SECTION 21 13 25

LOW-LEVEL HIGH EXPANSION FOAM SYSTEM, FIRE PROTECTION
07/21

PART 1 GENERAL

1.1 REFERENCES

The publications listed below form a part of this specification to the extent referenced. The publications are referred to within the text by the basic designation only. Unless a specific document version or date is indicated, use criteria from the most current reference as of the date of solicitation or if amended, date of solicitation amendment.

AMERICAN SOCIETY OF CIVIL ENGINEERS

ASCE 7	Minimum Design Loads for Buildings and Other Structures

AMERICAN SOCIETY OF MECHANICAL ENGINEERS (ASME)

ASME B40.100	(2013) Pressure Gauges and Gauge Attachments

AMERICAN SOCIETY OF SANITARY ENGINEERING (ASSE)

ASSE 1015	Performance Requirements for Double Check Backflow Prevention Assemblies and Double Check Fire Protection Backflow Prevention Assemblies

AMERICAN WATER WORKS ASSOCIATION (AWWA)

AWWA 10084	Standard Methods for the Examination of Water and Wastewater
AWWA B300	Hypochlorites
AWWA B301	Liquid Chlorine
AWWA C104/A21.4	Cement-Mortar Lining for Ductile-Iron Pipe and Fittings for Water
AWWA C110/A21.10	Ductile-Iron and Gray-Iron Fittings for Water
AWWA C111/A21.11	Rubber-Gasket Joints for Ductile-Iron Pressure Pipe and Fittings
AWWA C151/A21.51	Ductile-Iron Pipe, Centrifugally Cast, for Water
AWWA C203	Coal-Tar Protective Coatings and Linings for Steel Water Pipelines - Enamel and Tape - Hot-Applied
AWWA C500	Metal-Seated Gate Valves for Water Supply

	Service
AWWA C606	Grooved and Shouldered Joints
AWWA C651	Disinfecting Water Mains
AWWA C652	Disinfection of Water-Storage Facilities

ASME INTERNATIONAL (ASME)

ASME B16.1	Gray Iron Pipe Flanges and Flanges Fittings: Classes 25, 125, and 250
ASME B16.11	Forged Fittings, Socket-Welding and Threaded
ASME B16.18	Cast Copper Alloy Solder Joint Pressure Fittings
ASME B16.21	Nonmetallic Flat Gaskets for Pipe Flanges
ASME B16.22	Wrought Copper and Copper Alloy Solder Joint Pressure Fittings
ASME B16.26	Cast Copper Alloy Fittings for Flared Copper Tubes
ASME B16.3	Malleable Iron Threaded Fittings: Classes 150 and 300
ASME B16.39	Malleable Iron Threaded Pipe Unions: Classes 150, 250, and 300
ASME B16.4	Gray Iron Threaded Fittings: Classes 125 and 250
ASME B16.5	Pipe Flanges and Flanged Fittings: NPS 1/2 Through NPS 24
ASME B16.9	Factory-Made Wrought Steel Buttwelding Fittings
ASME B18.2.2	Nuts for General Applications: machine Screw Nuts, Hex, Square, Hex Flange, and Coupling Nuts (Inch Series)
ASME B16.19/B36.19M	Stainless Steel Pipes
ASME SA182	Standard Specification for Forged or Rolled-Alloy and Stainless Steel Pipe Flanges, Forged Fittings, and Valves and Parts for High-Temperature Services

ASTM INTERNATIONAL (ASTM)

ASTM A 135/A 135M	Standard Specification for Electric-Resistance-Welded Steel Pipe

ASTM A 182/A 182M	Standard Specification for Forged or Rolled Alloy and Stainless Steel Pipe Flanges, Forged Fittings, and Valves and Parts for High-Temperature Service
ASTM A 183	Standard Specification for Carbon Steel Track Bolts and Nuts
ASTM A 193/A 193M	Standard Specification for Alloy-Steel and Stainless Steel Bolting for High Temperature or High Pressure Service and Other Special Purpose Applications
ASTM A 449	Standard Specifications for Hex Cap Screws, Bolts, and Studs, Steel, Heat Treated, 120/105/90 ksi Minimum Tensile Strength, General Use
ASTM A 47/A 47M	Standard Specification for Ferritic Malleable Iron Castings
ASTM A 53/A 53M	Standard Specification for Pipe, Steel, Black and Hot-Dipped, Zinc-Coated, Welded and Seamless
ASTM A 536	Standard Specification for Ductile Iron Castings
ASTM A 795/A 795M	Standard Specification for Black and Hot-Dipped Zinc-Coated (Galvanized) Welded and Seamless Steel Pipe for Fire Protection Use
ASTM F 436	Standard Specification for Hardened Steel Washers

FM GLOBAL (FM)

FM P7825a	Factory Mutual Research Approval Guide - Fire Protection
FM P7825b	Factory Mutual Research Approval Guide - Electrical Equipment
FM APP GUIDE	(updated on-line) Approval Guide http://www.approvalguide.com/

INTERNATIONAL BUILDING CODES

IBC	International Building Code

Joint Base Lewis - McChord

JBLM Design Standards	http://www.lewis-mcchord.army.mil/designstandards/index1.htm

MANUFACTURERS STANDARDIZATION SOCIETY OF THE VALVE AND FITTINGS INDUSTRY (MSS)

MSS SP-58	Pipe Hangers and Supports - Materials, Design, Manufacture, Selection, Application, and Installation.
MSS SP-71	Gray Iron Swing Check Valves, Flanged and Threaded Ends
MSS SP-80	Bronze Gate, Globe, Angle and Check Valves

NATIONAL FIRE PROTECTION ASSOCIATION (NFPA)

NFPA 11	Standard for Low-, Medium- and High-Expansion Foam
NFPA 13	Installation of Sprinkler Systems
NFPA 16	Standard for the Installation of Foam-Water Sprinkler and Foam-Water Spray Systems.
NFPA 20	Standard for the Installation of Stationary Pumps for Fire Protection
NFPA 24	Standard for the Installation of Private Fire Service Mains and Their Appurtenances
NFPA 70	National Electrical Code
NFPA 72	National Fire Alarm and Signaling Code
NFPA 101	Life Safety Code
NFPA 291	Recommended Practice for Fire Flow Testing and Marking of Hydrants
NFPA 1963	Standard for Fire Hose Connections

NATIONAL INSTITUTE FOR CERTIFICATION IN ENGINEERING TECHNOLOGIES (NICET)

NICET 1014-7	Program Detail Manual for Certification in the Field of Fire Protection Engineering Technology (Field Code 003) Subfield of Automatic Sprinkler System Layout

UNDERWRITERS LABORATORIES (UL)

UL 262	Gate Valves for Fire-Protection Service
UL 668	Hose Valves for Fire Protection Service
UL 864	UL Standard for Safety Control Units and Accessories for Fire Alarm Systems
UL Directory A	Building Materials Directory
UL Directory B	Fire Protection Equipment Directory

U.S. DEPARTMENT OF DEFENSE (DOD)

UFC 3-301-01	Structural Engineering
UFC 3-310-04	Seismic Design of Buildings
UFC 3-520-01	Interior Electrical Systems
UFC 3-600-01	Fire Protection Engineering for Facilities
UFC 3-601-02	Operations and Maintenance: Inspection, Testing, and Maintenance of Fire Protection Systems
UFC 4-010-01	DoD Minimum Antiterrorism Standards for Buildings
UFC 4-021-01	Design and O&M: Mass Notification Systems
UFC 4-211-01	Aircraft Maintenance Hangars

1.2 GENERAL REQUIREMENTS

a. Low-Level High Expansion Foam System(s) shall be provided in areas indicated on the drawings or contained in the project's "Scope of Work" or "Statement of Work". The Low-Level High Expansion Foam System(s) shall provide fire protection for the entire Hangar Maintenance Area of the hangar. Except as modified herein, the system shall be designed and installed in accordance with UFC 3-600-01, UFC 4-021-01, UFC 4-211-01, JBLM Design Standards, NFPA 11, NFPA 13, NFPA 20, NFPA 24, NFPA 70, and NFPA 72 as applicable. Pipe sizes for the Low-Level High Expansion Foam System(s) which are not indicated on drawings shall be determined by hydraulic calculation. The Contractor shall design any portions of the Low-Level High Expansion Foam System(s) that are not indicated on the drawings including locating generators, sprinklers, piping and equipment. The Contractor is responsible for sizing of pipe and equipment when this information is not indicated on the drawings or is not specified herein for a complete and ready for use system(s).

b. Low-Level High Expansion Foam System shall be a designated seismic system in accordance with IBC and ASCE 7. Importance factor Ip shall be equal to 1.5. Provide seismic protection for equipment in accordance with Section 26 05 48.00 10, UFC 3-600-01, JBLM Design Standards, NFPA 13, and IBC. Provide special inspections in accordance with Section 01 45 35 CODE REQUIRED SPECIAL INSPECTIONS, STRUCTURAL OBSERVATIONS, TESTS AND PROCEDURES. Provide designated seismic system certification for the Low-Level High Expansion Foam System components listed in this section in accordance with ASCE 7. Comply with all applicable Special Inspector of Record requirements of UFC 3-600-01.

c. All water discharged from the inspector's test valves and drains in addition to water discharged during hydrant flow testing, full forward flow testing of the backflow preventer, and Low-Level High Expansion Foam System(s) discharge testing are subject to compliance with JBLM EPA issued Municipal Separate Storm Sewer (MS4) Permit and JBLM 200-3 for requirements for dechlorinization.

d. All existing foam concentrate from existing concentrate storage tanks shall be the responsibility of the Low-Level High Expansion Foam System Contractor to dispose of at an offsite licensed hazardous material collection site for disposal.

e. All Low-Level High Expansion Foam Generators or other equipment installed above 8 feet above the floor in the Hangar Maintenance Areas that requires maintenance at frequencies of 2 years or less shall be provided with an open steel grate mezzanine with permanent ladders meeting OSHA requirements. To minimize multiple permanent ladders, a single permanent ladder can be installed as long as the open steel grate mezzanines are connected with a catwalk system to allow access to individual Low-Level High Expansion Foam Generators.

f. At completion of the project, all manufacturer's codes and passwords shall be provided to JBLM DPW personnel allowing access to the programming of the Low-Level High Expansion Foam System Release Panel, Fire Pump Controllers (Fire Pump and Pressure Maintenance (Jockey) Pump), Low-Level High Expansion Foam Concentrate Pump Controllers (Foam Pump and Pressure Maintenance (Jockey) Pump, Fire Alarm Mass Notification System Control Panel, etc.

1.3 SYSTEM DESCRIPTION

a. Design and provide a new automatic Low-Level High Expansion Foam System(s), including Optical Flame Detection System, control, and releasing system, as indicated on the drawings and in accordance with applicable codes and standards. The system(s) shall provide a uniform distribution of Low-Level High Expansion Foam System solution for complete coverage over the Hangar Maintenance Area of the hangar as indicated on the drawings. The Low-Level High Expansion Foam System(s) shall be balanced to operate both independently and with simultaneous operation of the overhead wet pipe sprinkler system(s) specified in Section 21 13 13.00 10 WET PIPE SPRINKLER SYSTEM, FIRE PROTECTION.

b. The electronic detection, control, and release system shall include wiring, raceways and other accessories and miscellaneous items required for a complete operating system even though each item is not specifically mentioned or described.

c. Design and install each system to give full consideration to blind spaces, piping, electrical equipment, ductwork, and all other construction and equipment to provide complete coverage in accordance with the drawings to be submitted. Devices and equipment shall be listed by a Nationally Recognized Testing Laboratory unless otherwise specified.

d. The Contractor is responsible for the installation, pre-testing, Preliminary System Acceptance Testing, and Final System Acceptance Testing of the Low-Level High Expansion Foam System(s) as required by this specification section and the drawings.

1.4 BASIS FOR CALCULATIONS

The design of the system shall be based upon a water supply with a static pressure and flow at the residual pressure indicated on the drawings or

contained in a hydrant Flow Test Report provided by the Fire Protection Specialist. Water supply shall be presumed available at the point of connection to the existing system. Hydraulic calculations shall be based upon the Hazen-Williams formula with a "C" value of 120 for steel piping, 150 for copper tubing, 140 for new cement-lined ductile-iron piping, and 100 for existing underground piping. Additionally, hydraulic calculations shall be based on operation of the fire pump(s) provided in Section 21 30 00 FIRE PUMPS.

1.5 COORDINATION OF TRADES

Piping offsets, fittings, and any other accessories required shall be furnished as required to provide a complete installation and to eliminate interference with other construction. Generators shall not be installed in locations obstructed by roof framing member. These obstructions can negatively affect or disrupt the Low-Level High Expansion Foam System discharge and coverage.

1.6 DELIVERY AND STORAGE

All equipment delivered and placed in storage shall be housed in a manner to preclude any damage from the weather, sunlight, humidity and temperature variations, dirt and dust, or other contaminants. Additionally, all pipes shall either be capped or plugged until installed.

1.7 FIELD MEASUREMENTS

The Contractor shall become familiar with all details of the work, verify all dimensions in the field, and shall advise the Contracting Officer of any discrepancy before performing the work.

1.8 SUBMITTALS

Government approval is required for submittals with a "G" designation; submittals not having a "G" designation are for Contractor Quality Control approval information only. The following shall be submitted in accordance with Section 01 33 00 SUBMITTAL PROCEDURES:

Shop drawings, manufacturer's catalog data, sway brace calculations, hydraulic calculations, preliminary system test procedures, final system test procedures, and contractor certifications, must be reviewed, approved, stamped, and signed by the Fire Protection Specialist prior to submitting for government approval per UFC 3-600-01.

Projects located on McChord Field shall follow Air Force requirements with government approval being required by the AFCEC/COSM fire protection engineer.

Projects located on Lewis Main shall follow Army requirements with government approval being required by the USACE fire protection engineer.

SD-01 Preconstruction Submittals

Low-Level High Expansion Foam System Discharge Testing, Safety, and Environmental Plan; G

Submit Low-Level High Expansion Foam System(s) solution containment and disposal plan as required under paragraph entitled Low-Level

High Expansion Foam System Discharge Testing, Safety, and Environmental Plan.

SD-02 Shop Drawings

Shop Drawings; G

Submit two hard copies and one electronic (.pdf) version of the Low-Level High Expansion Foam System Shop Drawings, no later than 21 days prior to the start of the Low-Level High Expansion Foam System installation.

Descriptive Index, Legend, and Schedules; G

System Layout; G

Point-to-Point Wiring Diagrams; G

Installation Details; G

System Operation Description; G

Sequence of Operations Matrix; G

Voltage Drop Calculations; G

Battery Calculations; G

SD-03 Product Data

Materials and Equipment; G

The data shall be highlighted to show model, size, options, etc., that are intended for consideration. Data shall be adequate to demonstrate compliance with all contract requirements. In addition, a complete table of contents that includes equipment description and model number shall be provided. Catalog data sheets shall also indicate U.L. Listing / FM approval and the country of manufacture.

Graphic Map; G

Graphic maps, include representation of the graphic map to be providing locations of all drains and valves.

SD-05 Design Data

Flow Test Data; G

Sway Brace Details and Calculations; G

Details and load calculations shall be provided for sizing of sway bracing.

Hydraulic Calculations; G

Hydraulic calculations, including a drawing showing hydraulic reference points and pipe segments.

Battery Calculations; G

Voltage Drop Calculations; G

Hydraulic surge analysis; G

System hydraulic transit (surge) analysis showing hydraulic transit pressure occurring throughout the system at both design flow and non-flow conditions.

Low-Level High Expansion Foam System Spread/Coverage Calculations; G

Low-Level High Expansion Foam System Narrative; G

Diagrams shall be supplemented with a narrative description of the system. Indicate Low-Level High Expansion Foam System Control Panel along with the make and model of devices and equipment to which the Low-Level High Expansion Foam System is connected.

SD-06 Test Reports

Megger Testing Report; G

Provide electronic copies (.pdf or WORD) of the completed Megger Testing for review and approval prior to Preliminary System Acceptance Testing.

Loop Resistance Testing Report; G

Provide electronic copies (.pdf or WORD) of the completed Loop Resistance Testing for review and approval prior to Preliminary System Acceptance Testing.

Fire Protection Specialist Review Letter for Equipment Submittals; G

Preliminary Acceptance Testing Procedures; G

Proposed procedures for Preliminary Acceptance Testing shall be approved by the government at least 14 days prior to the proposed start of the tests. Proposed date and time to begin Preliminary Acceptance Testing, shall be submitted with the Preliminary Acceptance Testing Procedures. Contractor to coordinate all tests with the Fire Protection Specialist, the AFCEC/COSM or USACE fire protection engineer and/or DPW representative.

Preliminary Acceptance Testing Report; G

Electronic copies (.pdf) of the completed Preliminary Acceptance Testing Report including digital video recordings, no later than 14 days after the completion of the Preliminary Tests.

Fire Protection Specialist Preliminary Acceptance Testing Report; G

Final Acceptance Testing Procedures; G

Proposed procedures for Final Acceptance Testing shall be approved by the government, no later than 14 days prior to the proposed start of the tests. Proposed date and time to begin Final Acceptance Testing, shall be submitted with the Final Acceptance Testing Procedures. Contractor to coordinate all tests with the Fire Protection Specialist, the AFCEC/COSM or USACE fire protection engineer and/or DPW representative.

Safety Plan; G

Environmental Plan; G

Final Acceptance Testing Report; G

Electronic copies (.pdf) of the completed Final Acceptance Testing Reports including digital video recordings, no later than 14 days after the completion of the Final Acceptance Tests.

SD-07 Certificates

Fire Protection Specialist Certifications; G

The name and documentation of certification of the proposed Fire Protection Specialists, no later than 14 days after the Notice to Proceed and prior to the submittal of the Low-Level High Expansion Foam System(s) drawings and hydraulic calculations.

Final Acceptance Testing Certification Letter by Fire Protection Specialist; G

Low-Level High Expansion Foam System Designer Certification; G

The name and documentation of certification of the proposed Low-Level High Expansion Foam System Designer.

Qualifications of Welders; G

Qualifications of Low-Level High Expansion Foam System Installer; G

The name and documentation of certification of the proposed Sprinkler System Installer, concurrent with submittal of the Fire Protection Specialist Qualifications

Qualification of Low-Level High Expansion Foam Release System Installer; G

The name and documentation of certification of the proposed Low-Level High Expansion Foam Release System Installer.

Qualifications of Low-Level High Expansion Foam Release System Designer; G

The name and documentation of certification of the proposed Low-Level High Expansion Foam Release System Designer.

Qualifications of Low-Level High Expansion Foam Release System

Supervisor; G

The name and documentation of certification of the proposed Low-Level High Expansion Foam Release System Supervisor.

Qualifications of Low-Level High Expansion Foam Release System Technician; G

The name and documentation of certification of the proposed Low-Level High Expansion Foam Release System Technician.

Qualifications of Low-Level High Expansion Foam Release System Electrician; G

The name and documentation of certification of the proposed Low-Level High Expansion Foam Release System Electrician.

Qualifications of Test Personnel; G

The name and documentation of certification of the proposed Test Personnel.

Manufacturer's Representative Certification; G

The name and documentation of certification of the proposed Manufacturer's Representative.

Certificates of qualifications, as specified; G

Seismic Certification of Dedicated Seismic Systems; G

State of Washington Certificate of Competency; G

Provide a State of Washington Certificate of Competency for any individual, business, or firm engaged in the inspecting, designing, testing, maintaining or servicing of fire and life safety systems.

Cybersecurity Equipment Certification; G

Cybersecurity Installation Certification; G

Materials and Equipment; G

Certificates from manufacturers to substantiate that components, equipment and material proposed for installation and use meet requirements as specified, concurrent with submittal of manufacturer's catalog data of equipment proposed for installation. Certificates shall be on a form for this purpose or on official letterhead of the manufacturer with specified information stated as required. Certificates shall be provided for the following:

a. Low-Level High Expansion Foam Release Panel: Certification that the Low-Level High Expansion Foam Release Panel is electrically compatible with the solenoid on the electrically-actuated automatic Foam/Water Flow Control Valve, and the solenoid is compatible with the electrically-actuated valve. Electronic solenoids used for release of the

Low-Level High Expansion Foam System must be listed for use with both the Low-Level High Expansion Foam Release Panel and the Foam/Water Flow Control Valve.

b. Gaskets. Certification from the manufacturer that gasket material is listed or approved for dry-pipe sprinkler system service for all piping containing foam/water solution.

c. Certification for compliance with Low-Level High Expansion Foam Release Panel ground fault detection requirements.

SD-09 Field Reports

Inspections by Fire Protection Specialist; G

SD-10 Operation and Maintenance Data

Operation and Maintenance Instructions; G

Submit two hard copies and one electronic (.pdf) version of manuals.

SD-11 Closeout Submittals

Posted Instructions; G

Submit the proposed Posted Instructions for approval prior to installation.

As-Built Drawings

As-built shop drawings, at least 14 days after completion of the Final Tests. The Sprinkler System Drawings shall be updated to reflect as-built conditions after all related work is completed. Provide electronic drawings in AutoCAD format on a CD.

Warranty Letter

Dongle and Software

Spare Parts

Instruction of Government Employees

On-site Training; G

After final system acceptance testing has been approved by the government, propose an On-site Training schedule along with proposed date and time at least 14 days prior to the proposed start of On-site Training.

Manufacturer Certification Training for Equipment Installed; G

The Low-Level High Expansion Foam Release System Contractor shall be responsible for factory training of (2) JBLM fire alarm technicians either at JBLM or at the manufacturer's factory. This includes all costs associated with wages, training, travel, and per

diem (lodging, meals, rental car, rental car gas, parking at airport, etc.). The number of days for factory training shall be determined by the manufacturer of the Fire Alarm Mass Notification system installed.

Training Plan; G

1.8.1 Combined Submittals

The Shop Drawings, Materials and Equipment, Sway Bracing and Hydraulic Calculations shall be submitted in the same package so they can be reviewed at the same time.

1.9 HYDRAULIC CALCULATIONS (OVERHEAD SPRINKLER SYSTEM)

Hydraulic calculation procedures shall be as outlined in NFPA 13 except that calculations shall be performed by computer using software intended specifically for fire protection system design using the design criteria shown on the drawings or if design criteria is not provided on the drawings, the design criteria provided in UFC 3-600-01, UFC 4-211-01, NFPA 11, and NFPA 13, whichever is more stringent. Calculations that uses typical k-factors for typical Low-Level High Expansion Foam System generators, branch lines, sprigs (stub-ups), or drops is not acceptable. Calculations shall be based on the water supply data provided by the Fire Protection Specialist. Calculations shall substantiate that the design area used in the calculations is the most demanding hydraulically. Water supply curves and system requirements shall be plotted on semi-logarithmic graph paper so as to present a summary of the complete hydraulic calculation. A summary sheet indicating sprinklers in the design area and their respective hydraulic reference points, elevations, actual discharge pressures and actual flows shall be provided. Elevations of hydraulic reference points (nodes) shall be indicated. Documentation shall identify each pipe individually and the nodes connected thereto. The diameter, length, flow, velocity, friction loss, number and type fittings, total friction loss in the pipe, equivalent pipe length and Hazen-Williams coefficient shall be indicated for each pipe. For gridded systems, calculations shall show peaking of demand area friction loss to verify that the hydraulically most demanding area is being used. If the submittal shop drawings cannot clearly identify hydraulic reference points (nodes) and remote areas, a drawing showing hydraulic reference points and pipe designations used in the calculations shall be included that is independent of shop drawings.

1.10 FIRE PROTECTION SPECIALIST (QUALIFIED FIRE PROTECTION ENGINEER)

Work specified in this section shall be performed under the supervision of and certified by the Fire Protection Specialist (Qualified Fire Protection Engineer). The Fire Protection Specialist shall be an individual who is a registered professional engineer in the State of Washington and has NCEES licensing. The Fire Protection Specialist shall be regularly engaged in the design and installation of the type and complexity of system specified in the Contract documents, and shall have served in a similar capacity for at least three systems that have performed in the manner intended for a period of not less than 6 months. Any individual, business, or firm engaged in the inspecting, testing, maintaining, designing, or servicing of fire and life safety systems and equipment shall be certified to perform these activities in accordance with the State of Washington. The Fire Protection Specialist shall not be a part of the specialty subcontractor design team and shall

have no business relationships (owner, partner, operating officer, distributor, salesman or technical representative) with any construction subcontractors involved with the project or with any fire protection equipment device manufacturers, suppliers or installers for any such equipment provided as part of this project.

1.11 CONTRACTOR QUALIFICATIONS

1.11.1 Qualifications of Low-Level High Expansion Foam System Designer

The Low-Level High Expansion Foam System Designer shall be certified as a Level IV Technician by National Institute for Certification in Engineering Technologies (NICET) in the Water-Based Systems Layout subfield of Fire Protection Engineering Technology in accordance with NICET 1014-7 and licensed to perform this type of work in the State of Washington in accordance with UFC 3-601-02 and hold a State of Washington "Certificate of Competency". Submit certifications and data showing that Low-Level High Expansion Foam System Designer has successfully designed at least three Low-Level High Expansion Foam Systems of the same type and complexity.

1.11.2 Qualifications of Welders

Submit certificates of each welder's qualifications prior to site welding; certifications shall not be more than one year old.

1.11.3 Qualifications of Low-Level High Expansion Foam System Installer

The installer performing the Low-Level High Expansion Foam System work shall be licensed to perform this type of work in the State of Washington in accordance with UFC 3-601-02 and hold a State of Washington "Certificate of Competency". Submit certifications and data showing that the Low-Level High Expansion Foam System Installer is regularly engaged in the installation of Low-Level High Expansion Foam System included in this project and has successfully installed at least three Low-Level High Expansion Foam Systems of the same type and complexity. Low-Level High Expansion Foam System Installer shall certify that each system has performed satisfactorily, in the manner intended, for a period of not less than 6 months

1.11.4 Qualifications of Low-Level High Expansion Foam Release System Designer

System working plans and calculations shall be prepared and submitted for approval by an individual that has obtained National Institute for Certification in Engineering Technologies (NICET) Level III certification in the Fire Alarm Technology subfield of fire protection engineering technology in accordance with NFPA 72. Provide a copy of the NICET Certification for review and approval.

1.11.5 Qualifications of Low-Level High Expansion Foam Release System Installer

National Institute for Certification in Engineering Technologies (NICET) Level II certification with a minimum of (2) two years of experience in the Fire Alarm Technology subfield of fire protection engineering technology.

The Low-Level High Expansion Foam Release System Installer shall be factory trained in the installation, adjustment, testing, and operation of the Low-Level High Expansion Foam Release System devices, cabinets and panels specified herein and on the drawings. Provide a copy of the NICET Certification for review and approval.

1.11.6 Qualifications of Low-Level High Expansion Foam Release System Supervisor

National Institute for Certification in Engineering Technologies (NICET) Level III certification with a minimum of (8) eight years of experience in the Fire Alarm Technology subfield of fire protection engineering technology shall oversee the installation of equipment and shall be factory trained in the installation, adjustment, testing, and operation of the equipment specified herein. Provide a copy of the NICET Certification for review and approval.

1.11.7 Qualifications of Low-Level High Expansion Foam Release System Technician

National Institute for Certification in Engineering Technologies (NICET) Level II certification with a minimum of (4) four years of experience in the Fire Alarm Technology subfield of fire protection engineering technology is required for the Fire Alarm Mass Notification System Technicians utilized to install and terminate Low-Level High Expansion Foam Release System devices, cabinets and panels. The Low-Level High Expansion Foam Release System technicians installing the equipment shall be factory trained in the installation, adjustment, testing, and operation of the equipment specified herein. Provide a copy of the NICET Certification for review and approval.

1.11.8 Qualifications of Low-Level High Expansion Foam Release System Electrician

National Institute for Certification in Engineering Technologies (NICET) Level II certification with a minimum of (2) two years of experience in the Fire Alarm Technology subfield of fire protection engineering technology shall be allowed to install wire, cable, conduit and backboxes for the Low-Level High Expansion Foam Release System. Provide a copy of the NICET Certification for review and approval.

1.11.9 Qualifications of Test Personnel

Low-Level High Expansion Foam Release System Technicians with National Institute for Certification in Engineering Technologies (NICET) Level III certification in the Fire Alarm Technology subfield of fire protection engineering technology and licensed to perform this type of work in the State of Washington shall be required to test and certify the installation of the Low-Level High Expansion Foam Release System devices, cabinets and panels. The Low-Level High Expansion Foam Release System Technician testing the equipment shall be factory trained in the installation, adjustment, testing, and operation of the equipment specified herein. Provide a copy of the NICET Certification for review and approval.

1.11.10 Manufacturer's Representative Certification

The Manufacturer's Representative shall be an employee of the manufacturer or manufacturer authorized dealer with necessary technical training on the Low-Level High Expansion Foam Release System being installed. Provide a copy of the Certification from the Manufacturer for review and approval.

1.12 REGULATORY REQUIREMENTS

Compliance with referenced NFPA standards is mandatory. This includes advisory provisions listed in the appendices of such standards, as though the word "shall" had been substituted for the word "should" wherever it appears. In the event of a conflict between specific provisions of this specification and applicable NFPA standards, this specification shall govern. Interpret reference to "Authority Having Jurisdiction" to mean JBLM Public Works Life Safety Systems Manager.

1.13 SHOP DRAWINGS

The Low-Level High Expansion Foam System Shop Drawings shall conform to the requirements established for "Plans" as prescribed in NFPA 11, "Working Plans" as prescribed in NFPA 13, and "Shop Drawings" as prescribed in NFPA 72. Drawings shall include plan and elevation views demonstrating that the equipment will fit the allotted spaces with clearance for installation and maintenance. Each set of drawings shall include the following:

a. Submitted shop drawing size shall be ISO A1 (22x34).

b. Each submittal drawing shall bear the NICET stamp, designer's signature, and date of the signature. Submittal drawings not having this information will be returned without review by the Fire Protection Specialist.

c. Descriptive index of drawings in the submittal with drawings listed in sequence by drawing number. A legend identifying device symbols, nomenclature, and conventions used.

d. Floor plans shall be drawn to a scale not less than 1/8" = 1'-0" which clearly show locations of sprinklers, foam generators, piping layout, projected aircraft outlines (silhouettes), risers, pipe hangers, seismic separation assemblies, sway bracing, inspector's test connections, drains, wiring riser diagrams, wiring details, and other applicable details necessary to clearly describe the proposed arrangement. Each type of fitting used and the locations of reducing couplings, and welded joints shall be indicated.

e. Equipment room layout drawings and equipment details shall be drawn to a scale of not less than 1/2" = 1'-0" which clearly show details of each system component (Low-Level High Expansion Foam System Pump, Inductor, Concentrate Storage Tank, Flow Control Valve, Generators, mounting details, etc.), clearances between each other and from other equipment and construction in the room.

f. Submittal drawings shall indicate the location of control panels, detectors, Manual Foam Start Stations, Manual Foam Stop Stations, supervisory switches, solenoids, notification appliances, and other electrical devices.

g. The overhead Fire Protection Sprinkler System and Low-Level High

Expansion Foam System shall be on two separate floor plan drawings.

h. Actual center-to-center dimensions between sprinklers on branch lines and between branch lines, from end sprinklers to adjacent walls, from walls to branch lines, from sprinkler feed mains, cross-mains and branch lines to finished floors, roofs, and ceilings. and from foam generators to adjacent walls, A detail shall show the dimension from the sprinkler and sprinkler deflector to the ceiling in finished areas.

i. Gridlines horizontally and vertically shall be provided as part of the backgrounds.

j. When the floor plan exceeds a single drawing, match lines shall be provided that indicate on which sheet the building continues.

k. When the floor plan exceeds a single drawing, a key plan shall also be provided that identifies which portion of the building is provided on that drawing and which drawings are used for other portions of the building.

l. Foam generators and system piping layout annotated with hydraulic nodes that correspond to hydraulic calculations. Submittal drawings not identifying all hydraulic nodes will not be accepted.

m. Longitudinal and transverse building sections showing typical branch line and cross-main pipe routing as well as elevation of each typical sprinkler above finished floor.

n. Details of each type of riser assembly, each pipe hanger, each means of branch line restraint, restraint of underground water main at point-of-entry into the building, and electrical devices and interconnecting wiring.

o. For all trapeze hangars, provide a table indicating the size of the pipe to be supported, size and type of the trapeze member, section modulus of the trapeze member, distance from the structure to pipe being supported (A and B dimensions), and the section modulus required.

p. Details for each sway brace configuration, orientation, angle, and structural connection along with calculations. The maximum L/R ratio shall be 200. The "total Calculated Load" divided by the "Allowable Load per Fastener" shall not exceed a maximum value of 0.90. A single sway brace calculation depicting a "worst case" calculation will not be acceptable.

q. Point-to-Point Wiring Diagrams showing the points of connection and terminals used for electrical field connections in the system, including interconnections between the equipment or systems which are supervised or controlled by the system. Diagrams must show connections from field devices to the Low-Level High Expansion Foam System Release Panel and initiating circuits, switches, relays and terminals.

r. Field wiring diagrams showing locations of devices and points of connection and terminals used for all electrical field connections in the system, with wiring color code scheme. In addition, conduit routing and sizes, and the number of conductors contained in each shall be indicated.

s. Installation Details showing mounting information, wiring terminations of electrical field connections.

t. Electrical connection drawings and control diagrams indicating overall operation of the Low-Level High Expansion Foam System. This shall include identification and operation of each major component of the system including Interfacing with Low-Level High Expansion Foam System Control Components.

u. System Operation Description and Action Matrix explaining how the system operates.

v. One-line riser diagrams shall show all initiating, notification, and modules on the appropriate circuits and be provided with the following information:

(1) Each Initiation Devices shall be provided with the device address, room name, and room number in the order that devices are connected on each circuit. The device address shall match the device address indicated on the floor plan.

(2) Each notification Appliance shall be provided with the circuit number and appliance address, room name, room number, appliance output (candela or watts) in the order that devices are connected on each circuit. Appliance address shall match the appliance address indicated on the floor plan

(3) Monitor, Control, Relay, and Isolation modules shall be provided with module address, room name, and room number. Module address shall match the module address indicated on the floor plan.

(4) Per NFPA 72, a riser diagram is required to show the type and number of system components/devices on each circuit and the number of conductors for each circuit. Since a circuit is defined in NFPA 72 as a connection path between locations, the riser diagram shall show the order that devices are connected.

w. Voltage Drop Calculations and Battery Calculations.

x. Optical Flame Detection System floor plans shall be drawn to a scale not less than 1/8" = 1'-0" which clearly show locations of the manufacturer's recommended detector layout including horizontal and vertical angles for correct aiming. Provide a plan with the "Cone-of-Vision" for each Optical Flame Detector and respective aim points. Provide elevation details drawn at a scale of not less than 1/2" = 1'-0" which clearly shows the "Cone-of-Visions" and respective aim points demonstrating that the "Cone-of-Visions" do not extend more than 5 feet outside the hangar doors.

1.14 QUALITY ASSURANCE

1.14.1 Authority Having Jurisdiction

Projects located on McChord Field shall follow Air Force requirements with the AFCEC/COSM fire protection engineer being the Authority Having Jurisdiction.

Projects located on Lewis Main shall follow Army requirements with the USACE fire protection engineer being the Authority Having Jurisdiction.

1.15 FIRE RISER AREA

All Low-Level High Expansion Foam System risers shall be located in a mechanical room or a dedicated fire protection room having direct exterior access. Low-Level High Expansion Foam System risers rooms that exit through the Hangar Maintenance Area where Low-Level High Expansion Foam System discharge occurs shall not be allowed.

1.16 GENERAL LOW-LEVEL HIGH EXPANSION FOAM SYSTEM DESIGN REQUIREMENTS

1.16.1 Fire Area

A Fire Area is the aggregate floor area enclosed and bounded by fire walls, fire barriers, exterior walls or horizontal assemblies of a Facility. Areas of the Facility not provided with surrounding walls shall be included in the Fire Area if such areas are included within the horizontal projection of the roof or floor above.

1.16.2 Performance Requirements

Low-Level High Expansion Foam System application shall be from foam generators by aeration specified herein and as indicated on the drawings, when provided.

Cover 90 percent of the aircraft's projected aircraft outlines (silhouettes) on the floor with Low-Level High Expansion Foam within 60 seconds upon system actuation (e.g. Manual Foam Start Station). For fixed winged aircraft, the areas under engines extending beyond the wing edge and under the rear elevators are not considered part of the projected aircraft outlines (silhouettes). For rotary winged aircraft, the rotor sweep is considered part of the projected aircraft outlines (silhouettes).

Additionally, cover the aircraft maintenance area and adjacent floor areas not cut-off from the hangar bay (e.g. self-closing or automatically closing doors/shutters) with Low-Level High Expansion Foam to a depth of 3.28 feet (1 meter) within 4 minutes.

Where more than one Low-Level High Expansion Foam System is present within a fire area, design the releasing system to only release the Low-Level High Expansion Foam System associated with the fire event. Such as where a hangar bay is subdivided by a non-rated wall into two bays with independent Low-Level High Expansion Foam Systems or where a large hangar bay is provided with multiple Low-Level High Expansion Foam Systems, zone the initiation devices to only release the Low-Level High Expansion Foam System associated with the fire event. However, design the fire flow and concentrate supply to allow for sufficient simultaneous operation of all Low-Level High Expansion Foam Systems within the fire area.

1.16.3 Rate of Foam Discharge

The Rate of Foam Discharge shall be in accordance with UFC 3-600-01, UFC 4-211-01, and NFPA 11 as applicable and on the drawings when provided.

1.16.4 Concentrate and Water Supply

System shall discharge foam solution over the protected area for a minimum of 15 minutes from the Low-Level High Expansion Foam System Generators while simultaneously discharging water through the overhead wet pipe sprinkler system specified in JBLM Specification 21 13 13.00 10 WET PIPE SPRINKLER SYSTEM, FIRE PROTECTION and JBLM Specification 21 13 17.00 10 DRY PIPE SPRINKLER SYSTEM, FIRE PROTECTION. Reduction of the discharge duration based on a discharge rate higher than the specified minimum is not permitted.

The Low-Level High Expansion Foam Concentrate Storage Tank shall be sized for a 15 minute discharge duration of concentrate at the hydraulically calculated waterflow rate or the nominal concentrate injection rate of 130 percent, whichever is greater.

1.16.5 Hydraulic Calculations

Design of Low-Level High Expansion Foam Systems shall be by hydraulic calculations for uniform distribution of Low-Level High Expansion Foam solution over the protected area as defined by UFC 4-211-01 and on the drawings if provided. Hydraulic Calculations shall conform to the NFPA standards listed above and to the requirements specified herein.

1.16.5.1 Hydraulic Calculation Start Point

a. For systems supplied from a non-potable fire service water distribution system, hydraulic calculations shall begin at the fire water tank or reservoir.

b. For systems supplied from the potable water distribution hydraulic calculations shall begin at the point of connection to the existing distribution system piping.

c. Base hydraulic calculations on the operation of the minimum number of Fire Pumps running necessary to supply the Low-Level High Expansion Foam System Generators and the sprinkler design area. Fire Pumps are specified under [Section 21 30 00 FIRE PUMPS.

1.16.5.2 Hydraulically Design of the System

a. The sprinkler system installed at the roof level of the Hangar Maintenance Area shall be designed to deliver a density of 0.20 g.p.m. per squarer foot over the hydraulically most demanding 5,000 square feet.

b. Hydraulically most demanding area shall not be increased for sloped ceilings exceeding a 2 in 12 slope.

c. Hydraulically most demanding area shall be increased by 30 percent for a dry pipe automatic fire protection sprinkler system.

d. Hydraulic calculations shall include pressure discharge graphs or tables showing pressure discharge relationship for foam generators.

e. Design shall be such that operating pressure of foam solution nozzles is maintained between (the foam generator's manufacturer's minimum

operating pressure +5 psi and the foam generators' maximum pressure -10 psi during system discharge.

f. Hydraulic calculations shall include the manufacturer’s minimum pressure drop across flow control valve for the features indicated. Include "Demand Calculations" and "Supply Driven Calculations".

g. Provide a combined hydraulic demand calculation of the foam/water system based on the foam generator output, water flows, and pressure, and the most hydraulically demanding area of the overhead sprinkler system in the Hangar Maintenance Area, as defined by UFC 4-211-01 and on the drawings if provided.

h. Demonstrate the combined fire water demand calculation does not exceed the available fire water supply.

i. Confirm that the resulting Low-Level High Expansion Foam System supply from this calculation does not exceed the quantity of foam concentrate to be stored in the foam concentrate storage tank or the quantity indicated on the drawings if shown.

1.16.6 Foam Spread/Coverage Calculations

Provide Foam Spread/Coverage Calculations and diagrams demonstrating the performance requirements to cover the projected aircraft outlines (silhouettes) are met within one minute. The Foam Spread/Coverage Calculation method does not remove the obligation to demonstrate system compliance during testing. Include the following parameters in determining the maximum foam spread after one minute:

a. Time for the Low-Level High Expansion Foam System Control Panel to open the flow control valve after initiation.

b. Time for the foam/water to reach each generator based on the piping velocities in the hydraulic supply calculation.

c. Time for the foam to reach the floor of the Hangar Maintenance Area after discharging from the generator based on the height and orientation of each generator.

d. Time for the foam to spread across the floor based on the manufacturer's foam spread diagrams, or at a rate not to exceed 1 ft. /sec.

1.16.7 Hose Reels

Hose systems including Hose Reels shall not be provided.

1.16.8 System Hydraulic Surge Analysis

Manufacturer's calculations are required for determining the minimum surge arrestor capacities where the following distances are exceeded from the fire pump discharge to the most remote dry-pipe, pre-action, or foam/water riser. Include the surge arrestor calculations performed by the manufacturer in the design calculations.

a. 1,500 feet for a system not exceeding a working pressure of 175 psi.

b. 1,000 feet for a system not exceeding a working pressure of 250 psi.

c. 500 feet for a system not exceeding a working pressure of 175 psi, and plastic piping is used (e.g. PVC, HDPE).

d. 300 feet for a system not exceeding a working pressure of 250 psi, and plastic piping is used (e.g. PVC, HDPE).

A Hydraulic Surge Analysis shall study the entire fire suppression system, including the foam water system, sprinkler system, site piping, fire pumps, and reservoirs using commercially available software. The study shall determine the pressure surges or water hammer due to pump starting and stopping, valves opening and closing, and foam water initially reaching the foam generators. The Hydraulic Surge Analysis shall consider fire water pumps starting when foam system is activated. The Hydraulic Surge Analysis shall be performed under the supervision of and certified by the Fire Protection Specialist.

1.17 PROJECTS LOCATED ON LEWIS MAIN SHALL FOLLOW CHAPTER 6 REQUIREMENTS OF UFC 4-211-01 FOR ARMY SPECIFIC CRITERIA.

1.17.1 Keys

Keys and locks for equipment shall be identical and shall be mastered to a 211 key.

1.17.2 Foam Concentrate Proportioning System

Provide a foam concentrate pumping system with an atmospheric foam concentrate storage tank. Provide a listed In-Line Balanced Pressure Proportioner Assembly.

1.17.3 Activation

System activation shall be controlled by an addressable Low-Level High Expansion Foam System Control Panel listed for releasing service. The following will release the Low-Level High Expansion Foam Systems:

a. Projects located on Lewis Main shall follow Army requirements.

b. Manual Foam Start Stations shall be located adjacent to each man door existing out of the Hangar Maintenance Area or as shown on drawings if provided. Zoned Manual Foam Start Stations are not permitted. Program the Manual Foam Start Stations to simultaneously release the foam/water discharge from all zones viewable from the foam release station.

c. The operation of one water flow switch simultaneous with one Optical Flame Detector. Actuation of the fire sprinkler system alone shall not activate the high-expansion foam system, unless an Optical Flame Detector alarms simultaneously.

d. The operation of two simultaneous Optical Flame Detectors. The first automatic initiating device shall activate the general fire alarm, blue beacons, and report to the fire department. The second automatic initiating device shall activate the foam system, and report to the fire department.

1.17.4 Hydraulic Calculation Start Point

Confirm that the foam/water demand does not exceed capacity of the foam concentrate pumps.

1.17.5 Flow Control Valves

a. Water flow through the foam concentrate In-Line Balanced Pressure Proportioner Assembly and to the foam generator system shall be controlled by Flow Control Valves. Flow Control Valves include control of the opening and closing speed of the valve, and provide pressure regulation to the discharge devices, and provide for remote closing of the valve from Manual Foam Stop Stations.

b. Once activated, the system shall remain activated. However, foam flow will be interrupted/stopped momentarily by depressing and holding a Manual Foam Stop Station button which are placed on the hangar maintenance area walls, in exit corridors from the Hangar Maintenance Area, and as shown on the drawings if provided

1.17.6 Foam Concentrate Pump and Foam Jockey Pump Control

Upon activation of the foam/water system, remote start the Foam Concentrate Pump from the Foam System Control Panel. Do not start the Foam Concentrate Pump upon a drop in pressure. Upon depressing the Manual Foam Stop Station, stop the Foam Concentrate Pump and the Foam Concentrate Jockey Pump to prevent excessive concentrate from being pumped into the foam solution piping. As long as the foam/water system is in alarm, releasing the Manual Foam Stop Station will restart the Foam Concentrate Pump and Foam Concentrate Jockey Pump.

1.17.7 Manual Foam Stop Station Operation

a. Once depressed, and so long as the button is held down, design the system so the Manual Foam Stop Station prevents/stops discharge of the foam/water system regardless of whether or not the foam/water system was activated automatically or manually, and whether or not the activation occurs prior to or after the Manual Foam Stop Station is pressed and held.

b. Program the Manual Foam Stop Stations to simultaneously stop the foam/water discharge from the depressed stop station.

c. Unless the Foam System Control Panel has been reset and all activation alarms (manual and automatic) have been cleared; restore the foam/water system operation when the Manual Foam Stop Station button is released.

d. Do not exceed 15 seconds to fully close the flow control valve (and stop the Foam Concentrate Pump and Foam Concentrate Jockey Pump) when the Manual Foam Stop Station button is depressed under full flow.

e. Where the foam/water system is still in alarm, do not exceed 5 seconds to fully open the Flow Control Valves upon release of the Manual Foam Stop Station button.

1.18 PROJECTS LOCATED ON McCHORD FIELD SHALL FOLLOW CHAPTER 5 REQUIREMENTS OF UFC 4-211-01 FOR AIR FORCE SPECIFIC CRITERIA

1.18.1 Keys

Keys and locks for equipment shall be identical and shall be mastered to a CAT 30 key.

1.18.2 Foam Concentrate Proportioning System

Foam proportioning shall be by a foam inductor taking suction from an atmospheric High Expansion Foam Concentrate Storage Tank located directly beneath/adjacent the inductor.

1.18.3 Activation

System activation shall be controlled by an addressable Low-Level High Expansion Foam System Control Panel listed for releasing service. The following will release the Low-Level High Expansion Foam Systems:

a. Projects located on McChord Field shall follow Air Force requirements.

b. Manual Foam Start Stations located adjacent to each man door exiting out of the Hangar Maintenance Area or as shown on drawings if provided. Provide Manual Foam Start Stations within each zone for the release of that zone.

c. Actuation of the fire sprinkler system shall not activate the high-expansion foam system.

d. The simultaneous operation of two Optical Flame Detectors in the Hangar Maintenance Area is required to automatically release the high-expansion foam. Actuation of the fire sprinkler system shall not activate the high-expansion foam system. The first Optical Flame Detector shall activate the general fire alarm, the blue beacons, and report to the fire department. The second Optical Flame Detector shall activate the foam system, and report to the fire department.

1.18.4 Hydraulic Calculation Start Point

For projects located on McChord Field, provide a design that indicates the inductor's flow rate, inlet pressure, back pressure, and concentrate lift height for a near empty concentrate storage tank. Hydraulically calculate the back pressure for the inductor using the Hazen-Williams equation with a C-factor of a 100 for all piping downstream of the inductor.

1.18.5 Flow Control Valves

a. Water flow through the foam concentrate proportioning system (inductors) and to the foam generator system shall be controlled by Flow Control Valves. Flow Control Valves include control of the opening and closing speed of the valve, and provide pressure regulation to the discharge devices, and provide for remote closing of the valve from Manual Foam Stop Stations.

b. Once activated, the system shall remain activated. However, foam flow will be interrupted/stopped momentarily by depressing and holding a Manual Foam Stop Station button which are placed on the Hangar Maintenance Area walls and as shown on the drawings if provided

1.18.6 Manual Foam Stop Station Operation

a. Once depressed, and so long as the button is held down, design the system so the Manual Foam Stop Station prevents/stops discharge of the foam/water system regardless of whether or not the foam/water system was activated automatically or manually, and whether or not the activation occurs prior to or after the Manual Foam Stop Station is pressed and held.

b. Program the Manual Foam Stop Stations to simultaneously stop the foam/water discharge from all zones viewable from the depressed stop station.

c. Unless the Foam System Control Panel has been reset and all activation alarms (manual and automatic) have been cleared; restore the foam/water system operation when the Manual Foam Stop Station button is released.

d. Do not exceed 15 seconds to fully close the flow control valve when the Manual Foam Stop Station button is depressed under full flow.

e. Where the foam/water system is still in alarm, do not exceed 5 seconds to fully open the Flow Control Valves upon release of the Manual Foam Stop Station button.

1.18.7 Foam System Control

Provide a foam system alarm and control consisting of an addressable Foam System Control Panel, Optical Flame Detectors, Manual Foam Start Stations, Manual Foam Stop Stations, signage panels, visual notification appliances, and miscellaneous appurtenances and circuit wiring in conduit, as required for a complete, operational, and fully functioning system. All components comprising the foam system alarm and control shall be sourced through the manufacturer of the Foam System Control Panel and Optical Flame Detectors (which is Det-Tronics), to ensure compatibility.

PART 2 PRODUCTS

2.1 MATERIALS AND EQUIPMENT

Materials and Equipment shall be domestically made and standard products of a manufacturer regularly engaged in the manufacture of such products and shall essentially duplicate items that have been in satisfactory use for at least 2 years prior to bid opening. The Materials and Equipment shall have been for sale on the commercial market through advertisements, manufacturers' catalogs, or brochures during the 2 year period.

2.1.1 Source Limitations

Obtain Low-Level High Expansion Foam Concentrate, proportioning system, Low-Level High Expansion Foam Generators, and major accessories through one manufacturer. All components shall be listed for use together as single system.

2.2 NAMEPLATES

Major components of equipment shall have the manufacturer's name, address, type or style, model or serial number, catalog number, date of installation,

installing Contractor's name and address, and the contract number provided on a new plate permanently affixed to the item or equipment.

2.3 REQUIREMENTS FOR FIRE PROTECTION SERVICE

Materials and Equipment shall have been tested by Underwriters Laboratories, Inc. and listed in UL Fire Prot Dir or approved by Factory Mutual and listed in FM P7825a and FM P7825b. Where the terms "listed" or "approved" appear in this specification, such shall mean listed in UL Fire Prot Dir or FM P7825a and FM P7825b. Submit manufacturer's catalog data included with the Sprinkler System Drawings for all items specified herein. The data shall be highlighted to show model, size, options, etc., that are intended for consideration. Data shall be adequate to demonstrate compliance with all contract requirements. Manufacturer's catalog data shall be current and shall not indicate products that have been superseded or products that no longer are manufactured.

2.4 UNDERGROUND PIPING COMPONENTS

2.4.1 Pipe

Provide outside-coated, cement mortar-lined, Class 52 ductile-iron pipe with a rated working pressure rating of Class 125 of 175 p.s.i. conforming to NFPA 24 for piping under the building and less than 5 feet outside of the building walls. Piping with a working pressure exceeding 175 p.s.i. shall be Class 250 having a minimum rated working pressure of 300 p.s.i. Minimum pipe size for UFC 3-600-01 and NFPA 13 systems shall be 6 inches. Minimum pipe size for NFPA 13D and NFPA 13R systems shall be 4 inches. Piping more than 5 feet outside of the building walls shall be outside coated, AWWA C104/A21.4 cement mortar-lined, AWWA C151/A21.51 ductile-iron pipe, and AWWA C110/A21.10 fittings conforming to NFPA 24 or provided under Section 33 11 00 WATER DISTRIBUTION.

2.4.2 Fittings and Gaskets

Flanged elbows or bends (straight sizes), tees, crosses, concentric reducers, base elbows (except reducing size) and bottom base tees shall be Class 125 ductile iron conforming to AWWA C110/A21.10. Fittings with a working pressure exceeding 175 p.s.i. shall be Class 250 having a minimum rated working pressure of 300 p.s.i. Gaskets shall be suitable in design and size for the pipe with which such gaskets are to be used. Gaskets for ductile iron pipe joints shall conform to AWWA C111/A21.11.

2.4.3 Bolts

Bolts shall be ASTM A 449, Type 1 or 2, Grade 5. Bolts shall extend no less than three full threads beyond the nut with Bolts tightened to the required torque. Provide Bolts with a bituminous coating and wrapped in a minimum 6 mil polyethylene plastic.

2.4.4 Nuts

Nuts shall be ASTM A 193/A 193M or ASTM A 194/A 194M, Grade 5. Provide Nuts with a bituminous coating and wrapped in a minimum 6 mil polyethylene plastic.

2.4.5 Washers

Washers shall meet the requirements of ASTM F 436. Flat circular Washers shall be provided under all bolt heads and nuts. Provide Washers with a bituminous coating and wrapped in a minimum 6 mil polyethylene plastic.

2.4.6 Rodding

Provide Rodding with a bituminous coating and wrapped in a minimum 6 mil polyethylene plastic.

2.4.7 Valves and Valve Boxes

Valves shall be gate valves conforming to AWWA C500 or UL 262. Valves shall have cast-iron body and bronze trim. Valve shall open by counterclockwise rotation. Except for post indicator valves, all underground valves shall be provided with an adjustable cast-iron or ductile iron valve box of a size suitable for the valve on which the box is to be used, but not less than 5.25 inches in diameter. The box shall be coated with bituminous coating. A cast-iron or ductile-iron cover with the word "WATER" cast on the cover shall be provided for each box.

2.4.8 Gate Valve and Indicator Posts

Gate valves for underground installation shall be of the inside screw type with counter-clockwise rotation to open. Where indicating type valves are shown or required, indicating valves shall be gate valves with an approved indicator post of a length to permit the top of the post to be located 3 feet above finished grade. Gate valves for use with indicator post shall conform to UL 262. Indictor post shall conform to UL 789. Provide each indicator post with one coat of primer and two coats of red enamel paint.

2.4.9 Buried Utility Warning and Identification Tape

Detectable aluminum foil plastic-backed tape or detectable magnetic plastic tape manufactured specifically for warning and identification of buried piping shall be provided for all buried piping. Tape shall be detectable by an electronic detection instrument. Tape shall be provided in rolls, 3 inches minimum width, color-coded for the utility involved and imprinted in bold black letters continuously and repeatedly over the entire tape length. Warning and identification shall be "CAUTION BURIED WATER PIPING BELOW" or similar wording. Code and lettering shall be permanent and unaffected by moisture and other substances contained in the trench backfill material. Tape shall be buried at a depth of 12 inches below the top surface of earth or the top surface of the subgrade under pavement.

2.5 ABOVEGROUND WATER ONLY PIPING COMPONENTS

Aboveground piping containing water only shall be Schedule 40 black steel or copper for Low-Level High Expansion Foam Systems. Galvanized piping is not allowed.

2.5.1 Steel Piping Components

2.5.1.1 Steel Pipe

Except as modified herein, Steel Pipe shall be black with a working pressure rating of Class 125 of 175 p.s.i. as permitted by NFPA 13 and shall conform

to applicable provisions of ASTM A 795/A 795M, ASTM A 53/A 53M, or ASTM A 135/A 135M. Piping with a working pressure exceeding 175 p.s.i. shall be Class 250 having a minimum rated working pressure of 300 p.s.i. Pipe in which threads are cut, grooves are cut, grooves are rolled formed, or flanges are installed shall be Schedule 40, except Schedule 30 piping is allowed for sizes 8 inches and greater in diameter. Pipe shall be marked with the name of the manufacturer, kind of pipe, and ASTM designation.

2.5.1.2 Fittings for Non-Grooved Steel Pipe

Fittings shall be Class 125 with a minimum working pressure rating of 175 p.s.i. and shall be cast iron conforming to ASME B16.4, steel conforming to ASME B16.9 or ASME B16.11, or malleable iron conforming to ASME B16.3. Fittings with a working pressure exceeding 175 p.s.i. shall be Class 250 having a minimum rated working pressure of 300 p.s.i. Steel press fittings shall be approved for fire protection systems. Plain-end fittings with mechanical couplings, fittings that use steel gripping devices to bite into the pipe, restrictive orifices, and segmented welded fittings shall not be used.

2.5.1.3 Grooved Mechanical Joints and Fittings

Joints an fittings shall be Class 125 with a minimum working pressure rating of 175 p.s.i. and shall be the product of the same manufacturer along with the grooving tools. Fittings with a working pressure exceeding 175 p.s.i. shall be Class 250 having a minimum rated working pressure of 300 p.s.i. Segmentally welded fittings or saddle tees using rubber gasket fittings shall is not allowed. Fitting and coupling houses shall be malleable iron conforming to ASTM A 47/A 47M, Grade 32510, and ductile iron conforming to ASTM A 536, Grade 65-45-12. Gasket shall be the flush type that fills the entire cavity between the fitting and the pipe. Nuts and bolts shall be heat-treated steel conforming to ASTM A 183 and shall be cadmium plated or zinc electroplated. Flange by grooved adapters will not be allowed.

2.5.1.4 Flanges

Class 150 Flanges shall conform to NFPA 13 and ASME B16.1. Flanges with a working pressure exceeding 175 p.s.i. shall be Class 250 having a minimum rated working pressure of 300 p.s.i.

2.5.1.4.1 Gaskets

Gaskets shall be AWWA C111/A21.11, cloth inserted red rubber or non-asbestos compressed material in accordance with ASME B16.21, 1/16" thick, and full face or self-centering flat ring type.

2.5.1.4.2 Bolts

Bolts shall be ASTM A 449, Type 1 or 2, Grade 5. Bolts shall extend no less than three full threads beyond the nut with Bolts tightened to the required torque.

2.5.1.4.3 Nuts

Nuts shall be ASTM A 193/A 193M or ASTM A 194/A 194M, Grade 5.

2.5.1.4.4 Washers

Washers shall meet the requirements of ASTM F 436. Flat circular Washers shall be provided under all bolt heads and nuts.

2.5.2 Copper Tube Components

2.5.2.1 Copper Tube

Copper Tube shall conform to ASTM B 88, Types K and L, soft annealed.

2.5.2.2 Copper Fittings and Joints

Cast copper alloy solder-joint pressure fittings shall conform to ASME B16.18 and wrought copper and bronze solder-joint pressure fittings shall conform to ASME B16.22 and ASTM B 75. Cast copper alloy fittings for flared copper tube shall conform to ASME B16.26 and ASTM B 62. Brass or bronze adapters for brazed tubing may be used for connecting tubing to flanges and to threaded ends of valves and equipment. Extracted brazed tee joints produced with an acceptable tool and installed as recommended by the manufacturer may be used. Grooved mechanical joints and fittings shall be designed for not less than 125 psig service and shall be the product of the same manufacturer. Grooved fitting and mechanical coupling housing shall be ductile iron conforming to ASTM A 536. Gaskets for use in grooved joints shall be molded synthetic polymer of pressure responsive design and shall conform to ASTM D 2000 for circulating medium up to 230 degrees F. Grooved joints shall conform to AWWA C606. Coupling nuts and bolts for use in grooved joints shall be steel and shall conform to ASTM A 183.

2.6 ABOVEGROUND FOAM CONCENTRATE PIPING COMPONENTS

Aboveground foam concentrate piping shall be Schedule 40 stainless steel for Low-Level High Expansion Foam Systems. Galvanized piping is not permitted. Concentrate piping shall be located above grade and where concealed, concentrate piping must use welded or flanged fittings.

2.6.1 Stainless Steel Piping Components

2.6.1.1 Stainless Steel Pipe

Except as modified herein, Steel pipe shall be Type 304 or 316 Stainless Steel with a working pressure rating of Class 125 of 175 p.s.i. as permitted by NFPA 13 and shall conform to applicable provisions of ASME B36.19/B36.19M, ASTM A 182/A 1822M, and ASTM A 193/A 193M. Piping with a working pressure exceeding 175 p.s.i. shall be Class 250 having a minimum rated working pressure of 300 p.s.i. Pipe in which threads are cut, welded, or flanges are installed shall be Schedule 40, except Schedule 30 piping is allowed for sizes 8 inches and greater in diameter. Pipe shall be marked with the name of the manufacturer, kind of pipe, and ASTM designation.

2.6.1.2 Fittings for Non-Grooved Steel Pipe

ittings shall be Class 125 with a minimum working pressure rating of 175 p.s.i and shall be stainless steel conforming to ASTM A 182/A 1822M or ASME SA182. Fittings with a working pressure exceeding 175 p.s.i. shall be Class 250 having a minimum rated working pressure of 300 p.s.i. Plain-end fittings with mechanical couplings, fittings that use steel gripping devices to bite into the pipe and segmented welded fittings, or fittings using grooved

couplings shall not be used. If using welded joints and fittings, consideration must be given to the maintenance of the system and provide flanged joints at certain locations to allow for the ease of maintenance and equipment removal. Gasket material must be approved by the foam concentrate manufacturer.

2.6.1.3 Flanges

Class 150 Flanges shall conform to NFPA 13 and ASME B16.1. Flanges with a working pressure exceeding 175 p.s.i. shall be Class 250 having a minimum rated working pressure of 300 p.s.i.

2.6.1.3.1 Gaskets

Gaskets shall be AWWA C111/A21.11, full face or self-centering flat ring type, and approved by the Low-Level High Expansion Foam manufacturer for use with their Low-Level High Expansion Foam.

2.6.1.3.2 Bolts

Bolts shall be ASTM A 449, Type 1 or 2, Grade 5. Bolts shall extend no less than three full threads beyond the nut with Bolts tightened to the required torque.

2.6.1.3.3 Nuts

Nuts shall be ASTM A 193/A 193M or ASTM A 194/A 194M, Grade 5.

2.6.1.3.4 Washers

Washers shall meet the requirements of ASTM F 436. Flat circular Washers shall be provided under all bolt heads and nuts.

2.6.1 Pressure Relief Valves

The concentrate piping shall be provided with a Pressure Relief Valve not sized less than ½" in size. The Pressure Relief Valve shall be cast bronze with a rough brass finish. The Pressure Relief Valve shall be set to operate at a minimum pressure of 175 p.s.i. or 10 p.s.i. in excess of the maximum system pressure, whichever is greater.

2.7 ABOVEGROUND FOAM/WATER SOLUTION PIPING COMPONENTS

Aboveground foam/water solution piping shall be Schedule 40 black steel for Low-Level High Expansion Foam Systems. Galvanized piping is not allowed.

2.7.1 Steel Piping Components

2.7.1.1 Steel Pipe

Except as modified herein, Steel Pipe shall be black with a working pressure rating of Class 125 of 175 p.s.i. as permitted by NFPA 13 and shall conform to applicable provisions of ASTM A 795/A 795M, ASTM A 53/A 53M, or ASTM A 135/A 135M. Piping with a working pressure exceeding 175 p.s.i. shall be Class 250 having a minimum rated working pressure of 300 p.s.i. Pipe in which threads are cut, grooves are cut, grooves are rolled formed, or flanges are installed shall be Schedule 40, except Schedule 30 piping is

allowed for sizes 8 inches and greater in diameter. Pipe shall be marked with the name of the manufacturer, kind of pipe, and ASTM designation.

2.7.1.2 Fittings for Non-Grooved Steel Pipe

Fittings shall be Class 125 with a minimum working pressure rating of 175 p.s.i. and shall be cast iron conforming to ASME B16.4, steel conforming to ASME B16.9 or ASME B16.11, or malleable iron conforming to ASME B16.3. Fittings with a working pressure exceeding 175 p.s.i. shall be Class 250 having a minimum rated working pressure of 300 p.s.i. Plain-end fittings with mechanical couplings, fittings that use steel gripping devices to bite into the pipe and segmented welded fittings shall not be used.

2.7.1.3 Grooved Mechanical Joints and Fittings

Joints an fittings shall be Class 125 with a minimum working pressure rating of 175 p.s.i. and shall be the product of the same manufacturer along with the grooving tools. Fittings with a working pressure exceeding 175 p.s.i. shall be Class 250 having a minimum rated working pressure of 300 p.s.i. Segmentally welded fittings or saddle tees using rubber gasket fittings shall is not allowed. Fitting and coupling houses shall be malleable iron conforming to ASTM A 47/A 47M, Grade 32510, and ductile iron conforming to ASTM A 536, Grade 65-45-12. Gasket shall be the flush type that fills the entire cavity between the fitting and the pipe and listed for use in dry pipe systems. Nuts and bolts shall be heat-treated steel conforming to ASTM A 183 and shall be cadmium plated or zinc electroplated. Flange by grooved adapter will not be allowed.

2.7.1.4 Flanges

Class 150 Flanges shall conform to NFPA 13 and ASME B16.1. Flanges with a working pressure exceeding 175 p.s.i. shall be Class 250 having a minimum rated working pressure of 300 p.s.i.

2.7.1.4.1 Gaskets

Gaskets shall be AWWA C111/A21.11, full face or self-centering flat ring type, and approved by the Low-Level High Expansion Foam manufacturer for use with their Low-Level High Expansion Foam.

2.7.1.4.2 Bolts

Bolts shall be ASTM A 449, Type 1 or 2, Grade 5. Bolts shall extend no less than three full threads beyond the nut with Bolts tightened to the required torque.

2.7.1.4.3 Nuts

Nuts shall be ASTM A 193/A 193M or ASTM A 194/A 194M, Grade 5.

2.7.1.4.4 Washers

Washers shall meet the requirements of ASTM F 436. Flat circular Washers shall be provided under all bolt heads and nuts.

2.8 PIPE HANGERS AND SUPPORTS

Pipe Hangers and Supports shall meet MSS SP-58 and MSS SP-69 requirements and shall be listed in UL Fire Prot Dir, FM P7825a, and FM P7825b for fire protection use. Pipe Hangers and Supports shall be adjustable and of the type suitable for the application, construction, and pipe type and sized to be supported. Finish of rods, nuts, washers, hangers, and supports shall be zinc-plated after fabrication.

2.9 VALVES

Valves shall be UL listed UL Fire Prot Dir or FM approved FM P7825a and FM P7825b for fire protection service. Valves shall have flange, grooved, or threaded end connections. All Low-Level High Expansion Foam System valves affecting foam delivery must be electrically supervised for correct position.

2.9.1 Control Valves and Gate Valves

Manually operated Low-Level High Expansion Foam System control valve may be butterfly style with an integral tamper switch where installed on water only piping or shall be flanged gates valve style with an externally mounted tamper switch. Gate valve shall be outside stem and yoke (OS&Y) type, counter clock wise opening, and shall be listed in UL Bld Mat Dir or FM P7825a and FM P7825b.

2.9.2 Isolation Control Valves

Isolation Control Valves must be full port ball type with an operating handle that indicates the on/off position of the valve. Unit must be socket weld or flanged type. Valve body and ball must be 316 stainless steel complying with ASTM A351.

2.9.3 Check Valves

Check Valves 2 inches and larger shall be listed in UL Bld Mat Dir or FM P7825a and FM P7825b. Check Valves 4 inches and larger shall be of the swing type with flanged cast or ductile iron body, shall have a clear waterway, a cast or ductile iron clapper with replaceable EPDM rubber facing, and shall meet the requirements of MSS SP-71, for Type 3 or 4. Check Valves shall be suitable for either vertical or horizontal mounting and equipped with a removable handhole cover. The direction of flow shall be indicated by an arrow cast in the valve body. Provide a Check Valve on all Low-Level High Expansion Foam System riser installations. Check Valves installed on water only piping can be grooved.

2.9.4 Reducers

Changes in pipe sizing shall be made with eccentric reducers keeping the bottom of the piping at the same elevation to minimize trapped water in the Low-Level High Expansion Foam System piping.

2.9.5 Hose Valves

Hose Valves shall comply with UL 668 and shall have a minimum rating of 300 psi. Hose Valves shall be non-rising stem, all bronze, 90 degree angle or straight pattern type, with 2-1/2 inch American National Standard Fire Hose Screw Thread (NH) male outlet in accordance with NFPA 1963. Hose Valves shall be equipped with 2-1/2 inch lugged cap, cap, gasket, and chain. Hose

Valve finish shall be polished brass or rough chrome plated.

2.10 WATERFLOW ALARM

Electrically operated, exterior-mounted, water flow alarm bell shall be provided and installed in accordance with NFPA 13. Waterflow alarm bell shall be 10 inch in diameter, rated for 24 VDC, and shall be connected to the Fire Alarm Control Panel in accordance with Section 28 31 74 INTERIOR FIRE DETECTION AND ALARM SYSTEM or Section 28 31 76 INTERIOR FIRE ALARM AND MASS NOTIFICATION SYSTEM.

2.11 VALVE SUPERVISORY (TAMPER) SWITCH

Switch shall be suitable for mounting to the type of control valve to be supervised in the normally open position or in the normally closed position. The switch shall be tamper resistant and contain one set of SPDT (Form C) contacts arranged to transfer upon closure/opening of the valve of more than two rotations of the valve stem from its normal position.

2.12 FIRE DEPARTMENT CONNECTION

Fire Department Connection shall be projecting or flush type with cast brass body, matching wall escutcheon lettered "Auto Spkr" with a chromium plated or brass finish. The Fire Department Connection shall have two inlets with individual self-closing clappers, lugged caps, and chains. Female inlets shall have 2-1/2 inch diameter American National Fire Hose Connection Screw Threads (NH) per NFPA 1963.

2.13 DISINFECTING MATERIALS

All portions of the fire protection sprinkler system installed on the potable side of the backflow preventer shall be disinfected.

2.13.1 Liquid Chlorine

Liquid Chlorine shall conform to AWWA B301.

2.13.2 Hypochlorites

Calcium Hypochlorite and sodium Hypochlorite shall conform to AWWA B300.

2.14 IDENTIFICATION SIGNS

2.14.1 Identification Signs

Valve Identification Signs shall be minimum 6 inches wide x 2 inches high with enamel baked finish on minimum 18 gauge steel or 0.024 inch aluminum with red letters on a white background or white letters on red background. Wording of sign shall include, but not be limited to "control valve", "main drain", "auxiliary drain", "inspector's test", "alarm test", "alarm line", and similar wording as required by NFPA 13 to identify operational components. All Fire Protection Sprinkler System valves must be marked with permanent tags indicating "Normally Open" or "Normally Closed".

2.14.2 Fire/Smoke Wall, Ceiling, and Floor Assembly Marking and Identification

Fire walls, fire barriers, fire partitions, smoke barriers, smoke partitions or any other wall, ceiling, or floor assembly required to have protected openings that are penetrated by Fire Protection Sprinkler System piping and equipment shall be provided with markings and identification in accordance with the IBC and NFPA 101. Wall, Ceiling, and Floor Assembly Marking and Identification shall meet the following criteria at a minimum:

a. Be located in accessible concealed floor, floor/ceiling, or attic spaces.

b. Be located within 15'-0" of the end of each wall.

c. At intervals not exceeding 30'-0" measured horizontally along the wall or partition.

d. Include lettering not less than 3" in height with a minimum 3/8" stroke in a contrasting color.

e. Identify the wall type and its fire-resistance rating, as applicable.

2.14.3 Equipment Signage

Equipment Signage shall have a white background with a minimum 2 inches high red letters unless indicated differently below, the use of a "Sharpie" to write information will not be allowed. Exterior wall mounted signs shall be located at an elevation not exceeding 8 feet above exterior grade. Equipment signage shall be provided for the following items:

a. Fire Department Connection: Wall mounted fire department connection shall be provided with a metal weatherproof sign that shall be placed on the exterior wall of the building directly over the fire department connection. The sign shall be a minimum of 20 inches long by 15 inches tall and shall state "FIRE DEPARTMENT CONNECTION". If facing a parking area, 'No Parking' signage shall be provided. Striping will be painted on the pavement in front of the device.

b. Fire Department Connection: Yard mounted fire department connection shall be provided with 2 inch high white reflective stenciling/labeling along the length of the exposed fire department connection piping. The stenciling/labeling shall indicate the building number (XXXX) that it serves and state "FDC XXXXX". If facing a parking area, 'No Parking' signage shall be provided. Striping will be painted on the pavement in front of the device.

c. Wall Mounted Post Indicating Valve:

(1) Wall mounted post indicating valve shall be provided with a metal weatherproof metal sign that shall be placed on the exterior wall of the building directly over the post indicating valve. The sign shall be a minimum of 20 inches long by 15 inches tall and shall state "POST INDICATING VALVE".

(2) Each post indicating valve shall be provided with a weatherproof metal sign that shall be placed on the exterior wall of the building directly over the post indicating valve. The sign shall indicate the area of the facility that the post indicating valve covers. Sign shall be a minimum of 8 inches long and 4 inches high and will have a white background with a minimum 1 inch high

red letters.

d. Yard Mounted Post Indicating Valve:

(1) Yard mounted post indicating valve shall be provided with 2 inch high white reflective stenciling along the length of the yard post indicator housing. The stenciling shall indicate the building number (XXXX) that it serves and state "PIV XXXXX".

(2) If facing a parking area, 'No Parking' signage shall be provided. Striping will be painted on the pavement in front of the device.

(3) Each yard mounted post indicating valve shall be provided with a weatherproof metal sign that is secured to the post indicting valve housing with (2) stainless steel hose clamps. The sign shall indicate the area of the facility that the post indicating valve covers. Sign shall be a minimum of 8 inches long and 4 inches high and will have a white background with a minimum 1 inch high red letters.

e. Backflow Preventer Test valves: The test valves utilized for full forward flow testing of the backflow preventer shall be provided with a metal weatherproof sign that shall be placed on the exterior wall of the building directly over the backflow preventer test valves. The sign shall be a minimum of 20 inches long by 15 inches tall and shall state "BACKFLOW TEST VALVES".

f. Low-Level High Expansion Foam System Riser:

(1) Each Low-Level High Expansion Foam System Riser shall be provided with a metal or phenolic sign that is chain hung on the sprinkler system riser. The sign shall indicate the area of the facility that the Low-Level High Expansion Foam System Riser covers. Sign shall be a minimum of 8 inches long and 4 inches high and will have a white background with a minimum 1 inch high red letters.

(2) Paint a 3 inch wide red painted stripe on the floor a minimum of 36 inches away from the Low-Level High Expansion Foam System Riser equipment consisting of backflow preventer and all system risers.

g. Low-Level High Expansion Foam System Riser Room: The room in which the Low-Level High Expansion Foam System riser has been installed shall be provided with a metal or phenolic sign. The sign shall be placed on the exterior side of the door of the room containing the fire sprinkler riser. The sign shall be a minimum of 16 inches long by 3 inches tall and shall state "HIGH EXPANSION FOAM SYSTEM ROOM".

h. Low-Level High Expansion Foam System Release Panel Room: Paint a 3 inch wide red painted stripe on the floor a minimum of 36 inches in front and on both sides of the Low-Level High Expansion Foam System Release Panel and equipment

i. Access Panels: Each access panel shall be provided with a metal or phenolic sign. The sign shall indicate the valve in the access panel. Sign shall be a minimum of 3 inches long by 2 inches tall with 1 inch high red text that states "AUXILIARY DRAIN" etc.

j. Gas Shutoff: The building gas meter control valve shall be provided with a metal weatherproof sign that shall be placed on the exterior wall of the building directly over the gas meter. The sign shall be a minimum of 20 inches long by 15 inches tall and shall state "GAS SHUTOFF".

k. POL Storage Buildings: POL storage buildings shall be provided with a metal weatherproof signage at each exterior door. The sign shall be a minimum of 16 inches long by 3 inches tall and shall state "POL STORAGE".

l. HAZMAT Storage Buildings: HAZMAT storage buildings shall be provided with a metal weatherproof signage at each exterior door. The sign shall be a minimum of 16 inches long by 3 inches tall and shall state "HAZMAT STORAGE".

m. Lawnmower Storage Buildings: Lawnmower storage buildings shall be provided with a metal weatherproof signage at each exterior door. The sign shall be a minimum of 16 inches long by 3 inches tall and shall state "LAWNMOWER STORAGE".

n. Emergency Low-Level High Expansion and Water System Shutdown: Provide sequential signage on each Low-Level High Expansion and Water System Flow Control Valve for the emergency shutdown procedures. Locate these signs so they are readily visible near each Low-Level High Expansion and Water System Flow Control Valve. Signs shall be white background and a minimum 1/2" wide blue border with red lettering not less than 1" high. At a minimum, provide each sign with the language "EMERGENCY FOAM SHUTDOWN PROCEDURE" and the order and action to be performed (e.g. "1 - CLOSE FOAM CONCENTRATE VALVE", "2 - CLOSE LOW-LEVEL HIGH EXPANSION FOAM SYSTEM CONTROL VALVE"). Continue the sequence as required for system shutdown.

o. Low-Level High Expansion Foam System Release Panel: The Low-Level High Expansion Foam System Release Panel shall be provided with a phenolic sign on the exterior of the Low-Level High Expansion Foam System Release Panel. The sign shall be a minimum of 3 inches long by 2 inches tall with 1 inch high red text that states "FOAM FIRE PROTECTION SYSTEM".

p. Power Supplies: Each Power Supply shall be provided with a phenolic sign on the exterior of the Power Supply. The sign shall be a minimum of 3 inches long by 2 inches tall with 1 inch high red text that states "BPS-X" where "X" identifies the Power Supply number.

2.15 SEISMIC SEPARATION OR BUILDING EXPANSION / SEPARATION ASSEMBLIES

Provide a Seismic Separation Assembly or Building Expansion / Separation Assembly that is capable of allowing movement along all (3) axes of movement (up/down, Left/right, and in/out). Seismic Separation Assembly or Building Expansion / Separation Assembly shall be provided with flanged fittings for foam concentrate piping and grooved flexible couplings for water only and foam solution piping. Seismic Separation Assembly or Building Expansion / Separation Assembly shall be installed where the overhead piping crosses a seismic separation joint or a building expansion / separation joint. Seismic Separation Assembly or Building Expansion / Separation Assembly shall

consist of either (2) flexible sections of braded hose, (2) 90° elbows, and (1) 180° return or (2) flexible section of braided hose, (2) 45° elbows, and (1) 90° elbow. Seismic Separation Assembly or Building Expansion / Separation Assembly shall include a factory supplied center support nut located at the midpoint of the assembly for hanging and a drain plug. Seismic Separation Assembly or Building Expansion / Separation Assembly comprised of (6) 90° elbows with grooved flexible couplings shall not be allowed

2.16 PRESSURE RELIEF VALVE

Each WET system riser shall be provided with a Pressure Relief Valve not sized less than ½" in size and shall be cast bronze with a rough brass finish. The Pressure Relief Valve shall be installed before the water flow switch and set to operate at a minimum pressure of 175 p.s.i. or 10 p.s.i. in excess of the maximum system pressure, whichever is greater.

2.17 AUTOMATIC AIR VENTS

Provide an automatic float type air vent to reduce the amount of trapped air within all wet pipe based automatic fire protection sprinkler systems. Provide a ball valve in an accessible location between the system piping and the Automatic Air Vent to facilitate maintenance of the automatic air vent. An Automatic Air Vent shall be installed at the highest point of the system piping to vent a minimum of at least 95 percent of the volumetric capacity of the system. The Automatic Air Vent discharge shall not terminate in the building. The Automatic Air Vent discharge shall be piped down to discharge just above exterior grade level.

2.18 PRESSURE GAUGES

All Pressure Gauges for Low-Level High Expansion Foam Systems shall have permanently installed oil-filled throttling type needle or pulsation dampening Pressure Gauges to provide visual supervision of system operating pressures. Each Water Pressure Gauge shall be provided with a 304 or 316 stainless steel ball valve for easy water pressure gauge replacement without shutting down the system. Provide a minimum 3-1/2" diameter pressure gauge with a 1/4" national pipe thread connection. The pressure gauge shall have an accuracy of 3-2-3% over the range of the gauge per ASME B40.100 (3% over the first 1/4 of the gauge range, 2% over the middle 1/2 of the gauge range, and 3% over the last 1/4 of the gauge range). The pressure gauge shall be calibrated to register up to a maximum of 300 p.s.i. for operating pressures less than 175 p.s.i. and a minimum of 50 p.s.i. above operating pressure when the operating pressure exceeds 175 p.s.i. Any part of a Pressure Gauge in contact with foam solution or foam concentrate shall be 304 or 316 stainless steel. Pressure Gauges having copper in contact with foam solution or foam concentrate is not allowed.

2.19 BACKFLOW PREVENTION ASSEMBLY

2.19.1 Reduced Pressure Backflow Preventer Assembly

Reduced Pressure Backflow Prevention Assembly shall be used on all Low-Level High Expansion Foam Systems and shall comply with ASSE 1015. The assembly shall have a bronze, cast-iron or stainless steel body with flanged ends. The assembly shall include pressure gauge test ports and OS&Y shutoff valves on the inlet and outlet, 2-positive-seating check valve for

continuous pressure application, and four test cocks. Assemblies shall be rated for working pressure of 175 psi. Provide a funnel drain beneath the intermediate chamber that is routed to discharge on the outside of the building over a 2 foot by 2 foot concrete splash block to minimize damage to adjacent construction or landscaping unless discharge is directly over a hard surface such as concrete or asphalt. A test port for a pressure gauge shall be provided on the supply side and on the discharge side of the Reduced Pressure Backflow Prevention Assembly valves. The supply side and discharge side of the backflow preventer shall be provided with a permanently installed pressure gauge in accordance with NFPA 13. Backflow preventers installed in Washington State must meet the State of Washington requirements.

2.19.2 Pressure Loss Through Reduced Pressure Backflow Preventer Assembly

The pressure loss utilized in hydraulic calculations through the Reduced Pressure Backflow Prevention Assembly shall be the greater of 12 psi or the pressure drop documented in the manufacturers pressure loss curve at a flow rate equal to the fire protection system water demand, at the location of the Reduced Pressure Backflow Prevention Assembly.

2.20 FULL FORWARD FLOW TESTING CONNECTION

Provide (1) permanently installed 2½" hose valve for each 250 g.p.m. of interior system demand for full forward flow testing of the backflow preventer assembly. Hose valves shall be permanently installed on the exterior wall of the building. The piping serving the 2½" hose valves shall be provided with a normally closed grooved butterfly valve.

2.21 GRAPHIC MAP

Provide a full graphical representation of the floor plan(s) that shall be installed directly adjacent to the sprinkler riser. The Graphic Map shall be a minimum of 11"x17" in size, but shall be based upon the actual building footprint with all text being at a minimum of 1/8" scale.

2.21.1 Graphic Map Information

The Graphic Map shall include the following information at a minimum: Building Name(s) (and numbers where applicable), room names and numbers, doors, location of the Low-Level High Expansion Foam System riser, location of all auxiliary drains, location of all valves, location of the Low-Level High Expansion Foam Release Panel, location of Manual Foam Start Stations, Manual Foam Stop Stations, locations of Optical Flame Detectors, and a "North" Arrow.

2.21.2 Graphic Map Material

The Graphic Map shall be printed on white bond paper, laminated, and securely mounted to the wall using an approved method for permanent mounting.

2.22 LOW-LEVEL HIGH EXPANSION FOAM AND WATER SYSTEM TEST HEADER

Provide a linear Low-Level High Expansion Foam and Water System Test Header to meet the demand of the Low-Level High Expansion Foam and Water System. Provide (1) permanently installed 2½" hose valve for each 375 g.p.m. of interior system demand. The piping serving the 2½" hose valves shall be

provided with a normally closed grooved butterfly valve to isolate the test header from the remainder of the system. Locate the Low-Level High Expansion Foam and Water System Test Header inside the Hangar Maintenance Area within 20 feet of an exterior door or directly outside the fire protection equipment room on an exterior wall. Locate Low-Level High Expansion Foam and Water System Test Header to discharge to a hard surface within a 100-foot hose lay. Provide test header with automatic ball drip with discharge routed to the exterior of the Hangar Maintenance Area. If the Low-Level High Expansion Foam and Water System Test Header is combined with the fire pump test header, valving shall be provided to allow independent testing the Low-Level High Expansion Foam and Water System and each fire pump.

2.23 IN-LINE BASKET STRAINER

Provide an In-Line Basket Strainer with a stainless-steel mesh sized no greater than 1/4". The In-Line Basket Strainer shall consist of a welded steel body with ASTM A53/A53M pipe and Class 150 steel flanges. The In-Line Basket Strainer shall be designed to permit removal of the strainer screen for replacement and repair without removing the body from the piping. A flush outlet shall be provided with each In-Line Basket Strainer. The open screen area shall be at least 6 times greater than the nominal pipe size open area. Friction loss through the In-Line Basket Strainer shall not exceed 1 PSI at design flow when tested with clean strainer screen and clean water.

2.24 LOW-LEVEL HIGH EXPANSION FOAM LIQUID CONCENTRATE

Low-Level High Expansion Foam Concentrate shall be the product of one manufacturer that is listed or approved for use with the Low-Level High Expansion Foam Generators, and shall not contain PFOS/PFOA components. Concentrate shall have a minimum 20-year shelf life. Manufacture date shall be no more than six months before ship date to site. Mixing of non-identical specification concentrate will not be permitted.

2.25 LOW-LEVEL HIGH EXPANSION FOAM SYSTEM RELEASE PANEL POWER SUPPLIES

2.25.1 Primary Power Supply

Primary Power shall be 120 VOLTS A.C. service for the Low-Level High Expansion Foam System Release Panel from the AC service to the building in accordance with NFPA 72 and UFC 3-520-01 INTERIOR ELECTRICAL SYSTEMS Section 3-2.7 Power for Fire Protection Systems. The breaker supplying power to the Low-Level High Expansion Foam System Release Panel shall be red and provided with a red colored means of lockout. The electrical panel and breaker supplying the Low-Level High Expansion Foam System Release Panel shall be identified on the inside cover of each Fire Low-Level High Expansion Foam System Release Panel.

2.25.2 Secondary Power Supply

Provide Secondary Power for system operation in the event of primary power failure. Transfer from Primary Power to Secondary Power or restoration from Secondary Power to Primary Power shall be automatic and shall not cause transmission of a false alarm.

2.25.3 Batteries

Provide 24 Volts D.C. sealed, maintenance-free, sealed lead acid Batteries as the source for emergency power to the Low-Level High Expansion Foam System Release Panel. Batteries shall be maintained in a fully charged condition by means of a solid-state battery charger. Provide an automatic transfer switch to transfer the load from Primary Power to Secondary Power in the event of the failure of Primary Power. Battery boxes shall not be mounted more than 48" above finished floor. Batteries equal to or exceeding 50 amp-hour shall not be mounted more than 36" above finished floor. Batteries shall be factory dated and installed within 12 months of the date of manufacturing.

2.25.4 Capacity

Sufficient capacity to operate the Low-Level High Expansion Foam System Release Panel under supervisory and trouble conditions, including audible trouble signal devices for 72 hours and under alarm conditions for an additional 15 minutes. Include full current draw of solenoid in battery calculations.

2.25.5 Battery Chargers

Provide a solid state, fully automatic, variable charging rate Battery Charger. The Battery Charger shall be capable of providing 120 percent of the connected system load and shall maintain the batteries at full charge. In the event the batteries are fully discharged (20.4 Volts D.C.), the Battery Charger shall recharge the batteries back to 95 percent of full charge within 48 hours after a single discharge cycle as described in paragraph CAPACITY above. Provide pilot light to indicate when batteries are manually placed on a high rate of charge as part of the unit assembly if a high-rate switch is provided.

2.26 OPTICAL FLAME DETECTOR INHIBIT SWITCH

Provide a 2-position non-key operated switch located within the Low-Level High Expansion Foam System Release Panel enclosure, that when activated disables the releasing function of all Optical Flame Detectors in the Hangar Maintenance Area through programming at the Low-Level High Expansion Foam System Release Panel. When the Inhibit Switch is placed in inhibit mode, only the releasing functions of the Optical Flame Detectors are disabled while leaving all other functions of the Low-Level High Expansion Foam System Release Panel operational. Monitor the Inhibit Switch at the Low-Level High Expansion Foam System Release Panel. Provide a supervisory signal to Joint Base Lewis-McChord Emergency Command Center (JBECC) indicating the Optical Flame Detectors are inhibited, a trouble signal is not permitted. Label the Inhibit Switch "INHIBIT OPTICAL FLAME DETECTION." Provide engraved labels on the Inhibit Switch indicating when the Optical Flame Detectors are in "NORMAL" or "INHIBIT" mode.

2.27 OPTICAL FLAME DETECTOR SUPERVISED DISCONNECT SWITCH

Provide a key operated Supervised Disconnect Switch in the Hangar Maintenance Area in a readily accessible location near a Manual Foam Stop Station. The Supervised Disconnect Switch shall allow building occupants to disable all Optical Flame Detectors through programming at the Low-Level High Expansion Foam System Release Panel. Provide a Supervised Disconnect Switch that disables the releasing and notification functions of the Optical Flame Detectors, while leaving all other functions of the Low-Level

High Expansion Foam System Release Panel operational. Operation of the switch shall not create a supervisory signal. While the switch is in the disable mode, the Optical Flame Detectors shall not retain any history of alarm conditions such that when the Supervised Disconnect Switch is placed in the enable mode the Low-Level High Expansion Foam System Release Panel shall not immediately go into alarm and is a non-latching supervisory condition only.

The Diverter Valve Control Panel and Supervised Disconnect Switch shall be installed adjacent to each other in the Hangar Maintenance Area outside of the Low-Level High Expansion Foam System Riser Room. When the Low-Level High Expansion Foam System Riser Room is not adjacent to the Hagar Maintenance Area, the Diverter Valve Control Panel and Supervised Disconnect Switch shall be installed adjacent to each other in a location readily visible to all locations in the Hangar Maintenance Area. Provide a NEMA 250 Type 4 Supervised Disconnect Switch and backbox or house the components in a NEMA 250 Type 4 enclosure. Provide a non-flashing or rotating red indicating light not less than 400 cd (208/120 Volts A.C.) powered from a dedicated emergency panel. Control light initiation through the Low-Level High Expansion Foam System Release Panel. A backup power supply or supervision of the power supply to the light is not required when supplied from the dedicated emergency panel. Mount the light above the Supervised Disconnect Switch.

Provide a sign directly above the Supervised Disconnect Switch with a white background and a minimum 1/2" wide blue border, with "DISABLE FOAM SYSTEM", "DISABLE LOW LEVEL WATER ONLY SYSTEM" OR "DISABLE PRE-ACTION SYSTEM" in red lettering not less than 1" high. Provide Supervised Disconnect Switch with a visual alarm that automatically illuminates when the Supervised Disconnect Switch position is "off normal" and remains illuminated until Supervised Disconnect Switch is restored to the "normal" position. Provide engraved labels on the Supervised Disconnect Switch indicating when the Optical Flame Detectors are "ENABLED" or "DISABLED". Do not install backboxes or route conduit in front of sign in a manner that obstructs any lettering.

Key for the Supervised Disconnect Switch shall not be identical to the Fire Alarm Mass Notification System and shall not be mastered to a 211 or CAT 30 key.

2.28 ALARMS

2.28.1 Fire Alarm

Provide equipment and interconnections for the automatic transmittal of an alarm over the building Fire Alarm Mass Notification System as specified in Section 28 31 76 INTERIOR FIRE ALARM AND MASS NOTIFICATION SYSTEM. Arrange so that actuation of any alarm initiating device (Optical Flame Detectors or Manual Foam Start Stations), trouble and supervisory conditions shall cause activation of the Fire Alarm Mass Notification System.

2.28.2 Pressure (Waterflow) Alarm Switches

Pressure (Waterflow) Alarm Switches shall include a 1/2" NPT male pipe thread, two 1/2" conduit knockouts, and two sets of SPDT (Form C) contacts. The Pressure (Waterflow) Alarm Switches shall be factory adjusted to transfer the contacts at 4 to 8 psi on rising pressure. Pressure

(Waterflow) Alarm Switches shall include a water-tight NEMA 250 Type 4 die-cast aluminum housing with a tamper resistant cover which requires a special key for removal. The cover shall be provided with a tamper switch which shall operate upon removal of the cover. Pressure (Waterflow) Alarm Switches used on wet-pipe systems shall have an adjustable, instantly recycling pneumatic retard to prevent false alarms due to water pressure variation. Retard adjustment shall be factory set at approximately 20-40 seconds and adjustable between 0-90 seconds.

2.28.3 Valve Supervisory (Tamper) Switches

Electrically supervise normally open control valves. Valve Supervisory (Tamper) Switches shall be UL listed as "Extinguishing System Attachment" for the location and type of valve supervised. Valve Supervisory (Tamper) Switches shall contain double pole, double throw contacts. Operation of the Valve Supervisory (Tamper) Switch shall cause a supervisory signal to be transmitted to the Fire Alarm Mass Notification System Control Panel upon not more than two complete turns of the valve wheel or a closure of 10 percent, whichever is less. Valve Supervisory (Tamper) Switches shall be equipped with screw terminals for each conductor.

2.28.4 Solenoid Coil Supervisory Switches

Provide a Solenoid Coil Supervisory Switch on all releasing solenoid valves with removeable coils that are not energized when the Low-Level High Expansion Foam System Release Panel is in a normal, non-alarm condition. The Solenoid Coil Supervisory Switch shall electronically monitor the inductance and continuity of the solenoid valve's coil. The status of the solenoid valve's coil shall be signaled to the Low-Level High Expansion Foam System Release Panel via relay outputs that are suitable for monitoring by the supervisory inputs of the Low-Level High Expansion Foam System Release Panel. Removal of the coil from the solenoid valve shall be detected by the Solenoid Coil Supervisory Switch and result in the Low-Level High Expansion Foam System Release Panel indicating a supervisory condition. The Solenoid Coil Supervisory Switch shall provide local visual indication of this state and require a local manual reset operation after the coil has been restored to proper operating position. The solenoid coil supervisory switch shall have no effect on the operation of the releasing circuit or the solenoid valve. The solenoid coil supervisory switch shall visually indicate that its power is applied and that the solenoid coil supervisory switch is actively monitoring the solenoid valve's coil. The Solenoid Coil Supervisory Switch shall visually indicate that the releasing circuit is energized to prevent replacement of the removed coil resulting in activation of the Low-Level High Expansion Foam System during testing and if the coil is open or shorted. Visual indication shall be Light Emitting Diodes (LEDs) that illuminate on the Solenoid Coil Supervisory Switch, Green to indicate power on and system normal, Red to indicate releasing circuit energized, and Amber for diagnostic codes. Note that NFPA 13 requires removal of a solenoid coil from the valve that it controls to result in an audible and visual indication of system impairment at the Release Panel.

The Solenoid Coil Supervisory Switch shall be compatible with 24 Volts D.C. Solenoid Valves that is UL listed for releasing service at 9-11 watts. The circuit for the Solenoid Coil Supervisory Switch shall be rated for 20 mA maximum standby and 40 mA maximum alarm circuit. The cabling for the Solenoid Coil Supervisory Switch shall be a minimum No. 16 AWG copper installed as Class A in conduit.

2.29 LOW-LEVEL HIGH EXPANSION FOAM SYSTEM BEACONS

Blue rotating Low-Level High Expansion Foam System Beacons will not be less than 400 candela (Cd) operating on a 208 or 120 Volts A.C. power source and powered from a dedicated emergency panel. Low-Level High Expansion Foam System Beacons shall be 360-degree Light Emitting Diode (LED).

2.30 MANUAL FOAM START STATIONS

Manual Foam Start Stations shall be conventional and weatherproof. Provide distinctively different NEMA 250 Type 4 Manual Foam Start Stations and signage from the Fire Alarm Mass Notification System Manual Pull Stations. Provide tamper cover with colored portions in yellow and lettering on the cover reading "FOAM"; the words "FIRE", "ALERT", "ALARM", or "AGENT" are prohibited to appear on the cover. Provide locking type Manual Foam Start Stations that when activated require a key to be reset. Manual Foam Start Stations shall be of all metal construction and have a dual action release configuration to prevent accidental system discharge. Break-glass-front stations are not permitted. Manual Foam Start Stations shall provide positive visible indication of operation.

2.31 MANUAL FOAM STOP STATIONS

Provide NEMA 250 Type 4 Manual Foam Stop Stations of the "dead-man" type. Provide Manual Foam Stop Stations with distinctive signage at each device. Provide a red mushroom type push button and include the word "PUSH". Provide the colored portions of the tamper cover in blue and lettering on the cover stating "STOP"; the words "FIRE", "ALERT", "ALARM", or "AGENT" are prohibited to appear on the cover or Manual Foam Stop Station.

2.32 OPTICAL FLAME DETECTORS

Provide triple infrared (IR) Optical Flame Detectors that are listed/approved for the expected fuel hazards in the Hangar Maintenance Area. Provide Optical Flame Detectors that are immune to radar and radio frequency emissions from hand held equipment or equipment on-board the aircraft. Provide shielded circuiting for both the Signaling Line Circuit (SLC) and power circuit from the Optical Flame Detectors to the Low-Level High Expansion Foam System Control Panel and ground shielding in accordance with the Optical Flame Detectors manufacturer.

Optical Flame Detectors shall not alarm on non-fire sources, including but not limited to, arc welding, lightning, sunlight, radiant heaters, aircraft engine exhaust, hot surfaces, strobes, beacons, etc. Provide Optical Flame Detectors that are immune to radar and radio frequency emissions.

The Optical Flame Detection System shall be interfaced with the building Fire Alarm Mass Notification System, but shall not rely on it for operation.

The Optical Flame Detector System shall provide continuous and automated detection, while monitoring system operation through continuous supervision of its inputs/outputs. The Optical Flame Detectors shall include continuous automatic periodic self-testing and calibration during operation, including lens cleanliness check, and IR sensor testing and automatic calibration. The Optical Flame Detectors shall have manual testing capability of the lens and sensors, that is easily performed and verified at the Optical Flame

Detectors without disassembly of the Optical Flame Detectors. Each Optical Flame Detector shall have an integral indicator lamp, visible from the Hangar Maintenance Area floor, indicating whether it is in alarm (red), fault (amber), normal (green) status.

2.33 DIVERTER VALVE AND CONTROLS FOR CONTAINMENT TANKS

Design and install Diverter Valve Control Panel to Activate Diverter Valve that diverts Hangar Maintenance Area trench drain flow to an underground containment tank when the Low-Level High Expansion Foam System is activated. In normal operation (when the foam system is not activated) trench drain flow is through the oil water separator to the waste water treatment plant. Automatic activation shall be initiated by the Low-Level High Expansion Foam System Release Panel. The Fire Alarm Mass Notification System shall monitor the Diverter Valve Control Panel for automatic or manual operation and transmit a non-latching Supervisory signal upon activation. See civil site plans for location of motorized diverter valve, which will be outside the hangar on the site.

Automatically activate audible and visual alarms when the containment tank capacity level exceeds 5%. Provide a silence switch for the audible alarm. Provide indication of the diverter valve position at the monitoring panel through the use of limit switches. Provide visual indication of when the valve is fully open or closed. Provide the valve with remote manual reset capability through a "Valve Position Restore" button. Provide the panel with a visual alarm (yellow strobe or beacon) that automatically illuminates when the valve position is "off normal" or "closed", and remains illuminated until valve is restored to the full normal "open" position. Install the diverter valve motorized operator above grade or list it for a submersible environment.

The containment system monitoring panel and diverter valve panel may be combined. At a minimum, provide NEMA 250 Type 4 panel(s). Rate any devices, conduits, or electrical enclosures installed below grade or within the containment tank for prolonged submersion, minimum NEMA 250 Type 6P.

The Diverter Valve Control Panel and Supervised Disconnect Switch shall be installed adjacent to each other in the Hangar Maintenance Area outside of the Low-Level High Expansion Foam System Riser Room. When the Low-Level High Expansion Foam System Riser Room is not adjacent to the Hagar Maintenance Area, the Diverter Valve Control Panel and Supervised Disconnect Switch shall be installed adjacent to each other in a location readily visible to all locations in the Hangar Maintenance Area.

2.34 PROJECTS LOCATED ON LEWIS MAIN SHALL FOLLOW CHAPTER 6 REQUIREMENTS OF UFC 4-211-01 FOR ARMY SPECIFIC CRITERIA

2.34.1 Low-Level High Expansion Foam System Flow Control Valves

Provide Low-Level High Expansion Foam System Flow Control Valves listed or approved for use with the Low-Level High Expansion Foam Concentrate with remote resetting capability for each Low-Level High Expansion Foam System. Provide Low-Level High Expansion Foam System Flow Control Valve with automatic re-closing feature and adjustable speed control. For hydraulic calculations, include the manufacturer's minimum pressure drop across flow control valve for the features indicated.

Arrange valves for manual release at the valve. Provide pressure gages and other appurtenances at the Low-Level High Expansion Foam System Flow Control Valve as required by NFPA 13. All trim piping shall be brass with compatible fittings. Trim piping shall be factory configured and installed. Gaskets shall be made of EPDM. Low-Level High Expansion Foam System Flow Control Valve shall be operated by a Low-Level High Expansion Foam Release Panel listed for releasing service and independent of the building fire alarm system. Low-Level High Expansion Foam System Flow Control Valve located in electrical classified locations shall be listed for the classification of the area where located. Low-Level High Expansion Foam System Flow Control Valve shall include the following features as standard elements of the Low-Level High Expansion Foam System Flow Control Valve and trim package:

a. Solenoid valve shall be of the normally closed, de-energized type, which opens when energized upon receipt of an electrical signal from the Low-Level High Expansion Foam Release Panel to which it is connected. Solenoids used for release of the Low-Level High Expansion Foam System must be listed for use with the Low-Level High Expansion Foam Release Panel and the Low-Level High Expansion Foam System Flow Control Valve.

b. Low-Level High Expansion Foam System Flow Control Valve shall gradually open upon receipt of power from the Low-Level High Expansion Foam System Release Panel and shall slowly close upon interruption of power. Speed control setting shall be such that valve closure occurs within 15 seconds after depressing a Manual Foam Stop Station, and will fully open the Low-Level High Expansion Foam System Flow Control Valve within 5 seconds upon release of the Manual Foam Stop Station.

2.34.2 Low-Level High Expansion Foam Concentrate Storage Tanks

Provide a vertical, closed cell translucent or opaque single wall polyethylene Low-Level High Expansion Foam Concentrate Storage Tank compatible with the required Low-Level High Expansion Foam Concentrate.

Provide a reverse float level gauge with minimum 50-gallon increments permanently marked on the Low-Level High Expansion Foam Concentrate Storage Tank or gauge. Indicate on the Low-Level High Expansion Foam Concentrate Storage Tank or gauge the empty, full, and minimum level required to operate the system. Do not include the inaccessible portion of concentrate at the bottom of the tank that cannot be accessed by the suction line, in the tank's capacity markings. Provide a closeable fill opening and pressure/vacuum vent assembly.

2.34.2.1 Low-Level High Expansion Foam System Storage Tank Marking

Permanently label each Low-Level High Expansion Foam System Storage Tank with its capacity, concentrate manufacturer, concentrate type, and percentage of concentrate induction. The label shall specifically identify the required concentrate manufacturer's name, concentrate name, concentrate identifying product numbers/codes, concentrate manufacturer's contact information including process to obtain 24-hour concentrate re-supply. The label shall include a warning statement indicating only this specific concentrate is permitted to be used in this system. Tank shall have a NFPA 704 diamond sign indicating Health = 1; flammability = 2; and instability = 0.

2.34.2.2 Low-Level High Expansion Foam Concentrate Leak Detection

Provide a Low-Level High Expansion Foam Concentrate Leak Detection device that is to report a supervisory condition at the Fire Alarm / Mass Notification System Control Panel when the level of Low-Level High Expansion Foam Concentrate is more than 6" below the normal full level of Low-Level High Expansion Foam Concentrate. This signal is to alert JBLM of a condition in which the Low-Level High Expansion Foam Concentrate is leaking from the Low-Level High Expansion Foam Concentrate Storage Tank.

2.34.2.3 Low-Level High Expansion Foam Concentrate Spill Control

Spill control must be provided around each Low-Level High Expansion Foam Storage Tank to prevent spilled/leaked Low-Level High Expansion Foam Concentrate from reaching any drains. Spill control must consist of a minimum 4" high concrete berm or similar that is sized to contain the full volume of the Low-Level High Expansion Foam Tank.

2.34.3 Low-Level High Expansion Foam System Proportioning by In-Line Balance Pressure Proportioners

2.34.3.1 In-Line Balance Pressure Proportioners

Provide In-Line Balance Pressure Proportioner that is factory assembled and tested by the manufacturer. Disassembly, reassembly, or modification of the In-Line Balance Pressure Proportioner by the installing contractor is not allowed.

The In-Line Balance Pressure Proportioner shall contain all necessary components including Low-Level High Expansion Foam Proportioner, pressure balancing spool valve, duplex gauge, control valve, drain valve, check valves, interconnecting brass pipe, and valve identification nameplates. The In-Line Balance Pressure Proportioner shall consist of a body, inlet nozzle, and metering orifice, all of which are corrosion resistant brass. Clearly marked on the In-Line Balance Pressure Proportioner shall be the flow direction arrow, as well as the type and percentage of concentrate the In-Line Balance Pressure Proportioner was designed. The metering orifice will be sized according to the type and percentage of concentrate used. The In-Line Balance Pressure Proportioner body shall be brass, bronze, or stainless steel. The In-Line Balance Pressure Proportioner shall be completely pressure tested by the manufacturer.

2.34.3.2 Spool-Type Pressure Balancing Valve

Balancing shall be accomplished through the use of a Spool-Type Pressure Balancing Valve that shall sense Low-Level High Expansion Foam Concentrate and water inlet pressures at the outer ends of a dumbbell-shaped piston and shall react to pressure changes by covering or uncovering the foam supply port to the In-Line Balance Pressure Proportioner. The Spool-Type Pressure Balancing Valve shall be of 83600 brass construction with a phosphor-bronze piston and Buna-N rubber O-rings and seals. Interconnecting foam concentrate piping shall be of brass construction. Pressure sensing hoses shall be Teflon® with stainless braid cover and permanently attached brass couplings. Spool-Type Pressure Balancing Valve nameplates shall be provided and shall specify Spool-Type Pressure Balancing Valve function and normal operating position.

2.34.4 Low-Level High Expansion Foam Concentrate Pumps

Low-Level High Expansion Foam Concentrate Pumps shall be directly connected to an electric motor drive with a drip proof enclosure, positive displacement rotary gear or vane type, operating at a speed not greater than 1.800 rpm. Metallic Low-Level High Expansion Foam Concentrate Pump components in contact with foam concentrate shall be of bronze or stainless-steel construction. Each Low-Level High Expansion Foam Concentrate Pump shall be furnished with suction strainer, relief valve, a suction gauge, and a discharge gauge. Low-Level High Expansion Foam Concentrate Pumps shall be mounted on a carbon steel base and shall have guards over couplings. Low-Level High Expansion Foam Concentrate Pump capacity, discharge pressure and motor size shall be as determined by the Fire Protection Specialist or as shown on the drawings.

Provide a reserve Low-Level High Expansion Foam Concentrate Pump of equal capacity. Automatically operate the reserve Low-Level High Expansion Foam Concentrate Pump upon failure of the primary Low-Level High Expansion Foam Concentrate Pump. Arrange foam concentrate supply piping to meet the foam concentrate demand from either the primary or reserve Low-Level High Expansion Foam Concentrate Pump.

2.34.5 Low-Level High Expansion Foam Concentrate Jockey Pump

Low-Level High Expansion Foam Concentrate Jockey Pump shall be bronze construction, TEFC motor, horizontal close coupled regenerative turbine pump with mechanical seal, stainless steel metal parts, buna elastomers, ceramic seat, carbon washers, stainless steel shaft or shaft sleeve. Low-Level High Expansion Foam Concentrate Jockey Pump shall be end suction style with a vertically split pump casing with a motor that prevents overloading at the highest head condition.

2.34.6 Low-Level High Expansion Foam Concentrate Pump Controllers

Each Low-Level High Expansion Foam Concentrate Pump and the Low-Level High Expansion Foam Concentrate Jockey Pump shall have a dedicated controller. Low-Level High Expansion Foam Concentrate Pump Controllers shall be a full-Service Electric Fire Pump Controller, with NEMA 2 Enclosure. Low-Level High Expansion Foam Concentrate Pump Controllers shall be the automatic type and listed for fire pump service and shall be arranged for starting from the Manual Foam Start Stations or automatic fire detection system, and stopping from Manual Foam Stop Stations, all via signals from the Low-Level High Expansion Foam Release Panel. The Low-Level High Expansion Foam Concentrate Pump Controllers shall monitor the status of the Low-Level High Expansion Foam Concentrate Pump it controls (by voltage or other suitable means), and shall start the back-up Low-Level High Expansion Foam Concentrate Pump upon failure of the primary Low-Level High Expansion Foam Concentrate Pump. Low-Level High Expansion Foam Concentrate Pump Controllers shall be completely terminally wired, ready for field connections, and mounted in a NEMA Type 2 drip-proof enclosure arranged so that controller current carrying parts will not be less than 12 inches above the floor. Low-Level High Expansion Foam Concentrate Pump Controllers shall be equipped with an externally operable isolating switch which manually operates the motor circuit. Means shall be provided in the Low-Level High Expansion Foam Concentrate Pump Controllers for measuring current for all motor circuit conductors. Low-Level High Expansion Foam Concentrate Pump Controllers shall monitor and provide

individually displayed audible and visual alarms on the front panel for loss of a phase or line power, phase reversal, low foam concentrate level, and pump room temperature. Each alarm lamp shall be labeled with rigid etched plastic label. Low-Level High Expansion Foam Concentrate Pump Controllers shall be equipped with the following:

a. Voltage surge arresters installed in accordance with NFPA 20.

b. The pressure switch for automatic starting of Low-Level High Expansion Foam Concentrate Pumps shall be disabled. The Low-Level High Expansion Foam Concentrate Pumps shall only start and stop from a signal from the Low-Level High Expansion Foam Release Panel.

c. Thermostat switch with adjustable setting to monitor the pump room temperature and to provide an alarm when temperatures falls below 40 degrees F.

d. Terminals for remote monitoring of pump running, pump power supply trouble.

2.34.7 Low-Level High Expansion Foam Concentrate Pump Power Supplies

The Low-Level High Expansion Foam Concentrate Pump and Low-Level High Expansion Foam System Foam Concentrate Jockey Pump Power Supplies and arrangement to the Low-Level High Expansion Foam Concentrate Pump Controller and Low-Level High Expansion Foam Concentrate Jockey Pump Controller shall be the same for a standard Fire Pump arrangement in accordance with NFPA 20.

2.34.8 Low-Level High Expansion Foam Generators

Low-Level High Expansion Foam Generators shall be capable of producing not less than the cubic feet of Low-Level High Expansion Foam solution per minute determined by the Fire Protection Specialist.

Low-Level High Expansion Foam Generator discharge characteristics shall not result in any foam solution being discharged on aircraft fuselage and wing components from direct impingement or misting. Low-Level High Expansion Foam Generator operating pressure shall be such that high pressure pipe, fittings, and system components are not used.
Low-Level High Expansion Foam Generator shall not be obstructed by structural members or other obstructions that negatively impact the distribution system hydraulics.

The Low-Level High Expansion Foam Generator shall be listed for use with the Low-Level High Expansion Foam Concentrate. The Low-Level High Expansion Foam Generator shall be powered by a water reaction motor. The water reaction motor shall provide both the screen wetting solution and the energy to drive the fan. The Low-Level High Expansion Foam Generator shall not require an outside power source, such as electricity. A stainless-steel screen shall be provided for maximum reliability under fire conditions. System shall be designed to provide at each generator the manufacturer's minimum operating pressure +10 psi.

2.34.9 Low-Level High Expansion Foam Releasing System

2.34.9.1 General Requirements

Provide a separate Fire Alarm Mass Notification Control Panel and Low-Level High Expansion Foam Release Panel for each building. Where multiple releasing systems are provided within a single building, they may be combined into a single Low-Level High Expansion Foam Release Panel. Combining the Fire Alarm Mass Notification Control Panel and Low-Level High Expansion Foam Release Panel into a common control panel is not allowed.

Provide a Low-Level High Expansion Foam Release Panel for the control and release of the Low-Level High Expansion Foam System. Design the system so the loss of the Fire Alarm Mass Notification Control Panel or another Low-Level High Expansion Foam Release Panel does not prohibit the Low-Level High Expansion Foam Release Panel from functioning as intended. Do not connect the Low-Level High Expansion Foam Release Panel to other control units through the use of a network cable. Communicate functionality between panels through addressable modules only. A common Low-Level High Expansion Foam Release Panel may control multiple releasing systems or agents.

Connect and supervise only initiating and notification devices used by the Low-Level High Expansion Foam System. Release the Low-Level High Expansion Foam System only by the initiating devices. Additional devices are not allowed to release the Low-Level High Expansion Foam System.

2.34.9.2 Low-Level High Expansion Foam Release Panels

The Low-Level High Expansion Foam Release Panel shall be addressable and listed for "Releasing Device Service". Low-Level High Expansion Foam Release Panel shall contain components and equipment required to provide the specified operational and supervisory functions of the system. Components shall be housed in a surface mounted steel cabinet with hinged door and cylinder lock. Low-Level High Expansion Foam Release Panel shall be a clean, uncluttered, and orderly factory assembled and wired unit. Low-Level High Expansion Foam Release Panel shall include integral "power on," "alarm," and "trouble" lamps with annunciation of each alarm, supervisory and trouble signal. The panel shall have prominent rigid plastic or metal identification plates for zones, indicating lights, controls, meters, and switches. Lamps and fuses mounted on circuit boards shall be identified by permanent markings on the circuit board. Nameplates for fuses shall also include ampere rating. Low-Level High Expansion Foam Release Panel switches shall be within the locked cabinet. A suitable means shall be provided for testing the control panel visual indicating devices (meter and lamps). Meters and lamps shall be plainly visible when the cabinet door is closed. An integral graphical annunciator shall be provided to indicate and annunciate, by zone, any alarm, supervisory or trouble condition on the system, including the Optical Flame Detection System, by use of LED and LCD indication. Upon restoration of power, start-up shall be automatic, and shall not require any manual operation. The loss of primary power or the sequence of applying primary or emergency power shall not affect the transmission of alarm, supervisory or trouble signals.

2.34.9.3 Annunciator Panel

Provide integral with the main Low-Level High Expansion Foam System Release Panel. Supervision will not be required provided a fault in the annunciator circuits results only in loss of annunciation and will not affect the normal functional operation of the remainder of the system. Annunciator shall have an alpha-numeric display and provide the description of the device.

2.35 PROJECTS LOCATED ON McCHORD FIELD SHALL FOLLOW CHAPTER 5 REQUIREMENTS OF UFC 4-211-01 FOR AIR FORCE SPECIFIC CRITERIA

2.35.1 Low-Level High Expansion Foam System Flow Control Valves

Provide Low-Level High Expansion Foam System Flow Control Valves listed or approved for use with the Low-Level High Expansion Foam Concentrate with remote resetting capability for each Low-Level High Expansion Foam System. Provide Low-Level High Expansion Foam System Flow Control Valve with automatic re-closing feature and adjustable speed control. For hydraulic calculations, include the manufacturer's minimum pressure drop across flow control valve for the features indicated.

Arrange valves for manual release at the valve. Provide pressure gages and other appurtenances at the Low-Level High Expansion Foam System Flow Control Valve as required by NFPA 13. All trim piping shall be brass with compatible fittings. Trim piping shall be factory configured and installed. Gaskets shall be made of EPDM. Low-Level High Expansion Foam System Flow Control Valve shall be operated by a Low-Level High Expansion Foam Release Panel listed for releasing service and independent of the building fire alarm system. Low-Level High Expansion Foam System Flow Control Valve located in electrical classified locations shall be listed for the classification of the area where located. Low-Level High Expansion Foam System Flow Control Valve shall include the following features as standard elements of the Low-Level High Expansion Foam System Flow Control Valve and trim package:

a. Solenoid valve shall be of the normally closed, de-energized type, which opens when energized upon receipt of an electrical signal from the Low-Level High Expansion Foam Release Panel to which it is connected. Solenoids used for release of the Low-Level High Expansion Foam System must be listed for use with the Low-Level High Expansion Foam Release Panel and the Low-Level High Expansion Foam System Flow Control Valve.

b. Low-Level High Expansion Foam System Flow Control Valve shall gradually open upon receipt of power from the Low-Level High Expansion Foam System Release Panel and shall slowly close upon interruption of power. Speed control setting shall be such that valve closure occurs within 15 seconds after depressing a Manual Foam Stop Station, and will fully open the Low-Level High Expansion Foam System Flow Control Valve within 5 seconds upon release of the Manual Foam Stop Station.

c. Provide field adjustable pressure reducing trim when used with an inductor.

d. Pressure regulation shall maintain a constant pressure at the inductor and at the Low-Level High Expansion Foam Generator. Pressure deviation shall not exceed ± 10 psi.

2.35.2 Low-Level High Expansion Foam Concentrate Storage Tanks

Provide a vertical, closed cell translucent or opaque double wall polyethylene Low-Level High Expansion Foam Concentrate Storage Tank compatible with the required Low-Level High Expansion Foam Concentrate. Enter the Low-Level High Expansion Foam Concentrate Storage Tank only through the top with no taps on the bottom or sides of the Low-Level High

Expansion Foam Concentrate Storage Tank. Inductor dip tube shall enter through the top of the tank.

Provide a reverse float level gauge with minimum 50-gallon increments permanently marked on the Low-Level High Expansion Foam Concentrate Storage Tank or gauge. Indicate on the Low-Level High Expansion Foam Concentrate Storage Tank or gauge the empty, full, and minimum level required to operate the system. Do not include the inaccessible portion of concentrate at the bottom of the tank that cannot be accessed by the suction line, in the tank's capacity markings. Provide a closeable fill opening and pressure/vacuum vent assembly.

2.35.2.1 Low-Level High Expansion Foam System Storage Tank Marking

Permanently label each Low-Level High Expansion Foam System Storage Tank with its capacity, concentrate manufacturer, concentrate type, and percentage of concentrate induction. The label shall specifically identify the required concentrate manufacturer's name, concentrate name, concentrate identifying product numbers/codes, concentrate manufacturer's contact information including process to obtain 24-hour concentrate re-supply. The label shall include a warning statement indicating only this specific concentrate is permitted to be used in this system. Tank shall have a NFPA 704 diamond sign indicating Health = 1; flammability = 2; and instability = 0.

2.35.2.2 Low-Level High Expansion Foam Concentrate Leak Detection

Provide a Low-Level High Expansion Foam Concentrate Leak Detection device that is to report a supervisory condition at the Fire Alarm / Mass Notification System Control Panel when the level of Low-Level High Expansion Foam Concentrate is more than 6" below the normal full level of Low-Level High Expansion Foam Concentrate. This signal is to alert JBLM of a condition in which the Low-Level High Expansion Foam Concentrate is leaking from the Low-Level High Expansion Foam Concentrate Storage Tank.

2.35.3 Low-Level High Expansion Foam System Proportioning by Inductors

Low-Level High Expansion Foam System proportioning shall be by a single foam inductor for each foam-water riser.

a. Tune the inductor specifically for the system required flow rate, inlet pressure, back pressure, concentrate type, proportioning ratio, and lift height of a near empty Low-Level High Expansion Foam Concentrate Storage Tank. Off the shelf pre-tuned generic model inductors are not allowed.

b. Design inductor to 115% of the nominal injection rate.

c. Size inductor for the exact orifice of Low-Level High Expansion Foam / and water pipe.

d. Fit concentrate suction line of the inductor with a low loss bronze or brass check valve assembly by the manufacturer that is included in the device's hydraulic design.

e. Suggested manufacturers of approved inductors include Ansul, Chemguard, Delta Fire, Fomtec, Matre Maskin, Skum, and Wilson Foam.

2.35.4 Low-Level High Expansion Foam Generators

Low-Level High Expansion Foam Generators shall be capable of producing not less than the cubic feet of Low-Level High Expansion Foam solution per minute determined by the Fire Protection Specialist.

Low-Level High Expansion Foam Generator discharge characteristics shall not result in any foam solution being discharged on aircraft fuselage and wing components from direct impingement or misting. Low-Level High Expansion Foam Generator operating pressure shall be such that high pressure pipe, fittings, and system components are not used except for upstream of the inductor.

Low-Level High Expansion Foam Generator shall not be obstructed by structural members or other obstructions that negatively impact the distribution system hydraulics or foam induction capabilities.

The Low-Level High Expansion Foam Generator shall be listed for use with the Low-Level High Expansion Foam Concentrate. The Low-Level High Expansion Foam Generator shall be powered by a water reaction motor. The water reaction motor shall provide both the screen wetting solution and the energy to drive the fan. The Low-Level High Expansion Foam Generator shall not require an outside power source, such as electricity. A stainless-steel screen shall be provided for maximum reliability under fire conditions. System shall be designed to provide at each generator the [manufacturer's minimum operating pressure +10 psi.

2.35.5 Low-Level High Expansion Foam Releasing System

2.35.5.1 General Requirements

Provide a separate Fire Alarm Mass Notification Control Panel and Low-Level High Expansion Foam Release Panel for each building. Where multiple releasing systems are provided within a single building, they may be combined into a single Low-Level High Expansion Foam Release Panel. Combining the Fire Alarm Mass Notification Control Panel and Low-Level High Expansion Foam Release Panel into a common control panel is not allowed.

Provide a Low-Level High Expansion Foam Release Panel for the control and release of the Low-Level High Expansion Foam System. Design the system so the loss of the Fire Alarm Mass Notification Control Panel or another Low-Level High Expansion Foam Release Panel does not prohibit the Low-Level High Expansion Foam Release Panel from functioning as intended. Do not connect the Low-Level High Expansion Foam Release Panel to other control units through the use of a network cable. Communicate functionality between panels through addressable modules only. A common Low-Level High Expansion Foam Release Panel may control multiple releasing systems or agents.

Connect and supervise only initiating and notification devices used by the Low-Level High Expansion Foam System. Release the Low-Level High Expansion Foam System only by the initiating devices. Additional devices are not allowed to release the Low-Level High Expansion Foam System.

2.35.5.2 Low-Level High Expansion Foam Release Panels

a. The Low-Level High Expansion Foam System Release Panel shall be Det-Tronics Eagle Quantum Premier Fire Detection/ Releasing System, and shall be furnished complete with minimum 60-node Safety Systems Software (S3) configuration/logic programming/diagnostic tools software package including USB dongle key and RS232 cable.

b. Low-Level High Expansion Foam System Release Panel drawings must be provided by the manufacturer (Det-Tronics), and the contractor must provide funding to the manufacturer as required to provide these drawings.

c. Low-Level High Expansion Foam System Release Panel alarm, supervisory, and trouble signal reporting to the Fire Alarm Control Panel shall be via discrete dry contact output points.

d. Modular type Low-Level High Expansion Foam System Release Panel installed in a surface mounted NEMA 250 Type 4 painted steel cabinet with hinged door and cylinder lock. All detectors shall be listed for use with that Low-Level High Expansion Foam System Release Panel.

e. Optical Flame Detectors shall be networked with the Low-Level High Expansion Foam System Release Panel so that during commission IR detectors can be calibrated from the Low-Level High Expansion Foam System Release Panel.

f. The Low-Level High Expansion Foam System Release Panel shall provide a real time display of current IR levels at any Optical Flame Detector, have the ability to set the Optical Flame Detector sensitivity for each Optical Flame Detector from the Low-Level High Expansion Foam System Release Panel, be able to download Optical Flame Detector level log history, have remote test and diagnostics capability (manual self-test, lens dirty, sensor failure, power out of tolerance, device non-responsive), and remote setup and programming of Optical Flame Detector options (lens heater power level, detector alarm LED function, alarm latching or non-latching, device address, sensitivity level, timing and gate count for alarm).

g. Low-Level High Expansion Foam System Release Panel shall be electro-magnetic interference / radio frequency interference tolerant at all frequencies and rated to SIL level 2 capability (IEC 61508), a safety assessment evaluation which evaluates critical fault paths, redundancies, and statistical measurement / prediction to ensure a specific level of long term reliable performance and stability to co-exist with aircraft radar systems.

h. The Low-Level High Expansion Foam System Release Panel shall be a neat, compact, factory-wired assembly containing all parts and equipment required to provide specified operating and supervisory functions of the system. Low-Level High Expansion Foam System Release Panel cabinet shall be finished on the inside and outside with factory-applied enamel finish. Provide main annunciator located on the exterior of the cabinet door or visible through the cabinet door. Provide audible trouble signal.

i. Provide prominent engraved rigid plastic or metal identification plates, or silk-screened labels attached to the rear face of the Low-

Level High Expansion Foam System Release Panel viewing window, for all lamps and switches.

j. System power shall be 120 Volts A.C. service, transformed through a two winding isolation transformer and rectified to 24 Volts D.C. for operation of all system initiating, actuating, signal sounding, trouble signal and fire alarm tripping circuits. System shall be electrically supervised on all circuits. A ground fault condition or a single break in any circuit which prevents the required operation of the system shall result in the operation of the system trouble signal. Loss of A.C. power, a break in the standby battery power circuits, or abnormal A.C. power or low battery voltage shall result in the operation of the system trouble signals. The abnormal position of any system switch in the Low-Level High Expansion Foam System Release Panel shall result in the operation of the system trouble signals. Trouble signals shall operate continuously until the system has been restored to normal at the Low-Level High Expansion Foam System Release Panel. System trouble shall also be annunciated on the appropriate zone of the building Fire Alarm Mass Notification System Control Panel. The Manual Foam Start Stations, Manual Foam Stop Stations, Optical Flame Detectors, and all associated wiring shall be connected to and supervised by the Low-Level High Expansion Foam System Release Panel.

k. Low-Level High Expansion Foam System Release Panel shall be equipped with a NEMA Type 4 enclosure.

l. Low-Level High Expansion Foam System Release Panel shall be UL Listed and FM Approved for releasing device service.

m. Permanently label all switches.

n. Provide panel with the following switches:

(1) Trouble silencing switch which transfers audible trouble signals (including remote trouble devices, if provided) to an indicating lamp. Upon correction of the trouble condition, audible signals will again sound until the switch is returned to its normal position, or the trouble signal circuit shall be automatically restored to normal upon correction of the trouble condition. The silencing switch may be a momentary action, self-resetting type.

(2) Alarm silencing switch which when activated will silence all associated alarm devices without resetting the Low-Level High Expansion Foam System Release Panel, and cause operation of system trouble signals.

(3) Individual zone disconnect switches which when operated will disable only their respective initiating circuit and cause operation of the system and zone trouble signals.

(4) Reset switch which when activated will restore the system to normal standby status after the cause of the alarm has been corrected, and all activated initiating devices reset.

(5) Lamp test switch.

(6) System release disable switch to disable the releasing functions of the Low-Level High Expansion Foam System Release Panel while leaving all detection and other functions of the Low-Level High Expansion Foam System Release Panel operational. Activation of this switch shall transmit a non-latching supervisory alarm signal to the building Fire Alarm Mass Notification System Control Panel. Switch shall be provided within a lockable Low-Level High Expansion Foam System Release Panel.

o. Provide X3301 Multispectrum IR Optical Flame Detectors manufactured by Det-Tronics. Provide Optical Flame Detectors with Hangar Mode as the factory default. Control and monitor Optical Flame Detectors from a factory assembled Eagle Quantum Premier fire detection/releasing control unit manufactured by Det-Tronics. Optical Flame Detector lens heating option shall be set to zero. Use a low setting

2.35.5.3 Annunciator Panel

Provide integral with the main Low-Level High Expansion Foam System Release Panel. Supervision will not be required provided a fault in the annunciator circuits results only in loss of annunciation and will not affect the normal functional operation of the remainder of the system. Annunciator shall have an alpha-numeric display and provide the description of the device.

PART 3 EXECUTION

3.1 EXAMINATION

After becoming familiar with all details of the work, verify all dimensions in the field, and advise the Fire Protection Specialist, the AFCEC/COSM or USACE fire protection engineer and/or DPW representative of any discrepancy before performing the work.

3.2 FIRE PROTECTION RELATED SUBMITTALS

The Fire Protection Specialist shall prepare a list of the submittals from the Contract Submittal Register that relate to the successful installation of the Low-Level High Expansion Foam System. The submittals identified on this list shall be accompanied by a letter of approval signed and dated by the Fire Protection Specialist when submitted to the Government.

3.3 INSTALLATION REQUIREMENTS

Equipment, materials, workmanship, fabrication, assembly, erection, installation, examination, inspection, and testing shall be in accordance with the applicable provisions of UFC 3-600-01, UFC 4-021-01, UFC 4-211-01, JBLM Design Standards, NFPA 11, NFPA 13, NFPA 20, NFPA 24, NFPA 70, NFPA 72, and publications referenced therein. Carefully remove materials so as not to damage material which is to remain. Replace existing work damaged by the Contractor's operations with new work of the same construction.

3.4 INSPECTIONS BY FIRE PROTECTION SPECIALIST

The Fire Protection Specialist shall inspect the Low-Level High Expansion Foam System periodically during the installation to assure that the Low-Level High Expansion Foam System is being provided and installed in accordance with the contract requirements. The Fire Protection Specialist,

after completion of each system inspection shall provide a site report within five working days that identifies the status of the installation and any corrections that are to be made to meet contract requirements. The site report is to be addressed to the General Contractor with a copy of the report being forwarded to the government representative acting as the Authority Having Jurisdiction.

3.5 ABOVEGROUND PIPING INSTALLATION

3.5.1 Protection of Piping Against Earthquake Damage

The system piping shall be seismically protected against damage from earthquakes. This requirement is not subject to determination under NFPA 13. Install the seismic protection of the system piping in accordance with UFC 3-310-04 and NFPA 13. Include the required features identified therein that are applicable to the specific piping system. Seismically brace foam/water solution piping regardless of geographic location. Base bracing calculations on a Ss of 0.95 or as indicated in the seismic analysis or US Seismic Design Maps, whichever is greater. Protection of piping and all Low-Level High Expansion Foam System equipment including Low-Level High Expansion Foam Tanks and Low-Level High Expansion Foam Generators against damage from earthquakes shall be provided. Longitudinal and lateral sway bracing shall be provided for piping.

3.5.2 Piping in Exposed Areas

Exposed piping shall be installed so as not to diminish exit access widths, corridors, or equipment access. Exposed horizontal piping, including drain piping, shall be installed to provide maximum headroom.

3.5.3 Piping in Finished Areas

In areas with suspended or dropped ceilings and in areas with concealed spaces above the ceiling, piping shall be concealed above ceilings. Piping shall be inspected, tested, and approved before being concealed. Risers and similar vertical runs of piping in finished areas shall be concealed and only installed exposed when piping cannot be concealed if approved by the Fire Protection Specialist. Piping shall be concealed in areas with suspended ceiling and shall be inspected, tested and approved before being concealed

3.5.4 Piping Installation Limitations

Install piping and seismic bracing at such heights and in such a manner so as not to obstruct any portion of windows, doorways, passageways, or lights. Coordinate installation of piping with all trades and field conditions to avoid conflicts and offset piping as required to clear any interferences that may occur. Install piping and seismic bracing at such heights and in such a manner so as not pose hazards to normal walking head heights, impact the minimum clear height requirements or present tripping hazards.

3.5.5 Pipe Joints

Pipe joints shall conform to NFPA 13, except as modified herein. Not more than four threads shall show after joint is made up. Joint compound shall be applied to male threads only. Joints shall be faced true, provided with gaskets and made square and tight. Welded joints will be permitted, only if welding operations are performed as required by NFPA 13 at the Contractor's

fabrication shop, not at the project construction site. Flanged joints shall be provided as required by NFPA 13. Grooved pipe and fittings shall be prepared in accordance with the manufacturer's latest published specification according to pipe material, wall thickness, and size. Grooved couplings, fittings, and grooving tools shall be products of the same manufacturer. For copper tubing, pipe and groove dimensions shall comply with the tolerances specified by the coupling manufacturer. The diameter of grooves made in the field shall be measured using a "go/no-go" gauge, Vernier or dial caliper, narrow-land micrometer, or other method specifically approved by the coupling manufacturer for the intended application. Groove width and dimension of groove from end of pipe shall be measured and recorded for each change in grooving tool setup to verify compliance with coupling manufacturer's tolerances. Grooved joints shall not be used in concealed locations, such as behind solid walls or ceilings, unless an access panel is provided for servicing or adjusting the joint.

3.5.6 Reducers

Reductions in pipe sizes shall be made with one-piece tapered reducing fittings. The use of grooved-end or rubber-gasketed reducing couplings will not be permitted. When standard fittings of the required size are not manufactured, single bushings of the face type will be permitted. Where used, face bushings shall be installed with the outer face flush with the face of the fitting opening being reduced. Bushings shall not be used in elbow fittings, in more than one outlet of a tee, in more than two outlets of a cross, or where the reduction in size is less than 1/2 inch.

3.5.7 Valves

Provide a Control Valve beneath each Low-Level High Expansion Foam System Flow Control Valve in each riser, when more than one Low-Level High Expansion Foam System Flow Control Valve is supplied from the same water supply pipe.

3.5.8 Pipe Supports and Hangers

Installation methods outlined in NFPA 13 are mandatory. Piping shall be installed straight and bear evenly on hangers and supports. .

3.5.9 Pipe and Conduit Penetrations

Cutting of existing or new structural members for passage of pipes, conduits, or for pipe-hanger fastenings will not be permitted.

3.5.9.1 Non-Fire Rated Penetrations in Existing Construction

Pipes that must penetrate existing non-fire rated concrete walls, masonry walls, or concrete floors shall be core-drilled. All other existing wall, ceiling, or floor penetrations shall be provided with a sleeve. The space between the existing wall, ceiling, or floor and the new sleeve shall be patched, sealed, and painted to match the existing finish where the penetration occurs.

3.5.9.2 Fire Rated Penetrations in Existing Construction

Pipes that must penetrate existing fire rated concrete walls, masonry walls, or concrete floors shall be core-drilled. All other existing fire rated

wall, ceiling, or floor penetrations shall be provided with a sleeve. The space between the core-drilled hole or sleeve and the pipe shall be firmly packed with mineral wool insulation. Seal space at both ends of the core-drilled hole or sleeve with plastic waterproof cement which will dry to a firm but pliable mass. Where piping penetrates fire walls, fire partitions, or fire floors the piping shall be provided with a fire seal and fire stopped in accordance with Section 07 84 00 FIRESTOPPING. The space between the existing fire rated wall, ceiling, or floor and the new sleeve shall be patched and sealed to maintain the fire rating of the wall, ceiling, or floor and painted to match the existing finish where the penetration occurs.

3.5.9.3 Non-Fire Rated Penetrations in High Moisture Spaces in Existing Construction

Pipes and conduits that must penetrate existing non-fire rated concrete walls, masonry walls, or concrete floors shall be core-drilled, including the underground supply piping that enters the building from the exterior. All other existing wall, ceiling, roof, or floor penetrations through high moisture areas (showers, coolers, freezers, exterior walls) shall be provided with a sleeve. The space between the core-drilled hole or sleeve and the pipe shall be firmly packed with mineral wool insulation. Seal space at both ends of the core-drilled hole or sleeve with plastic waterproof cement which will dry to a firm but pliable mass. Underground supply piping penetrations that allows water into the building shall be provided with a mechanically adjustable segmented elastomeric seal. The space between the existing wall, ceiling, roof, or floor and the new sleeve shall be patched, sealed, and painted to match the existing finish where the penetration occurs.

3.5.9.4 Non-Fire Rated Penetrations in New Construction

Pipes that must penetrate new non-fire rated concrete walls, masonry walls, concrete floors, shall be core-drilled. The space between the wall, ceiling, or floor and the sleeve shall be patched, sealed, and painted where the penetration occurs.

3.5.9.5 Fire Rated Penetrations in New Construction

Pipes that must penetrate new fire rated concrete walls, masonry walls, or concrete floors shall be core-drilled. All other new fire rated wall, ceiling, or floor penetrations shall be provided with a sleeve. The space between the core-drilled hole or sleeve and the pipe shall be firmly packed with mineral wool insulation. Seal space at both ends of the core-drilled hole or sleeve with plastic waterproof cement which will dry to a firm but pliable mass. Where piping penetrates fire walls, fire partitions, or fire floors the piping shall be provided with a fire seal and fire stopped in accordance with Section 07 84 00 FIRESTOPPING. The space between the new fire rated wall, ceiling, or floor and the new sleeve shall be patched and sealed to maintain the fire rating of the wall, ceiling, or floor and painted to match the existing finish where the penetration occurs.

3.5.9.6 Non-Fire Rated Penetrations in High Moisture Spaces in New Construction

Pipes and conduits that must penetrate new non-fire rated concrete walls, masonry walls, or concrete floors shall be core-drilled, including the underground supply piping that enters the building from the exterior. All

other new wall, ceiling, roof, or floor penetrations through high moisture areas (showers, coolers, freezers, exterior walls) shall be provided with a sleeve. The space between the core-drilled hole or sleeve and the pipe shall be firmly packed with mineral wool insulation. Seal space at both ends of the core-drilled hole or sleeve with plastic waterproof cement which will dry to a firm but pliable mass. Underground supply piping penetrations that allows water into the building shall be provided with a mechanically adjustable segmented elastomeric seal. The space between the new wall, ceiling, roof, or floor and the new sleeve shall be patched, sealed, and painted to match the existing finish where the penetration occurs.

3.5.10 Core-driller Holes

Core-driller holes shall provide required clearance between the pipe or conduit and the core-driller hole per NFPA 13. The installation of a flexible grooved coupling placed within 1 foot of each side of the core-driller hole will be allowable for the installation of an undersized core-drilled hole.

3.5.11 Sleeves

Secure sleeves in position and location during construction. Provide sleeves of sufficient length to pass through entire thickness of wall, ceiling, or floor penetrations. Sleeves shall provide required clearance between the pipe and the sleeve per NFPA 13. The installation of a flexible grooved coupling placed within 1 foot of each side of the penetration will not be an allowable substitution for an undersized sleeve. Sleeves shall be galvanized or black Schedule 40 steel pipe.

3.5.12 Escutcheons

Escutcheons shall be provided for pipe penetration of ceilings and walls. Escutcheons shall be securely fastened to the pipe at surfaces through which piping passes. Escutcheons shall be chromium-plated iron or chromium-plated brass, either one-piece or split-pattern, held in place by internal spring tension or setscrew.

3.5.13 Drains

Main drain piping shall be provided to discharge at a location on the outside of the building. Auxiliary drains shall be provided as required by NFPA 13 and piped to discharge on the outside of the building. Where branch lines terminate at low points and form trapped sections, such branch lines shall be manifolded to a common drain line. All drains installed in finished areas shall be installed in a lockable access panel. All drain discharges shall be provided with a 2 foot by 2 foot concrete splash block to minimize damage to adjacent construction or landscaping during full flow discharge unless discharge is directly over a hard surface such as concrete or asphalt. The Low-Level High Expansion Foam System piping shall be installed to slope back to the Low-Level High Expansion Foam System riser. All auxiliary drains installed in the Hangar Maintenance Area shall be routed to a perimeter wall and routed down to an elevation approximately 5 feet above the finished floor for installation of a valve, hose bib, and cap.

3.5.14 Installation of Fire Department Connection

Fire Department Connection shall be mounted on the exterior wall or adjacent

to and on the sprinkler system side of the backflow preventer when installed in the yard. The Fire Department Connection shall be installed approximately 3 feet above finished grade. The piping between the Fire Department Connection and the check valve shall be provided with an automatic drip in accordance with NFPA 13 and arranged to drain to the outside. The Fire Department Connection shall not serve the Low-Level High Expansion Foam System risers. The automatic ball drip for yard mounted Fire Department Connections shall be provided with a means of access for maintenance and inspections.

3.5.15 Surge Arrestors

At a minimum, provide the following Surge Arresters rated for a minimum working pressure of 275 p.s.i. Increase the minimum capacities listed below, when manufacturer's calculations are required and demonstrate a large capacity.

a. Provide 10 gallon capacity for each dry pipe or Pre-Action system riser located on the riser manifold supplying the Hangar Maintenance Area.

b. Provide 25 gallon capacity for each Low-Level High Expansion Foam/Water riser located on the riser manifold supplying the Hangar Maintenance Area.

c. For each riser room, combine the surge capacity of the risers in the room into a single common Surge Arresters. Where risers feed different fire areas, only use the greatest combined surge capacity from one fire area. Connect this common Surge Arresters to the riser manifold immediately upstream of the protected risers.

d. Coordinate with Surge Arresters required for sprinkler riser and any fire pump.

e. Where Surge Arresters are 100 gallon or larger in capacity, provide floor stands.

Provide each Surge Arrester with an indicating isolation valve to separate it from the system that is electrically supervised in the normally open position. Provide a drain after the isolation valve to relieve pressure from the Surge Arrester during testing and maintenance. When connecting the Surge Arresters to the riser, the use of piping, fittings, and valving smaller than the connecting orifice on the Surge Arrester is not permitted. Do not pressurize Surge Arresters with nitrogen prior to hydrostatic pressure testing of the system.

3.5.16 Low-Level High Expansion Foam System Flow Control Valves

Install the manual release for the Low-Level High Expansion Foam System Flow Control Valve no higher than 5 feet above finished floor. For hydraulic calculations, include the manufacturer’s minimum pressure drop across the Low-Level High Expansion Foam System Flow Control Valve for the features indicated.

Provide pressure gages and other appurtenances at the Low-Level High Expansion Foam System Flow Control Valves as required by NFPA 13.

3.5.17 Isolation Valve and Strainer

Provide an isolation valve and basket strainer in the piping ahead of the Low-Level High Expansion Foam System risers.

3.5.18 Low-Level High Expansion Foam Concentrate Appurtenances

Provide a brass, bronze, or stainless-steel full port quarter turn ball valve with an electrically supervised tamper switch in the Low-Level High Expansion Foam concentrate line. The use of automatically controlled valves in the Low-Level High Expansion Foam concentrate line is prohibited. For testing purposes, equip the concentrate line with fittings and valving to accommodate the connection to an auxiliary tank of alternate Low-Level High Expansion Foam System test foam concentrate. Cap auxiliary tank connection at all times, except when testing.

Provide a 3/4" copper line with ball valve from the fire water supply, that is used for flushing the concentrate line after use. Close Low-Level High Expansion Foam Concentrate Storage Tank shut-off valve prior to opening this valve. After flushing, drain concentrate line through test connection prior to re-opening Low-Level High Expansion Foam Concentrate Storage Tank shut-off valve.

3.6 IDENTIFICATION SIGNS

3.6.1 Identification Signs

Signs shall be affixed to each control valve, inspector test valve, main drain, auxiliary drain, test valve, and similar valves as appropriate or as required by NFPA 13. Signage shall be metal or phenolic having a white background with red letters that is chain hung and permanently affixed to each valve, the use of a "Sharpie" to write information will not be allowed.

3.6.2 Valve Tags

All sprinkler system valves shall be marked with permanent tags indicating "Normally Open" or "Normally Closed".

3.6.3 Hydraulic Placards

Hydraulic design data nameplates shall be permanently affixed to each sprinkler riser as specified in NFPA 13. Signage shall be metal or phenolic having a red background with white letters that is chain hung and permanently affixed to the system riser, the use of a "Sharpie" to write information will not be allowed.

3.6.4 General Information Sign

General Information Sign shall be permanently affixed to each sprinkler riser as specified in NFPA 13. Signage shall be metal or phenolic having a red background with white letters that is chain hung and permanently affixed to the system riser, the use of a "Sharpie" to write information will not be allowed.

3.6.5 Full Forward Flow Test Sign

Full Forward Flow Test Sign shall be metal or phenolic having a red background with white letters that is chain hung and permanently affixed to

the backflow preventer, the use of a "Sharpie" to write information will not be allowed. The Full Forward Flow Test Sign shall indicate the following information:

a. Pressure on the supply side of the backflow preventer assembly prior to testing.

b. Pressure on the discharge side of the backflow preventer assembly prior to testing.

c. Pressure on the supply side of the backflow preventer assembly during testing.

d. Pressure on the discharge side of the backflow preventer assembly during testing.

e. Total pressure drop across the backflow preventer assembly during testing.

f. System test flow rate based upon hydraulic system demands.

g. Manufacturer's documented pressure drop data from the pressure drop flow curve.

3.6.6 List of Sprinkles

Provide a List of Sprinklers in accordance with NFPA 13 to be located in the spare head cabinet.

3.6.7 Surge Arrestor Signs

After Surge Arresters are installed and pressurized in the field with nitrogen per the manufacturer's written directions, provide each Surge Arrester with signage indicating the set pressure of the Surge Arrester. Signage shall be metal or phenolic having a red background with white letters that is chain hung and permanently affixed to each Surge Arrester, the use of a "Sharpie" to write information will not be allowed.

3.6.8 Concentrate Flushing Line Ball Valve Signage

Signage for the Low-Level High Expansion Foam System Concentrate Flushing Line Ball Valve shall be metal or phenolic having a red background with white letters that is chain hung and permanently affixed to thee Flushing Line Ball Valve. Signage shall indicate the following instructions, "Flush concentrate line after discharge or testing", the use of a "Sharpie" to write information will not be allowed.

3.7 UNDERGROUND PIPING INSTALLATION

The fire protection water main shall be laid, and joints anchored, in accordance with NFPA 24. Minimum depth of cover shall be as required by NFPA 24, but no less than 3 feet. The supply line shall terminate inside the building with a flanged piece, the bottom of which shall be set not less than 6 inches above the finished floor. A blind flange shall be installed temporarily on top of the flanged piece to prevent the entrance of foreign matter into the supply line. Anchor the fitting below the building in accordance with NFPA 24. Buried steel components shall be provided with a

corrosion protective coating in accordance with AWWA C203. Piping more than 5 feet outside the building walls shall meet the requirements of Section 33 11 00 WATER DISTRIBUTION.

3.7.1 Underground Piping Restraint

Provide a concrete thrust block at the elbow where the pipe turns up toward the floor. In addition, the elbow shall be anchored by using steel rods from the elbow to the flange above the floor in the vertical direction and by using steel rods from the elbow to a pipe clamp on the horizontal run of piping at a point outside of the building's footing

3.7.2 Pipe and Fittings

Underground piping shall be inspected, tested and approved before burying, covering, or concealing. Fittings shall be provided for changes in direction of piping and for all connections. Changes in piping sizes shall be made using tapered reducing pipe fittings. Bushings shall not be used. Photograph all piping prior to burying, covering, or concealing.

3.7.3 Cleaning of Piping

Interior and ends of underground piping shall be clean and free of any water or foreign material. Piping shall be kept clean during installation by means of plugs or other approved methods. When work is not in progress, open ends of the piping shall be securely closed so that no water or foreign matter will enter the pipes or fittings. Piping shall be inspected before placing in position.

3.7.4 Threaded Connections

Jointing compound for underground pipe threads shall be polytetrafluoroethylene (PTFE) pipe thread tape conforming to ASTM D 3308 and shall be applied to male threads only. Exposed underground ferrous pipe threads shall be provided with one coat of zinc molybdate primer applied to a minimum of dry film thickness of 1 mil.

3.8 EARTHWORK

Earthwork shall be performed in accordance with applicable provisions of Section 31 00 00 EARTHWORK.

3.9 DISINFECTION

After all piping located on the potable side of the backflow preventer has been hydrostatically tested, the potable piping shall be disinfected. The potable piping shall be thoroughly flushed with potable water until all entrained dirt and other foreign materials have been removed before introducing chlorinating material. The chlorinating material shall be hypochlorites or liquid chlorine. Water chlorination procedure shall be in accordance with AWWA C651 and AWWA C652. The chlorinating material shall be fed into the sprinkler piping at a constant rate of 50 parts per million (ppm). A properly adjusted hypochlorite solution injected into the system with a hypochlorinator, or liquid chlorine injected into the system through a solution-fed chlorinator and booster pump shall be used. Chlorination application shall continue until the entire system if filled. The water shall remain in the system for a minimum of 24 hours. Each valve in the

system shall be opened and closed several times to ensure its proper disinfection. Following the 24-hour period, no less than 25 ppm chlorine residual shall remain in the system. The system shall then be flushed with clean water until the residual chlorine is reduced to less than one part per million. Samples of water in disinfected containers for bacterial examination will be taken from several system locations which are approved by the Contracting Officer. Samples shall be tested for total coliform organisms (coliform bacteria, fecal coliform, streptococcal, and other bacteria) in accordance with AWWA 10084. The testing method shall be either the multiple-tube fermentation technique or the membrane-filter technique. The disinfection shall be repeated until tests indicate the absence of coliform organisms (zero mean coliform density per 100 milliliters) in the samples for at least 2 full days. The system will not be accepted until satisfactory bacteriological results have been obtained. After successful completion, verify installation of all sprinklers and plugs and pressure test the system.

3.10 PIPE AND CONDUIT COLOR CODE MARKING

3.10.1 Painting of Pipe

Color code marking of piping shall be as specified in Section 09 90 00 PAINTS AND COATINGS and in UFC 3-600-01.

Paint all exposed, interior, black steel piping the same color as the walls and or ceiling, or a complementing color. Do not paint exposed interior fire protection piping red. Exposed piping in the fire protection equipment room and mechanical rooms may be left unpainted. Stainless steel piping may be cleaned and left unpainted.

Clean, prime, and paint new foam systems including valves, piping, conduit, hangers, miscellaneous metal work, and accessories. Clean the surfaces in accordance with SSPC SP 11. Immediately after cleaning, prime the metal surfaces with one coat of SSPC Paint 25 or SSPC Paint 25 primer applied to a minimum dry film thickness of 1.5 mils. Exercise care to avoid the painting of sprinklers and operating devices. Upon completion of painting, remove materials which were used to protect sprinklers and operating devices while painting is in process. Remove sprinklers and operating devices which have been inadvertently painted and provide new clean sprinklers and operating devices of the proper type. Finish primed surfaces as follows:

3.10.2 Pipe Identification

Mark all exposed interior piping with plastic wrap around-type pipe labels conforming to American Society of Mechanical Engineers/American National Standards Institute (ASME/ANSI) A13.1-1996, Scheme for the Identification of Piping Systems. Indicate the type of fluid carried and direction of flow. Labels that stick-on (adhesive backed) or are held on with straps/adhesive tape are not permitted. Labels are not required on any fire suppression system branch lines regardless of size, or mains and cross-mains less than a nominal 2-1/2 inches. Labels are not required on piping routed below the floor line in trenches or pits. At a minimum, the following labels are required.

a. FIRE PROTECTION WATER: Provide on dedicated potable and non-potable fire protection water supply piping.

b. FOAM CONCENTRATE: Provide on foam concentrate piping.

c. FIRE SPRINKLER: Provide on water-only sprinkler piping.

d. HIGH-EXPANSION FOAM: Provide on Low-Level High Expansion Foam solution piping.

3.10.3 Painting of Conduit

All Low-Level High Expansion Foam System junction/back boxes, covers and couplings shall be factory painted red in unfinished areas (i.e. above ceilings, mechanical rooms, etc.). In finished areas, conduit, junction/back boxes, covers and couplings can be painted to match the room finishing in finished areas. The inside cover of the junction box must be identified as "fire alarm" and the conduit must have painted red bands 3/4 inch wide at 20 foot intervals and on both sides of a floor, wall, or ceiling penetration. Painting shall comply with Section 09 90 00 PAINTS AND COATINGS and UFC 3-600-01 requirements.

3.11 ELECTRICAL WORK

Except as modified herein, electric equipment and wiring shall be in accordance with Sections 28 31 74 INTERIOR FIRE DETECTION AND ALARM SYSTEM and 28 31 76 INTERIOR FIRE ALARM AND MASS NOTIFICATION SYSTEM. Alarm signal wiring connected to the building fire alarm control system shall be in accordance with Sections 28 31 74 INTERIOR FIRE DETECTION AND ALARM SYSTEM and 28 31 76 INTERIOR FIRE ALARM AND MASS NOTIFICATION SYSTEM. All wiring for supervisory and alarm circuits shall be #16 AWG solid copper installed in metallic tubing or conduit. Wiring color code shall remain uniform throughout the system.

3.11.1 Panels and Component Installation

Where panels are located in normally occupied areas, provide recessed panels and combine miscellaneous components in common recessed enclosures to provide a clean installation. Where an auxiliary battery supply is required and cannot be recessed within the wall, locate it remotely in a normally unoccupied area.

Where panels, devices, and appliances are subjected to water spray/runoff under normal operating conditions, provide National Electrical Manufacturers Association (NEMA) 250 Type 4 enclosures and water tight conduit. Regardless of environmental conditions, do not provide openings or conduit entry into the top of the Low-Level High Expansion Foam System Release Panel.

3.11.2 Cabling

Provide Cabling materials under this section as specified in Section 26 20 00 INTERIOR DISTRIBUTION SYSTEM with the additions and modifications specified herein. Cabling size shall be sufficient to prevent voltage drop problems. A fully discharged 24 VOLTS D.C. battery is defined as being at 20.4 Volts D.C. and the minimum voltage required to operate detectors and/or notification appliances is defined as being 16.0 Volts D.C. yielding a maximum voltage drop of 4.4 Volts D.C. in the calculation.

3.11.2.1 Signaling Line Circuit (SLC) Cabling

Signaling Line Circuit (SLC) Cabling shall be a minimum of No. 18 AWG shielded copper cabling installed as Class A in conduit. Provide multiple signaling line circuits for each floor so that the failure of a single Signaling Line Circuit (SLC) shall not cause the facility to lose over 50 percent of the devices installed.

3.11.2.2 Initiating Device Circuit Cabling

Initiating Device Circuit Cabling shall be a minimum of No. 16 AWG copper cabling installed as Class A in conduit.

3.11.2.3 Visual Notification Appliance Cabling

Visual Notification Appliance Cabling shall be a minimum of No. 16 AWG copper cabling installed as Class A in conduit.

3.11.2.4 Audible Notification Appliance Cabling

Audible Notification Appliance Cabling shall be a minimum of No. 16 AWG copper cabling installed as Class A in conduit.

3.11.2.5 Power Cabling

Power Cabling operating at 120 VOLTS A.C. shall be a minimum of No. 12 AWG shielded copper cabling installed in conduit.

3.11.2.6 Power Limited Cabling

Acceptable Power Limited Cabling are FPL, FPLR, or FPLP as appropriate with red colored covering. Nonpower Limited cables shall comply with NFPA 70.

3.11.3 Alarm Wiring

Voltages shall not be mixed in any junction box, housing, or device, except those containing power supplies and control relays.

3.11.4 Conduit not in the Hangar Maintenance Area

Provide all wiring in electrical metallic conceal conduit in finished areas of new construction and wherever practicable in existing construction. The minimum conduit size shall be 3/4 inch. Run conduit or tubing (rigid, IMC, EMT, FMC, etc. as permitted by NFPA 72 and NFPA 70 concealed unless specifically indicated otherwise.

The use of flexible conduit not exceeding a 6 foot length shall be permitted when connecting to devices located on fire suppression equipment such as flow switches, pressure switches, solenoids, and tamper switches.

3.11.5 Conduit and Enclosure Installation in the Hangar Maintenance Area

Provide NEMA 250 Type 4 wall mounted devices and appliances within the Hangar Maintenance Area (including backboxes). Provide watertight conduit and watertight Junction Boxes throughout the Hangar Maintenance Area. Route conduit into the bottom of the backbox for Manual Foam Start Stations, Manual Foam Stop Stations, and Optical Flame Detectors. Provide the low point of each conduit run with a conduit drain on the bottom of the conduit allowing Low-Level High Expansion Foam that collects in the conduit to

drain. Where the conduit is in a hazardously classified area, provide breathers in isolated portions of the conduit (e.g. sealed off from the remaining conduit system). Rate drains and breathers for the electrical (hazard) classification in which they are installed, but not be less than NEMA 250 Type 4. The minimum conduit size shall be 3/4 inch. Run conduit or tubing (rigid, IMC, EMT, FMC, etc. as permitted by NFPA 72 and NFPA 70 concealed unless specifically indicated otherwise.

The use of flexible conduit not exceeding a 6 foot length shall be permitted when connecting to the following devices and appliances.

a. Devices located on fire suppression equipment such as flow switches, pressure switches, solenoids, and tamper switches.

b. Devices and appliances located in removable ceiling tiles.

c. Optical Flame Detectors.

d. Where flexible conduit is specifically noted in UFC 4-021-01.

A maximum of two conduit penetrations are permitted into a secured area. Most areas only require one penetration.

3.11.6 Conductor Terminations

Conductors that are terminated, spliced, or otherwise interrupted in any Cabinet, Enclosure, or Junction Box shall be connected to screw-type terminal blocks. The use of wire nuts or similar devices is prohibited. Wring shall conform to NFPA 70 standards. Each conductor or cable shall be labeled using 3/16” Kroy brand or similar shrink wrap to provide a unique and specific designation. Label shall be computer printed, not hand written. Each Cabinet, Power Supply, and Low-Level High Expansion Foam System Release Panel shall contain a laminated drawing that indicates each conductor, its label, circuit, and terminal. The laminated drawing shall be neat, using 12 point lettering minimum size, and mounted within each Cabinet, Power Supply, and Low-Level High Expansion Foam System Release Panel so that it does not interfere with the wiring or terminals. Maintain existing color code scheme where connecting to existing equipment.

3.11.7 Conduit Separation Distances

Class A looped cabling installed vertically in concealed locations shall be provided with a minimum Conduit Separation Distance of 1 foot. Class A looped cabling installed horizontally in concealed locations shall be provided with a minimum Conduit Separation Distance of 4 feet. Conduit Separation Distances are not required when conduit is installed exposed.

3.11.8 Operating Power

Power shall be 120 Volts A.C. service, transformed through a two winding isolation type transformer and rectified to 24 Volts D.C. for operation of all signal initiating, signal sounding, trouble signal, and actuating (releasing) circuits. Provide secondary D.C. power supply for operation of system in the event of failure of the A.C. supply. Transfer from normal to emergency power or restoration from emergency to normal power shall be fully automatic and shall not cause transmission of a false alarm. Obtain A.C.

operating power for Low-Level High Expansion Foam Release Panel(s), and battery charger as indicated on the drawings.

3.11.9 Surge Protection Devices

Provide Surge Protection Devices to protect all power supply circuits to the Fire Alarm Mass Notification System Control Panel and Low-Level High Expansion Foam Release Panel, including any subpanels such as Remote Power Supplies. Provide Surge Protection Devices to protect all Fire Alarm System circuits leaving or entering the building. Devices mounted on an exterior wall such as wall mounted exterior speakers do not require an Surge Protection Devices when lighting protection is provided on the building. Mount Surge Protection Devices in a separate enclosure, unless the Surge Protection Devices is listed and installed in the Fire Alarm Mass Notification System Control Panel and Low-Level High Expansion Foam Release Panel by the factory. Installing Surge Protection Devices not listed with the Fire Alarm Mass Notification System Control Panel and Low-Level High Expansion Foam Release Panel is prohibited.

3.12 FOAM RELEASING SYSTEM

Install the Low-Level High Expansion Foam Release Panel in a location readily accessible to the emergency responders and maintenance personnel.

For the purposes of this contract, all Det-Tronics installation recommendations shall be considered as mandatory requirements. All devices shall be grounded in strict accordance with the Det-Tronics installation instructions. All circuit wiring shall be installed as part of shielded cable assemblies, in rigid galvanized steel conduit, and grounded in strict conformance with the Det-Tronics installation instructions.

3.12.1 Battery Power Calculations

Verify that Secondary Power capacity exceeds the supervisory and alarm power requirements. The starting voltage for all calculations to size the batteries shall be 24 Volts D.C.

a. Substantiate the battery calculations for alarm and supervisory power requirements. Include ampere-hour demand requirements for each system component and for each panel component in compliance with UL 864.

b. Provide complete battery calculations for both the alarm and supervisory power requirements. Submit ampere-hour requirements for each system component with the calculations.

c. Provide Voltage Drop Calculations to indicate that sufficient voltage is available for proper operation of the system and all components, at the minimum rated voltage of 24 Volts D.C.

d. Use the calculated nominal battery voltage after operation on batteries for the specified time period to perform a voltage drop calculation for circuit containing device and/or appliances remote from the power sources.

e. Include full current draw of solenoid in battery calculations.

3.13 VALVE SUPERVISION

Electrically supervise all normally open and all normally closed control valves. This includes, but is not limited to, providing tamper switches on all manual valves in the foam concentrate system and In-Line Balance Pressure Proportioning System.

Mechanically lock or provide tamper seals such as zip-ties on drains and trim valves, that when opened or closed are detrimental to the operation of the Low-Level High Expansion Foam System such as the shutoff for the foam system pressure switch. Provide all valves with permanent tags indicating "Normally Open" or "Normally Closed".

Provide the manual release valve on the Low-Level High Expansion Foam System riser with the following signage, "OPENING THIS VALVE WILL RELEASE THE FOAM SYSTEM."

All auxiliary drain valves installed in the Hangar Maintenance Area shall be provided with electronic tamper switch. The use of tamper seals such as zip-ties will not be allowed.

3.14 LOW-LEVEL HIGH EXPANSION FOAM SYSTEM BEACONS

Provide blue visual alarm signals (rotating beacons) within the Hangar Maintenance Area to indicate Low-Level High Expansion Foam System activation.

Control the beacon initiation through the Low-Level High Expansion Foam Release Panel. A backup power supply or supervision of the power supply supplying the beacons is not required when supplied from the dedicated emergency panel. Mount beacons 20 - 30 feet above the floor of the Hangar Maintenance Area. Provide a sign next to each blue beacon with a yellow or lime-yellow background matching the manual foam releasing station signage, with "FOAM RELEASE WHEN ILLUMINATED" in red lettering not less than 3 inches high. Blue beacons are in addition to any general fire alarm notification such as the general fire alarm strobes.

a. For single door hangars, provide one beacon approximately centered on each of the three walls.

b. For drive through hangars, provide one beacon 10-25 feet from each corner of the hangar bay.

c. Provide additional beacons where at least one beacon is not viewable from normally occupied areas of the hangar bay.

d. Locate beacons to take into account building construction, aircraft configuration and positioning in the Hangar Maintenance Area.

3.15 LOW-LEVEL HIGH EXPANSION FOAM GENERATOR INSTALLATION

Install Low-Level High Expansion Foam System Generators to provide a minimum 20 inches clearance in front of the generator inlet. The use of all-thread rod for supporting generators is not permitted.

Provide the Low-Level High Expansion Foam System Generator supply piping with a tee or outlet for installation of a valve and a pressure gauge or sampling hose to be utilized during system testing.

Locate Low-Level High Expansion Foam System Generators to discharge within close proximity, but not directly upon the aircraft. When mounting Low-Level High Expansion Foam System Generators in the horizontal position, take into account the throw pattern of the Low-Level High Expansion Foam System Generator discharge. Do not locate the Low-Level High Expansion Foam System Generators where the discharge is obstructed (e.g. structural members) or in areas that obstruct service equipment (e.g. crane travel path). Use the initial discharge from the Low-Level High Expansion Foam System Generators to protect under the aircraft fuselage and underwing area, prior to spreading to the remaining floor area of the Hangar Maintenance Area.

Do not provide Low-Level High Expansion Foam System Generators in locations where the developing foam blanket will block exits from the Hangar Maintenance Area within the first minute of discharge. Blocked exits are defined as an exit that is obstructed by a foam blanket exceeding 5 feet in depth. In small Hangar Maintenance Areas where the entire floor may be covered with foam within the first minute, provide Low-Level High Expansion Foam System Generator locations so exits are one of the last areas blocked.

3.16 PROJECTS LOCATED ON LEWIS MAIN SHALL FOLLOW CHAPTER 6 REQUIREMENTS OF UFC 4-211-01 FOR ARMY SPECIFIC CRITERIA

3.16.1 In-Line Balance Pressure Proportioner Assembly Installation

Install In-Line Balance Pressure Proportions downstream of the Low-Level High Expansion Foam System Flow Control Valve, and ensure that the In-Line Balance Pressure Proportion meets the manufacturer's recommendation with regards to horizontal or vertical installations.

3.16.2 Low-Level High Expansion Foam Concentrate Ball Valve and Strainer

The Low-Level High Expansion Foam Concentrate piping shall be provided with an electronically supervised ball valve and Y style strainer that has a removable strainer downstream of the hydraulic control valve and before the Low-Level High Expansion Foam Proportioner.

3.17 PROJECTS LOCATED ON McCHORD FIELD SHALL FOLLOW CHAPTER 5 REQUIREMENTS OF UFC 4-211-01 FOR AIR FORCE SPECIFIC CRITERIA

3.17.1 Inductor Installation

Provide a single Low-Level High Expansion Foam System Inductor per Low-Level High Expansion Foam System riser meeting the requirements outlined below. Where more than one Low-Level High Expansion Foam System Inductor is used, a maximum of two Low-Level High Expansion Foam System Inductors may take suction from a common concentrate storage tank. Do not supply more than one fire area from a single Low-Level High Expansion Foam System Inductor.

Install inductor in the horizontal piping over the top of the Low-Level High Expansion Foam Concentrate Storage Tank. Provide the minimum straight pipe on both sides of the Low-Level High Expansion Foam System Inductor in accordance with the manufacturer. Install these sections of piping free of elbows, tees, and reducers. Provide liquid filled gauges, located no closer

than 2 feet before and after the Low-Level High Expansion Foam System Inductor.

3.18 MANUAL FOAM START STATION INSTALLATION

Install Manual Foam Start Stations within the Hangar Maintenance Area so they are unobstructed, readily accessible, and located within 10 feet of each required exit or exit access from the Hangar Maintenance Area. Manual Foam Start Stations are not required outside the Hangar Maintenance Area. Maintain a minimum separation distance of 5 feet between general fire alarm Manual Pull Stations (if provided) and the Manual Foam Start Stations. When located at required exit doors, install the Manual Foam Start Station and the fire alarm Manual Pull Station on opposite sides of the door.

Manual Foam Start Stations shall be of a type not subject to operation by jarring or vibration. Mount Manual Foam Start Stations on signage panel as specified herein and detailed in UFC 4-211-01. Manual Foam Start Stations shall be locking type that, when activated, require a key to be reset. Manual Foam Start Stations shall be surface mount. Do not locate addressable monitor modules for the Manual Foam Start Stations in the Hangar Maintenance Area.

Protect foam Manual Foam Start Stations located in the Hangar Maintenance Area from mechanical damage. Provide a clear plastic tamper cover over the Manual Foam Start Stations that when lifted emits an audible alarm. Exception: Audible alarm is not required where a Manual Foam Start Station is installed in a hazardous (classified) location.

Provide additional 1 inch high black block lettering on the sign indicating which zone is served by the Manual Foam Start Station.

3.19 MANUAL FOAM STOP STATION INSTALLATION

Provide Manual Foam Stop Station at each Manual Foam Start Stations. Use Manual Foam Stop Stations in conjunction with valves and equipment that stop the discharge of the Low-Level High Expansion Foam System. Do not locate addressable monitor modules for the Manual Foam Stop Stations in the Hangar Maintenance Area.

Protect Manual Foam Stop Stations located in the Hangar Maintenance Area from mechanical damage. Provide a clear plastic tamper cover (without audible alarm) over the Manual Foam Stop Stations.

3.19.1 Manual Foam Stop Stations in Corridors

Provide a Manual Foam Stop Station in the corridor of each required exit from the Hangar Maintenance Area through the support space. Locate the Manual Foam Start Station on the support side of the door, such that it is within 5 feet of the door and not obstructed when the door is fully open. Provide a 100 square inch fire rated door vision panel in these doors, such that an occupant can view into the Hangar Maintenance Area while operating the Manual Foam Start Station.

3.20 MANUAL FOAM START STATION AND MANUAL FOAM STOP STATION SIGNAGE

Provide two separate but adjacent metal signs a minimum of 24 inches high by 20 inches wide. Provide no more than 12 inches of separation between the two

signs. Do not use the words "FIRE", "ALARM", or "AGENT" on these signs. Do not install backboxes or route conduit in front of sign in a manner that obstructs any lettering.

Provide the sign for the Manual Foam Start Station with a yellow or lime-yellow background with “START FOAM SYSTEM” in red lettering not less than 3 inches high. Locate the Manual Foam Start Station with tamper cover on the lower portion of the sign. Provide the word “START” in minimum 1 inch (25.4 mm) high green lettering placed directly above the manual foam releasing station.

Provide the sign for the Manual Foam Stop Station with a white background and a minimum 1/2 inch wide blue border with “STOP FOAM SYSTEM” in blue lettering not less than 3 inches high. Locate the Manual Foam Stop Stations with tamper cover on the lower left portion of the sign. Provide the word “STOP” in minimum 1 inch high red lettering placed directly above the manual foam stop station.

To the right of the Manual Foam Stop Station button provide the following in minimum 1/2 inch high black lettering "To stop foam system, press and continuously hold STOP button until relieved by emergency responders. There may be up to a 30 second delay after pressing the STOP button before the foam stops".

3.21 OPTICAL FLAME DETECTOR INSTALLATION

Provide a sufficient number of Optical Flame Detectors around the perimeter of the Hangar Maintenance Area, such that all portions of the Hangar Maintenance Area are within the range and cone-of-vision of at least three Optical Flame Detectors. Exception: The area of the Hangar Maintenance Area within 5 feet of the perimeter wall is not required to be within the cone-of-vision of an Optical Flame Detector. No aircraft silhouette will be solely visible from Optical Flame Detectors located on one side of the fuselage. A minimum of two Optical Flame Detectors covering the aircraft silhouette are required on each side of the fuselage.

Provide Optical Flame Detector installation shop drawings directly from the manufacturer.

Angle Optical Flame Detectors and provide blinds (field of view inhibitors) so the cone-of-vision is contained within its designated suppression zone and does not extend more than 5 feet outside the Hangar Maintenance Area, into another fire area such as through a normally open roll-up fire door, or is within the view of hot sources such as radiant heaters.

Locate Optical Flame Detectors at a sufficient distance per the manufacturer's recommendations from sources that may cause false alarms such as welding, solar glare, radiant heaters, aircraft engine exhaust, strobes, hot surfaces and other relevant sources.

Mount Optical Flame Detectors in accordance with their listing at approximately 8 feet above the finished floor of the hangar bay. Do not mount optical detectors in inaccessible locations. Provide Optical Flame Detectors with 5 feet of flexible conduit to allow for minor adjustments during testing or changes in the mission of the Hangar Maintenance Area.

At least three separate dedicated zones shall be provided for reporting the status of the Optical Flame Detector system to the remote location. One dedicated zone for the first Optical Flame Detector in alarm, a second dedicated zone for the second Optical Flame Detector in alarm, and a third dedicated zone for a fault signal in the Optical Flame Detector system.

Calibrate Optical Flame Detectors to operate upon viewing the flame signature of the expected fuel(s) to be in the Hangar Maintenance Area. Use a 2 foot x 2 foot pool fire as the bases to set the sensitivity of the Optical Flame Detectors. Upon the 2 foot x 2 foot pool fire reaching full development, all Optical Flame Detectors within the cone-of-vision are required to activate within 30 seconds.

3.22 SPECIAL INSPECTIONS AND SEISMIC CERTIFICATION

Special Certification Requirements for Designated Seismic Systems Certifications shall be provided in accordance with Section 13.2.2 of ASCE 7 for designated seismic systems assigned to Seismic Design Categories C through F as follows:

a. Active mechanical and electrical equipment that must remain operable following the design earthquake ground motion shall be certified by the manufacturer as operable whereby active parts or energized components shall be certified exclusively on the basis of approved shake table testing in accordance with Section 13.2.5 or experience data in accordance with Section 13.2.6 unless it can be shown that the component is inherently rugged by comparison with similar seismically qualified components.

b. Evidence demonstrating compliance with this requirement shall be submitted for approval to the authority having jurisdiction after review and acceptance by a registered design professional

3.22.1 Statement of Special Inspections

Where special inspection or testing is required by Section 1705 of the IBC, the registered design professional in responsible charge shall prepare a statement of special inspections in accordance with Section 1704.3.1 for submittal by the applicant in accordance with Section 1704.2.3.

Exception: The statement of special inspections is permitted to be prepared by a qualified person approved by the building official for construction not designed by a registered design professional.

3.22.2 Content of Statement of Special Inspections

In accordance with Section 1704.3.1 of the IBC, the statement of special inspections shall identify the following:

a. The materials, systems, components and work required to have special inspection or testing by the building official or by the registered design professional responsible for each portion of the work.

b. The type and extent of each special inspection.

c. The type and extent of each test.

d. Additional requirements for special inspection or testing for seismic or wind resistance as specified in Sections 1705.11, 1705.12 and 1705.13.

e. For each type of special inspection, identification as to whether it will be continuous special inspection, periodic special inspection, or performed in accordance with the notation used in the referenced standard where the inspections are identified.

3.22.3 Designated Seismic Systems

In accordance with Section 1705.12.4 of the IBC, the special inspector shall examine designated seismic systems requiring seismic qualification in accordance with Section 13.2.2 of ASCE 7 and verify that the label, anchorage or mounting conforms to the certificate of compliance.

3.23 TESTING PRIOR TO PRELIMINARY ACCEPTANCE TESTING

3.23.1 Underground Piping

3.23.1.1 Hydrostatic Testing

New underground piping shall be Hydrostatically Tested in accordance with NFPA 24. The allowable leakage shall be measured at the specified test pressure by pumping from a calibrated container. The amount of leakage at the joints shall not exceed 2 quarts per hour per 100 gaskets or joints, regardless of pipe diameter. Hydrostatic Testing shall be in accordance with NFPA 24 at not less than 200 psi or 50 psi in excess of maximum system operating pressure whichever is greater for a 2 hour duration.

3.23.1.2 Flushing

Underground piping shall be Flushed in accordance with NFPA 24. This includes the requirement to flush the lead-in connection to the fire protection system at a minimum flow rate of not less than 10 feet per second or at the maximum sprinkler system water demand, whichever is greater. A copy of the underground flushing certificate shall be provided to the overhead sprinkler system contractor prior to connecting the overhead sprinkler system to the underground supply. If a flushing rate of 10 feet per second cannot be obtained, notify the contracting officer in writing no later than 3 working days after the date of testing. Flushing operations shall continue until water is clear, but not less than 10 minutes.

3.23.1.3 Disinfection

After Hydrostatic Tests and Flushing tests are successfully completed on the underground piping, the underground piping shall be Disinfected.

3.23.1.3.1 Chlorination

The chlorinating material shall be hypochlorites or liquid chlorine. The chlorinating material shall be fed into the underground piping at a constant rate of 50 parts per million (ppm). A properly adjusted hypochlorite solution injected into the system with a hypochlorinator, or liquid chlorine injected into the system through a solution-fed chlorinator and booster pump shall be used. Chlorination application shall continue until the entire underground piping being tested is filled. The water shall

remain in the system for a minimum of 24 hours. Each valve in the system shall be opened and closed several times to ensure its proper disinfection. Following the 24-hour period, no less than 25 ppm chlorine residual shall remain in the system.

3.23.1.3.2 Sample Testing

Samples shall be tested for total coliform organisms (coliform bacteria, fecal coliform, streptococcal, and other bacteria) in accordance with AWWA 10084. The testing method shall be either the multiple-tube fermentation technique or the membrane-filter technique. The disinfection shall be repeated until tests indicate the absence of coliform organisms (zero mean coliform density per 100 milliliters) in the samples for at least 2 full days. The system will not be accepted until satisfactory bacteriological results have been obtained.

3.23.2 Aboveground Piping

3.23.2.1 Hydrostatic Testing

Aboveground piping shall be Hydrostatically Tested in accordance with NFPA 13 at not less than 200 psi or 50 psi in excess of maximum system operating pressure whichever is greater and shall maintain that pressure without loss for a 2 hour duration. There shall be no drop in gauge pressure or visible leakage when the system is subjected to the Hydrostatic Test. The test pressure shall be read from a gauge located at the low elevation point of the system or portion being tested.

3.24 TESTING REPORTS FROM TESTING PRIOR TO PRELIMINARY SYSTEM ACCEPTANCE TESTING

Testing Reports From Testing Prior To Preliminary System Acceptance Testing shall be reviewed and approved by the Fire Protection Specialist, the AFCEC/COSM or USACE fire protection engineer and/or DPW representative.

3.24.1 Underground Piping

Upon completion of specified tests in accordance with NFPA 13 and NFPA 24, the Contractor shall complete the Material & Test Certificates for the underground system as specified in NFPA 13 and NFPA 24. Preliminary Test Report shall be provided by the installing contractor to the government for review and approval. The Contractor's Preliminary Test Report for underground work shall be signed.

3.24.2 Overhead Piping

Upon completion of hydrostatic test in accordance with NFPA 13, the Contractor shall complete the portion of the Material & Test Certificate from NFPA 13 for hydrostatic testing only and retain the Material & Test Certificate for Preliminary Testing. The Material & Test Certificate shall not be submitted to the government for review and approval until the remainder of the Preliminary Testing has been completed.

3.24.3 Fire Pump(s)

Upon completion of Fire Pump(s) start-up testing in accordance with NFPA 20, the Contractor shall complete the Material & Test Certificate from NFPA

20 for fire pump systems and retain the Material & Test Certificate for Preliminary Acceptance Testing. The Material & Test Certificate shall submit to the government for review and approval.

3.24.4 Foam Concentrate Pump(s)

Upon completion of Foam Concentrate Pump(s) start-up testing in accordance with NFPA 11 and NFPA 20. the Contractor shall complete the Material & Test Certificate from NFPA 20 for fire pump systems and retain the Material & Test Certificate for Preliminary Acceptance Testing. The Material & Test Certificate shall submit to the government for review and approval.

3.24.5 Low-Level High Expansion Foam System Generator Residual Pressure Test

Provide a report from the Low-Level High Expansion Foam System Generator residual pressure test for the most remote Low-Level High Expansion Foam System Generator during simultaneous operation of the Low-Level High Expansion Foam System, overhead Hangar Maintenance Area sprinkler system, and exterior hose demand (when applicable). A water only test is not acceptable for this test.

3.24.6 Low-Level High Expansion Foam Generator Residual Pressure Test

Provide a report from the Low-Level High Expansion Foam System Generator residual pressure test for the most remote Low-Level High Expansion Foam System Generator only. A water only test is acceptable for this test. Include verification of the hydraulic performance of the system.

3.24.7 Low-Level High Expansion Foam System Proportioning System

Provide a report from the Low-Level High Expansion Foam System Proportioner System testing demonstrating compliance in accordance with NFPA 11.

3.25 BREAK-IN PERIOD FOR FIRE ALARM MASS NOTIFICATION SYSTEM CONTROL PANEL AND LOW-LEVEL HIGH EXPANSION FOAM SYSTEM RELEASE PANEL

Provide a break-in period of at least 14 consecutive days after the Fire Alarm Mass Notification System Control Panel and Low-Level High Expansion Foam System Release Panel have been enabled, prior to Preliminary System Acceptance Testing.

3.26 SAFETY PLAN

The Low-Level High Expansion Foam System Contractor shall prepare a Safety Plan that is to be followed during Low-Level High Expansion Foam System discharge testing as follows:

a. Provide a safety plan for conducting the Low-Level High Expansion Foam System discharge test including precautions to be taken. The contractor shall remove any mobile / portable equipment from the Hangar Maintenance Area that is not needed for the test.

b. Provide a sketch of safe egress path for persons conducting and witnessing the test to exit the building without entering the foam blanket.

c. Provide protection for the facility, including electrical and mechanical equipment exposed to possible damage during Low-Level High Expansion Foam System discharge tests. This shall include provision of sandbags or similar means for preventing migration of Low-Level High Expansion Foam System discharge into adjacent areas. The Low-Level High Expansion Foam System Contractor shall cover the Hangar Maintenance Area walls and surface mounted equipment with plastic sheeting from the finished floor to 20 feet above the finished floor. Doors into adjacent areas shall be protected to prevent Low-Level High Expansion Foam System discharge leaking into the adjacent areas during the test and subsequent clean-up.

3.27 ENVIRONMENTAL PLAN

The Low-Level High Expansion Foam System Contractor shall prepare an Environmental Plan for containment and disposal of Low-Level High Expansion Foam Concentrate and Low-Level High Expansion Foam Solution discharged during the Low-Level High Expansion Foam System discharge testing as follows:

a. The Environmental Plan shall detail a containment plan on how the Low-Level High Expansion Foam is to be captured during the discharge test and disposed.

b. The Environmental Plan shall detail the means for temporary measures to prevent Low-Level High Expansion Foam System Concentrate or Low-Level High Expansion Foam System discharge from entering storm drains, sanitary sewers, drainage ditches, streams and water courses. Do not allow Low-Level High Expansion Foam System concentrate or Low-Level High Expansion Foam System discharge to come in contact with earth.

g. Contain all Low-Level High Expansion Foam Concentrate or Low-Level High Expansion Foam Solution on paved surfaces.

h. The Environmental Plan shall detail a disposal plan for the collection of all discharged Low-Level High Expansion Foam and all Low-Level High Expansion Foam released during rinsing by flushing water through system piping and disposal at an offsite licensed hazardous material collection site for disposal.

c. Obtain local, state or federal environmental permits as applicable.

3.28 PRELIMINARY ACCEPTANCE TESTING PROCEDURES

Preliminary Acceptance Testing Procedures shall include detailed step-by-step outline for each test and the expected test results to be performed at Preliminary System Acceptance Testing and shall be on its own page in the Preliminary Acceptance Testing Procedures. The Preliminary Acceptance Testing Procedures shall include a table of contents and shall be in a check-off format (pass/fail) with space to add applicable test data. Preliminary Acceptance Testing Procedures shall include the following tests that would be applicable to the project's Scope of Work:

a. Schedule of tests for each day, Example: Day 1, Day 2, Day 3 etc.

b. List of tests to be conducted.

c. Sequence of testing to be conducted.

d. Time estimates for each test.

a. How will the Low-Level High Expansion Foam System discharge test be recorded for future review.

b. Procedures for coordination and communication during the Low-Level High Expansion Foam System discharge test.

e. Blank forms for recording test data for each test. Use NFPA forms when available.

f. Include test procedures from the equipment manufacturer and NFPA in the Preliminary System Acceptance Testing Procedures for the following equipment:

    a. Foam System.

    b. Foam proportioner test.

    c. Low-Level High Expansion Foam System Release Panel.

g. How to simulate maximum overhead wet pipe automatic fire protection sprinkler system demand based on overhead wet pipe automatic fire protection sprinkler system hydraulic calculations.

h. List of equipment required for each test.

i. Calibration certificate for testing equipment

j. What measurements are to be made.

k. How they will be measurements be collected.

l. What tests are to be conducted.

m. What data is to be collected.

n. What are acceptable findings.

o. The corrective action for failure to meet acceptable findings.

p. The equipment required.

q. The personnel required.

r. Notification procedure for notifying contracting officer.

s. List of factory authorized representatives required to be present for Preliminary System Acceptance Testing.

t. Identify testing with the following:

    (1) Backflow Prevention Assembly Forward Flow Test.

    (2) Testing of Alarm Devices.

(3) Main Drain Flow Test.

(4) Integration with the Fire Alarm System.

(5) Integration of test for sprinkler systems.

(6) Fire pump Operation.

(7) Low-Level High Expansion Foam System.

(8) Fire Alarm / Mass Notification System.

(9) Det-Tronics Optical Flame Detectors.

(10) Manual Foam Start Stations.

(11) Manual Foam Stop Stations.

(12) Verify that the fire pumps are adequate to support the fire protection systems.

u. System restoration and flushing procedure after the completion of each acceptance test.

3.29 PRELIMINARY ACCEPTANCE TESTING PREPARATORY MEETING

A Preparatory Meeting may be held at the site to discuss the expectations and requirements of Preliminary Acceptance Testing by reviewing the Preliminary Acceptance Testing Procedures. The necessity of a Preparatory Meeting will be decided upon by the AFCEC/COSM or USACE fire protection engineer and/or DPW representative that would be attending the Preliminary Acceptance Testing. The Preparatory Meeting shall involve the General Contractor, the sprinkler system contractor, and the AFCEC/COSM or USACE fire protection engineer and/or DPW representative.

3.30 PRELIMINARY SYSTEM ACCEPTANCE TESTING FACTORY AUTHORIZED REPRESENTATIVE

The Low-Level High Expansion Foam Release System Contractor shall coordinate to have a Factory Authorized Representative present for Preliminary System Acceptance Testing of the following systems:

a. Fire Pump(s).

b. Fire Alarm Mass Notification System.

c. Foam Proportioning System.

d. Low-Level High Expansion Foam Release Panel.

e. Provide the services of representatives or technicians from the manufacturers of the Low-Level High Expansion Foam System and Low-Level High Expansion Foam System Release Panel experienced in the installation and operation of the type of system being provided, to supervise installation, adjustment, Preliminary System Acceptance Testing, and Final System Acceptance Testing of the system.

f. Det-Tronics System: The representative from the manufacturer of the Optical Flame Detector System shall perform all programming on, and witness and certify acceptance testing (including witnessing pan fire tests on site), on the triple IR detection system. The manufacturer's representative, who programs, and certifies and witness the acceptance tests, shall submit qualifications to the government for approval.

3.31 PRELIMINARY ACCEPTANCE TESTING

Preliminary Acceptance Testing shall be performed in accordance with the approved Preliminary Test Procedures. Furnish instruments and personnel required for preliminary Acceptance Testing. The system, including the underground water mains, and the aboveground piping and system components, shall be tested to assure that equipment and components function as intended. Preliminary Acceptance Testing shall be witnessed by the Fire Protection Specialist, the AFCEC/COSM or USACE fire protection engineer, and/or DPW representative. The DPW representatives shall be invited to attend and witness the Preliminary Acceptance Test, but are not required to be present. Upon completion of specified tests, the Contractor shall complete certificates and documentation as specified in paragraph SUBMITTALS.

3.31.1 Backflow Prevention Assembly Forward Flow Test

Each backflow prevention assembly shall be tested at system flow demand, including all applicable interior hose streams, as specified in NFPA 13. Backflow Preventers shall be tested in accordance with Washington State requirements. The Contractor shall provide all equipment and instruments necessary to conduct a complete forward flow test, including 2.5 inch or 3 inch diameter hoses, playpipe nozzles, Hose Monsters, calibrated pressure gauges, and pitot tube gauge. The Contractor shall provide all necessary supports to safely secure hoses and discharge outlets during the test. Full Forward Backflow Testing information shall include the following information: Pressure on the supply side of the backflow preventer assembly prior to testing, Pressure on the discharge side of the backflow preventer assembly prior to testing, Pressure on the supply side of the backflow preventer assembly during testing, Pressure on the discharge side of the backflow preventer assembly during testing, Total pressure drop across the backflow preventer assembly during testing, System test flow rate based upon hydraulic system demands, and the Manufacturer’s documented pressure drop data from the pressure drop flow curve.

3.31.2 Main Drain Flow Test

Following flushing of the underground piping, a main drain test shall be made to verify the adequacy of the water supply. Static and residual pressures shall be recorded on the certificate specified in paragraph SUBMITTALS. In addition, a main drain test shall be conducted each time after a main control valve is shut and opened.

3.31.3 Integration with the Fire Alarm System Testing

Each normally open control valve shall be closed and each normally closed control valve shall be opened to verify that the Fire Alarm System Control Panel identifies the correct control valve operated.

3.31.4 Trench Drain System Diverter Valve To Underground Containment Tank Testing

Test and verify operation of Trench Drain System Diverter Valve to Underground Containment Tank to underground containment tank. Testing shall include visual inspection of diverter valve positioning, status at diverter valve control panel and visual notification appliances.

3.31.5 Low-Level High Expansion Foam Concentrate System Testing

The Low-Level High Expansion Foam System Contractor shall provide Low-Level High Expansion Foam System concentrate for all testing (Testing Prior to Preliminary System Acceptance Testing, Preliminary System Acceptance Testing, and Final System Acceptance Testing) and any required retesting. Low-Level High Expansion Foam System Concentrate Storage Tank(s) shall be full or not less than the minimum quantity intended to provide the 15 minute operating time, whichever is greater) for all tests. Low-Level High Expansion Foam System concentrate removed from the Low-Level High Expansion Foam System Concentrate Storage Tank for repairs or adjustments shall not be reused unless the concentrate manufacturer certifies the removed concentrate is of the same quality as original new concentrate. Following approval of all testing by the Fire Protection Specialist, the AFCEC/COSM or USACE fire protection engineer and/or DPW representative and completion of all "punch list items", the Low-Level High Expansion Foam System Contractor shall replenish the Low-Level High Expansion Foam System Concentrate Storage Tank to full or not less than the minimum quantity intended to provide the 15 minute operating time, whichever is greater).

Low-Level High Expansion Foam Concentrate System Testing shall be conducted under the supervision of a technical representative employed by the Low-Level High Expansion Foam Concentrate Manufacturer. The complete Low-Level High Expansion Foam Concentrate System shall be adjusted and tested to assure proper operation. Test results, including all pressure settings and readings, shall be recorded on an appropriate test form signed and dated by Low-Level High Expansion Foam manufacturer's representative certifying that the system is in compliance with contract requirements and the manufacturer's recommended practices. Low-Level High Expansion Foam Concentrate System Testing shall include, but not be limited to, the following:

a. Filling the Low-Level High Expansion Foam System Concentrate Storage Tank.

b. Adjustment of Low-Level High Expansion Foam System Proportioners.

c. Collection of Low-Level High Expansion Foam System samples and testing with a conductivity meter to verify proportioning accuracy.

d. Other operational checks recommended by the Low-Level High Expansion Foam System Proportioner Manufacturer.

e. Readings of Low-Level High Expansion Foam in tanks before and after testing shall be taken, along with test time, to determine adequacy of tank for 15 minute supply.

f. Verification of the Low-Level High Expansion Foam Concentrate Storage Tank Leak Detection device.

3.31.6 Projects Located on Lewis Main Shall Follow Chapter 6 Requirements of UFC 4-211-01 for Army Specific Criteria

3.31.6.1 In-Line Balance Pressure Proportioning System Testing

The In-Line Balance Pressure Proportioning System shall be flow tested to determine that proportioning accuracy is within specified limits. The n-Line Balance Pressure Proportioner shall be tested at the design flow rate with the overhead sprinkler flow being simulated using the test header. Low-Level High Expansion Foam samples from n-Line Balance Pressure Proportioner shall be accomplished in accordance with NFPA 11 and the approved test plan. Low-Level High Expansion Foam solution concentrations shall be determined using a refractometer or conductivity measurements and the methods outlined in NFPA 11.

3.31.7 Projects Located on McChord Field Shall Follow Chapter 5 Requirements of UFC 4-211-01 for Air Force Specific Criteria

3.31.7.1 Low-Level High Expansion Foam System Inductor Testing

Each Low-Level High Expansion Foam System Inductor shall be flow tested to determine that proportioning accuracy is within specified limits. Each Low-Level High Expansion Foam System Inductor shall be tested at the design flow rate with the overhead sprinkler flow being simulated using the test header. Low-Level High Expansion Foam samples from each Low-Level High Expansion Foam System Inductor shall be accomplished in accordance with NFPA 11 and the approved test plan. Low-Level High Expansion Foam solution concentrations shall be determined using a refractometer or conductivity measurements and the methods outlined in NFPA 11.

3.31.8 Low-Level High Expansion Foam Release Panel Testing

Every feature and function of the Low-Level High Expansion Foam Release Panel, including initiating, alarm, and actuation systems shall be tested. The Low-Level High Expansion Foam System Contractor and Low-Level High Expansion Foam System Manufacturer's representatives shall conduct these tests under the direction of the Fire Protection Specialist, the AFCEC/COSM or USACE fire protection engineer and/or DPW representative. At a minimum, operation and supervision of the following functions and devices shall be demonstrated:

a. Test secondary power of all Low-Level High Expansion Foam Release System enclosures (Low-Level High Expansion Foam Release Panel and Power Supplies). Verify, by test, the secondary power system (back-up batteries) is capable of operating the system for the time period and in the manner specified for operation. The Low-Level High Expansion Foam Release System battery draw test shall consist of 72 hours of supervisory duration immediately followed by 15 minutes of solenoid operation. Voltage readings of all batteries shall be taken after primary power is disconnected from the system, after 72 hours of supervisory duration, and after the 15 minutes of alarm. The actuating solenoid shall be removed from the Low-Level High Expansion System Flow Control Valve and a bolt/screw driver placed in it to indicate when it receives power. Coordinate this testing with Section 28 31 76 INTERIOR FIRE ALARM AND MASS NOTIFICATION SYSTEM.

b. Verity that all notification appliances (blue beacons) are operational under Alarm operation of the Low-Level High Expansion Foam System.

c. Each circuit shall be tested for open, short, ground conditions by disconnecting a single device from the circuit. If there is a failure with any of these conditions, then the circuit test will be redone by removing each device on the circuit one at a time. While the device is removed during the circuit testing, the cabling shall be verified for Class A installation by verifying operation of the device upstream and downstream of the removed device. For this test, the actuating solenoid shall be removed from the Low-Level High Expansion System Flow Control Valve and a bolt/screw driver placed in it to indicate when it receives power.

d. Verify each Manual Foam Start Stations and Manual Foam Stop Stations reports correctly at the Low-Level High Expansion Foam System Release Panel without foam discharge. For this test, the actuating solenoid shall be removed from the Low-Level High Expansion Foam System Flow Control Valve and a bolt/screw driver placed in it to indicate when it receives power.

e. Verify each Optical Flame Detector Low-Level High Expansion Foam System Release Panel without foam discharge. For this test, the actuating solenoid shall be removed from the Low-Level High Expansion Foam System Flow Control Valve and a bolt/screw driver placed in it to indicate when it receives power.

f. Verify each Solenoid Actuator and Low-Level High Expansion Foam System Flow Control Valve circuit without foam discharge. For this test, the actuating solenoid shall be removed from the Low-Level High Expansion Foam System Flow Control Valve and a bolt/screw driver placed in it to indicate when it receives power.

g. Verify each initiating device is provided with the correct device label that matches "As-Built" floor plan drawings, "As-Built" one-line riser diagram drawings, and reports to the Low-Level High Expansion Foam System Release Panel. This also includes the testing of all monitor, control, relay, and isolation modules.

h. Visually inspect wiring.

i. Test the battery charger output.

j. Measure the current in circuits to ensure there is the calculated spare capacity for the circuits.

k. Measure voltage readings for circuits to ensure that voltage drop is not excessive.

l. Measure the voltage drop at the most remote appliance (based on wire length) on each notification appliance circuit.

m. Verification of enclosure key type and identification.

n. Verification of electrical panel and breaker identified on enclosures match electrical panel and breaker.

o. Verification breaker serving fire alarm equipment is red in color and provided with a red colored means of lockout.

p. Test each initiating device for proper operation and response at the Low-Level High Expansion Foam System Release Panel.

q. Verify that the Low-Level High Expansion Foam System Release Panel is operable under trouble conditions as specified.

r. Verify that the Low-Level High Expansion Foam System Release Panel is operable under trouble conditions as specified.

s. All operational and supervisory functions of the Low-Level High Expansion Foam System Release Panel.

t. Activation of the building Fire Alarm Mass Notification System.

u. Activation of the installation fire alarm reporting system (receipt of fire alarm, trouble, supervisory signals at receiving station).

v. Automatic and manual operation of the Low-Level High Expansion Foam System diverter valve.

w. All items "q" through "u" above tests shall then be repeated with the system on secondary (battery) power only.

x. Annunciator lamp at the Low-Level High Expansion Foam System Release Panel.

y. Test all functions of the Low-Level High Expansion Foam System Release Panel.

z. Verify the proper operation of the Low-Level High Expansion Foam System Disable Switch in the Low-Level High Expansion Foam System Release Panel.

aa. Verify the proper operation of the Low-Level High Expansion Foam System Inhibit Switch for the Low-Level High Expansion Foam System Release Panel.

bb. Verify that all conduits serving Manual Foam Start Stations, Manual Foam Stop Stations, Optical Flame Detector, and blue beacons have a conduit drain on the bottom of low points.

cc. Verify that all Manual Foam Start Stations, Manual Foam Stop Stations, Optical Flame Detector, blue beacons, associated conduit and back boxes, meet watertight and NEMA 250 Type 4 requirements to prevent moisture entry.

dd. Verify whether power supplies to Low-Level High Expansion Foam System Release Panel and power supplies are provided and surge protection.

ee. Verify that wire-nuts are not used in the Low-Level High Expansion Foam System Release system. Random checks by opening junction boxes to verify that screw type terminal blocks have been used throughout will be performed.

ff. Verify that conduit routing for Low-Level High Expansion Foam Release System meets JBLM separation requirements for Class A looped cabling installed vertically of 1 foot and 4 feet for horizontally installed conduits.

gg. Verify that control valves installed in the connection between an alarm initiating device intended to signal activation of a fire suppression system is supervised per NFPA 72. Presence of tamper switches shall be noted in a tamper switch matrix.

3.31.9 Optical Flame Detector Testing

The Low-Level High Expansion Foam System Contractor and the Optical Flame Detector manufacturer's representative shall conduct pan fire testing. Post suitable signs the day prior to and during testing indicating the date and time Optical Flame Detector testing is to occur. The Low-Level High Expansion Foam System Contractor shall protect the building and installed equipment from possible smoke and/or fire damage.

During testing, all suppression systems shall be disconnected. The Low-Level High Expansion Foam System shall be deactivated prior to beginning testing, to prevent accidental discharge. Remove solenoid from the Low-Level High Expansion Foam System Flow Control Valve. Disconnect the signal to the Fire Pump(s) and to the Low-Level High Expansion Foam System Concentrate Pump and Low-Level High Expansion Foam System Jockey Pump (Army projects).

Corrections made to Optical Flame Detectors or controls not responding shall require testing to be repeated as necessary. If the sensitivity of an Optical Flame Detector needs to be changed to pass a test, all other tests, and certifications/qualifications for immunity against false alarms, performed up to that time shall be repeated.

Demonstrate the performance requirements of the Optical Flame Detector coverage has been met through pan fire acceptance testing. Use a clean burning fuel in a 2 foot x 2 foot test pan, all of which is approved and provided by the Optical Flame Detector manufacturer to simulate the expected fuel. Provide a liquid tight welded steel fire pan, with closable lid, and steel sub-frame with rollers/casters to allow for convenient relocation, or equivalent.

At a minimum, place the test fire in each designated aircraft parking position (minimum of three) and at locations selected by the Fire Protection Specialist, the AFCEC/COSM or USACE fire protection engineer, and/or DPW representative.

To pass the pan fire test:

a. All detectors within the cone-of-vision of this test fire shall activate within 30 seconds of fuel ignition.

b. No detectors should active after 30 seconds of full fire development when the test fire is placed 10 feet outside the hangar bay opening.

In addition to the pan fire test, the following tests shall be performed in the hangar bay:

a. Activate each Optical Flame Detector manually (e.g. using a magnet, etc. per manufacturer's recommendation) and individually, and confirm that blue beacons are activated, and confirm that a single Optical Flame Detector does not activate the Low-Level High Expansion Foam System(s).

b. Simultaneously manually activate each Optical Flame Detector with each of the other Optical Flame Detectors individually, and confirm that blue beacons are activated, that the disconnected Low-Level High Expansion Foam System Flow Control Valve solenoid is activated, that the start signal is sent to the Low-Level High Expansion Foam System Concentrate Pump and Fire Pump (Army only), and that the building Fire Alarm Mass Notification System speakers and strobes activate.

c. Ensure that the following outputs from the Optical Flame Detector Controller are received by the Low-Level High Expansion Foam Releasing Panel, Fire Alarm Mass Notification System Control Panel, and Joint Base Lewis-McChord Emergency Command Center (JBECC).

(1) Optical Flame Detector first alarm.

(2) Optical Flame Detector second alarm.

(3) Optical Flame Detector gault.

d. Confirm that the Optical Flame Detector maintenance switch disables the Optical Flame Detector System.

e. Confirm that the Optical Flame Detector Inhibit Switch disables the disables the releasing function of all Optical Flame Detectors in the hangar bay.

f. At each aircraft parking location, and one additional location determined by the Fire Protection Specialist, the AFCEC/COSM or USACE fire protection engineer, and/or DPW representative perform arc welding of plate steel inside the Hangar Maintenance Area, at 125 amps for 5 minutes, and confirm that Optical Flame Detectors do not activate.

g. Perform welding activities in the facility for a maximum of 5 minutes, at one location determined by the Fire Protection Specialist, the AFCEC/COSM or USACE fire protection engineer, and/or DPW representative and confirm there is no feedback through the building ground to the Optical Flame Detector System.

The Low-Level High Expansion Foam System Contractor shall provide written documentation of tests and state that the Optical Flame Detector system is fully functional in accordance with all criteria and shall be responsible for the proper disposal of all fire testing materials.

3.31.10 Low-Level High Expansion Foam System Flow Control Valve Testing

Operate the Low-Level High Expansion Foam System Flow Control Valve(s) and adjust valve open/closure speed and discharge pressure settings as specified. Demonstrate proper pressure settings and valve operation speed by utilizing the nozzle test/drain assembly at the most remote nozzle to record system pressure and by using a Manual Foam Stop Station to stop and restart the Low-Level High Expansion Foam System flow. Seal the pressure regulator,

opening speed, and closure speed valves in their final "set" position with safety wire in the same manner as aviation mechanics seal critical fasteners on powerplants. Wire seals shall prohibit casual movement of valves. Permanently record the final Low-Level High Expansion Foam System Flow Control Valve discharge pressure setting on each valve.

3.31.11 Low-Level High Expansion Foam System Testing

The Low-Level High Expansion Foam System Contractor shall provide all Low-Level High Expansion Foam System Concentrate, gauges, sample collection apparatus, instruments, hose, personnel, elevating platforms, scaffolding, ladders, radios, appliances, instruments, and any other equipment necessary to fulfill Preliminary System Acceptance Testing requirements specified. Deficiencies found shall be corrected and the system retested at no cost to the Government.

The Low-Level High Expansion Foam System Contractor shall provide written documentation of a successful Preliminary System Acceptance Testing for the Optical Flame Detectors, Fire Alarm Mass Notification System, Fire Pump System(s), and Low-Level High Expansion Foam Release System before scheduling the Low-Level High Expansion Foam System Preliminary System Acceptance Testing and state that these systems are fully functional in accordance with all criteria. When all of these systems operate to the satisfaction of the system manufacturer's technical representative and the Fire Protection Specialist, the AFCEC/COSM or USACE fire protection engineer, and/or DPW representative. the Low-Level High Expansion Foam System Contractor shall conduct a full discharge test of each system servicing each separated fire area.

The Fire Protection Specialist, the AFCEC/COSM or USACE fire protection engineer, and/or DPW representative shall be present to witness the Preliminary System Acceptance Test.

The test shall be performed to demonstrate satisfactory performance, proper Low-Level High Expansion Foam concentration, operation of valves, release devices, alarms, interlocks which control the protected areas, and proper Low-Level High Expansion Foam System coverage. These tests shall be conducted by experienced personnel according to the equipment and Low-Level High Expansion Foam System manufacturers' recommendations. Preliminary System Acceptance Testing shall encompass all aspects of system operation and shall including the following the following at a minimum:

a. Conduct a Safety Meeting with attendance required for all witnesses (government and non-government personnel) immediately before Preliminary System Acceptance Discharge Testing.

b. Provide the approved Safety Plan for conducting test of Low-Level High Expansion Foam System(s). Provide a sketch of safe egress path for persons conducting and witnessing the test to exit the building without entering the foam blanket. During the discharge test, no one is permitted on the floor of Hangar Maintenance Area. Persons witnessing the test will be required to view from an elevated position (or equivalent) that does not require them to exit the building through the Low-Level High Expansion Foam. Ensure that there is adequate egress off the elevated position (or equivalent) which complies with the Life Safety Code (NFPA 101). The foam blanket will reach a level above the average person's height causing spatial and acoustic disorientation

possibly resulting in injury. Provide procedures for taking protective measures to avoid damage to life and property during and after the Low-Level High Expansion Foam System discharge test, as described in the applicable paragraph in this specification section.

c. Provide a signup sheet with signature mandatory for all witnesses. No person shall be permitted in the hangar vicinity during the Low-Level High Expansion Foam System discharge test who has not signed the signup sheet and also attended the safety meeting.

d. Have environmental permits in hand and present at the site prior to Preliminary System Acceptance Testing.

e. Provide copies of the Preliminary System Acceptance Testing Procedures that includes the schedule of tests for each day.

f. Preliminary System Acceptance Testing will consist of one hundred percent testing of the Low-Level High Expansion Foam System. Simultaneously conducting more than one test shall not be permitted. The Low-Level High Expansion Foam System Contractor and Low-Level High Expansion Foam System manufacturer's representatives shall conduct Preliminary System Acceptance Testing under the direction of the Fire Protection Specialist, the AFCEC/COSM or USACE fire protection engineer, and/or DPW representative.

g. Provide approved copies of the Preliminary System Acceptance Testing Procedures that are to be followed for each test in addition to recording data obtained during the Low-Level High Expansion Foam System discharge test.

h. The attendee sign-up sheet shall be separate from the Preliminary System Acceptance Testing Procedures.

i. Provide calibration certificates for each instrument and pressure gauge used for Low-Level High Expansion Foam System testing. The testing equipment shall be calibrated within 12 months from the date of testing. Test results obtained shall be considered invalid without current calibration certificates.

j. Have the names and credentials of Low-Level High Expansion Foam System manufacturer representatives and Factory Authorized Representatives that will be conducting the Preliminary System Acceptance Testing in hand and present at the site prior to Preliminary System Acceptance Testing.

k. Provide Low-Level High Expansion Foam Concentrate Storage Tank volume graph indicating volume in gallons corresponding to the level of Low-Level High Expansion Foam Concentrate in foam Low-Level High Expansion Foam System Concentrate Storage Tank. This information will be used to calculate the Low-Level High Expansion Foam System Concentrate volume required to flow the Low-Level High Expansion Foam System for 15 minutes. The foam tank levels shall be checked by the Low-Level High Expansion Foam manufacturer's representative, the Fire Protection Specialist, the AFCEC/COSM or USACE fire protection engineer, and/or DPW representative.

l. Measure Low-Level High Expansion Foam System Concentrate Storage Tank level prior to and after Low-Level High Expansion Foam System discharge test. Calculate Low-Level High Expansion Foam System Concentrate volume of Low-Level High Expansion Foam Concentrate discharged during the 15 minute Low-Level High Expansion Foam System discharge test. The foam tank levels shall be checked by the Low-Level High Expansion Foam manufacturer's representative, the Fire Protection Specialist, the AFCEC/COSM or USACE fire protection engineer, and/or DPW representative.

m. Water only discharge test shall be performed prior to the Low-Level High Expansion Foam System discharge test, with the Low-Level High Expansion Foam Concentrate shutoff/disconnected. Simulate maximum overhead wet pipe automatic fire protection sprinkler system demand and hose stream demands (as applicable) based on overhead wet pipe automatic fire protection sprinkler system hydraulic calculations through the test header. Verify overhead sprinkler system demand by using fire hose, hose monsters, pitot measurements and liquid filled calibrated pressure gages, or equivalent. The overhead Low-Level High Expansion Foam System Generators in the Hangar Maintenance Area should be simultaneously flowing water only. The Fire Protection Specialist, the AFCEC/COSM or USACE fire protection engineer, and/or DPW representative shall witness the flow simulation. When the test is complete, and before the Low-Level High Expansion Foam System discharge test, the Hangar Maintenance Area floor shall be cleared of any water and shall be allowed to dry.

n. Provide liquid filled calibrated pressure gages at each Low-Level High Expansion Foam System Generator and at each Low-Level High Expansion Foam System riser. This information is used to substantiate the hydraulic calculations and to determine actual flow from each Low-Level High Expansion Foam System Generator. It is recommended that sufficient length of hose or tube be provided to take pressure reading at the floor level during the water only discharge test.

o. For projects located on Lewis Main following Chapter 6 Requirements of UFC 4-211-01 for Army Specific Criteria:

(1) Measure the residual pressure at the most remote Low-Level High Expansion Foam System Generator with only the Low-Level High Expansion Foam System operating. Measure the inlet and outlet pressures of each Low-Level High Expansion Foam System Floe Control Valve. A water only test is acceptable for this test. Use this information to verify the hydraulic performance of the Low-Level High Expansion Foam System.

(2) Perform Low-Level High Expansion Foam System discharge test of the combined systems flowing simultaneously (with Low-Level High Expansion Foam System) to verify both 1 minute criteria and 4 minute criteria.

(3) Develop Low-Level High Expansion Foam Spread diagrams if not available from the manufacturer.

(4) Provide values of design parameters including:

1. Design pressure at the base of Low-Level High Expansion Foam System riser.

2. Design pressure at hydraulically most remote Low-Level High Expansion Foam System Generator.

3. Value of maximum fire water demand.

4. Value of maximum Low-Level High Expansion Foam System solution flow.

5. Limits of Low-Level High Expansion Foam System solution concentration in accordance with the UL listing of foam and contract requirements.

(5) Overhead wet pipe automatic fire protection sprinkler system simulated flow test:

1. Provide the number of playpipes used for each the flow rate of the overhead wet pipe automatic fire protection sprinkler system.
2. Indicate the GPM required per playpipe.

3. Indicate pitot pressure required for each playpipe.

(6) Demonstrate that the Low-Level High Expansion Foam System test header isolation valve is working properly.

(7) Test the Low-Level High Expansion Foam System proportioner(s) prior to the Low-Level High Expansion Foam System discharge test at the flow and for a time recommended by the Low-Level High Expansion Foam System manufacturer. The intent is to ensure that the Low-Level High Expansion Foam System Proportioner is performing as intended prior to the Low-Level High Expansion Foam System discharge test. Repeat this test during the Low-Level High Expansion Foam System discharge test.

(8) Provide a camera in ow-Level High Expansion Foam System riser(s), Fire Pump Room, and Fire Suppression Room to record gauge pressures, Fire Pump(s) start time, Low-Level High Expansion Foam System Flow Control Valve(s) opening time, and the Low-Level High Expansion Foam System Control Valve is closed at the end of the Low-Level High Expansion Foam System discharge test.

(9) Verify and record whether a start signal is provided from the Low-Level High Expansion Foam System Release Panel to Fire Pump Controller and Low-Level High Expansion Foam Pump Controller.

(10) Verify that under no circumstances does the Low-Level High Expansion Foam System and overhead wet pipe automatic fire protection sprinkler system pressure exceeds 175 PSI.

(11) Verify that a tamper switch is provided for the Low-Level High Expansion Foam Concentrate shutoff valve. Presence of tamper switches shall be noted in a tamper switch matrix.

p. For projects located on McChord Field following Chapter 5 Requirements of UFC 4-211-01 for Air Force Specific Criteria:

(1) Measure the residual pressure at the most remote Low-Level High Expansion Foam System Generator with only the Low-Level High Expansion Foam System operating. Measure the inlet and outlet pressures of each Low-Level High Expansion Foam System Flow Control Valve and at each Low-Level High Expansion Foam System Inductor. A water only test is acceptable for this test. Use this information to verify the hydraulic performance of the Low-Level High Expansion Foam System.

(2) Provide values of design parameters for the design inlet and discharge pressures at the Low-Level High Expansion Foam System Inductor(s).

(3) Test the Low-Level High Expansion Foam System Inductor(s) prior to the Low-Level High Expansion Foam System discharge test at a flow and for a time recommended by the Low-Level High Expansion Foam System manufacturer. The intent is to ensure that the Low-Level High Expansion Foam System Inductor is performing as intended prior to the Low-Level High Expansion Foam System discharge test. Repeat this test during the Low-Level High Expansion Foam System discharge test.

(4) Record gauge pressures at the inlet and outlet of the Low-Level High Expansion Foam System Inductor.

q. The Preliminary System Acceptance discharge test and any re-test will begin with the system in normal configuration; no recharging of the system piping is allowed. Hangar doors will be closed and will remain closed until the hangar is released to the Low-Level High Expansion Foam System Contractor's clean-up team.

r. Mark each aircraft outline (silhouette) on the floor with bright red tape. This is to determine the amount of time required to cover the projected aircraft outlines (silhouettes) from the activation of a Manual Foam Start Station. Provide additional bright red tape in each aircraft outline (silhouette) as required to subdivide each aircraft outline (silhouette) into ten equal area sections to assist in determining the Low-Level High Expansion Foam System coverage percent after 60 seconds of Low-Level High Expansion Foam System activation and for review of the video. Ensure that the red tape can be readily seen in the video prior to starting the Low-Level High Expansion Foam System discharge test.

s. Mark the perimeter walls of the Hangar Maintenance Area with bright red tape at 3.28 feet (1 meter) above finished floor. In lieu of marking the perimeter walls, provide 3.28 feet (1 meter) tall cones or posts placed around the perimeter of the Hangar maintenance Area, along the projected aircraft outlines (silhouettes), and within the projected aircraft outlines (silhouettes). Record the time for the Low-Level High Expansion Foam to reach a level of 3.28 feet (1 meter) in depth throughout the hangar, which shall not exceed 4 minutes from time of Low-Level High Expansion Foam System activation.

t. Low-Level High Expansion Foam shall not fall from the Low-Level High Expansion Foam System Generators within each projected aircraft outline (silhouette).

u. The Low-Level High Expansion Foam System discharge test is to begin with the fire pump(s) not running.

v. Once the Low-Level High Expansion Foam System test director indicates the 3.28 feet (1 meter) depth has been achieved, depress a Manual Foam Stop Station on a Manual Foam Stop Station remote to the Manual Foam Start Station used to initiate the Low-Level High Expansion Foam System. The Low-Level High Expansion Foam System Flow Control Valve shall close not faster than 5 seconds and not more than 15 seconds. Upon release of the Manual Foam Stop Station, the Low-Level High Expansion Foam System Flow Control Valve shall completely open within 5 seconds.

w. Designate a person to stop the Low-Level High Expansion Foam System discharge test (e.g. by appropriate means such as closing the manual control valve, etc.) based on radio communications, etc. when receiving notification that the 3.28 feet (1 meter) depth has been achieved or in case of an emergency. In case of a loss of communication, this person should be given instructions that the Low-Level High Expansion Foam System discharge test should be stopped no later than 4 minutes after the Low-Level High Expansion Foam System discharge test has commence

x. The Low-Level High Expansion Foam System discharge test shall not be conducted with standing water on the Hangar Maintenance Area floor. Crews and equipment shall be provided to remove standing water. The Hangar Maintenance Area floor shall not be wet at the start of the test.

y. Provide equipment used for the test such as radios, stop watch, foam fill pump, Low-Level High Expansion Foam Concentrate to top the Low-Level High Expansion Foam Concentrate Storage Tank, lifts, ladders, extension pole, air horn, smoke generator, manometer, sufficient cameras and tripods etc.

z. The designated person to start and stop the Low-Level High Expansion Foam System discharge test shall be in charge of operating an air horn of sufficient loudness to be heard on the video recording and by all witnesses throughout the Hangar Maintenance Area, Fire Pump Room and Fire Suppression Rooms via hand-held radios. The air horn will be used to establish the start time in the video to evaluate the Low-Level High Expansion Foam System coverage of the projected aircraft outlines (silhouettes) in 1 minute and the foam depth of 3.28 feet (1 meter) in 4 minutes. The air horn shall be sounded at the following times:

(1) 5 minute mark prior to starting the Low-Level High Expansion Foam System discharge test.

(2) 1 minute mark prior to starting the Low-Level High Expansion Foam System discharge test.

(3) 30 second mark prior to starting the Low-Level High Expansion Foam System discharge test.

(4) At the time the Manual Foam Start Station is activated to start the Low-Level High Expansion Foam System discharge test.

(5) 1 minute mark after starting the Low-Level High Expansion Foam System discharge test.

(6) At conclusion of the Low-Level High Expansion Foam System discharge test defined by the following, whichever is first:

1. The depth of Low-Level High Expansion Foam achieves a depth of 3.28 feet (1 meter) throughout the Hangar Maintenance Area.

2. 4 minute mark after starting the Low-Level High Expansion Foam System discharge test.

aa. A government witness at the Manual Foam Start Station shall radio a government witness at the Low-Level High Expansion Foam System riser(s), Fire Pump Room, and Fire Suppression Room at each of the timed milestones listed above, so that the government witnesses at the Low-Level High Expansion Foam System riser(s), Fire Pump Room, and Fire Suppression Room can provide a visible and audible signal for the recording cameras.

bb. The government witness in the Fire Suppression Room shall record how many seconds after the start time of the Low-Level High Expansion Foam System discharge test before the overhead wet pipe automatic fire protection sprinkler system test header valve is fully open.

cc. Provide an adequate number of cameras in the Hangar Maintenance Area to facilitate complete coverage without panning across the Hangar Maintenance Area floor. At least one video view will be from a ceiling mounted camera. Use stationary overhead cameras with a full view of the projected aircraft outline (silhouette) during the Low-Level High Expansion Foam System discharge test, to use for later determination of the percent projected aircraft outlines (silhouettes) coverage at 60 seconds and 3.28 feet (1 meter) depth in 4 minutes. Cameras shall have a full view of the bright red tape on the floor to outline the projected aircraft outlines (silhouettes), and additional bright red tape on the floor to subdivide the projected aircraft outlines (silhouettes) into ten equal area sections. The subdivision will assist in reviewing the video for percent aircraft outlines (silhouettes) coverage with foam at 60 seconds.

dd. Video of Low-Level High Expansion Foam System discharge testing shall be in disc (or digital) format that records the date and time-lapse in seconds on the video, from start to finish of each portion of the test. The Low-Level High Expansion Foam System discharge test will most likely require several cameras for complete documentation. The cameras filming the Low-Level High Expansion Foam System discharge on the Hangar Maintenance Area floor cannot pan. Four copies of the disc (or digital) formatted video shall be submitted and approved before the system will be considered accepted.

ee. Verify that surge arrestor pre-charge pressure is indicated on surge arresters.

ff. Verify that a pressure gauge with isolation valve is provided at surge arresters to monitor pressure and record pressure indicated on the pressure gauge.

gg. Demonstrate the performance criteria for opening the Low-Level High Expansion Foam System Flow Control Valve is met upon actuation of the Manual Foam Start Station and closing the Low-Level High Expansion Foam System Flow Control Valve is met upon actuation of the Manual Foam Stop Station and reopening of the Low-Level High Expansion Foam System Flow Control Valve is met upon releasing the Manual Foam Stop Station. A water only test is acceptable for this test.

hh. Verify that any and all valves in the system that when closed will disrupt or stop the flow of Low-Level High Expansion Foam Solution, Low-Level High Expansion Foam Concentrate, water, or that will disrupt or prevent an alarm signal are electronically supervised. Presence of tamper switches shall be noted in a tamper switch matrix.

ii. Verify that all pipe and conduit penetrations are sealed with listed fire proofing material. Provide catalog cut of fireproofing material.

jj. Verify that all fire protection pipes, valves, test headers, FDC are labeled and that labels have been adapted to properly indicate flow direction.

kk. Ensure that a sufficient quantity of Low-Level High Expansion Foam is available to top the Low-Level High Expansion Foam Concentrate Storage Tank at the end of Low-Level High Expansion Foam System discharge testing.

ll. Provide a Low-Level High Expansion Foam Concentrate Pump for filling the Low-Level High Expansion Foam Concentrate Storage Tank from a reserve Low-Level High Expansion Foam drum.

mm. The purpose of the Preliminary System Acceptance Testing is to ensure that the Final System Acceptance Testing is conducted flawlessly. It is the Low-Level High Expansion Foam System Contractor's responsibility to perform tests and make repairs to the systems until they can conduct a "perfect" Preliminary System Acceptance Test completely and without incident or failure. If a failure is noted during any portion of the Preliminary System Acceptance Testing, the item shall be corrected and then the entire Preliminary System Acceptance Testing process shall be repeated until it is completed flawlessly from start to finish. Only after a successful Preliminary System Acceptance Test is completed and the report reviewed and accepted by government can a Final System Acceptance Testing be scheduled.

3.32 PRELIMINARY SYSTEM ACCEPTANCE TESTING POST-DISCHARGE TEST REQUIREMENTS

The following tasks shall be conducted at completion of Preliminary System Acceptance Testing discharge testing.

a. Following the successful completion of Preliminary System Acceptance Testing, the Low-Level High Expansion Foam System Contractor shall flush all piping carrying Low-Level High Expansion Foam Solution with fresh water. Rinse all equipment and building surfaces exposed to Low-Level High Expansion Foam discharge with fresh water.

b. The Low-Level High Expansion Foam System Contractor shall completely drain the piping between the Low-Level High Expansion Foam System Flow Control Valves and each Low-Level High Expansion Foam System Generator leaving the piping dry.

c. The Low-Level High Expansion Foam System Contractor shall remove from the site the Low-Level High Expansion Foam Concentrate and Low-Level High Expansion Foam Solution collected during Low-Level High Expansion Foam System discharge testing and flushing of piping as indicated on the approved Environmental Plan for containment and disposal.

d. Contractor shall replenish Low-Level High Expansion Foam Concentrate consumed during the Preliminary System Acceptance Testing. All fire protection systems shall be returned to automatic operation and the facility restored to operational capability.

3.33 PRELIMINARY ACCEPTANCE TESTING REPORTS

Upon completion of specified Preliminary System Acceptance Testing, the Contractor shall provide Preliminary System Acceptance Testing Reports for all fire protection related specification sections in electronic format with bookmarks for approval prior to scheduling final acceptance test. The AFCEC/COSM or USACE fire protection engineer, and/or DPW representative requires 2 weeks to review a completed Preliminary System Acceptance Testing Report. After the review and approval of the completed Preliminary System Acceptance Testing Report, the Final System Acceptance Testing will be scheduled no sooner than two weeks after approval. The Preliminary System Acceptance Testing Reports shall include the following at a minimum:

a. Copies of the approved Preliminary System Acceptance Testing Procedures for each fire protection related specification section.

b. Copies of forms that record test readings / data obtained during Preliminary System Acceptance Testing.

c. Copies of credentials of manufacturer's representatives who was actually present at the site.

d. An overview of all testing performed.

e. Identify items needing corrections prior to Final Acceptance Testing.

f. Video recordings of the Preliminary System Acceptance Testing discharge test.

g. All test reports required by the project specifications and NFPA codes such as NFPA 11, NFPA 13, NFPA 20, NFPA 24, NFPA 72 etc.

h. Test report of Low-Level High Expansion Foam Concentrate Proportioning System.

(1) Report shall include all pressure readings and settings of system components.

(2) Report shall include conductivity or refractive index readings for Low-Level High Expansion Foam samples taken from the Low-

Level High Expansion Foam Proportioner(s).

(3) Report shall be signed by the factory-trained technical representative the foam concentrate manufacturer.

i. Test report of the Low-Level High Expansion Foam System Release Panel and initiating and indicating devices.

(1) Report shall include a unique identifier for each device with an indication of test results.

(2) Report shall be signed by the factory-trained technician employed by the Low-Level High Expansion Foam System Release Panel manufacturer.

j. Submit pressure discharge graphs or tables showing pressure discharge relationship for Low-Level High Expansion Foam System Generators.

3.33.1 Fire Protection Specialist Preliminary Acceptance Testing Report

The Fire Protection Specialist shall generate a Preliminary Acceptance Testing Report (on company letterhead) summarizing all Preliminary Acceptance Testing performed along with the test results and a summary of items requiring corrections from Preliminary Acceptance Testing prior to Final Acceptance Testing. The Fire Protection Specialist Preliminary Test Report shall be addressed to and sent to the General Contractor for corrections and to the AFCEC/COSM or USACE fire protection engineer, and/or DPW representative for their records.

3.34 FINAL ACCEPTANCE TESTING PROCEDURES

Final Acceptance Testing Procedures shall include detailed step-by-step outline for each test and the expected test results to be performed at Final System Acceptance Testing and shall be on its own page in the Final Acceptance Testing Procedures. The Final Acceptance Testing Procedures shall include a table of contents and shall be in a check-off format (pass/fail) with space to add applicable test data. Final Acceptance Testing Procedures shall include the following tests that would be applicable to the project's Scope of Work:

a. Schedule of tests for each day, Example: Day 1, Day 2, Day 3 etc.

b. List of tests to be conducted.

c. Sequence of testing to be conducted.

d. Time estimates for each test.

c. How will the Low-Level High Expansion Foam System discharge test be recorded for future review.

d. Procedures for coordination and communication during the Low-Level High Expansion Foam System discharge test.

e. Blank forms for recording test data for each test. Use NFPA forms when available.

f. Include test procedures from the equipment manufacturer and NFPA in the Final System Acceptance Testing Procedures for the following equipment:

   a. Foam System.

   b. Foam proportioner test.

   c. Low-Level High Expansion Foam System Release Panel.

g. How to simulate maximum overhead wet pipe automatic fire protection sprinkler system demand based on overhead wet pipe automatic fire protection sprinkler system hydraulic calculations.

h. List of equipment required for each test.

i. Calibration certificate for testing equipment

j. What measurements are to be made.

k. How they will be measurements be collected.

l. What tests are to be conducted.

m. What data is to be collected.

n. What are acceptable findings.

o. The corrective action for failure to meet acceptable findings.

p. The equipment required.

q. The personnel required.

r. Notification procedure for notifying contracting officer.

s. List of factory authorized representatives required to be present for Final System Acceptance Testing.

t. Identify testing with the following:

   (1) Testing of Alarm Devices.

   (2) Main Drain Flow Test.

   (3) Integration with the Fire Alarm System.

   (4) Integration of test for sprinkler systems.

   (5) Fire pump Operation.

   (6) Low-Level High Expansion Foam System.

   (7) Fire Alarm / Mass Notification System.

   (8) Det-Tronics Optical Flame Detectors.

   (9) Manual Foam Start Stations.

(10) Manual Foam Stop Stations.

(11) Verify that the fire pumps are adequate to support the fire protection systems.

u. System restoration and flushing procedure after the completion of each acceptance test.

3.35 FINAL ACCEPTANCE TESTING PREPARATORY MEETING

A Preparatory Meeting may be held at the site to discuss the expectations and requirements of Final Acceptance Testing by reviewing the Final Acceptance Testing Procedures. The necessity of a Preparatory Meeting will be decided upon by the AFCEC/COSM or USACE fire protection engineer and/or DPW representative that would be attending the Final Acceptance Testing. The Preparatory Meeting shall involve the General Contractor, the sprinkler system contractor, and the AFCEC/COSM or USACE fire protection engineer and/or DPW representative.

3.36 FINAL SYSTEM ACCEPTANCE TESTING FACTORY AUTHORIZED REPRESENTATIVE

The Low-Level High Expansion Foam Release System Contractor shall coordinate to have a Factory Authorized Representative present for Final System Acceptance Testing of the following systems:

a. Fire Pump(s).

b. Fire Alarm Mass Notification System.

c. Foam Proportioning System.

d. Low-Level High Expansion Foam Release Panel.

e. Provide the services of representatives or technicians from the manufacturers of the Low-Level High Expansion Foam System and Low-Level High Expansion Foam System Release Panel experienced in the installation and operation of the type of system being provided, to supervise installation, adjustment, Preliminary System Acceptance Testing, and Final System Acceptance Testing of the system.

f. Det-Tronics System: The representative from the manufacturer of the Optical Flame Detector System shall perform all programming on, and witness and certify acceptance testing (including witnessing pan fire tests on site), on the triple IR detection system. The manufacturer's representative, who programs, and certifies and witness the acceptance tests, shall submit qualifications to the government for approval.

3.37 FINAL ACCEPTANCE TESTING

Final Acceptance Testing shall be performed in accordance with the approved Final Test Procedures. Furnish instruments and personnel required for Final Acceptance Testing. The system, including the underground water mains, and the aboveground piping and system components, shall be tested to assure that equipment and components function as intended. Final Acceptance Testing shall be witnessed by the Fire Protection Specialist, the AFCEC/COSM or USACE fire protection engineer, and/or DPW representative. The DPW

representatives shall be invited to attend and witness the Final Acceptance Test, but are not required to be present. Upon completion of specified tests, the Contractor shall complete certificates and documentation as specified in paragraph SUBMITTALS.

3.37.1 Main Drain Flow Test

Following flushing of the underground piping, a main drain test shall be made to verify the adequacy of the water supply. Static and residual pressures shall be recorded on the certificate specified in paragraph SUBMITTALS. In addition, a main drain test shall be conducted each time after a main control valve is shut and opened.

3.37.2 Integration with the Fire Alarm System Testing

Each normally open control valve shall be closed and each normally closed control valve shall be opened to verify that the Fire Alarm System Control Panel identifies the correct control valve operated.

3.37.3 Trench Drain System Diverter Valve To Underground Containment Tank Testing

Test and verify operation of Trench Drain System Diverter Valve to Underground Containment Tank to underground containment tank. Testing shall include visual inspection of diverter valve positioning, status at diverter valve control panel and visual notification appliances.

3.37.4 Low-Level High Expansion Foam Concentrate System Testing

The Low-Level High Expansion Foam System Contractor shall provide Low-Level High Expansion Foam System concentrate for all testing (Testing Prior to Final System Acceptance Testing, Final System Acceptance Testing, and Final System Acceptance Testing) and any required retesting. Low-Level High Expansion Foam System Concentrate Storage Tank(s) shall be full or not less than the minimum quantity intended to provide the 15 minute operating time, whichever is greater) for all tests. Low-Level High Expansion Foam System concentrate removed from the Low-Level High Expansion Foam System Concentrate Storage Tank for repairs or adjustments shall not be reused unless the concentrate manufacturer certifies the removed concentrate is of the same quality as original new concentrate. Following approval of all testing by the Fire Protection Specialist, the AFCEC/COSM or USACE fire protection engineer and/or DPW representative and completion of all "punch list items", the Low-Level High Expansion Foam System Contractor shall replenish the Low-Level High Expansion Foam System Concentrate Storage Tank to full or not less than the minimum quantity intended to provide the 15 minute operating time, whichever is greater).

Low-Level High Expansion Foam Concentrate System Testing shall be conducted under the supervision of a technical representative employed by the Low-Level High Expansion Foam Concentrate Manufacturer. The complete Low-Level High Expansion Foam Concentrate System shall be adjusted and tested to assure proper operation. Test results, including all pressure settings and readings, shall be recorded on an appropriate test form signed and dated by Low-Level High Expansion Foam manufacturer's representative certifying that the system is in compliance with contract requirements and the manufacturer's recommended practices. Low-Level High Expansion Foam

Concentrate System Testing shall include, but not be limited to, the following:

a. Filling the Low-Level High Expansion Foam System Concentrate Storage Tank.

b. Adjustment of Low-Level High Expansion Foam System Proportioners.

c. Collection of Low-Level High Expansion Foam System samples and testing with a conductivity meter to verify proportioning accuracy.

d. Other operational checks recommended by the Low-Level High Expansion Foam System Proportioner Manufacturer.

e. Readings of Low-Level High Expansion Foam in tanks before and after testing shall be taken, along with test time, to determine adequacy of tank for 15 minute supply.

f. Verification of the Low-Level High Expansion Foam Concentrate Storage Tank Leak Detection device.

3.37.5 Projects Located on Lewis Main Shall Follow Chapter 6 Requirements of UFC 4-211-01 for Army Specific Criteria

3.37.5.1 In-Line Balance Pressure Proportioning System Testing

The In-Line Balance Pressure Proportioning System shall be flow tested to determine that proportioning accuracy is within specified limits. The n-Line Balance Pressure Proportioner shall be tested at the design flow rate with the overhead sprinkler flow being simulated using the test header. Low-Level High Expansion Foam samples from n-Line Balance Pressure Proportioner shall be accomplished in accordance with NFPA 11 and the approved test plan. Low-Level High Expansion Foam solution concentrations shall be determined using a refractometer or conductivity measurements and the methods outlined in NFPA 11.

3.37.6 Projects Located on McChord Field Shall Follow Chapter 5 Requirements of UFC 4-211-01 for Air Force Specific Criteria

3.37.6.1 Low-Level High Expansion Foam System Inductor Testing

Each Low-Level High Expansion Foam System Inductor shall be flow tested to determine that proportioning accuracy is within specified limits. Each Low-Level High Expansion Foam System Inductor shall be tested at the design flow rate with the overhead sprinkler flow being simulated using the test header. Low-Level High Expansion Foam samples from each Low-Level High Expansion Foam System Inductor shall be accomplished in accordance with NFPA 11 and the approved test plan. Low-Level High Expansion Foam solution concentrations shall be determined using a refractometer or conductivity measurements and the methods outlined in NFPA 11.

3.37.7 Low-Level High Expansion Foam Release Panel Testing

Every feature and function of the Low-Level High Expansion Foam Release Panel, including initiating, alarm, and actuation systems shall be tested. The Low-Level High Expansion Foam System Contractor and Low-Level High Expansion Foam System Manufacturer's representatives shall conduct these

tests under the direction of the Fire Protection Specialist, the AFCEC/COSM or USACE fire protection engineer and/or DPW representative. At a minimum, operation and supervision of the following functions and devices shall be demonstrated:

a. Test secondary power of all Low-Level High Expansion Foam Release System enclosures (Low-Level High Expansion Foam Release Panel and Power Supplies). Verify, by test, the secondary power system (back-up batteries) is capable of operating the system for the time period and in the manner specified for operation. The Low-Level High Expansion Foam Release System battery draw test shall consist of 72 hours of supervisory duration immediately followed by 15 minutes of solenoid operation. Voltage readings of all batteries shall be taken after primary power is disconnected from the system, after 72 hours of supervisory duration, and after the 15 minutes of alarm. The actuating solenoid shall be removed from the Low-Level High Expansion System Flow Control Valve and a bolt/screw driver placed in it to indicate when it receives power. Coordinate this testing with Section 28 31 76 INTERIOR FIRE ALARM AND MASS NOTIFICATION SYSTEM.

b. Verity that all notification appliances (blue beacons) are operational under Alarm operation of the Low-Level High Expansion Foam System.

c. Each circuit shall be tested for open, short, ground conditions by disconnecting a single device from the circuit. If there is a failure with any of these conditions, then the circuit test will be redone by removing each device on the circuit one at a time. While the device is removed during the circuit testing, the cabling shall be verified for Class A installation by verifying operation of the device upstream and downstream of the removed device. For this test, the actuating solenoid shall be removed from the Low-Level High Expansion System Flow Control Valve and a bolt/screw driver placed in it to indicate when it receives power.

d. Verify each Manual Foam Start Stations and Manual Foam Stop Stations reports correctly at the Low-Level High Expansion Foam System Release Panel without foam discharge. For this test, the actuating solenoid shall be removed from the Low-Level High Expansion Foam System Flow Control Valve and a bolt/screw driver placed in it to indicate when it receives power.

e. Verify each Optical Flame Detector Low-Level High Expansion Foam System Release Panel without foam discharge. For this test, the actuating solenoid shall be removed from the Low-Level High Expansion Foam System Flow Control Valve and a bolt/screw driver placed in it to indicate when it receives power.

f. Verify each Solenoid Actuator and Low-Level High Expansion Foam System Flow Control Valve circuit without foam discharge. For this test, the actuating solenoid shall be removed from the Low-Level High Expansion Foam System Flow Control Valve and a bolt/screw driver placed in it to indicate when it receives power.

g. Verify each initiating device is provided with the correct device label that matches "As-Built" floor plan drawings, "As-Built" one-line riser diagram drawings, and reports to the Low-Level High Expansion Foam

System Release Panel. This also includes the testing of all monitor, control, relay, and isolation modules.

h. Visually inspect wiring.

i. Test the battery charger output.

j. Measure the current in circuits to ensure there is the calculated spare capacity for the circuits.

k. Measure voltage readings for circuits to ensure that voltage drop is not excessive.

l. Measure the voltage drop at the most remote appliance (based on wire length) on each notification appliance circuit.

m. Verification of enclosure key type and identification.

n. Verification of electrical panel and breaker identified on enclosures match electrical panel and breaker.

o. Verification breaker serving fire alarm equipment is red in color and provided with a red colored means of lockout.

p. Test each initiating device for proper operation and response at the Low-Level High Expansion Foam System Release Panel.

q. Verify that the Low-Level High Expansion Foam System Release Panel is operable under trouble conditions as specified.

r. Verify that the Low-Level High Expansion Foam System Release Panel is operable under trouble conditions as specified.

s. All operational and supervisory functions of the Low-Level High Expansion Foam System Release Panel.

t. Activation of the building Fire Alarm Mass Notification System.

u. Activation of the installation fire alarm reporting system (receipt of fire alarm, trouble, supervisory signals at receiving station).

v. Automatic and manual operation of the Low-Level High Expansion Foam System diverter valve.

w. All items "q" through "u" above tests shall then be repeated with the system on secondary (battery) power only.

x. Annunciator lamp at the Low-Level High Expansion Foam System Release Panel.

y. Test all functions of the Low-Level High Expansion Foam System Release Panel.

z. Verify the proper operation of the Low-Level High Expansion Foam System Disable Switch in the Low-Level High Expansion Foam System Release Panel.

aa. Verify the proper operation of the Low-Level High Expansion Foam System Inhibit Switch for the Low-Level High Expansion Foam System Release Panel.

bb. Verify that all conduits serving Manual Foam Start Stations, Manual Foam Stop Stations, Optical Flame Detector, and blue beacons have a conduit drain on the bottom of low points.

cc. Verify that all Manual Foam Start Stations, Manual Foam Stop Stations, Optical Flame Detector, blue beacons, associated conduit and back boxes, meet watertight and NEMA 250 Type 4 requirements to prevent moisture entry.

dd. Verify whether power supplies to Low-Level High Expansion Foam System Release Panel and power supplies are provided and surge protection.

ee. Verify that wire-nuts are not used in the Low-Level High Expansion Foam System Release system. Random checks by opening junction boxes to verify that screw type terminal blocks have been used throughout will be performed.

ff. Verify that conduit routing for Low-Level High Expansion Foam Release System meets JBLM separation requirements for Class A looped cabling installed vertically of 1 foot and 4 feet for horizontally installed conduits.

gg. Verify that control valves installed in the connection between an alarm initiating device intended to signal activation of a fire suppression system is supervised per NFPA 72. Presence of tamper switches shall be noted in a tamper switch matrix.

3.37.8 Optical Flame Detector Testing

The Low-Level High Expansion Foam System Contractor and the Optical Flame Detector manufacturer's representative shall conduct pan fire testing. Post suitable signs the day prior to and during testing indicating the date and time Optical Flame Detector testing is to occur. The Low-Level High Expansion Foam System Contractor shall protect the building and installed equipment from possible smoke and/or fire damage.

During testing, all suppression systems shall be disconnected. The Low-Level High Expansion Foam System shall be deactivated prior to beginning testing, to prevent accidental discharge. Remove solenoid from the Low-Level High Expansion Foam System Flow Control Valve. Disconnect the signal to the Fire Pump(s) and to the Low-Level High Expansion Foam System Concentrate Pump and Low-Level High Expansion Foam System Jockey Pump (Army projects).

Corrections made to Optical Flame Detectors or controls not responding shall require testing to be repeated as necessary. If the sensitivity of an Optical Flame Detector needs to be changed to pass a test, all other tests, and certifications/qualifications for immunity against false alarms, performed up to that time shall be repeated.

Demonstrate the performance requirements of the Optical Flame Detector coverage has been met through pan fire acceptance testing. Use a clean burning fuel in a 2 foot x 2 foot test pan, all of which is approved and

provided by the Optical Flame Detector manufacturer to simulate the expected fuel. Provide a liquid tight welded steel fire pan, with closable lid, and steel sub-frame with rollers/casters to allow for convenient relocation, or equivalent.

At a minimum, place the test fire in each designated aircraft parking position (minimum of three) and at locations selected by the Fire Protection Specialist, the AFCEC/COSM or USACE fire protection engineer, and/or DPW representative.

To pass the pan fire test:

a. All detectors within the cone-of-vision of this test fire shall activate within 30 seconds of fuel ignition.

b. No detectors should active after 30 seconds of full fire development when the test fire is placed 10 feet outside the hangar bay opening.

In addition to the pan fire test, the following tests shall be performed in the hangar bay:

a. Activate each Optical Flame Detector manually (e.g. using a magnet, etc. per manufacturer's recommendation) and individually, and confirm that blue beacons are activated, and confirm that a single Optical Flame Detector does not activate the Low-Level High Expansion Foam System(s).

b. Simultaneously manually activate each Optical Flame Detector with each of the other Optical Flame Detectors individually, and confirm that blue beacons are activated, that the disconnected Low-Level High Expansion Foam System Flow Control Valve solenoid is activated, that the start signal is sent to the Low-Level High Expansion Foam System Concentrate Pump and Fire Pump (Army only), and that the building Fire Alarm Mass Notification System speakers and strobes activate.

c. Ensure that the following outputs from the Optical Flame Detector Controller are received by the Low-Level High Expansion Foam Releasing Panel, Fire Alarm Mass Notification System Control Panel, and Joint Base Lewis-McChord Emergency Command Center (JBECC).

    (1) Optical Flame Detector first alarm.

    (2) Optical Flame Detector second alarm.

    (3) Optical Flame Detector gault.

d. Confirm that the Optical Flame Detector maintenance switch disables the Optical Flame Detector System.

e. Confirm that the Optical Flame Detector Inhibit Switch disables the disables the releasing function of all Optical Flame Detectors in the hangar bay.

f. At each aircraft parking location, and one additional location determined by the Fire Protection Specialist, the AFCEC/COSM or USACE fire protection engineer, and/or DPW representative perform arc welding

of plate steel inside the Hangar Maintenance Area, at 125 amps for 5 minutes, and confirm that Optical Flame Detectors do not activate.

g. Perform welding activities in the facility for a maximum of 5 minutes, at one location determined by the Fire Protection Specialist, the AFCEC/COSM or USACE fire protection engineer, and/or DPW representative and confirm there is no feedback through the building ground to the Optical Flame Detector System.

The Low-Level High Expansion Foam System Contractor shall provide written documentation of tests and state that the Optical Flame Detector system is fully functional in accordance with all criteria and shall be responsible for the proper disposal of all fire testing materials.

3.37.9 Low-Level High Expansion Foam System Flow Control Valve Testing

Operate the Low-Level High Expansion Foam System Flow Control Valve(s) and adjust valve open/closure speed and discharge pressure settings as specified. Demonstrate proper pressure settings and valve operation speed by utilizing the nozzle test/drain assembly at the most remote nozzle to record system pressure and by using a Manual Foam Stop Station to stop and restart the Low-Level High Expansion Foam System flow. Seal the pressure regulator, opening speed, and closure speed valves in their final "set" position with safety wire in the same manner as aviation mechanics seal critical fasteners on powerplants. Wire seals shall prohibit casual movement of valves. Permanently record the final Low-Level High Expansion Foam System Flow Control Valve discharge pressure setting on each valve.

3.37.10 Low-Level High Expansion Foam System Testing

The Low-Level High Expansion Foam System Contractor shall provide all Low-Level High Expansion Foam System Concentrate, gauges, sample collection apparatus, instruments, hose, personnel, elevating platforms, scaffolding, ladders, radios, appliances, instruments, and any other equipment necessary to fulfill Final System Acceptance Testing requirements specified. The Final System Acceptance Test shall be flawless without deficiencies or aspects of the systems not operating as required. Deficiencies or aspects of the systems not operating as required shall be considered a failed Final System Acceptance Test and the system shall be retested from the beginning at a later date at no cost to the Government.

The Low-Level High Expansion Foam System Contractor shall provide written documentation of a successful Preliminary System Acceptance Testing for the Optical Flame Detectors, Fire Alarm Mass Notification System, Fire Pump System(s), and Low-Level High Expansion Foam Release System that was approved by the Fire Protection Specialist, AFCEC/COSM or USACE fire protection engineer, and/or DPW representative before scheduling the Low-Level High Expansion Foam System Final System Acceptance Testing. The Low-Level High Expansion Foam System Contractor shall conduct a 100 percent retest of the Preliminary System Acceptance Test including a full discharge test of each system servicing each separated fire area. Take appropriate action to make this a successful test.

The Fire Protection Specialist, the AFCEC/COSM or USACE fire protection engineer, and/or DPW representative shall be present to witness the Final System Acceptance Test.

The Final System Acceptance Testing shall be conducted by experienced personnel according to the equipment and Low-Level High Expansion Foam System manufacturers' recommendations. Final System Acceptance Testing shall encompass all aspects of system operation and shall including the following the following at a minimum:

a. Conduct a Safety Meeting with attendance required for all witnesses (government and non-government personnel) immediately before Final System Acceptance Discharge Testing.

b. Provide the approved Safety Plan for conducting test of Low-Level High Expansion Foam System(s). Provide a sketch of safe egress path for persons conducting and witnessing the test to exit the building without entering the foam blanket. During the discharge test, no one is permitted on the floor of Hangar Maintenance Area. Persons witnessing the test will be required to view from an elevated position (or equivalent) that does not require them to exit the building through the Low-Level High Expansion Foam. Ensure that there is adequate egress off the elevated position (or equivalent) which complies with the Life Safety Code (NFPA 101). The foam blanket will reach a level above the average person's height causing spatial and acoustic disorientation possibly resulting in injury. Provide procedures for taking protective measures to avoid damage to life and property during and after the Low-Level High Expansion Foam System discharge test, as described in the applicable paragraph in this specification section.

c. Provide a signup sheet with signature mandatory for all witnesses. No person shall be permitted in the hangar vicinity during the Low-Level High Expansion Foam System discharge test who has not signed the signup sheet and also attended the safety meeting.

d. Have environmental permits in hand and present at the site prior to FINAL System Acceptance Testing.

e. Provide copies of the Final System Acceptance Testing Procedures that includes the schedule of tests for each day.

f. Final System Acceptance Testing will consist of one hundred percent testing of the Low-Level High Expansion Foam System. Simultaneously conducting more than one test shall not be permitted. The Low-Level High Expansion Foam System Contractor and Low-Level High Expansion Foam System manufacturer's representatives shall conduct Final System Acceptance Testing under the direction of the Fire Protection Specialist, the AFCEC/COSM or USACE fire protection engineer, and/or DPW representative.

g. Provide approved copies of the Final System Acceptance Testing Procedures that are to be followed for each test in addition to recording data obtained during the Low-Level High Expansion Foam System discharge test.

h. The attendee sign-up sheet shall be separate from the Final System Acceptance Testing Procedures.

i. Provide calibration certificates for each instrument and pressure gauge used for Low-Level High Expansion Foam System testing. The testing equipment shall be calibrated within 12 months from the date of

testing. Test results obtained shall be considered invalid without current calibration certificates.

j. Have the names and credentials of Low-Level High Expansion Foam System manufacturer representatives and Factory Authorized Representatives that will be conducting the Final System Acceptance Testing in hand and present at the site prior to Final System Acceptance Testing.

k. Provide Low-Level High Expansion Foam Concentrate Storage Tank volume graph indicating volume in gallons corresponding to the level of Low-Level High Expansion Foam Concentrate in foam Low-Level High Expansion Foam System Concentrate Storage Tank. This information will be used to calculate the Low-Level High Expansion Foam System Concentrate volume required to flow the Low-Level High Expansion Foam System for 15 minutes. The foam tank levels shall be checked by the Low-Level High Expansion Foam manufacturer's representative, the Fire Protection Specialist, the AFCEC/COSM or USACE fire protection engineer, and/or DPW representative.

l. Measure Low-Level High Expansion Foam System Concentrate Storage Tank level prior to and after Low-Level High Expansion Foam System discharge test. Calculate Low-Level High Expansion Foam System Concentrate volume of Low-Level High Expansion Foam Concentrate discharged during the 15 minute Low-Level High Expansion Foam System discharge test. The foam tank levels shall be checked by the Low-Level High Expansion Foam manufacturer's representative, the Fire Protection Specialist, the AFCEC/COSM or USACE fire protection engineer, and/or DPW representative.

m. Water only discharge test shall be performed prior to the Low-Level High Expansion Foam System discharge test, with the Low-Level High Expansion Foam Concentrate shutoff/disconnected. Simulate maximum overhead wet pipe automatic fire protection sprinkler system demand and hose stream demands (as applicable) based on overhead wet pipe automatic fire protection sprinkler system hydraulic calculations through the test header. Verify overhead sprinkler system demand by using fire hose, hose monsters, pitot measurements and liquid filled calibrated pressure gages, or equivalent. The overhead Low-Level High Expansion Foam System Generators in the Hangar Maintenance Area should be simultaneously flowing water only. The Fire Protection Specialist, the AFCEC/COSM or USACE fire protection engineer, and/or DPW representative shall witness the flow simulation. When the test is complete, and before the Low-Level High Expansion Foam System discharge test, the Hangar Maintenance Area floor shall be cleared of any water and shall be allowed to dry.

n. Provide liquid filled calibrated pressure gages at each Low-Level High Expansion Foam System Generator and at each Low-Level High Expansion Foam System riser. This information is used to substantiate the hydraulic calculations and to determine actual flow from each Low-Level High Expansion Foam System Generator. It is recommended that sufficient length of hose or tube be provided to take pressure reading at the floor level during the water only discharge test.

o. For projects located on Lewis Main following Chapter 6 Requirements of UFC 4-211-01 for Army Specific Criteria:

(1) Measure the residual pressure at the most remote Low-Level High Expansion Foam System Generator with only the Low-Level High Expansion Foam System operating. Measure the inlet and outlet pressures of each Low-Level High Expansion Foam System Floe Control Valve. A water only test is acceptable for this test. Use this information to verify the hydraulic performance of the Low-Level High Expansion Foam System.

(2) Perform Low-Level High Expansion Foam System discharge test of the combined systems flowing simultaneously (with Low-Level High Expansion Foam System) to verify both 1 minute criteria and 4 minute criteria.

(3) Develop Low-Level High Expansion Foam Spread diagrams if not available from the manufacturer.

(4) Provide values of design parameters including:

1. Design pressure at the base of Low-Level High Expansion Foam System riser.

2. Design pressure at hydraulically most remote Low-Level High Expansion Foam System Generator.

3. Value of maximum fire water demand.

4. Value of maximum Low-Level High Expansion Foam System solution flow.

5. Limits of Low-Level High Expansion Foam System solution concentration in accordance with the UL listing of foam and contract requirements.

(5) Overhead wet pipe automatic fire protection sprinkler system simulated flow test:

4. Provide the number of playpipes used for each the flow rate of the overhead wet pipe automatic fire protection sprinkler system.
5. Indicate the GPM required per playpipe.

6. Indicate pitot pressure required for each playpipe.

(6) Demonstrate that the Low-Level High Expansion Foam System test header isolation valve is working properly.

(7) Test the Low-Level High Expansion Foam System proportioner(s) prior to the Low-Level High Expansion Foam System discharge test at the flow and for a time recommended by the Low-Level High Expansion Foam System manufacturer. The intent is to ensure that the Low-Level High Expansion Foam System Proportioner is performing as intended prior to the Low-Level High Expansion Foam System discharge test. Repeat this test during the Low-Level High Expansion Foam System discharge test.

(8) Provide a camera in ow-Level High Expansion Foam System riser(s), Fire Pump Room, and Fire Suppression Room to record gauge

pressures, Fire Pump(s) start time, Low-Level High Expansion Foam System Flow Control Valve(s) opening time, and the Low-Level High Expansion Foam System Control Valve is closed at the end of the Low-Level High Expansion Foam System discharge test.

(9) Verify and record whether a start signal is provided from the Low-Level High Expansion Foam System Release Panel to Fire Pump Controller and Low-Level High Expansion Foam Pump Controller.

(10) Verify that under no circumstances does the Low-Level High Expansion Foam System and overhead wet pipe automatic fire protection sprinkler system pressure exceeds 175 PSI.

(11) Verify that a tamper switch is provided for the Low-Level High Expansion Foam Concentrate shutoff valve. Presence of tamper switches shall be noted in a tamper switch matrix.

p. For projects located on McChord Field following Chapter 5 Requirements of UFC 4-211-01 for Air Force Specific Criteria:

(1) Measure the residual pressure at the most remote Low-Level High Expansion Foam System Generator with only the Low-Level High Expansion Foam System operating. Measure the inlet and outlet pressures of each Low-Level High Expansion Foam System Flow Control Valve and at each Low-Level High Expansion Foam System Inductor. A water only test is acceptable for this test. Use this information to verify the hydraulic performance of the Low-Level High Expansion Foam System.

(2) Provide values of design parameters for the design inlet and discharge pressures at the Low-Level High Expansion Foam System Inductor(s).

(3) Test the Low-Level High Expansion Foam System Inductor(s) prior to the Low-Level High Expansion Foam System discharge test at a flow and for a time recommended by the Low-Level High Expansion Foam System manufacturer. The intent is to ensure that the Low-Level High Expansion Foam System Inductor is performing as intended prior to the Low-Level High Expansion Foam System discharge test. Repeat this test during the Low-Level High Expansion Foam System discharge test.

(4) Record gauge pressures at the inlet and outlet of the Low-Level High Expansion Foam System Inductor.

q. The Final System Acceptance discharge test and any re-test will begin with the system in normal configuration; no recharging of the system piping is allowed. Hangar doors will be closed and will remain closed until the hangar is released to the Low-Level High Expansion Foam System Contractor's clean-up team

r. Mark each aircraft outline (silhouette) on the floor with bright red tape. This is to determine the amount of time required to cover the projected aircraft outlines (silhouettes) from the activation of a Manual Foam Start Station. Provide additional bright red tape in each aircraft outline (silhouette) as required to subdivide each aircraft outline (silhouette) into ten equal area sections to assist in

determining the Low-Level High Expansion Foam System coverage percent after 60 seconds of Low-Level High Expansion Foam System activation and for review of the video. Ensure that the red tape can be readily seen in the video prior to starting the Low-Level High Expansion Foam System discharge test.

s. Mark the perimeter walls of the Hangar Maintenance Area with bright red tape at 3.28 feet (1 meter) above finished floor. In lieu of marking the perimeter walls, provide 3.28 feet (1 meter) tall cones or posts placed around the perimeter of the Hangar maintenance Area, along the projected aircraft outlines (silhouettes), and within the projected aircraft outlines (silhouettes). Record the time for the Low-Level High Expansion Foam to reach a level of 3.28 feet (1 meter) in depth throughout the hangar, which shall not exceed 4 minutes from time of Low-Level High Expansion Foam System activation.

t. Low-Level High Expansion Foam shall not fall from the Low-Level High Expansion Foam System Generators within each projected aircraft outline (silhouette).

u. The Low-Level High Expansion Foam System discharge test is to begin with the fire pump(s) not running.

v. Once the Low-Level High Expansion Foam System test director indicates the 3.28 feet (1 meter) depth has been achieved, depress a Manual Foam Stop Station on a Manual Foam Stop Station remote to the Manual Foam Start Station used to initiate the Low-Level High Expansion Foam System. The Low-Level High Expansion Foam System Flow Control Valve shall close not faster than 5 seconds and not more than 15 seconds. Upon release of the Manual Foam Stop Station, the Low-Level High Expansion Foam System Flow Control Valve shall completely open within 5 seconds.

w. Designate a person to stop the Low-Level High Expansion Foam System discharge test (e.g. by appropriate means such as closing the manual control valve, etc.) based on radio communications, etc. when receiving notification that the 3.28 feet (1 meter) depth has been achieved or in case of an emergency. In case of a loss of communication, this person should be given instructions that the Low-Level High Expansion Foam System discharge test should be stopped no later than 4 minutes after the Low-Level High Expansion Foam System discharge test has commence

x. The Low-Level High Expansion Foam System discharge test shall not be conducted with standing water on the Hangar Maintenance Area floor. Crews and equipment shall be provided to remove standing water. The Hangar Maintenance Area floor shall not be wet at the start of the test.

y. Provide equipment used for the test such as radios, stop watch, foam fill pump, Low-Level High Expansion Foam Concentrate to top the Low-Level High Expansion Foam Concentrate Storage Tank, lifts, ladders, extension pole, air horn, smoke generator, manometer, sufficient cameras and tripods etc.

z. The designated person to start and stop the Low-Level High Expansion Foam System discharge test shall be in charge of operating an air horn of sufficient loudness to be heard on the video recording and by all

witnesses throughout the Hangar Maintenance Area, Fire Pump Room and Fire Suppression Rooms via hand-ed radios. The air horn will be used to establish the start time in the video to evaluate the Low-Level High Expansion Foam System coverage of the projected aircraft outlines (silhouettes) in 1 minute and the foam depth of 3.28 feet (1 meter) in 4 minutes. The air horn shall be sounded at the following times:

(1) 5 minute mark prior to starting the Low-Level High Expansion Foam System discharge test.

(2) 1 minute mark prior to starting the Low-Level High Expansion Foam System discharge test.

(3) 30 second mark prior to starting the Low-Level High Expansion Foam System discharge test.

(4) At the time the Manual Foam Start Station is activated to start the Low-Level High Expansion Foam System discharge test.

(5) 1 minute mark after starting the Low-Level High Expansion Foam System discharge test.

(6) At conclusion of the Low-Level High Expansion Foam System discharge test defined by the following, whichever is first:

1. The depth of Low-Level High Expansion Foam achieves a depth of 3.28 feet (1 meter) throughout the Hangar Maintenance Area.

2. 4 minute mark after starting the Low-Level High Expansion Foam System discharge test.

aa. A government witness at the Manual Foam Start Station shall radio a government witness at the Low-Level High Expansion Foam System riser(s), Fire Pump Room, and Fire Suppression Room at each of the timed milestones listed above, so that the government witnesses at the Low-Level High Expansion Foam System riser(s), Fire Pump Room, and Fire Suppression Room can provide a visible and audible signal for the recording cameras.

bb. The government witness in the Fire Suppression Room shall record how many seconds after the start time of the Low-Level High Expansion Foam System discharge test before the overhead wet pipe automatic fire protection sprinkler system test header valve is fully open.

cc. Provide an adequate number of cameras in the Hangar Maintenance Area to facilitate complete coverage without panning across the Hangar Maintenance Area floor. At least one video view will be from a ceiling mounted camera. Use stationary overhead cameras with a full view of the projected aircraft outline (silhouette) during the Low-Level High Expansion Foam System discharge test, to use for later determination of the percent projected aircraft outlines (silhouettes) coverage at 60 seconds and 3.28 feet (1 meter) depth in 4 minutes. Cameras shall have a full view of the bright red tape on the floor to outline the projected aircraft outlines (silhouettes), and additional bright red tape on the floor to subdivide the projected aircraft outlines (silhouettes) into ten equal area sections. The subdivision will assist

in reviewing the video for percent aircraft outlines (silhouettes) coverage with foam at 60 seconds.

dd. Video of Low-Level High Expansion Foam System discharge testing shall be in disc (or digital) format that records the date and time-lapse in seconds on the video, from start to finish of each portion of the test. The Low-Level High Expansion Foam System discharge test will most likely require several cameras for complete documentation. The cameras filming the Low-Level High Expansion Foam System discharge on the Hangar Maintenance Area floor cannot pan. Four copies of the disc (or digital) formatted video shall be submitted and approved before the system will be considered accepted.

ee. Verify that surge arrestor pre-charge pressure is indicated on surge arresters.

ff. Verify that a pressure gauge with isolation valve is provided at surge arresters to monitor pressure and record pressure indicated on the pressure gauge.

gg. Demonstrate the performance criteria for opening the Low-Level High Expansion Foam System Flow Control Valve is met upon actuation of the Manual Foam Start Station and closing the Low-Level High Expansion Foam System Flow Control Valve is met upon actuation of the Manual Foam Stop Station and reopening of the Low-Level High Expansion Foam System Flow Control Valve is met upon releasing the Manual Foam Stop Station. A water only test is acceptable for this test.

hh. Verify that any and all valves in the system that when closed will disrupt or stop the flow of Low-Level High Expansion Foam Solution, Low-Level High Expansion Foam Concentrate, water, or that will disrupt or prevent an alarm signal are electronically supervised. Presence of tamper switches shall be noted in a tamper switch matrix.

ii. Verify that all pipe and conduit penetrations are sealed with listed fire proofing material. Provide catalog cut of fireproofing material.

jj. Verify that all fire protection pipes, valves, test headers, FDC are labeled and that labels have been adapted to properly indicate flow direction.

kk. Ensure that a sufficient quantity of Low-Level High Expansion Foam is available to top the Low-Level High Expansion Foam Concentrate Storage Tank at the end of Low-Level High Expansion Foam System discharge testing.

ll. Provide a Low-Level High Expansion Foam Concentrate Pump for filling the Low-Level High Expansion Foam Concentrate Storage Tank from a reserve Low-Level High Expansion Foam drum.

3.38 FINAL SYSTEM ACCEPTANCE TESTING POST-DISCHARGE TEST REQUIREMENTS

The following tasks shall be conducted at completion of Final System Acceptance Testing discharge testing.

a. Following the successful completion of Final System Acceptance Testing, the Low-Level High Expansion Foam System Contractor shall flush all

piping carrying Low-Level High Expansion Foam Solution with fresh water. Rinse all equipment and building surfaces exposed to Low-Level High Expansion Foam discharge with fresh water.

b. The Low-Level High Expansion Foam System Contractor shall completely drain the piping between the Low-Level High Expansion Foam System Flow Control Valves and each Low-Level High Expansion Foam System Generator leaving the piping dry.

c. The Low-Level High Expansion Foam System Contractor shall remove from the site the Low-Level High Expansion Foam Concentrate and Low-Level High Expansion Foam Solution collected during Low-Level High Expansion Foam System discharge testing and flushing of piping as indicated on the approved Environmental Plan for containment and disposal.

d. Contractor shall replenish Low-Level High Expansion Foam Concentrate consumed during the Preliminary System Acceptance Testing. All fire protection systems shall be returned to automatic operation and the facility restored to operational capability.

3.39 FINAL ACCEPTANCE TESTING REPORTS

Upon completion of specified Final System Acceptance Testing, the Contractor shall provide Final System Acceptance Testing Reports for all fire protection related specification sections in electronic format with bookmarks for approval. The AFCEC/COSM or USACE fire protection engineer, and/or DPW representative requires 2 weeks to review a completed Final System Acceptance Testing Report. The Final System Acceptance Testing Reports shall include the following at a minimum:

a. Copies of the approved Final System Acceptance Testing Procedures for each fire protection related specification section.

b. Copies of forms that record test readings / data obtained during Final System Acceptance Testing.

c. Copies of credentials of manufacturer's representatives who was actually present at the site.

d. An overview of all testing performed.

e. Identify items needing corrections prior to Final Acceptance Testing.

f. Video recordings of the Final System Acceptance Testing discharge test.

g. All test reports required by the project specifications and NFPA codes such as NFPA 11, NFPA 13, NFPA 20, NFPA 24, NFPA 72 etc.

h. Test report of Low-Level High Expansion Foam Concentrate Proportioning System.

(1) Report shall include all pressure readings and settings of system components.

(2) Report shall include conductivity or refractive index readings for Low-Level High Expansion Foam samples taken from the Low-Level High Expansion Foam Proportioner(s).

(3) Report shall be signed by the factory-trained technical representative the foam concentrate manufacturer.

i. Test report of the Low-Level High Expansion Foam System Release Panel and initiating and indicating devices.

(1) Report shall include a unique identifier for each device with an indication of test results.

(2) Report shall be signed by the factory-trained technician employed by the Low-Level High Expansion Foam System Release Panel manufacturer.

j. Submit pressure discharge graphs or tables showing pressure discharge relationship for Low-Level High Expansion Foam System Generators.

k. Provide documentation indicating the final position of control valves.

3.39.1 Final Acceptance Testing Certification Letter

The Fire Projection Specialist shall certify in writing (on company letterhead) after completion of the Final Acceptance Testing that the Optical Flame Detectors, Fire Alarm Mass Notification System, Fire Pump System(s), Low-Level High Expansion Foam Release System, and the Low-Level High Expansion Foam System performs as intended, has been installed in accordance with the contract requirements, and is ready to be put into service. The Certification Letter shall be addressed to and sent to the to the AFCEC/COSM or USACE fire protection engineer, and/or DPW representative for their records.

3.40 POSTED INSTRUCTIONS

Provide Posted Instructions that shall be installed at control equipment, at each remote control station, and as directed by the Fire Protection Specialist, the AFCEC/COSM or USACE fire protection engineer, and/or DPW representative.

3.40.1 Posted Instructions Information

Posted Instructions shall provide a description of system operation, instructions and schematic diagrams of the overall Low-Level High Expansion Foam System and each subsystem. Posted Instructions shall clearly indicate all necessary steps for the operation of the Low-Level High Expansion Foam System(s). The Posted Instructions shall also contain condensed operating instructions explaining the system for normal operation, refilling the Low-Level High Expansion Foam Concentrate Storage Tank, and routine testing.

3.40.2 Posted Instructions Material

Posted Instructions shall be in engraved white letters on red rigid plastic or red enameled steel backgrounds and shall be of adequate size to permit them to be easily read. Minimum text size shall be 1/8" high.

3.41 CLOSEOUT SUBMITTALS

The Low-Level High Expansion Foam System Contractor shall submit the

following items for records, review, and approval prior to any Operations and Maintenance Instructions or On-Site Training.

a. As-Built Drawings

b. Warranty Letter

c. Spare Parts

d. Operation and Maintenance (O&M) Instructions

e. Instruction of Government Employees

f. Copy of a filled out test form for Low-Level High Expansion Foam Samples

g. Bottles for Low-Level High Expansion Foam Samples

3.42 OPERATIONS AND MAINTENANCE INSTRUCTIONS

The contractor shall submit Operations and Maintenance Instructions prior to performing On-Site Training to the government representative acting as the Authority Having Jurisdiction for approval. Manuals shall include the manufacturer's name, model number, parts list, and tools that should be kept in stock by the owner for routine maintenance including the name of a local supplier, simplified wiring and controls diagrams, possible breakdowns, troubleshooting guide, and recommended service organization (including address and telephone number) for each item of equipment. Each service organization submitted shall be capable of providing 4-hour onsite response to a service call on an emergency basis.

Operations and Maintenance Instructions shall be grouped by technical sections consisting of manufacturer's brochures, schematics, printed instructions, general operating procedures, and safety precautions. Operations and Maintenance Instructions shall include a narrative description of the sequence or sequences of operation of the overall fire protection system(s) and a separate description for each major subsystem. Information to be provided shall include specific settings for all adjustable valves. The Operations and Maintenance Instructions shall include conduit layout, equipment layout, and simplified wiring and control diagrams for the system as installed. The Operations and Maintenance Instructions shall include procedures and instructions pertaining to frequency of preventive maintenance, inspection, adjustment, lubrication and cleaning necessary to minimize corrective maintenance and repair.

3.43 ON-SITE TRAINING

The Contractor shall conduct two sessions of On-Site Training for at least 8 hours each, on two different days, to accommodate shifts and availability for JBLM operations and maintenance personnel as designated by the Contracting Officer. The Low-Level High Expansion Foam System Release Panel manufacturer shall provide a minimum of 4-days startup assistance. On-Site Training shall start after the Final System Acceptance Testing has been completed and approved. The On-Site Training shall cover all of the items contained in the approved Operations and Maintenance Instructions. Provide the services of representatives or technicians from the manufacturers of the Low-Level High Expansion Foam System and Low-Level High Expansion Foam System Release Panel

experienced in the installation and operation of the type of system being provided to provide On-Site Training to JBLM operations and maintenance personnel.

Each On-Site Training session shall include a walk-through of the facility while describing the operation of the equipment and system, and video of this description for future review by JBLM operations and maintenance personnel. Each On-Site Training session shall also include emergency procedures, and demonstrate how to perform all the routine maintenance, and unique maintenance and safety requirements. The Low-Level High Expansion Foam System Contractor or subcontractor (e.g. Optical Flame Detectors, Fire Pump System(s) Contractor, Low-Level High Expansion Foam Release System, etc.) shall demonstrate (on or at the equipment itself), and video for future review by JBLM operations and maintenance personnel, all the routine maintenance (e.g. weekly, monthly, yearly, etc.) in the equipment manuals and cut sheets, and required by military criteria or NFPA standards. The Low-Level High Expansion Foam System Contractor or subcontractor, during walk thru of the facility, shall describe the warning signs of equipment failure, but the Low-Level High Expansion Foam System Contractor is not required to demonstrate how to repair equipment.

On-Site Training shall be provided by to JBLM operations and maintenance personnel in the building in which the systems have been installed following the approved Operations and Maintenance Manuals. Dates and times of the On-Site Training shall be coordinated through the Contracting Officer not less than two weeks prior to the On-Site Training sessions.

Lesson plans, operating instructions, maintenance procedures, and training data shall be furnished in manual format for On-Site Training. The operations training course shall familiarize JBLM operations and maintenance personnel with proper operation of the Low-Level High Expansion Foam Systems. The maintenance training course shall provide JBLM operations and maintenance personnel adequate knowledge required to diagnose, repair, maintain, and expand functions inherent to the Low-Level High Expansion Foam System(s). Film or tape all On-Site Training sessions and provide (1) copy of the On-Site Training on a DVD to the following:

a. JBLM Fire Department.

b. DPW Public Works.

c. JBLM Fire Alarm Shop.

d. JBLM Plumbing Shop.

3.44 SPARE PARTS

Spare Parts data for each different item of material and equipment specified. The data shall include a complete list of Spare Parts and supplies, with source of supply, and a list of Spare Parts recommended by the manufacturer to be replaced after 1 year and 3 years of service. Furnish three (3) or 10 percent rounded up to the next whole number (whichever is fewer) of the following Spare Parts and accessories:

a. Keys used for the Supervised Disconnect Switch.

b. Fuses for each fused circuit.

c. Each type of notification appliance in the system (e.g. blue beacon, etc.).

d. Each type of initiating device included in the system (e.g. Manual Foam Start Stations, Manual Foam Stop Stations, etc.).

e. Each type of system components (e.g. Optical Flame Detectors, etc.).

f. Lockable and labeled spare parts cabinet with sufficient volume to house the required spare parts that shall be installed in the same room as the Fire Alarm Mass Notification System Control Panel.

g. All manufacturer's codes and passwords shall be provided to JBLM DPW personnel allowing access to the programming of the Low-Level High Expansion Foam System Release Panel, Fire Pump Controllers (Fire Pump and Pressure Maintenance (Jockey) Pump), Low-Level High Expansion Foam Concentrate Pump Controllers (Foam Pump and Pressure Maintenance (Jockey) Pump, Fire Alarm Mass Notification System Control Panel, etc.

3.44 SPECIAL TOOLS

All software, connecting cables, dongles, codes and passwords, and proprietary equipment, necessary for the maintenance, testing, adding and deleting devices, and reprogramming of the Low-Level High Expansion Foam Release System and supporting equipment (i.e. pump controllers) along with a list of special tools, test equipment required for maintenance and testing shall be furnished DPW Fire Alarm Shop and DPW Plumbing Shop prior to the Final System Acceptance Testing.

-- End of Section --