

D. All materials shall be domestically produced and fabricated and shall be certified as such in the Compliance Submittals. Refer to Division 01 and 33 52 43.11 for more restrictions.

E. All components shall be suitable for use in their specified system including aviation fuel systems and motor fuels. See requirements listed in Section 33 52 43.11.

1.02 QUALITY CONTROL

A. Aviation piping specialties shall be in compliance with the applicable codes and standards such as ASTM, ANSI, API, etc. as specified in Divisions 00 and 01.

B. Contractor shall prepare and provide compliance submittals for all piping specialties including the manufacturer, type, materials, dimensions, and certifications required. See Division 01 for Compliance Submittal requirements.

C. For the purpose of standardization and conformance, components are specified using a manufacturer's name and model number unless noted otherwise.

PART 2 - MATERIALS

2.01 COMPONENTS

A. Strainers for all Aviation Fuels

1. The body shall be fabricated carbon steel "basket" type with a flanged bolted cover and threaded drain. Piping connections shall be in-line ANSI 150-pound raised-face flanged. Strainer shall have factory applied epoxy coating.

2. Strainer shall be duplex design with stainless steel perforated basket and mesh strainer

   a. Perforated Basket: 5/32" diameter perforation on 3/16" centers, 63% open area, 33 holes per square inch, staggered line
   b. Mech Strainer: 20 mesh, 51.8% open area, 0.036 openings, 0.014 wire diameter.

3. Materials of Construction

   a. Body and Cover: Carbon Steel ASTM A216 Grade WCB
   b. Cover Gasket: Spiral Wound Stainless Steel with non-asbestos filter

4. The piping system strainers shall be Titan BS85-CS or approved equal.

B. Braided Hose Flexible Connections – all liquids

1. Flexible connections shall be stainless steel braided hose with stainless steel equal bellows style expansion joint.
2. The assemblies shall have T-321 stainless steel bellows with 150-pound raised faced flanged ends.

C. Fuel Sampling Connections

1. To determine the quality of fuel within the piping system, fuel sample (Millipore) connections will be required.
2. The kit shall include stainless steel probe, ball valve and dry break quick coupler with chain - affixed dust plug of aluminum suitable for sampling aviation jet fuel or aviation gasoline from piping systems or equipment. Sampling connection shall be installed on side of pipe, (not top or bottom) or as noted on the plans.
3. Fuel sampling connections installed on filter vessels shall include a ¼" NPT SS tee to allow fuel sampling and differential pressure gauge readings from the same thread-o-let. Filter separators shall be provided with (2) Fuel sample connections, one on each nozzle.
4. The assembly or kit shall be Gammon #7 and Gammon #7T on filter vessels, Schultz or approved equal.

D. Automatic Air Eliminator

1. Air vent shall have a two-piece T-316 stainless steel body, with a stainless steel fixed pivot ball float and viton seals.
2. Piping connections shall be 3/4-inch unless noted otherwise in the drawings
3. Maximum allowable pressure of 250-psi @ 450°F
4. Minimum Specific Gravity of 0.49
5. 5/64" orifice suitable for a maximum working pressure of 133-psi
6. The air vents shall be Armstrong 21-AR, or an approved equal
7. Non repairable air vents such as the Armstrong 11-AV shall not be permitted.

E. Sight Flow Indicators

1. Sight flow indicators shall be as manufactured by OPW model Visi-Flo Type 1500 Series, Kenco, or approved equal.
2. Indicators shall be propeller style with two viewing windows of high strength tempered windows and Teflon window gaskets.
3. Cast-steel body shall be suitable for 275-psi working pressure.
4. End connections shall be either threaded or 150-pound ANSI raised-faced flanged.

F. Aviation Fuel Loading Hose Swivel Joint

1. To provide operational flexibility, the unloading and loading hose units shall be equipped with an OPW Style 40 swivel joint or approved equal.
2. The swivel joint shall provide 1 plane of rotation and be of carbon steel construction with a 150# ANSI flanged inlet and FNPT threaded outlet.

3. Seal material shall be Buna-N for Jet-a and Fluorocarbon for Avgas

G. Flow Meters and Meter Registers

1. The flow meters and registers shall be a complete system by a single manufacturer.
2. Meters shall be continuous duty, positive displacement, straight-through flow type, designed for Class 1 Div. 2 exterior installation. Meter shall be one-way flow and factory-fabricated. Meter shall conform to ASME BPVC SEC VIII D1.
3. Meter housing shall be constructed of ductile iron
4. Provide meter with ANSI Class 150 flanged end connections on the inlet and outlet piping. Provide a leakproof drain at the lowest point of the meter housing equipped with a ball valve.
5. Provide meter with mechanical automatic thermal compensation. Provide meter with strainer. Provide meter with and accuracy adjustment mechanism that will operate without change during the life of the meter, except by manual adjustment.
6. Meter shall be factory calibrated and re-proven in the field by the Contractor during commissioning.
7. Meter error shall not exceed 0.1 percent for any one predetermined flow rate and accuracy setting. The maximum meter error shall not exceed 0.3 percent for any one given accuracy adjustment at any flow rate ranging from ten percent and maximum rated flow.
8. Meter Register
    a. Meter shall be equipped a direct-drive electronic register mounted on the meter housing with 4GB of non-volatile memory, RS-232 and RS-485 serial ports, input voltage 12-30 VDC, UL Class 1 Division 2, Groups C & D.
9. Meter shall be TCS 700 SPD, no alternatives shall be considered by the Owner
10. Meter Register shall be TCS 3000, no alternatives shall be considered by the Owner

H. Static Grounding Reel

1. Hunter Rota-Reel with 50 foot cable, and 100A Mueller 21C Jaw Clip, painted red with power coating material. Cable shall be 3/32” diameter, 7 x 7 Galvanized steel.

I. Aviation Fuel Loading Hose

1. Provide hose that conforms to EI 1529, Grade 2, Type E, semi-hardwall. Provide each hose with couplings on each end installed by the manufacturer.
2. Hoses for fuels shall be constructed with a steel helix wire and outer cover of PVC or similar cover for flexibility, abrasion resistance and a low coefficient of friction for petroleum product use and suited to Jet-A, Avgas, Diesel and Unleaded Gasoline.
3. Wetted tube shall be of static dissipating black nitrile synthetic rubber.
4. Provide steel ferrules and aluminum KAMLOK on facility connection for mating to swivel at the unloading rack.
5. Hose manufacturer shall be Dayco ‘Flexever’, Tift, Goodyear or approved equal.

J. Instrument Tubing and Fittings

1. Tubing

a. Material shall be ASTM A269 Type 304 annealed stainless steel.
b. Wall thickness shall be as required by the fittings, but not less than .049”.

2. Fittings
   a. Manufacturer shall be Parker-Hannifin “Ferulok” or Swagelok stainless steel bit-type tube fittings for flareless tubes.

3. Instrument Valves

   a. Instrument valves shall be bar stock type globe valves equal to Crane Model No. 222, as indicated otherwise in this Division or as approved equal.
   b. Body shall be Crane 18-8 SMO alloy steel, with working pressure of 3000 psi.
   c. Packing shall be fire resistant and as recommended by the manufacturer for use with hydrocarbon fuels.

2.02 INSTALLATION

A. All components shall be installed in the piping system as indicated on the Contract Drawings. Where exact dimensions are not indicated, the drawings may be scaled to determine an approximate location.

B. The Contractor shall be responsible for providing the necessary labor and materials to install the component.

C. The Contractor shall be responsible for providing the proper clearances of all components to assure adequate operational and maintenance clearances.

2.03 INSPECTION AND TESTING

A. The work will be inspected for approved manufacturer, component type and final installation.

B. The Contractor shall be responsible for the adjustments of all devices to assure proper function of the device is provided.

END OF SECTION

SECTION 33 52 43.41
AVIATION FUEL SYSTEM INSTRUMENTATION

PART 1 - GENERAL

1.01 SUMMARY

A. The work of this Section includes the furnishing and installing of distributed instrumentation in support of a new Information and Control System and modifications that are part of the work and related to the existing aviation fuel system infrastructure at the NAA Jet-A fuel facility at the Naples Airport (APF) in Naples, Florida.

B. Equipment shall include, but not be limited to:

1. Pressure Gauges
2. Flow Switches
3. Tank Gauging System

C. Provide all labor, equipment and material necessary to integrate new and existing equipment into a new, complete and fully operational control system as indicated on the Drawings and as specified in the Contract Documents.

D. Provide final system performance verification to ensure that the system functions as intended. The system shall be capable of being run in 1) a manual mode or 2) in an automatic mode supplemented by manual operations.

E. The control system shall include all control devices, sensors, actuators, valves, transmitters, control panels, color-coded control wiring, meters, gauges, and tubing as specified and as required to fulfill the intent of these specifications. Coordinate all this work with the mechanical, electrical and fueling system specifications.

F. Raceway requirements, supports, and other applicable requirements governing the installation of control conductors shall conform to Division 26 unless expressly modified and specified in this Section.

G. All equipment with internal wiring shall be supplied ready for field connections at terminal blocks.

H. The drawings and specifications shall be considered complementary, one to the other, so that materials and labor indicated, or called for, or implied by the one and not the other, shall be supplied and installed as though specifically called for by both.

1.02 APPLICABLE STANDARDS

A. Comply with the requirements of the referenced standards identified herein. If more stringent requirements be demanded by the State of Florida, County of Palm Beach, City of Palm Beach or the Local Airport Authority (including the Fire Chief) – the requirements of these authorities shall take precedence provided they exceed the requirements of code and this Section unless noted otherwise.

B. INSTRUMENT SOCIETY OF AMERICA: Comply with the Instrumentation symbols and Identification standard ISA-S5.1

C. UNDERWRITER LABORATORIES: Provide electrical components and assemblies - whenever possible - which have been UL listed and shall be labeled.

D. ANSI/NFPA 70: National Electric Code (NEC)

E. NEMA: Comply with the National Electrical Manufacturer's Association's "Industrial Controls and Systems" standard.

F. Comply with all standards which are applicable to the work of this Section, those listed in these specifications and in particular, those listed in Section 1700.

G. Level Monitoring System

1. ANSI/ISA 12.27.01-2011: Requirements for process sealing between electrical systems and flammable or combustible process fluids
2. EN 60529: Degrees of protection by housing (IP code)
3. EN 61010-1: Protection Measures for Electrical Equipment for Measurement, Control, Regulation and Laboratory Procedures.
4. IEC/EN 61326: "Emission in accordance with Class A requirements" Electromagnetic compatibility (EMC requirements)
5. NAMUR NE 21: Electromagnetic compatibility (EMC) of industrial process and laboratory control equipment.
6. NAMUR NE 43: Standardization of the signal level for the breakdown information of digital transmitters with an analog output signal
7. NAMUR NE 53: Software of field devices and signal-processing devices with digital electronics
8. NAMUR NE 107: Status classification as per NE107
9. NAMUR NE 131: Requirements for field devices for standard applications
10. IEC61508: Functional safety of electrical/electronic/programmable electronic safety-related systems

1.03 QUALITY ASSURANCE

A. All instrumentation shall be new and suited to the exterior or interior environment and for the hazardous classification area that it will be installed in.

1.04 PROJECT RECORD DOCUMENTATION

A. Submit a comprehensive report of the check-out and debugging of the completed system at turnover.

B. At the completion of the project, submit a recommended spare parts list for the overall project and submit a corresponding unit cost breakdown.

1.05 SUBMITTALS

A. Manufacturer's Product Data: Submit material specifications and installation data for products specified under Part 2 – Products of each individual Section.

B. Record Drawings

1. Prior to the final inspection and at a time designated by the Engineer, provide three (3) sets of data on instrumentation equipment used in the project. Data shall be in bound form and shall include the following items:
   a. Location of conductor terminations for each instrument at the monitoring equipment.
   b. Any details reflecting field changes of the installation and setup of instruments.

c. Certificates of setup and calibration results witnessed by Owners representation and/or authorities having jurisdiction.

2. The contractor shall be required to keep a set of drawings on the job site during construction for the sole purpose of tracking the record data on a day-to-day basis.

3. Payment requisition may not be approved if the drawings are not kept current.

4. Refer to the Conditions of the Contract and General Requirements for record (as-built) drawings.

PART 2 - MATERIALS

2.01 GENERAL

A. Provide products suitable to the application herein intended - that is, a fuel system for combustible and flammable liquids in a critical application where a failure of the control system could seriously compromise the use of the overall fuel system. Provide a system that is reliable and complementary to the nature of the application.

B. Provide transient protection for all outdoor control circuits.

C. Provide wire markers on all control circuit wiring. Markers shall be as provided by Panduit Corporation, Brady, or accepted alternate.

D. Provide control transformers for electric operated devices as necessary to integrate the control system into the overall fuel system for the fuel facility at PBI airport.

2.02 PRESSURE GAUGES

E. Static Pressure Gauges

1. Provide 4-1/2 inch diameter dial in a metal case, diaphragm actuated, glycerin filled, black figures on white background, front recalibration adjustment with tubing, static pressure tips. Pressure gauges shall be graduated in psi. The range shall be from 0 to 150 PSIG unless noted otherwise on the Piping and Instrumentation Diagrams (P&ID's) and detailed plans.

2. Pressure gauges for the indication of line pressure serving filter/separator vessels shall be compatible with the Gammon Differential pressure gauge with a push-button drain. See details on the drawings for additional requirements.

F. Assemblies for Line Pressure Gauges

1. Provide a needle valve of stainless steel construction suitable for line pressures up to a maximum of 250 PSIG. Size the piping and valve at 1/2" or as noted on the drawings. Each assembly shall include a pulsation damper, or pressure snubber, of stainless construction with 1/4" connections. Provide vent and sample connection as detailed on the plans.

2.03 FLOW SWITCH

A. The flow switch is an independently mounted flow sensing device that makes or breaks an electrical circuit when the flow stops or starts.

B. Acceptable Suppliers

1. Ameritol Electronic Flow Switch, FX Series or approved equal.

C. Sensor Head:

1. Material of Construction: 316L Stainless Steel Standard

2. Operating Temperature: -50 to +350F (-46 to +177C) Standard
3. Operating Pressure: Vacuum to 4000 PSIG (275 Bar)
4. Response Time: From 3 Seconds
5. Repeatability: ± 0.5% of Range at Constant Conditions
6. Process Connection: ¾" MNPT, 1" MNPT Standard

D. The flow switch shall be installed in a horizontal pipe in the upright position

E. Housing: Powder coated explosion proof, NEMA 4X, UL/CSA rated to Class 1, Div.1&2.

F. Power Input: 120 VAC, 50/60 Hz

G. Electrical Connection: 1" FNPT

H. Electrical Switch: DPDT Relay

I. Electrical enclosure: Nema type 7 and 9

2.04 TANK GAUGING SYSTEM

A. New Magnetostructive (Mag) Probe Gauging Systems

1. Acceptable suppliers
   a. Veeder Root, or approved equal
2. Magnetostrictive In-Tank probe level gauge characteristics
   a. Shall be constructed such that it does not require a stilling tube and it is so recommended by the manufacturer in writing.
   b. Technology: Magnetostrictive, Dual Float
   c. Measurement Accuracy:
      1) Product Level: +/-0.0300"
      2) Water Level: +/-0.03"
   d. Operating Temperature Range: -40 to +122ºF
   e. Material: Stainless steel
   f. Riser Mount: 4" dia. riser required for in-tank leak
   g. Probe Lengths: 48"(min) – 144" (max), probe length shall suit the proposed tank in which it shall be installed
   h. Location Approval: UL Class I, Div 1, Groups C and D
   i. Operating Temperature: -40 ºF to 175 ºF
   j. Operating Pressure: 150 PSIG
   k. Field Wiring: 22AWG, 2-Conductor twisted pair w/ shield Belden 8441, 8761, Alpha 1736C or equiv.
   l. Clearance off tank bottom: as specified by manufacturer
   m. Mag Probes shall be Stainless Steel Mag Plus In-Tank probe, or approved equal
3. Test Equipment
   a. The Contractor shall provide all necessary devices to test the completed Mag probe level sensor level installations, calibration, and commissioning.
4. Field calibration reports shall be provided to the Engineer and included in the O & M Manual.
5. Store the unit and install the unit in compliance with manufacturer requirements.

PART 3 - EXECUTION

3.01 INSTALLATION

A. Install a complete control system as specified, indicated, or required for the proper and safe operation of the Fueling Facility. All materials and workmanship shall comply with these specifications as a minimum. However, the Contractor shall conform to the manufacturer's recommendations. Should a conflict arise between the specifications and the manufacturer's recommendations, the Contractor shall identify the same as soon as the conflict arises and notify the Owner's representative in writing.

B. The Contractor shall provide all openings in floors, walls, roofs, and other structures that are necessary but not necessarily shown on the drawings for complete equipment installation.

C. All internal and external connections that are necessary to allow the system to function as specified shall be provided, tested and turned over to the Owner by the Contractor.

3.02 FIELD QUALITY CONTROL

A. All manufacturer trips to the site for calibration and conformance inspections shall be coordinated with the Engineer.

3.03 EXAMINATION

A. The contractor shall review all existing conditions and shall verify that all necessary, specified and provided systems are ready to be turned over to the Owner PRIOR to requesting that the Engineer perform final system evaluations. The Contractor is responsible for providing completed systems without dependence upon the Engineer or other Owner representatives.

3.04 DELIVERY, HANDLING AND STORAGE

A. The Contractor shall provide factory shipping cartons for each piece of equipment and control device. Provide factory applied plastic end caps on each length of tubing. Maintain cartons and end caps through shipping, storage and handling as required to prevent equipment and tubing damage, and to eliminate dirt and moisture from entering equipment and lodging inside of the tubing. Store equipment and materials inside an enclosure provided by the Contractor and protected from the weather.

3.05 CONTROL WIRING

A. Install all electric wiring in accordance with ANSI/NFPA 70, this specification and Division 26 (as applicable).

B. Install control wiring, without splices between terminal points, using an assigned color-code and numbered on both ends. Install in a neat, workmanlike manner, securely fastened. Install in accordance with this specification and Division 26 (as applicable).

1. Install circuits over 25-volt with color-coded 90°F, 600 volt insulation, minimum No. 14 AWG wire in conduit.

2. Install circuits under 25-volt with color-coded minimum No. 16 wire in conduit with high temperature (105°F (41°C) plastic insulation on each conductor and plastic sheath over all. Provide shielded cables where indicated on plans or where required by the instrument provided.

3. Provide surge protection on all control and control power circuits routed outside of the control panels. Surge protection shall consist of surge suppressors, transient, protectors and optical isolated relays as applicable.

3.06 TESTING

A. Field Test: When the installation of the system is complete, calibrate equipment and verify operation before the system is placed on-line. All testing, calibrating, adjusting and final field tests shall be completed by the installer and witnessed by the Owner's Representative. Provide a detailed cross-check of each sensor within the system by making a comparison between the reading at the sensor and a standard traceable to the National Bureau of Standards.

B. Provide a crosscheck of each control point within the system by making a comparison between the control command and the field-controlled device. Verify that all systems are operable from local controls in the specified failure mode upon system failure or loss of power. Submit the results of functional and diagnostic tests and calibrations to the Owner's Representative for final system acceptance.

C. At necessary points during construction and upon completion of the work, demonstrate system operation to the Owner's designated representative, for verification of proper operation.

END OF SECTION

SECTION 33 52 43.43
AVIATION FUEL SYSTEM INSPECTION, TESTING AND FLUSHING

PART 1 - GENERAL

1.01 DESCRIPTION

A. This Section applies to the inspection of all fabrications, assemblies, discrete elements and overall installation performed as part of the aviation fuel systems.

B. This Section identifies required cleaning, inspection, soaking, flushing and swabbing of all aviation fuel system piping and equipment.

1.02 RELATED DOCUMENTS

A. Divisions 00 and 01 of the specifications apply to the work of this Section.

B. General provisions, including laboratory testing are also described under 33 52 43.11.

C. American Petroleum Institute (API) referenced documents.

D. ATA 103, current edition.

E. ATA 123, current edition.

F. JIG 2, Issue 11, Appendix A12 for fuel quality standards.

G. EI 1540, Design, construction, operation and maintenance of aviation fueling facilities, current edition.

H. Section 33 52 43.42 Aviation Fuel System Controls is complimentary to this Section.

1.03 QUALITY ASSURANCE

A. The quality of each weld is critical to avoiding fuel system operational and quality impacts, and rework costs. Workmanship and quality are paramount to placing piping, systems and equipment into service. Contractor shall employ a strict procedure for encouraging and documenting quality assessments, repairs and tests to ensure limited failures and impacts on Owner and the operation of the fuel system.

B. All tests shall be performed in accordance with this Section, those particular Sections that identify separate testing, and those tests required of the Contractor by the Aviation Fuel Quality Representatives of the airlines, and the Owner.

C. Coordinate all tests with the Operator in advance to allow the Operator to document testing and inspection activities for operational purposes.

D. Any pipe welder who fails more than 2 weld examinations during any calendar month shall be immediately discharged by the Contractor. Repair all welds per the specification. A welder shall be discharged by Contractor if 4 welds fail over the life of the Project.

E. Contractor shall list and track the nature of each test, the segment or segments being tested, and results of each test in a log that shall be submitted to the Engineer on a monthly basis. Submit the log to the Operator and Engineer on a monthly basis with the application for payment and at project close-out.

F. All Work, as specified herein, shall be observed by the Engineer and the Operator.

1.04 SUBMITTALS

A. The Contractor shall develop written plans for all fuel system tests, evaluations, demonstrations and operational training. All such plans shall be submitted to the

Engineer for review and approval at least 3 weeks prior to a scheduled test, evaluation, demonstration and training. All Contractor plans shall, at a minimum, include the following data. Include filling of filter separator vessels as part of any procedure involving temporary or new filter vessels.

1. Identification of system or component
2. Date and time to be performed
3. Method and Description of Event
4. Personnel performing the test and their credentials
5. Coordination of approvals
6. Event results
7. Conclusions and recommendations

B. Contractor shall submit for review to the Engineer the qualifications of the personnel to be utilized in testing and flushing prior to proceeding.

C. All inspections, soaking, testing and flushing tasks shall be recorded and certified by the Contractor and shall include the signatures of the personnel involved during each evaluation.

PART 2 - MATERIALS

2.01 EQUIPMENT

A. The Contractor shall provide all necessary devices to test and flush the complete system. Items shall include but, not be limited to the following:

1. Electronic holiday detectors
2. Air compressors and air driers
3. Pumps, filters and frac tanks
4. Pressure and temperature recorders (calibration certs are required)
5. Temporary flow rate sensors, indicators and recorders (calibration certs are required) and the temporary ultrasonic measuring devices shall be sized according to the Jet-A liquid being handled and each pipe size being evaluated

B. The Contractor shall provide API compliant temporary flushing vessels (filter/separators) where necessary. The development of a flushing plan is critical to success. Contractor shall work with the Engineer to develop and then follow an approved procedure that meets the referenced standards and these specifications.

C. Contractor shall provide all piping, connectors, hoses, pumps, tanker vehicles and operators to test and flush all segments of the system segment(s).

PART 3 - EXECUTION

3.01 GENERAL

A. The Contractor shall be responsible for the operation of all permanent and temporary equipment and systems and conduct all performance tests in a safe and effective manner. The Contractor shall provide all the necessary equipment, tools, media and labor required for the proper performance of the tests.

B. Unless fuel is wasted by the Contractor, the Owner shall be responsible for the procurement and delivery of all products required for testing and flushing. When purchased by the Contractor, the fuels to be purchased shall be on spec and proven as such prior to receipt. Water shall not be used for the testing and flushing of any aviation fuel piping or components.

C. Upon completion of system testing and flushing, the fuel used shall be tested to determine cleanliness and specification qualities. The fuel that is determined acceptable for use, shall be returned to storage by Contractor in cooperation with the Operator. In the event the fuel is unacceptable for use, it must be removed from the system and site at the Contractor's expense. Cost of replacing wasted fuel shall be borne by Contractor.

3.02 INSPECTION OF FUEL PIPE WELDING

A. Above Ground Piping: Large bore aboveground fuel piping shall be 10 percent radiographed. All socket welds and fillet welds shall be inspected with magnetic particle testing.

B. Perform individual additional testing (radiograph, magnetic particle, dye penetrant, etc.) as required by the Engineer based on visual inspections that raise concerns of welding integrity at no increase in the contract sum.

C. It will be the responsibility of the Contractor to coordinate, arrange and pay for radiographic testing by an approved testing laboratory service.

D. All joints are required to be pressure-tested in service where connections are made to existing piping or equipment. All such connections shall be pressure tested in service and inspected by Contractor, Engineer and Operator before accepting the line for service.

E. Piping factory welds, if performed, shall also be radiographed by an approved testing laboratory with results provided to the Contractor upon delivery and receipt of the piping. Manufacturer shall provide certifications of all factory testing.

F. All radiographing and testing reports shall be in accordance with ANSI B31.3. Each weld must be stamped and numbered for future identification and shall appear on final ("As-Built") fabrication layout drawings generated by Contractor and submitted to Engineer at project close-out.

G. All welds shall be left exposed until radiographed, processed and certified. Welds which do not meet the standards of B31.3 shall be repaired, cut out and re-welded and re-radiographed by the Contractor at no additional cost to the Owner. All welding shall have a workmanlike appearance. Welds will be visually inspected by the Engineer - in addition to specified third-party inspections.

3.03 INSPECTION OF PIPE & VALVE COATINGS:

A. The Contractor shall inspect all exterior pipe, joint and valve coatings with a Holiday Tester to locate any damage to the protective coatings during the course of construction.

B. The inspection shall be performed by using an approved tester at a voltage recommended by the coating manufacturer.

C. All damaged sections shall be repaired by using the procedures and materials specified in Section 09 97 13.51.

3.04 INSPECTION OF TANK COATINGS

A. The Contractor shall inspect all underground tank and/or oil-water separator interior coatings with a Holiday Tester to locate any damage to the protective coatings during the course of construction.

B. The inspection shall be performed by using an approved tester at a voltage recommended by the coating manufacturer.

C. All damaged sections shall be repaired by using the procedures and materials specified in Section 09 97 13 51.

3.05 PRESSURE TESTING OF PIPING

A. All piping shall be pressure tested as specified below. Inspection of welds and joints during the inspection shall be performed by Engineer, Operator and Contractor simultaneously.

B. Small bore segments: The Contractor shall test all segments of the small-bore piping after fabrication and assembly is essentially complete, but prior to connection to large bore piping.

C. All fuel piping shall be initially tested by employing a pneumatic pressure test in accordance with ANSI B31.3. The test shall be performed using dry compressed air at a pressure of 50 psig for 4 hours. Soap test all joints in small bore tests.

1. If pressure loss is observed in any fuel piping, identify the leak, repair the leak and restart the test.

D. If the pneumatic test is successful, the Contractor shall begin preparation for hydrostatic testing.

E. In preparation for hydrostatic testing, the Contractor shall remove all control valves, meters, and other equipment which is not rated by the manufacturer for the test pressure as specified. Piping spools and blind flanges shall be provided and installed by the Contractor.

F. Prior to hydrostatic testing the Contractor shall carefully fill the fuel system piping with the proper grade of fuel. During the filling process care should be taken to properly vent all high points to disperse all air pockets.

G. The hydrostatic testing shall be in accordance with ANSI B31.3 and shall include a two-step process. The initial step shall gradually bring system pressure up to 25 psig. Quickly visually inspect the piping for any leaks and make necessary adjustment. Once the visual inspection has been accepted, Contractor shall allow the system to settle for 30-minutes. Contractor shall then closely inspect all joints, components and connections. Make secure any leaks if identified.

H. The second hydrostatic step will be to gradually bring system pressure up to 1.5 times the normal system operating pressure and re-check all joints, components, and connections.

1. The second step shall hold pressure at 1.5 times normal operating pressure for 4-hours.

2. If piping system is exposed to direct sunlight throughout the test, then contractor shall relieve excess pressure developed as a result of thermal expansion on an hourly basis throughout the hydrostatic pressure test.

I. During the testing period, if a leak develops, the Contractor shall abort the test, repair the defect and restart the test.

3.06 STORAGE TANK AND PIPING SOAK TESTS

A. Each tank, vessel and all system piping shall be soak tested using the liquid that will be stored. Atmospheric and off-spec piping need not be soak tested.

B. Tanks shall be soak tested after filling the bottoms to at least half the tank volume.

C. A soak test shall be performed over a minimum of 4-days and after the epoxy coating has been inspected, field repairs have been made, and accepted.

D. Reference samples:

1. Pull reference samples of the liquid being loaded into the tank – regardless of source.

2. Utilize approved sample containers that have been thoroughly flushed, swabbed with compliant product provided by Owner. Allow the container to drain and dry prior to use.

3. When taking samples, take the sample from the top of the fuel truck through the vent opening.

E. Chain of custody:

1. When taking samples for soak testing, initiate a 'chain of custody record' in conformance with Owner requirements.

F. Contractor shall develop, using Owner-supplied references, their own CHECKLIST to document and record results and tasks completed.

G. Required Jet A tests.

1. Fuel Appearance: ASTM D 4176

2. Existent Gum: ASTM D 381

3. MSEP: ASTM D 7224

4. Conductivity: ASTM D 2624

5. Saybolt Color: ASTM D 156 (Report only)

6. Thermal Stability: ASTM D 3241

7. Distillation: ASTM D 86

8. Flash Point: ASTM D 56

H. Required Avgas tests

1. Fuel Appearance: ASTM D 4176

2. Existent Gum: ASTM D 381

3. Distillation: ASTM D 86

4. Change in Volume of Aqueous Layer: ASTM D 1094

I. Sample and reference comparisons

1. The third-party lab, paid for by contractor, shall compare the results obtained from the lab samples and reference samples (Batch Certificates) taken.

2. All fuel samples shall be stored and shipped in 1-gallon epoxy lined steel fuel sample shipping containers meeting US DOT 17C and tested in accordance with ASTM Standard Practice D-4306.

a. 49 CFR 172,700 by the US DOT requires that any employee who offer dangerous goods for shipment must be trained in all aspects of packing and labeling.

b. Shipping of Jet-A and AvGas in epoxy lined steel containers requires the use of a shipping box with the correct required labels.
c. 1-gallon epoxy lined steel container shall be Gammon TL-2935B-4, or equal
d. Shipping box and labels shall be:
   1) Jet-A: Gammon TL-9050, or equal
   2) AvGas: Gammon TL-9051, or equal

3. Acceptance of results from the third part comparisons shall be valid if within specification limits (including the variance allowed for recertification) as outlined in JIG 2, Issue 11, Appendix A12.

4. All results and comparisons shall be forwarded to the Engineer and Owner's Fuel Quality Representative for review and acceptance.

5. No system element (tank, vessel or fuel piping) shall be either flushed or enter service until the soak test results are accepted in writing by the Engineer of Record and Owner's Fuel Quality Representative.

3.07 SYSTEM FLUSHING OF LARGE AND SMALL-BORE PIPING

A. It will be the Contractor's responsibility to provide the Owner with a complete and functional system. One important aspect of this accomplishment is the interior cleanliness of the piping system. Therefore, this becomes a critical part of the Contractor's responsibility.

B. All fuel system flushing activities shall be in conducted in strict accordance with Air Transport Association of America Specification 103 Standards for Jet Fuel Quality Control at Airports (ATA 103), Section 3.15 Flushing Standards and Specifications, and shall be carried out using fuel meeting ASTM 1655 specification for kerosene Jet-A type aviation grade turbine fuels.

C. Small portions of piping, such as spool pieces can be swabbed using Jet Fuel in lieu of flushing, using the following procedure:

1. Lint free cloth soaked on clean certified Jet fuel

2. Packed sufficiently to contact entire circumference of interior of pipe, use proper pipe cleaner brush if needed for the diameter of pipe being cleaned

3. Use new material for each cleaning, repeat until no visual contamination is observed on lint free cloth after swabbing.

4. Install pipe or use pipe plugs, flanges or tape over openings including flange holes to prevent contamination until installed.

D. Prior to starting the flushing process for any portion of the fuel system the Contractor and their subcontractor shall develop a detailed Flushing Plan, which shall outline the sequence and schedule of flushing activities for approval by the Engineer.

E. Piping shall not be connected to large bore piping until flushing is completed unless a particular section or connection is specifically allowed in writing by the Engineer and Operator.

F. The Contractor shall be responsible for providing and installing all temporary manifolds, connections and devices to facilitate the flushing process.

G. When possible, temporary piping assemblies shall be used to form a closed loop piping system for recirculation. When not possible, fuel will be flushed into approved and contained vessels or tank trucks provided by the Contractor.

H. Components such as control valves, meters and control devices shall not be in place during flushing.

I. For aviation fuels, the desired velocity rate for flushing is 10 feet per second to satisfy Airline QA Standards and ATA 103. To accomplish this, the Contractor must provide temporary pumps and filter/separators to supplement the permanent system in order to obtain the desired flow rate and velocity.

J. A passing two-test minimum is required to ensure piping cleanliness. The system being flushed must be displaced with clean fuel prior to taking second test.

K. Acceptance Criteria Specifications:

1. After displacing three-times (minimum) the volume of the system being flushed, a minimum of (2) consecutive acceptable test results are required to ensure piping system cleanliness. The system volume being flushed must be displaced one-time with clean fuel prior to taking second test.

2. Visual - All fuel samples must be clear and bright. Other visual clues must be observed and acted upon accordingly, i.e.; feel, color, odor, etc. This test shall be performed with a minimum of 1-gallon of jet fuel.

3. Perform a membrane test per ASTM D2276. A minimum of 1-gallon of jet fuel shall be used for this test. Visually assess the membrane and compare it with a color rating booklet. The Membrane Color shall have a maximum wet rating of “A3”, “B3”, or “G3” with a Particulate Contamination maximum rating of “B” scale on the shell particle assessment guide. Flushing shall continue and the membrane test repeated, until a sample is obtained which meets these requirements. Note: If color rating exceeds the above limits or is in dispute, a matched weight gravimetric rating not to exceed 0.5 mg/gal shall govern.

4. Water - 30 ppm maximum (Velcon Hydro Kit, or Shell Hydro Kit)

5. Water Separation (MSEP) Rating - 85 minimum (ASTM D7224), or Water Separation (WSIM) rating 88 minimum (ASTM D8073)

L. Final Acceptance:

1. It shall be the responsibility of the Engineer or Record and Owner’s Fuel Quality Representative, to render a final decision on system cleanliness and acceptance before connection to large bore piping is permitted to be placed into operation.

M. After flushing has been completed and approved, the Contractor shall remove all temporary cross connections, spool pieces, etc., and install control valves, metering elements, control devices, etc. The Contractor shall also be responsible for replacing all existing filter media and cleaning the interior of aboveground fuel storage tanks and filter vessels after flushing has been completed so that the entire facility may be received in a new and clean condition.

N. Dispensing new (and existing) fuel line flushing fuel into storage tanks is a part of this project. When the Contractor’s flushing procedure dictates that flushed fuel be returned to one of the two storage tanks, the Contractor shall perform an ATA 103 8-point test as itemized in Paragraphs 3.06.G & H and an ASTM D3241 JFTOT exam 1) prior to and 2) immediately after the completed flush. After the flush, the fuel in the tank shall be quarantined until the results of the flush are provided to the Airline and BED Fuel Quality Representatives for acceptance. Contractor shall expedite the results and pay all fees associated with acceleration of the results. In general, it is desirable that the tank would be at least half full of fuel when flushing into storage. Coordinate the outage with the Operator in advance.

3.08 TEMPORARY CONNECTIONS FOR FLUSHING

A. The Contractor and their subcontractor shall be responsible for providing and installing all temporary manifolds, connections and devices to facilitate the flushing process.

B. Hoses shall be complete and tested in accordance with API and ATA requirements. Certifications shall be provided for all hoses. New hoses shall be soaked per ATA requirements before use. Hoses shall be fitted and pressure tested with KAMLOK fittings that are suited to safety wiring. All hose connects shall be safety wired.

C. Temporary connection points and incidental drips shall be contained by half barrels or other approved means. Any fuel reaching the ground shall be immediately cleaned up by the contractor in accordance with all applicable Federal, State, County, and local rules and regulations.

D. Provide temporary grounding for temporary filter vessels.

E. Provide new coalescer and separator cartridges inside all temporary vessels and provide a functional DP gauge and inlet and outlet pressure gauges for use during testing. Provide an upstream Gammon or Schultz Type 7 MSP sample point on the vessel inlet. The vessels shall be visually inspected internally by Contactor, Engineer and Operator for cleanliness prior to installing the cartridges.

F. Temporary flushing vessel appurtenances (including AAV and TRV) are the responsibility of the Contractor. Failure of these devices to perform as required may expose the existing system and fuel it holds to spillage or waste. Any such waste will be the responsibility of the contractor. All such vessels shall have AAV and TRV protection suited to the system pressures demanded by the flushing process.

G. Unless approved otherwise by the Engineer and Operator, the temporary filter vessel shall meet the current edition of API 1591. The vessel may be either horizontal or vertical.

3.09 SYSTEM TESTING

A. After all individual devices and components have been tested and after the piping system has been tested and flushed, the Contractor shall perform overall operational system tests. It shall be the responsibility of the Contractor to debug, test and verify operation of the installed systems in complete conformance to itemized functions of each system as identified throughout Divisions 26, 33 and 01.

B. The Contractor shall be responsible for establishing all testing procedures and shall demonstrate operation of each completed “system” to Engineer and Owner. Each demonstration may be video-recorded by the Owner at his discretion. At a minimum, the following tests must be completed:

1. Filter Separators
    a. Confirm proper operation of all MSP connections and the proper functionality of AAV and TRV connections. Verify proper operation of the DP gauge during flow through the vessel. Verify the proper operation of the Water Float by manually lifting the weight off the float, or electronic water probe where applicable.
2. Physically verify all existing and new valve operations, open and closed. Verify that normally open valves are in the open position and that normally closed valves are left in the normally closed position. Verify proper spring action of all existing and new spring return valves.
3. Confirm proper DTR unit operations on all new Double Block and Bleed plug valves, where installed.

4. Confirm all tank data and alarms are transferred and reporting to the tank level monitoring panel.
5. All pump operations and flow switches are operating correctly.
6. All EFSO devices are reporting nominally
   a. With one fueling pump circulating fuel through the system, test each “Emergency Stop” pushbutton station to verify that the pumps stop. Vary the operation of the pumps to ensure both are verified. Utilize a recirculation process to accomplish the test so that shock waves in the system are completely avoided. Restrict flow to the tank receiving fuel.
7. Tank Level Indicator Adjustments
   a. During the filling operation of the operating tanks, adjust and calibrate the tank level indicators including the final setting of the low level and high level alarms.
   b. Demonstrate proper communication of tank level’s to the Owner’s cloud-based accounting system
8. Scully overfill and grounding verification systems are functional
9. Loading control valve dead man control functionality
10. Loading meter calibration and communication of transaction data to the Owner’s cloud-based accounting system
11. Set-point and correct operation of the back pressure control valve
12. Overfill Prevention Valve
    a. During the filling operation of the operating tank, verify overfill valve closure when valve test lever is actuated.
13. Sump Separator Testing
    a. The sump separator shall be filled with both water and fuel sumped from the tanks. After obtaining enough fuel, allow time for fuel/water mixture to separate. Manually drain the water to the waste collection tank.
14. See other Sections and the drawings for other criteria, requirements and scope.

C. VacTruck contact water removal from all tanks. At the completion of the project, assist the Operator in testing the piping for vacuum removal of contact water from the waste tank.

END OF SECTION

SPECIAL PROVISIONS

SP-1
REFERENCE TO FDOT STANDARDS

SP-1.1 The construction plans specify items of work to be constructed in accordance with FDOT Standard Specifications. This shall refer to the Florida Department of Transportation Standard Specifications for Road and Bridge Construction, current issue in force at time of bidding. The construction details for various work elements shall conform to the FDOT Standard Plans for Road Construction, current issue in force at time of bidding.

The construction details contained in the FDOT Standard Specifications and Standard Plans which are not required to accomplish the work set out in proposal and/or shown on the plans will have no application to these specifications.

SP-1.2 Intent. The intent of this specification is to simplify construction by using common practices and details for items such as construction of pavements, retaining structures, fencing, pavement marking, erosion control, and other miscellaneous items.

SP-1.3 Conflicts. In the event of any conflict(s) between the Contract Documents and the FDOT Standard Specifications, the precedence in resolving such conflict(s) shall be as follows:

a. Bid Documents, Contract requirements, General Conditions of the Construction Contract, Technical Specifications, Special Provisions, and Construction Plans for the Fuel Facility Expansion Project as located in this bid package shall govern over FDOT Standard Specifications or details.

b. Greater quantities shall govern over lesser.

c. Higher quality and/or more stringent requirements as judged by the Engineer or RPR shall govern over lesser.

SP-1.4 Definitions. The definitions of terms in the FDOT Standard Specifications shall be modified as follows for the project.

a. References to the “Engineer”, “Engineer of Tests”, or “Division of Tests”, shall be understood to mean the Engineer or RPR of the Owner as defined in Article 1 of the General Conditions of the Construction Contract.

b. References to the “Department”, “State of Florida Department of Transportation”, or “FDOT” shall be understood to mean the Owner as defined in Article 1 of the General Conditions of the Construction Contract.

SP-1.5 Pertinent Sections. FDOT Standard Specifications pertinent to this project include, but are not limited to, the following:

FDOT Section	Description
104	**Prevention, Control, and Abatement of Erosion and Water Pollution**
110	**Clearing and Grubbing**
120	**Excavation and Embankment**
160	**Stabilizing**
210	**Reworking Limerock Base**
285	**Optional Base Course**
300	**Prime and Tack Coats**

327	**Milling of Existing Asphalt Pavement**
330	**Hot Bituminous Mixtures – General Construction Requirements**
334	**Superpave Asphalt Concrete**
350	**Cement Concrete Pavement**
400	**Concrete Structures**
530	**Revetment Systems**
700	**Highway Signing**

Specification sections not listed above but cross-referenced in the above individual sections are also included herewith and made part of these Contract Documents.

SP-1.6 Measurement. There will not be any separate measurement for this item. Measurement for work items referenced to FDOT standards will be in accordance with the respective specification and as indicated for each item in the Bid Schedule.

SP-1.7 Basis of Payment. There will not be any separate payment for this item. Payment for work items referenced to FDOT standards will be as indicated for each respective item in the Bid Schedule and shall be full compensation for labor, equipment, materials and incidentals necessary to complete the work in conformance with the Plans and Specification to the satisfaction of the Owner. Incidentals include, but are not limited to, items which have specific FDOT bid item numbers in the referenced specifications but are not included in the Bid Schedule.

END ITEM SP-1

SP-2
FUEL RESISTENT CONCRETE LINER SEALER FOR SECONDARY CONTAINMENT

SP-2.1 PRODUCT DESCRIPTION

The new concrete surfaces within the fuel farm secondary containment areas and oil-water separator system are exposed to diesel and jet fuel and water as it gets washed away and treated before discharge. The Carboline Semstone liner and sealer or equivalent shall have superior bonding strength, low odor, low permeability, and high chemical resistance. The Carboline Semstone coating system (or functionally proven equivalent) product shall be applied to all new secondary containment surfaces or as otherwise noted in the drawings. For additional information on this specific product you can visit the Carboline Company.

https://www.carboline.com/products/product-details/Semstone-140

SP-2.2 INSTALL

This document is meant as a guideline for the installation of the Semstone 140 AFC system. Contact Carboline Technical service for further assistance prior to the installation of a Semstone system. If an approved equal in lieu of this product, refer to the manufacturer's guidelines.

SP-2.3 SURFACE PREPARATION

Follow NACE 6/SSPC 13 guidelines. Concrete or screed substrate should be sound, free from laitance, dust, and other contamination with a minimum of 3,625 PSI compressive strength. The substrate should be dry and free from excess rising moisture. Abrade the surface to achieve an ICRI CSP 2-7 surface profile.

All control joints must be honored. Welded joints and cracks in the concrete may be coated, but if movement occurs the coating will also crack.

All residues must be removed to provide a dry, dust free open textured surface. Contact Carboline Technical Service for further information.

SP-2.3 MIXING

All mixing should follow the mixing instructions on the specific Semstone Product Data pages. The intent of this specification is to simplify construction by using common practices and details for items such as construction of pavements, retaining structures, fencing, pavement marking, erosion control, and other miscellaneous items.

SP-2.4 NOTE

The technical data presented in this document is accurate to the best of Carboline's knowledge based on laboratory testing of the product(s) or system(s) described. Actual results in the field may vary depending on field conditions and application methods. The performance characteristics stated do not constitute a guarantee or warranty that the products will meet the stated results under all circumstances. Contact Carboline technical staff with questions.

END ITEM SP-2

APPENDIX

SUBSURFACE SOIL EXPLORATION
ANALYSIS AND RECOMMENDATIONS
PROPOSED NAPLES AIRPORT FUEL FARM EXPANSION
2707 FUEL FARM ROAD
NAPLES, COLLIER COUNTY, FLORIDA

Ardaman & Associates, Inc.

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Louisiana: Baton Rouge, Monroe, New Orleans, Shreveport

Ardaman & Associates, Inc.

Geotechnical, Environmental and
Materials Consultants

Ardaman Project No. 18-33-4531
August 23, 2018

HANSON PROFESSIONAL SERVICES, INC.
9015 Town Center Parkway, Suite 105
Lakewood Ranch, FL 34202

Attention: Mr. Michael Harris

SUBJECT: Subsurface Soil Exploration
Analysis and Recommendations
Proposed Naples Airport Fuel Farm Expansion
2707 Fuel Farm Road
Naples, Collier County, Florida

Gentlemen:

As requested and authorized by **Hanson Professional Services, Inc.**, Ardaman & Associates, Inc. (Ardaman) has completed the subsurface soil exploration program for the subject project. The purposes of this program were to evaluate the general subsurface conditions at the site and provide recommendations for site preparation and foundation design.

This report documents our findings and conclusions. It has been prepared for the exclusive use of **Hanson Professional Services, Inc.** for specific application to the subject project in accordance with generally accepted geotechnical engineering practices. No other warranty, expressed or implied, is made.

SCOPE

The scope of our services was limited to the following items:

1. Conducting three Standard Penetration Test (SPT) borings to determine the nature and condition of the subsurface soils.

2. Reviewing each soil sample obtained in our field exploration program by a geotechnical engineer in our laboratory for further identification and assignment of laboratory tests, if required.

3. Analyzing the existing soil conditions with respect to the proposed construction as it relates to foundation design.

4. Preparing this report to document the results of our field exploration, engineering analysis and foundation design recommendations.

SITE LOCATION AND PROJECT DESCRIPTION

The subject site is the Naples Municipal Airport. The existing fuel farm is located on the south side of the Naples Municipal Airport at 2707 Fuel Farm Road off Terminal Drive in Naples, Collier County, Florida. A **Site Location Map** is presented as **Figure 1**.

We understand the project includes a new fuel tank, a relocated tank and a precast restroom/equipment shelter building. The new fuel tank is to be located on the east side of the existing fuel farm. The relocated tank is to be located on the west side of the existing fuel farm. The proposed precast building is to be located west of the fuel farm and relocated tank area.

FIELD EXPLORATION PROGRAM

Our field exploration consisted of performing three Standard Penetration Test (SPT) borings. The SPT borings were drilled to a depth of 15 feet below the existing ground surface. The SPT borings were conducted using methods consistent with ASTM D-1586. The equipment and procedures used in the SPT borings are described in detail in the **Appendix**.

The locations of the borings are shown on the attached **Figure 2–Boring Location Plan**. They were located by measurement from the site features shown on an aerial photograph of the site obtained from Google Earth Pro©. Therefore, the locations indicated should be considered accurate only to the degree implied by the method of measurement used. If a more precise location of the borings is desired, then we recommend that a registered land surveyor be employed to locate the borings on site. GPS coordinates of each boring location are provided on the boring logs.

GENERAL SUBSURFACE CONDITIONS

The general subsurface conditions encountered during the field exploration are shown on the attached soil boring logs. Soil stratification is based on examination of recovered soil samples and interpretation of the field boring logs. The stratification lines represent the approximate boundaries between the soil types, the actual transitions may be gradual.

In general, the borings encountered very loose to medium dense fine sands (SP and SP-SM) from the existing ground surface to depths ranging from approximately 4.5 to 9.5 feet below the existing ground surface. The fine sands are typically underlain by hard limestone extending to the termination of the borings at a depth of about 15 feet below the existing ground surface. Exceptions to the general soil profile were SPT-1 encountered a 1.5-foot thick stratum of loose clayey fine sands (SC) at 4.5 feet and SPT-2 encountered loose to dense silty fine sands (SM) with trace to some amounts of gravel-size rock fragments at a depth of 4.5 feet extending to a depth of 9 feet below the existing ground surface.

Groundwater was encountered in the boreholes at a depth of 3 feet below the existing ground surface at the time of our field exploration (August 14, 2018). The groundwater depths shown on the boring logs represent the groundwater surface encountered on the dates shown. Fluctuations in groundwater level should be anticipated throughout the year due to seasonal variations in rainfall, and other factors.

LABORATORY TESTING PROGRAM

Representative soil samples obtained during our field sampling operation were packaged and transferred to our office and, thereafter, examined by a geotechnical engineer to obtain more accurate descriptions of the existing soil strata. The soil descriptions shown on the log are based upon visual-manual procedures in accordance with local practice. Soil classification is in general accordance with the Unified Soil Classification System (ASTM D-2487) and is also based on visual-manual procedures.

PROPOSED CONSTRUCTION

The project includes two areas for proposed tanks, generally in the areas of SPT-2 and SPT-3. The project also, includes a small precast restroom/equipment shelter building in the area of SPT-1. Site grading within these areas is expected to be minimal.

ANALYSIS AND RECOMMENDATIONS

In view of our findings, subsurface soil conditions appear to be adequate to allow use of a shallow footing foundation system. Compaction of the surface soils is recommended to increase the soil bearing capacity and minimize foundation settlement.

The following are our recommendations for overall site preparation and foundation design that we feel are best suited for the proposed facility and existing soil conditions.

SITE PREPARATION:

1. The entire structure areas "footprints", plus a minimum margin of 5 feet, should be stripped and grubbed of all surface vegetation, debris or other deleterious material, as encountered. These materials should be disposed of in areas designated by the Owner.

2. The cleared surfaces in construction areas should be proofrolled using the appropriate compaction equipment for site and soil conditions. Adjust the moisture content of the soil, as necessary, to aid compaction. Sufficient passes should be made to develop a minimum dry density of 95 percent of the Modified Proctor Maximum Dry Density (ASTM D-1557) to a depth of 12 inches below the compacted surface. Replace all material, if determined to be deleterious, in areas that "yield" during the proofrolling operation and replace with suitable fill material conforming to that stated in Item 4.

   Care should be exercised to avoid damaging any neighboring structures during the compaction operation.

3. After satisfactory proofrolling of the cleared surface in accordance with the above, filling with suitable material may proceed. Fill material should conform to that stated in Item 4 below. The fill should be placed in level lifts not exceeding 12 inches in uncompacted thickness. Each lift should be compacted by repeated passes with appropriate compaction equipment to achieve at least 95 percent of the Modified Proctor Maximum Dry Density (ASTM D-1557). The filling and compaction operations should continue until the desired elevation(s) is achieved.

4. Fill material should preferably consist of clean to slightly silty fine sands (SP or SP-SM), free of organic or other deleterious materials, with less than 12 percent passing the U.S. Sieve No. 200. The fill soils should be placed and compacted within +2% to -4% of the optimum moisture as defined by ASTM D-1557.

5. Excavate the continuous wall footing lines and/or column footings to the proposed bottom of footing elevations and, thereafter, verify the in-place compaction. If necessary, compact the bottom of the excavations to achieve a minimum dry density of 95 percent of the Modified Proctor Maximum Dry Density (ASTM D-1557). This density should be developed to a minimum depth of 12 inches below the bottom of the footings. Overexcavate and recompact, as necessary, to fulfill the above compaction criteria. The moisture content of the foundation soils must be controlled during the compaction procedure to aid compaction.

6. Ardaman should be employed by the Owner to observe and test all prepared and compacted areas to document that all unsuitable soils are removed and that the natural foundation and fill soils are prepared and compacted in accordance with the above recommendations.

FOUNDATION DESIGN:

Foundation soils prepared in accordance with the above recommendations should be suitable for supporting the proposed structure on an economical and conventionally designed shallow foundation system. The foundations may be designed for an allowable net soil contact pressure of 2,000 pounds per square foot (psf) or less.

Column (square) footings should be a minimum of 24 inches wide and wall footings should be a minimum of 16 inches wide. Minimum soil coverage of 12 inches should be maintained from the bottom of the exterior foundations to the adjacent outside finished grades.

Based on the boring information and the assumed loading conditions, the recommended allowable net soil contact pressure will yield a minimum factor of safety in excess of two against bearing capacity failure. The total settlement is estimated to be 1-inch or less, and differential settlement between adjacent footings is estimated to be ¾-inch or less. Because foundation soils are mostly coarse-grained, the majority of settlement will occur during construction as the load is being applied.

DEWATERING

If the control of groundwater is required to achieve the necessary stripping, excavation, proof-rolling, filling, compaction, and any other earthwork, sitework, and/or foundation subgrade preparation operations required for the project, the actual method(s) of dewatering should be determined by the contractor. Dewatering should be performed to lower the groundwater level to depths that are adequately below excavations and compaction surfaces. Adequate groundwater level depths below excavations and compaction surfaces vary depending on soil type and construction method, and are usually 2 feet or more. Dewatering solely with sump pumps may not achieve the desired results.

GENERAL COMMENTS

The analysis and recommendations in this report are based on the data obtained from the three soil borings performed at the approximate locations indicated on the attached **Figure 2–Boring Location Plan**.

This report does not reflect any variations that may occur between the borings. The nature and extent of variations may not become evident until during the course of construction. If variations then appear evident, it will be necessary for a reevaluation of the recommendations of this report to be made after performing on-site observations during the construction period and noting the characteristics of any variations.

When the final design and specifications are completed, we would like the opportunity to review them to determine whether changes in the original concept may have affected the validity of our recommendations and whether these recommendations have been implemented in the design and specifications.

While the borings are representative of subsurface conditions at their respective locations and for their respective vertical reaches, local variations characteristic of the subsurface materials of the region are anticipated and may be encountered. The boring logs and related information are based on the driller's logs and visual examination of selected sample in the laboratory. The delineation between soil types shown on the logs is approximate and the description represents our interpretation of subsurface conditions at the designated boring locations and on the particular date drilled.

If you have any questions about this report, please contact this office.

Very truly yours,
Ardaman & Associates, Inc.
Florida Certificate of Authorization No. 00005950

Matthew R. Elmore, E.I.
Project Engineer

GARY ALAN DREW
LICENSE
No. 35504
STATE OF
FLORIDA
PROFESSIONAL ENGINEER

This document has been digitally signed and sealed by

on the date adjacent to the seal.

Printed copies of this document are not considered signed and sealed and the signature must be verified on any electronic copies.

Gary A. Drew, P.E. No. 35504
Vice President/Branch Manager
MRE/GAD:mre

ATTACHMENTS

- **SITE LOCATION MAP (FIGURE 1)**
- **BORING LOCATION PLAN (FIGURE 2)**
- **BORING LOGS – SPT-1 THROUGH SPT-3**

N
W E
S

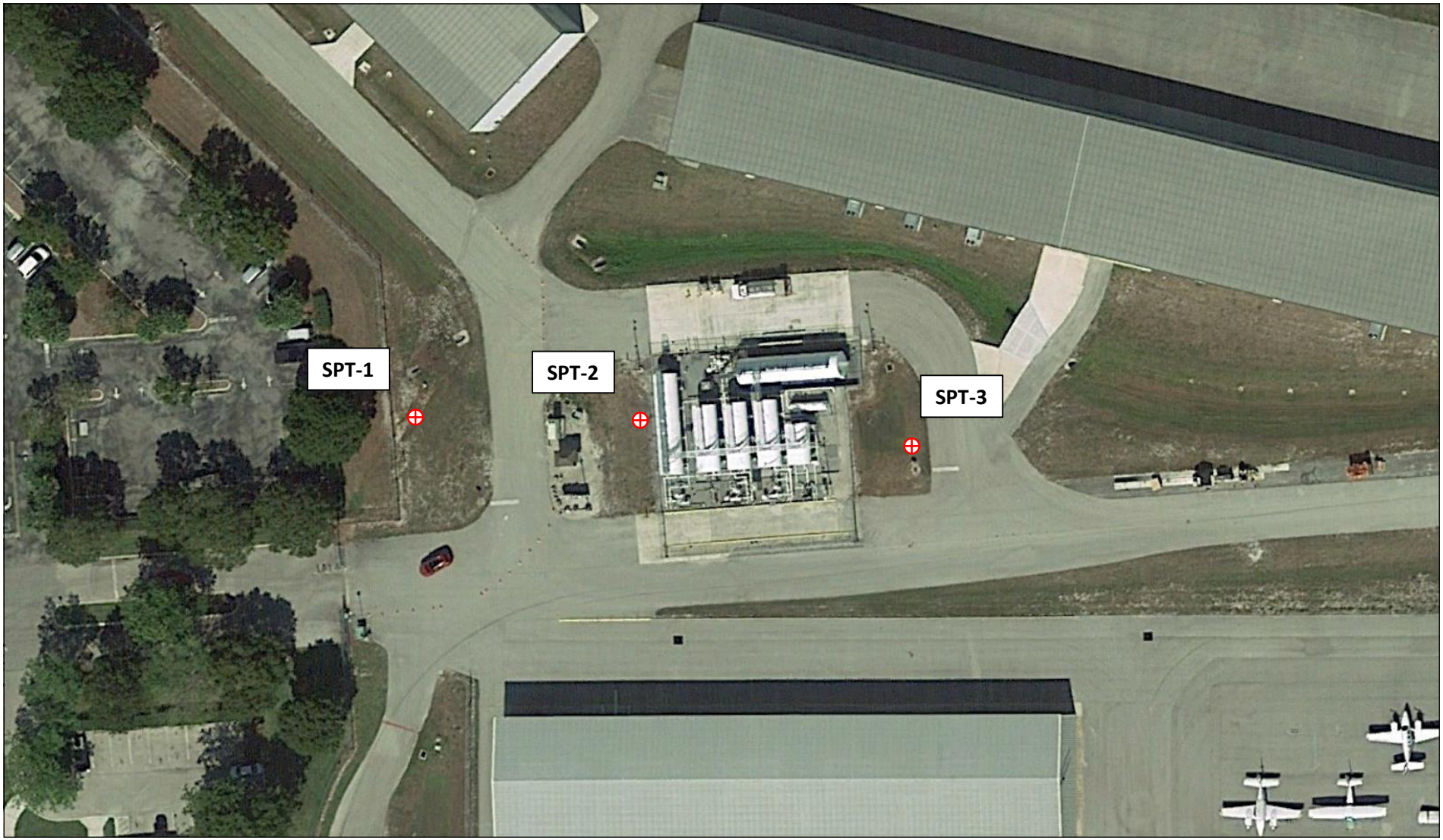
FIGURE 1
SITE LOCATION MAP

SOURCE: GOOGLE EARTH PRO©

Ardaman & Associates, Inc.
Geotechnical, Environmental and Materials Consultants

Naples Airport Fuel Farm Expansion
2707 Fuel Farm Road
Naples, Collier County, FL

Drawn By:	Checked By:	Date:
ME	GD	8/22/18
File No.: 18-33-4531	**Approved By:** Gary Drew, P.E.	**Figure No:** 1



N
W E
S

FIGURE 2
BORING LOCATION PLAN

SOURCE: GOOGLE EARTH PRO©

Ardaman & Associates, Inc.
Geotechnical, Environmental and Materials Consultants

Naples Airport Fuel Farm Expansion
2707 Fuel Farm Road
Naples, Collier County, FL

Drawn By:	Checked By:	Date:
ME	GD	8/22/18

File No.:	Approved By:	Figure No:
18-33-4531	Gary Drew, P.E.	2

BORING LOCATION: SEE BORING LOCATION PLAN
LATITUDE: N 26°8'49.88" **LONGITUDE:** W 81°46'25.20"
DATE DRILLED: 14-AUG-18 **STA:** **OFF:**
GROUND SURFACE ELEVATION: **TIME:**
WATER TABLE DEPTH (ft): 3.0' **DATE:** 14-AUG-18

CLIENT: HANSON PROFESSIONALS SERVICES, INC.
PROJECT: NAPLES AIRPORT FUEL FARM EXPANSION
2707 FUEL FARM ROAD
LOCATION: NAPLES, COLLIER COUNTY, FL
DRILL CREW: LOCKLEY / BENAVIDES **LOGGED BY:** M. ELMORE, E.I.

DRILL MAKE & MODEL: CME-55 W/AUTO **BIT:** 2-15/16" DIA. TRICONE ROLLER **DRILLING RODS:** AW
DRILLING METHOD: ROTARY WASH WITH DRILLING FLUID **WEATHER CONDITIONS:** SUN / RAIN

DEPTH, FT.	BLOWS	SPT N-VALUE	SAMPLE NO.	GRAPHIC LOG	USCS	SOIL DESCRIPTION	REMARKS	% WATER CONTENT	PERCENT FINES	% ORGANIC CONTENT	LIQUID LIMIT	PLAST. INDEX
0	2- 3- 3	6	1		SP	Poorly Graded Sand - Gray to brown fine sand.						
	4- 6- 6	12	2									
3	3- 4- 5	9	3									
	3- 2- 1	3	4		SC	Clayey Sand - Brown clayey fine sand.						
6	1- 2- 2	4	5		SP-SM	Poorly Graded Sand with Silt - Brown slightly silty fine sand.						
	2- 2- 2	4	6									
9	6- 50/1"-	50/1"	7			Hard Limestone.						
12												
	50/2"- -	50/2"	8			TERMINATED AT 14.2'						
15												
18												
21												

Ardaman & Associates, Inc.
Geotechnical, Environmental and Materials Consultants

REVIEWED BY: GARY A. DREW, P.E. **FILE NO:** 18-33-4531 **BORING NO.:** SPT-1

BORING LOCATION: SEE BORING LOCATION PLAN
LATITUDE: N 26°8'51.87" **LONGITUDE:** W 81°46'21.51"
DATE DRILLED: 14-AUG-18 **STA:** **OFF:**
GROUND SURFACE ELEVATION: **TIME:**
WATER TABLE DEPTH (ft): 3.0' **DATE:** 14-AUG-18

CLIENT: HANSON PROFESSIONALS SERVICES, INC.
PROJECT: NAPLES AIRPORT FUEL FARM EXPANSION
2707 FUEL FARM ROAD
LOCATION: NAPLES, COLLIER COUNTY, FL
DRILL CREW: LOCKLEY / BENAVIDES **LOGGED BY:** M. ELMORE, E.I.

DRILL MAKE & MODEL: CME-55 W/AUTO **BIT:** 2-15/16" DIA. TRICONE ROLLER **DRILLING RODS:** AW
DRILLING METHOD: ROTARY WASH WITH DRILLING FLUID **WEATHER CONDITIONS:** SUN / CLOUDS / RAIN

DEPTH, FT.	BLOWS	SPT N-VALUE	SAMPLE NO.	GRAPHIC LOG	USCS	SOIL DESCRIPTION	REMARKS	% WATER CONTENT	PERCENT FINES	% ORGANIC CONTENT	LIQUID LIMIT	PLAST. INDEX
0	2- 1- 1	2	1		SP	Poorly Graded Sand - Gray to light gray fine sand.						
	3- 4- 6	10	2									
3	3- 2- 2	4	3		SP-SM	Poorly Graded Sand with Silt - Brown slightly silty fine sand.						
	1- 2- 31	33	4		SM	Silty Sand - Brown silty fine sand, trace to some gravel (rock fragments).						
6						Soft Weathered Limestone.						
	16- 2- 1	3	5		SM	Silty Sand - Brown silty fine sand, trace to some gravel (rock fragments).						
	4- 10- 21	31	6									
9						Hard Limestone.						
	50/6"- -	50/6"	7									
12												
	50/0"- -	50/0"	8			TERMINATED AT 14.0'						
15												
18												
21												

Ardaman & Associates, Inc.
Geotechnical, Environmental and Materials Consultants

REVIEWED BY: GARY A. DREW, P.E. **FILE NO:** 18-33-4531 **BORING NO.:** SPT-2

BORING LOCATION: SEE BORING LOCATION PLAN
LATITUDE: N 26°8'51.31" **LONGITUDE:** W 81°46'19.74"
DATE DRILLED: 14-AUG-18 **STA:** **OFF:**
GROUND SURFACE ELEVATION: **TIME:**
WATER TABLE DEPTH (ft): 3.0' **DATE:** 14-AUG-18

CLIENT: HANSON PROFESSIONALS SERVICES, INC.
PROJECT: NAPLES AIRPORT FUEL FARM EXPANSION
2707 FUEL FARM ROAD
LOCATION: NAPLES, COLLIER COUNTY, FL
DRILL CREW: LOCKLEY / BENAVIDES **LOGGED BY:** M. ELMORE, E.I.

DRILL MAKE & MODEL: CME-55 W/AUTO **BIT:** 2-15/16" DIA. TRICONE ROLLER **DRILLING RODS:** AW
DRILLING METHOD: ROTARY WASH WITH DRILLING FLUID **WEATHER CONDITIONS:** SUN / CLOUDS

DEPTH, FT.	BLOWS	SPT N-VALUE	SAMPLE NO.	GRAPHIC LOG	USCS	SOIL DESCRIPTION	REMARKS	% WATER CONTENT	PERCENT FINES	% ORGANIC CONTENT	LIQUID LIMIT	PLAST. INDEX
0	1- 2- 2	4	1		SP	Poorly Graded Sand - Gray to light gray fine sand.						
	2- 2- 4	6	2									
3	3- 4- 3	7	3		SP-SM	Poorly Graded Sand with Silt - Brown slightly silty fine sand.						
	1- 50/0"-	50/0"	4			Hard Limestone.						
6					SM	Silty Sand - Brown silty fine sand, trace to some gravel (rock fragments).						
9	50/3"- -	50/3"	5			Hard Limestone.						
12												
	50/4"- -	50/4"	6			TERMINATED AT 14.3'						
15												
18												
21												

Ardaman & Associates, Inc.
Geotechnical, Environmental and Materials Consultants

REVIEWED BY: GARY A. DREW, P.E. **FILE NO:** 18-33-4531 **BORING NO.:** SPT-3

APPENDIX

- **SOIL BORING, SAMPLING AND TESTING METHODS**
  PROJECT SOIL DESCRIPTION PROCEDURE – UNIFIED

SOIL BORING, SAMPLING AND TESTING METHODS

STANDARD PENETRATION TEST

The Standard Penetration Test (SPT) is a widely accepted method of in-situ testing of foundation soils (ASTM D-1586). A 2-foot (0.6 m) long, 2-inch (50 mm) O.D. split-barrel sampler attached to the end of a string of drilling rods is driven 18 inches (0.45 m) into the ground by successive blows of a 140-pound (63.5 Kg) hammer freely dropping 30 inches (0.76 m). The number of blows needed for each 6 inches (0.15 m) of penetration is recorded. The sum of the blows required for penetration of the second and third 6-inch (0.15 m) increments penetration constitutes the test result or N-value. After the test, the sampler is extracted from the ground and opened to allow visual description of the retained soil sample. The N-value has been empirically correlated with various soil properties allowing a conservative estimate of the behavior of soils under load. The following tables relate N-values to a qualitative description of soil density and, for cohesive soils, an approximate unconfined compressive strength (Qu):

Cohesionless Soils:

N-Value Safety Hammer	N-Value Auto Hammer	Description	Relative Density
< 4	< 3	Very loose	0 - 15%
4 - 10	3 - 8	Loose	15 - 35%
10 - 30	8 - 24	Medium dense	35 - 65%
30 - 50	24 - 40	Dense	65 - 85%
> 50	> 40	Very dense	85 - 100%

Cohesive Soils:

N-Value Safety Hammer	N-Value Auto Hammer	Description	Unconfined Compressive Strength, Qu
< 2	< 1	Very soft	< 0.25 tsf (25 kPa)
2 - 4	1 - 3	Soft	0.25 - 0.50 tsf (25 - 50 kPa)
4 - 8	3 - 6	Firm	0.50 - 1.0 tsf (50 - 100 kPa)
8 - 15	6 - 12	Stiff	1.0 - 2.0 tsf (100 - 200 kPa)
15 - 30	12 - 24	Very stiff	2.0 - 4.0 tsf (200 - 400 kPa)
> 30	> 24	Hard	> 4.0 tsf (400 kPa)

The tests are usually performed at 5-foot (1.5 m) intervals. However, more frequent or continuous testing is done by our firm through depths where a more accurate definition of the soils is required. The test holes are advanced to the test elevations by rotary drilling with a cutting bit, using circulating fluid to remove the cuttings and hold the fine grains in suspension. The circulating fluid, which is bentonitic drilling mud, is also used to keep the hole open below the water table by maintaining an excess hydrostatic pressure inside the hole. In some soil deposits, particularly highly pervious ones, flush-coupled casing must be driven to just above the testing depth to keep the hole open and/or prevent the loss of circulating fluid. After completion of a test boring, the hole is kept open until a steady state groundwater level is recorded. The hole is then sealed by backfilling with neat cement.

Representative split-spoon samples from each sampling interval and from different strata are brought to our laboratory in air-tight jars for classification and testing, if necessary. Afterwards, the samples are discarded unless prior arrangements have been made.

POWER AUGER BORINGS

Auger borings are used when a relatively large, continuous sampling of soil strata close to the ground surface is desired. A 4-inch (100 mm) diameter, continuous flight, helical auger with a cutting head at its end is screwed into the ground in 5-foot (1.5 m) sections. It is powered by the rotary drill rig. The sample is recovered by withdrawing the auger out of the ground without rotating it. The soil sample so obtained, is described and representative samples put in bags or jars and returned to the laboratory for classification and testing, if necessary.

HAND AUGER BORINGS

Hand auger borings are used, if soil conditions are favorable, when the soil strata are to be determined within a shallow (approximately 5-foot [1.5 m]) depth or when access is not available to power drilling equipment. A 3-inch (75 mm) diameter hand bucket auger with a cutting head is simultaneously turned and pressed into the ground. The bucket auger is retrieved at approximately 6-inch (0.15 m) intervals and its contents emptied for inspection. Sometimes post-hole diggers are used, especially in the upper 3 feet (1 m) or so. The soil sample obtained is described and representative samples put in bags or jars and transported to the laboratory for classification and testing, if necessary.

UNDISTURBED SAMPLING

Undisturbed sampling implies the recovery of soil samples in a state as close to their natural condition as possible. Complete preservation of in-situ conditions cannot be realized; however, with careful handling and proper sampling techniques, disturbance during sampling can be minimized for most geotechnical engineering purposes. Testing of undisturbed samples gives a more accurate estimate of in-situ behavior than is possible with disturbed samples.

Normally, we obtain undisturbed samples by pushing a 2.875-inch (73 mm) I.D., thin wall seamless steel tube 24 inches (0.6 m) into the soil with a single stroke of a hydraulic ram. The sampler, which is a Shelby tube, is 30 (0.8 m) inches long. After the sampler is retrieved, the ends are sealed in the field and it is transported to our laboratory for visual description and testing, as needed. Undisturbed sampling is noted on the boring logs as thus "U-".

LABORATORY TEST METHODS

Soil samples returned to our laboratory are looked at again by a geotechnical engineer or geotechnician to obtain more accurate descriptions of the soil strata. Laboratory testing is performed on selected samples as deemed necessary to aid in soil classification and to help define engineering properties of the soils. The test results are presented on the soil boring logs at the depths at which the respective sample was recovered, except that grain-size distributions or selected other test results may be presented on separate tables, figures or plates as discussed in this report, the results of which will be located in an Appendix. The soil descriptions shown on the logs are based upon visual-manual procedures in accordance with local practice. Soil classification is in general accordance with the Unified Soil Classification System (ASTM D-2487) and is also based on visual-manual procedures. Following is a list of abbreviations that may appear in the Remarks column on the boring logs indicating additional laboratory testing was performed, the results of which will usually be located in an Appendix.

DD: Unit Weight/Classification of Undisturbed "Shelby Tube" samples

PP: Pocket Penetrometer reading on cohesive samples in tons per sq. ft. (tsf)

k: Hydraulic Conductivity

Qu: Unconfined Compression Strength; ASTM D-2166

UU: Unconsolidated-Undrained Triaxial Test; ASTM D 2850

Consol: One-Dimensional Consolidation test performed on subsample from undisturbed sample; ASTM D-2435

THE PROJECT SOIL DESCRIPTION PROCEDURE FOR SOUTHWEST FLORIDA[1]
For use with the ASTM D 2487 Unified Soil Classification System
CLASSIFICATION OF SOILS FOR ENGINEERING PURPOSES

BOULDERS (>12" [300 mm]) and COBBLES (3" [75 mm] TO 12" [300 mm]):

GRAVEL: Coarse Gravel: 3/4" (19 mm) to 3" (75 mm)
Fine Gravel: No. 4 (4.75 mm) Sieve to 3/4" (19 mm)

Descriptive adjectives:

0 – 5%	---	no mention of gravel in description
5 – 15%	---	trace
15 – 29%	---	some
30 – 49%	---	gravelly (shell, limerock, cemented sands)

SANDS

COARSE SAND: No. 10 (2 mm) Sieve to No. 4 (4.75 mm) Sieve
MEDIUM SAND: No. 40 (425 μm) Sieve to No. 10 (2 mm) Sieve
FINE SAND: No. 200 (75 μm) Sieve to No. 40 (425 μm) Sieve

Descriptive adjectives:

0 – 5%	---	no mention of sand in description
5 – 15%	---	trace
15 – 29%	---	some
30 – 49%	---	sandy

SILT/CLAY: < #200 (75 μm) sieve

SILTY OR SILT: PI < 4
SILTY CLAYEY OR SILTY CLAY: 4 ≤ PI ≤ 7
CLAYEY OR CLAY: PI > 7

Descriptive adjectives:

0 – 5%	--- clean (no mention of silt or clay in description)
5 – 12% to 15%	--- slightly
16 – 35%	--- clayey, silty, or silty clayey
36 – 49%	--- very

ORGANIC SOILS

Organic Content	Descriptive adjectives	Classification
0 – 2.5%	no mention of organics in description	See above
2.6 – 5%	slightly organic	See above
5 – 20%	organic	Add "with organic fines" to group name

THE PROJECT SOIL DESCRIPTION PROCEDURE FOR SOUTHWEST FLORIDA(1)
For use with the ASTM D 2487 Unified Soil Classification System
CLASSIFICATION OF SOILS FOR ENGINEERING PURPOSES

HIGHLY ORGANIC SOILS AND MATTER

Organic Content	Description	Classification
20-75%	highly organic sand or muck	Peat (PT)
	sandy peat	Peat (PT)
>75%	amorphous or fibrous peat	Peat (PT)

STRATIFICATION AND STRUCTURE

Descriptive Term with interbedded	Thickness
seam:	less than 1/2-inch (13 mm) thick
layer:	1/2 to 12-inches (13 to 300 mm) thick
stratum:	more than 12-inches (300 mm) thick
pocket:	small, erratic deposit, usually less than 1-foot
occasional:	one or less per foot of thickness
frequent:	more than one per foot of thickness
calcareous:	containing calcium carbonate (reaction to diluted HCL)
hardpan:	spodic horizon usually medium dense
marl:	mixture of carbonate clays, silts, shells and sands.

ROCK CLASSIFICATION

Description
Hard Limestone or Caprock – N-values >50 bpf
Soft Weathered Limestone – N values <50 bpf

---

(1) This soil description procedure was developed specifically for projects in southwest Florida because it is believed that the terminology will be better understood as a result of local practice. It is not intended to supplant other visual-manual classification procedures for description and identification of soils such as ASTM D 2488. BY: G.A. DREW, P.E. (1995) (Revised 2016).

UNIFIED SOIL CLASSIFICATION SYSTEM (ASTM D2487)

Criteria for Assigning Group Symbols and Group Names Using Laboratory Tests [A]					Soil Classification	
					Group Symbol	Group Name [B]
Coarse Grained Soils: More than 50% retained on No. 200 sieve	**Gravels:** More than 50% of coarse fraction retained on No. 4 sieve	**Clean Gravels:** Less than 5% fines [C]	$Cu \geq 4$ and $1 \leq Cc \leq 3$ [E]		GW	Well-graded gravel [F]
			$Cu < 4$ and/or $1 > Cc > 3$ [E]		GP	Poorly graded gravel [F]
		Gravels with Fines: More than 12% fines [C]	Fines classify as ML or MH		GM	Silty gravel [F,G,H]
			Fines classify as CL or CH		GC	Clayey gravel [F,G,H]
	Sands: 50% or more of coarse fraction passes No. 4 sieve	**Clean Sands:** Less than 5% fines [D]	$Cu \geq 6$ and $1 \leq Cc \leq 3$ [E]		SW	Well-graded sand [I]
			$Cu < 6$ and/or $1 > Cc > 3$ [E]		SP	Poorly graded sand [I]
		Sands with Fines: More than 12% fines [D]	Fines classify as ML or MH		SM	Silty sand [G,H,I]
			Fines classify as CL or CH		SC	Clayey sand [G,H,I]
Fine-Grained Soils: 50% or more passes the No. 200 sieve	**Silts and Clays:** Liquid limit less than 50	**Inorganic:**	PI > 7 and plots on or above "A" line [J]		CL	Lean clay [K,L,M]
			PI < 4 or plots below "A" line [J]		ML	Silt [K,L,M]
		Organic:	Liquid limit - oven dried / Liquid limit - not dried	< 0.75	OL	Organic clay [K,L,M,N] / Organic silt [K,L,M,O]
	Silts and Clays: Liquid limit 50 or more	**Inorganic:**	PI plots on or above "A" line		CH	Fat clay [K,L,M]
			PI plots below "A" line		MH	Elastic Silt [K,L,M]
		Organic:	Liquid limit - oven dried / Liquid limit - not dried	< 0.75	OH	Organic clay [K,L,M,P] / Organic silt [K,L,M,Q]
Highly organic soils:	Primarily organic matter, dark in color, and organic odor				PT	Peat

[A] Based on the material passing the 3-in. (75-mm) sieve

[B] If field sample contained cobbles or boulders, or both, add "with cobbles or boulders, or both" to group name.

[C] Gravels with 5 to 12% fines require dual symbols: GW-GM well-graded gravel with silt, GW-GC well-graded gravel with clay, GP-GM poorly graded gravel with silt, GP-GC poorly graded gravel with clay.

[D] Sands with 5 to 12% fines require dual symbols: SW-SM well-graded sand with silt, SW-SC well-graded sand with clay, SP-SM poorly graded sand with silt, SP-SC poorly graded sand with clay

[E] $Cu = D_{60}/D_{10}$ $\quad Cc = \dfrac{(D_{30})^2}{D_{10} \times D_{60}}$

[F] If soil contains ≥ 15% sand, add "with sand" to group name.

[G] If fines classify as CL-ML, use dual symbol GC-GM, or SC-SM.

[H] If fines are organic, add "with organic fines" to group name.

[I] If soil contains ≥ 15% gravel, add "with gravel" to group name.

[J] If Atterberg limits plot in shaded area, soil is a CL-ML, silty clay.

[K] If soil contains 15 to 29% plus No. 200, add "with sand" or "with gravel," whichever is predominant.

[L] If soil contains ≥ 30% plus No. 200 predominantly sand, add "sandy" to group name.

[M] If soil contains ≥ 30% plus No. 200, predominantly gravel, add "gravelly" to group name.

[N] PI ≥ 4 and plots on or above "A" line.

[O] PI < 4 or plots below "A" line.

[P] PI plots on or above "A" line.

[Q] PI plots below "A" line.