SECTION 21 13 25 - HIGH EXPANSION FOAM SYSTEM

PART 1 - GENERAL

1.1 SUMMARY

A. Design and provide a new automatic low-level high expansion foam fire extinguishing system, including electronic detection, control, and release systems, as indicated on drawings. Systems shall provide uniform distribution of high expansion foam solution to provide complete coverage over the protected area as indicated on drawings. System shall be balanced to operate both independently and with simultaneous operation of the overhead sprinkler system specified in Section 21 13 13 “Wet Pipe Sprinkler System.”

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. The design, equipment, materials, installation, and workmanship shall be in strict accordance with UFC 3-600-01, UFC 4-211-01, NFPA 11, NFPA 13, NFPA 70, and NFPA 72, except as modified herein. Each system shall include all materials, accessories and equipment necessary to provide each system complete and ready for use. 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 for approval. Devices and equipment for fire protection service shall be of a make and type listed by a Nationally Recognized Testing Laboratory unless otherwise specified.

D. Furnish piping offsets, fittings, and any other accessories as required to provide a complete installation and to eliminate interference with other construction. Design any portions of the system that are not indicated on the drawings, including locating and sizing piping and equipment when this information is not indicated on the drawings or is not specified herein.

E. The design of the system shall be based on hydraulic calculations, and the other provisions specified herein.

F. The Contractor is responsible for the installation, testing, and acceptance testing of the high expansion foam system as required by this specification and the plans. The contractor is also responsible for portions of the design per this specification and the plans.

1.2 PRECONSTRUCTION SUBMITTALS

A. Environmental Protection: Submit high expansion foam solution containment and disposal plan as required under paragraph entitled “Environmental Protection.”
1.3 ACTION SUBMITTALS

A. Product Data: For each of the following products, Manufacturer's catalog data for each separate piece of equipment proposed for use in the system. Data shall indicate the name of the manufacturer of each item of equipment, with data highlighted to indicate model, size, options, etc. proposed for installation. In addition, a complete equipment list with equipment description, model number, and quantity shall be provided.

1. Pipe, fittings, and mechanical couplings
2. Valves, including gate, check, and globe
3. Pipe hangers and supports
4. Pressure switch
5. Surge Arrester
6. Terminal cabinets/assemblies
7. Storage batteries
8. Annunciator panel
9. High expansion visual alarm
10. Battery charger
11. Trench Drainage Diverter Valve Controls
12. Surge Analysis
13. Foam Generators
14. Foam Generator Spread Curves
15. Seismic Protection
16. Water Tight Junction Boxes
17. Foam/Water Flow Control Valves
18. Strainer
19. Foam Concentrate Jockey Pump
20. Foam/Water Proportioning System
21. Foam Concentrate
22. Foam Proportioner
23. Double Wall Foam Concentrate Tank
24. Manual Foam Releasing Stations
25. Manual Foam Stop Stations
26. Releasing Service Fire Alarm Control Unit (RSFACU)
27. Optical Flame Detectors and Controller
28. Listing or Approval of Equipment
29. Surge arrestors
30. Materials and Equipment

B. Spare Parts: Spare parts data for each different item of material and equipment specified. The data shall include a complete list of parts and supplies, with current unit prices and source of supply, and a list of parts recommended by the manufacturer to be replaced after 1 year and 3 years of service. A list of special tools and test equipment required for maintenance and testing of the products supplied by the Contractor shall be included.

C. Proposed Diagrams and Instructions: A copy of the proposed diagrams and instructions for the overall foam system, prior to posting.

D. Design Data:
1. Foam Delivery calculations: Submit foam delivery calculations demonstrating foam solution is delivered to the most remote high expansion generator within 30 seconds of system activation.

2. Pressure discharge graphs or tables: Submit pressure discharge graphs or tables showing pressure discharge relationship for discharge nozzles.

3. Battery standby power requirements calculations:
   a. Substantiating battery standby power requirements calculations showing battery capacity, supervisory and alarm power requirements.
   b. Provide complete battery calculations for both the alarm and supervisory power requirements. Ampere hour requirements for each system component shall be submitted with the calculations.

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

5. Hydraulic Calculations: Provide hydraulic calculations complying with the requirement of this Section and Section 21 13 13 “Wet Pipe Sprinkler System.” Calculations shall be signed and sealed by a qualified professional engineer.

6. Foam Spread/Coverage Calculations: Provide the following calculations/information to verify that the design meets the requirements shown on the plans:
   a. Provide liquid travel time in seconds from the Foam/Water Flow Control Valve to each foam generator.
   b. Provide Hi-Ex foam spread time from each foam generator in accordance with foam equipment manufacturer's recommendations for foam spread time.
   c. Provide total time to meet the design criteria.
   d. Provide calculations for liquid travel time and foam spread time indicated above.
   e. Provide a sketch showing locations of Foam/Water Flow Control Valve. Show pipe diameters, length of associated pipe, and travel time in seconds.
   f. Provide a full size to-scale drawing with the aircraft silhouette, foam generators and foam-spread diagrams at one-minute elapsed time from the activation of a manual foam discharge station.
   g. Include the requested information in a tabular form on the Foam Spread Drawing.
   h. Note that the "One Minute or Less" coverage requirement starts at the actuation of manual foam discharge station.

E. Shop Drawings: Prepare shop drawings for High Expansion Foam Systems in accordance with the requirements for "Plans" as specified in NFPA 11, "Working Plans" as specified in NFPA 13, and "Shop Drawings" as specified in NFPA 72. Each drawing shall be 24 by 36 inches. Unless otherwise noted, floor plans shall be drawn to a scale not less than 1/8" = 1'-0". Show data essential for proper installation of each system. Show details, plan view, elevations and sections of the systems supply and piping. Show piping schematic of systems supply, devices, valves, pipe and fittings. Show point to point electrical wiring diagrams. Submit drawings stamped by the Qualified Fire Protection Engineer.
1. Do not commence work until the design of each system and the various components have been approved. Show:
   a. Room, space or area layout and include data essential to the proper installation of each system
   b. Sprinkler heads, discharge nozzles and system piping layout annotated with reference points for design calculations
   c. 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
   d. Optical flame detector manufacturer's recommended detector layout (plan view) including horizontal and vertical angles for correct aiming.

2. Provide three copies of the high expansion foam system shop drawings, no later than 21 days prior to the start of sprinkler system installation.

3. Do not commence work until the design of each system and the various components have been approved. Show:
   a. A descriptive index with drawings listed in sequence by number. A legend sheet identifying device symbols, nomenclature, and conventions in accordance with symbols shown in NFPA 170 used in the package.
   b. Floor plans drawn to a scale not less than 1/8 inch equals 1 foot clearly showing locations of devices, equipment, risers, electrical power connections, areas covered by each generator, and other details required to clearly describe the proposed arrangement.
   c. Piping plan for high expansion foam system incorporating that shown. Generators and associated piping shall be shown. Abbreviated presentation forms will not be accepted. Each type of fitting used and the locations of bushings, reducing couplings, and welded joints shall be identified. A separate plan shall be provided for each overhead sprinkler system and each foam system.
   d. Piping plan and isometric drawing of the concentrate system and details of all associated valves, fittings, and other components. Drawing shall incorporate that shown.
   e. Shop drawings of each inductor. Shop drawings must be accompanied with an inductor datasheet fully annotated with the flow rate, inlet pressure, back pressure, inlet K-factor, and outlet K-factor to which the inductor will be calibrated.
   f. Location of control panels, detectors, manual stations, supervisory switches, solenoids, notification appliances, and other electrical devices. Conduit routing and sizes, and the number of conductors contained in each shall be indicated. For optical flame detectors provide a plan with the cone-of-visions and respective aim points. Provide elevation showing cone-of-visions and respective aim points demonstrating that the cone-of-visions do not extend more than 5 feet outside the hangar doors.
   g. Longitudinal and transverse building sections showing typical pipe routing and elevation above finished floor.
   h. Equipment room layout drawings drawn to a scale of not less than inch equals 1 foot to show details of each system component, clearances between each other and from other equipment and construction in the room.
i. Details of each type of pipe hanger, sway bracing for earthquake protection restraint of underground water main at point-of-entry into the building, proportioners, foam generators, foam tanks, and mounting details, foam system control valve header and related components. Include bracing for foam generators and foam tanks.

j. Details of all components required for support of the sprinkler piping from the building structural system, including hangers and bracing, and details of all connections to the components of the metal building system. Provide plans, elevation drawings, and details as required to fully convey the clearances required for the floor and wall penetrations.

k. Connection drawings and control diagrams indicating overall mechanical operation of the high expansion system. This shall include identification and operation of each major component of the system. Diagrams shall be supplemented with a narrative description of the system. Indicate foam system control panel, make and model of devices and equipment to which the system is connected.

l. 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 shall show connections from field devices to the Releasing Service Fire Alarm Control Unit (RSFACU) and remote foam system control units, initiating circuits, switches, relays and terminals.

m. 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

n. Interfacing with fire suppression control components shall be clearly indicated on drawings. Solenoids shall be FM approved for release by the releasing panel.

o. Optical flame detector manufacturer's recommended detector layout (plan view) including horizontal and vertical angles for correct aiming.

p. Details of each foam generator and mounting details, high expansion foam system control valve header and related components.

1.4 INFORMATIONAL SUBMITTALS

A. Qualification Data: The name and documentation of certification of the proposed Fire Protection Specialists and Qualified Fire Protection Engineer (QFPE), no later than 14 days after the Notice to Proceed and prior to the submittal of the sprinkler system drawings and hydraulic calculations.

B. Installers Qualifications: Data approved, prior to submittal of any other data or drawings, to substantiate that the proposed installer is regularly engaged in the installation of the type and complexity of fire protection system included in this project. Data shall identify the location of three systems recently installed by the proposed installer which are comparable to the system specified. Contractor shall certify that each system has performed satisfactorily, in the manner intended, for a period of not less than 6 months.

1. Prior to commencing work, submit data showing that the Contractor has successfully installed automatic high expansion foam fire extinguishing systems of the same type and
design as specified herein, or that he has a firm contractual agreement with a subcontractor having the required experience. Include the names and locations of at least two installations where the Contractor, or the subcontractor referred to above, has installed such systems. Indicate the type and design of each system, and certify that the system has performed satisfactorily for a period of at least 18 months.

2. The installer shall be experienced and regularly engaged in the installation of the type and complexity of fire protection system included in this project. A statement prior to submittal of any other data or drawings, that the proposed installer is regularly engaged in the installation of the type and complexity of system included in this project shall be provided. In addition, data identifying the locations of at least three systems recently installed by the proposed installer which are comparable to the system specified shall be submitted. Contractor shall certify that each system has performed satisfactorily, in the manner intended, for a period of not less than 6 months.

C. Post-discharge Test Requirements: Details of method proposed for required tests at Final Acceptance, including step-by-step test procedures; list of equipment to be used; names, titles, and affiliations and qualifications of personnel who will participate in the tests; methods for protecting the facility and equipment during testing; means for containing the foam solution during discharge tests; and proposed means for disposal. Test plan shall include a drawing showing proposed number and arrangement of fire hoses and nozzles proposed for use in testing foam proportioners. Blank forms the Contractor plans to use to record test results shall be included. Provide completed Preliminary Acceptance Test (PAT), and Final Acceptance Test (FAT) checklists. See paragraph in this specification with checklist items.

D. Certificates for Installer: Submit installer and systems technician qualifications as required under paragraph entitled Qualifications of Installer.

E. Materials and Equipment Certificates: 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. Certificate shall be signed by an officer of the corporation. Certificates shall be provided for the following:

1. Foam concentrate. Certification that concentrate proposed for use has been tested and is in compliance with approved specifications.
2. Concentrate control valve. Certification that the valve is designed and, constructed as specified and will function as intended.
3. Proportioning system. Certification that the foam proportioning system complies with contract specifications and manufacturer's recommendations.
4. Control panel. Certification that the control panel releasing module is electrically compatible with the electrically-actuated automatic water control valve.
5. Gaskets. Certification from the foam manufacturer that the foam concentrate and foam/water solution is compatible with all gasket materials that it will contact in this system.
6. Foam Containment and Disposal Plan.
7. Compliance with foam system control panel ground fault detection requirement.
F. Material and Equipment Qualifications: Provide materials and equipment that are standard products of manufacturers regularly engaged in the manufacture of such products, which are of a similar material, design and workmanship. Standard products must have been in satisfactory commercial or industrial use for 2 years prior to bid opening. The 2-year use must include applications of equipment and materials under similar circumstances and of similar size. The product must have been for sale on the commercial market through advertisements, manufacturers' catalogs, or brochures during the 2 year period.

1. Alternative Qualifications: Products having less than a two-year field service record will be acceptable if a certified record of satisfactory field operation for not less than 6000 hours, exclusive of the manufacturer's factory or laboratory tests, can be shown.

2. Source Limitations: Obtain foam concentrate, proportioning system, foam generators, and major accessories through one source. All components shall be listed for use together as single system.

3. Product Options: Drawings indicate size, profiles, and dimensional requirements of foam fire-extinguishing systems and are based on the specific system indicated. Other manufacturers' foam fire-extinguishing systems complying with requirements may be considered.

4. Code Compliance: Electrical Components, Devices and Accessories: Listed and labeled as defined in NFPA 70, Article 100, by testing agency acceptable to authorities having jurisdiction, and marked for intended use.

5. NFPA Compliance: Fabricate and label foam fire-extinguishing systems to comply with NFPA 11, except where contract documents provide specific criteria which is different than NFPA.

1.5 SUBMITTAL PREPARER’S QUALIFICATIONS

A. Fire Protection Specialist: The Fire Protection Specialist has obtained National Institute for Certification in Engineering Technologies, Automatic Sprinkler Systems, Level III certification or Special Hazards Suppression Systems, Level IV certification, as applicable to the project. Shop drawings and calculations must be prepared by this Fire Protection Specialist. The QFPE must review the shop drawings, hydraulic calculations and material submittals. The shop drawings must bear the Review Stamp of the QFPE prior to submitting the fire extinguishing system shop drawings.

B. Qualified Fire Protection Engineer (QFPE): An individual who is a registered professional engineer (P.E.) who has passed the fire protection engineering written examination administered by the National Council of Examiners for Engineering and Surveying (NCEES) and has relevant fire protection engineering experience.

1.6 CLOSEOUT SUBMITTALS

A. Test Plan: Test plan shall be complete in describing what measurements are to be made and how they will be collected. Include copies of proposed data collection forms and test reports. Clearly describe what tests are to be conducted, what data is to be collected, acceptable findings, corrective action for failure to meet acceptable findings, equipment required, personnel required, notification procedure for notifying contracting officer, list of manufacturers
employees to assist, integration of test for sprinkler systems, fire pumps, high expansion foam, and fire alarm systems. Verify that the fire pumps are adequate to support the fire protection systems.

1. Provide an initial test plan with test procedures 60 days prior to final acceptance test. Include the following information:
   a. Schedule of tests for each day, Example: Day 1, Day 2, Day 3 etc.
   b. List of tests.
   c. Blank forms for recording test data for each test.
   d. Test procedure for each test.
   e. List of equipment required for each test.
   f. Calibration certificate for testing equipment

2. Submit the preliminary acceptance test report to the Contracting Officer and AHJ before requesting a Final Acceptance Test. Provide the preliminary acceptance test report, digital recording or videotape of the preliminary test, a “Punch List” (list of deficiencies prepared at the completion of preliminary test), and a Final Acceptance Test plan 15 days prior to final acceptance test

3. Provide the Final Acceptance Test Report within 15 days after the completion of the Final Acceptance Test. Provide the final acceptance test report in booklet form showing field tests performed with the digital or video of the final test to document compliance with the specified performance criteria.

4. Provide documentation of readings, test results, and indicate the final position of control valves. Include all required Final Acceptance Test NFPA forms. The Final Acceptance Test report shall include the resolution of punch list items developed during preliminary acceptance testing.

5. Reports for tests, as follows:
   a. Reports as outlined in NFPA 13 documenting results of flushing and hydrostatic tests.
   b. Trip tests of wet pipe sprinkler system and foam deluge system.
   c. Test report of foam concentrate proportioning system. Report shall include all pressure readings and settings of system components. Report shall include conductivity readings for foam samples taken from the high expansion foam proportioner. Report shall be signed by the factory-trained technical representative employed by the foam concentrate manufacturer.
   d. Test report of the foam system control panel and initiating and indicating devices. Report shall include a unique identifier for each device with an indication of test results. Report shall be signed by the factory-trained technician employed by the control panel manufacturer.
   e. Video of tests specified to be recorded.

B. Operation and Maintenance Manuals: Manuals in loose-leaf binder format and grouped by technical sections consisting of manufacturer's brochures, schematics, printed instructions, general operating procedures, and safety precautions. Manuals shall include a narrative description of the sequence or sequences of operation of the overall fire protection system and a
separate description for each major subsystem. Information to be provided shall include specific settings for all adjustable valves. The manuals shall list routine maintenance procedures, possible breakdowns, and repairs, and troubleshooting guide. The manuals shall include conduit layout, equipment layout, and simplified wiring and control diagrams for the system as installed. The manuals shall include procedures and instructions pertaining to frequency of preventive maintenance, inspection, adjustment, lubrication and cleaning necessary to minimize corrective maintenance and repair.

C. Record-Drawings (As-Built Drawings): For Fire Extinguishing System, one set of reproducible and six copies, within 14 calendar days after successful completion of required testing. A separate set of approved submittal drawings of the overall system, marked up to indicate as-built conditions, shall be maintained on site. These drawings shall be maintained in a current condition at all times and shall be made available for review immediately upon request during normal working hours. Variations from the approved drawings, for whatever reason, including those occasioned by modifications, change orders, optional materials, and/or required for coordination between trades shall be indicated in sufficient detail to accurately reflect the as-built conditions.

D. Video Tape of Preliminary and Final Hi-Ex foam discharge test.

E. Spare Parts: Furnish the following spare parts:

1. Two of each type of detector installed (including two optical flame detectors).
2. One of each type notification appliance installed.
3. Four of each type of fuse required by the system.
4. One each foam system manual start station and stop station
5. One fire alarm manual pull station
6. Six complete sets of system keys. Keys must be CAT 60.

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

A. Foam application must be from foam generators providing not less than a 700:1 expansion ratio by aeration specified herein and as indicated on the drawings. Design must be such that foam solution must begin discharging at the most remote foam nozzle within 30 seconds from system activation. Submit foam delivery calculations demonstrating compliance.

B. Cover 90 percent of the aircraft’s projected silhouette on the floor with high expansion foam within 60 seconds upon system actuation (e.g. manual foam pull 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 silhouette for this compliance criterion. For rotary winged aircraft, the rotor sweep is considered part of the silhouette for this compliance criterion.
C. Additionally, cover the aircraft servicing area and adjacent floor areas not cut-off from the hangar bay (e.g. self-closing or automatically closing doors/shutters) with high expansions foam to a depth of 3.2 ft. (1 meter) within four minutes.

D. Rate of Foam Discharge: The rate of discharge shall be as shown on the drawings.

E. Foam Concentrate Proportioning System: Foam proportioning must be by a foam inductor taking suction from an atmospheric high expansion foam concentrate storage tank located directly beneath/adjacent the inductor.

F. Concentrate and Water Supply: System must apply foam solution over the protected area for a minimum of 15 minutes while simultaneously discharging water through the overhead wet pipe sprinkler system specified in Section 211313 WET PIPE SPRINKLER SYSTEM. Reduction of the discharge duration based on a discharge rate higher than the specified minimum is not permitted.

G. Activation: System activation must be controlled by an addressable foam system control panel listed for releasing service.

H. The following will activate the low-level high-expansion foam systems:

1. Manual foam activation stations located as shown on drawings.

2. The cross-zoning of two optical flame detectors in the hangar bay 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, and report to the fire department. The second optical flame detector shall activate the foam system, and report to the fire department.

I. Hydraulic Calculations: Design of low-level high expansion foam systems must be by hydraulic calculations for uniform distribution of HIGH EXPANSION FOAM solution over the protected area as defined on the drawings and must conform to the NFPA standards listed above and to the requirements specified herein.

J. Base hydraulic calculations on the operation of the minimum number of pumps running necessary to supply the high-expansion generators and the sprinkler design area. Pumps are specified under Section 21 31 13 Electric-Drive, Centrifugal Fire Pumps.

K. Hydraulically design the system as follows:

1. Calculations must include pressure discharge graphs or tables showing pressure discharge relationship for foam generators. Design must be such that operating pressure of foam solution nozzles is maintained between (the foam generator's manufacturer's minimum operating pressure +5 psig and the foam generators' manufacturer's maximum operating pressure -10 psig during system discharge. Hydraulic calculations must assume a minimum 20 psi pressure loss for the flow control valve or the minimum pressure loss...
necessary for flow/pressure regulation as published by the manufacturer's literature, whichever is greater. Include "Demand Calculations" and "Supply Calculations".

2. 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 sprinkler system in the hangar bay. Demonstrate the combined fire water demand calculation does not exceed the available fire water supply. Confirm that the resulting foam/water demand from this calculation does not exceed the quantity of foam concentrate shown on the plans.

3. Provide a foam spread calculation/diagram demonstrating the performance requirements to cover the aircraft silhouette are met within one minute. This calculation method is a reasonable approach to demonstrate the design meets the performance requirements, but does not take all aspects into consideration. This 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 RSFACU to open the flow control valve after initiation of the manual foam releasing station.
   b. Time for the foam/water reach the each generator based on the piping velocities in the hydraulic supply calculation.
   c. Time for the foam to reach the floor of the hangar bay 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.
   e. Hydraulically design the sprinkler system to provide 0.2 gpm/sq. ft. over the hydraulically most demanding 5,000 sq. ft. in the hangar bay. Do not increase design area for sloped ceilings.

L. Flow Control Valves: Water flow thru the foam concentrate proportioning system and to the foam generator system must be controlled by flow control valves. Flow control valves must be listed and include control of the opening and closing speed of the valve, provide pressure regulation to the discharge devices, and provide for remote resetting of the valve. Foam proportioning equipment shall activate automatically upon tripping of the flow control valve for the corresponding foam system. The flow control valve shall be tripped by independent detection systems. No valve will be operated by the building fire evacuation and alarm system. Use of motor-operated valves is prohibited. Once activated, the system shall remain activated until reset manually, however, foam flow may be interrupted/stopped momentarily by depressing and holding the "foam stop" button strategically placed on the hangar bay walls as shown on the plans.

M. Flow control valves shall be operated by an addressable foam system control panel listed for releasing service.

N. Hose System: Hose systems including hose reels shall not be provided.

O. 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.

1. 1,500 feet for a system not exceeding a working pressure of 175 psi.
2. 1,000 feet for a system not exceeding a working pressure of 250 psi.
3. 500 feet for a system not exceeding a working pressure of 175 psi, and plastic piping is used (e.g. PVC, HDPE).
4. 300 feet for a system not exceeding a working pressure of 250 psi, and plastic piping is used (e.g. PVC, HDPE).

P. A surge protection 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 study shall consider fire water pumps starting when foam system is activated. The study shall be performed under the supervision of and certified by the Fire Protection Specialist. The Fire Protection Specialist shall have performed such a study for at least three similar systems, that have performed in the manner intended for a period of not less than 6 months. Submit data for approval showing the name and certification of all involved individuals with such qualifications at or prior to submittal of the study. This includes aboveground and underground pipe.

Q. Protection of System Against Earthquake Damage: Seismically protect the system against damage from earthquakes. Install the seismic protection of the system components and piping, including sway bracing as required, in accordance with UFC 3-310-04, NFPA 13 and Annex A. Submit load calculations for sizing of sway bracing, for systems that are required to be protected against damage from earthquakes. Include the required features identified therein that are applicable to the specific piping system.

R. Calculations: Submit design calculations for the system:

1. Hydraulic calculations showing basis for design in accordance with NFPA 11 and NFPA 13.
2. Pressure discharge graphs or tables showing pressure discharge relationship for sprinkler heads and discharge nozzles.
3. Substantiating battery standby power requirements calculations showing battery capacity, supervisory and alarm power requirements.
4. System surge analysis showing surge pressure occurring throughout the system at both design flow and non-flow conditions.

2.2 MATERIALS

A. Materials and equipment shall be 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.

2.3 REQUIREMENTS FOR FIRE PROTECTION SERVICE
A. All equipment and material shall be listed by a Nationally Recognized Testing Laboratory (NRTL) unless otherwise noted in this section or referenced standards.

2.4 PRESSURE RATINGS

A. Valves, fittings, couplings, proportioners, alarm switches, strainers, and similar devices shall be rated for the maximum working pressures that can be experienced in the system, but in no case less than 175 psi.

2.5 NAMEPLATES

A. Major components of equipment shall have the manufacturer's name, address, type or style, model or serial number, and catalog number on a plate permanently affixed to the item of equipment.

2.6 ABOVEGROUND PIPING SYSTEMS HANDLING WATER OR FOAM SOLUTION

A. Pipe:

1. Pipe shall be standard weight conforming to ASTM A 53/A 53M. Pipe shall be Schedule 40 for pipe sizes 2-inch and smaller, Schedule 10 for pipe sizes 2-1/2-inch and larger. Pipe shall be marked as to the brand or name of the manufacturer, kind of pipe and the ASTM designation in accordance with the "Product Marking" provisions of the ASTM standard. Do not use galvanized piping for foam-water system piping.

2. Rubber gaskets used with grooved-end fittings shall be UL listed for use in dry-pipe sprinkler systems. Use of restriction orifices, reducing flanges, and plain-end fittings with mechanical couplings (which utilize steel gripping devices to bite into the pipe when pressure is applied) are not permitted.

3. Provide listed/approved gaskets for dry-pipe service on all foam/water solution piping.

B. Grooved Fittings and Couplings: Grooved fittings, couplings and bolts shall be provided by the same manufacturer. Fittings and couplings shall be malleable iron or ductile iron complying with ASTM A 536. Couplings shall be of the rigid type except that flexible type will be provided where flexible joints are specifically required by NFPA 13. Coupling gaskets shall be Grade E (EPDM) approved for dry pipe fire protection service. Gasket shall be the flush type that fills the entire cavity between the coupling and the pipe. Nuts and bolts shall be heat-treated steel conforming to ASTM A 183 and shall be cadmium plated or zinc electroplated. Gaskets must be compatible with foam concentrate and foam/water solution to which it will be exposed.

C. Non-Grooved Fittings: Non-grooved fittings shall be threaded or flanged. Do not use fittings that couple plain-end pipe or welded sprinkler fittings or outlets for foam-water solution. Threaded fittings shall be cast iron or malleable iron. Plain-end fittings with mechanical couplings, fittings which require drilling a hole in the pipe, and fittings which use steel gripping devices to bite into the pipe and welded sprinkler fittings or outlets are not allowed in the foam system and shall not be used.
D. Flanges and Gaskets: Flanges shall conform to NFPA 13. Flanges shall be the type that are welded or threaded to the pipe. Flanges which are bolted to grooved pipe will not be permitted. Gaskets shall be full face type EPDM or other approved material. Gaskets shall be compatible with foam concentrate and to foam/water solution to which it will be exposed.

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

F. Nuts: Nuts shall be ASTM A 193/A 193M, Grade 5 ASTM A 563M.

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

H. Pipe Hangers: Hangers shall be listed by a Nationally Recognized Testing Laboratory (NRTL) and be of the type suitable for the application, construction and size pipe involved.

I. Control Valve: Unless otherwise indicated, valves shall be indicating type in accordance with NFPA 13. Valves 2-1/2 inch and larger shall be flanged outside screw and yoke (OS&Y) type. Gate valves shall open by counterclockwise rotation.

J. Check Valve: Check valves 4 inches and larger shall be flanged, swing type, cast or ductile iron body and cover, cast or ductile iron clapper with replaceable EPDM rubber facing. 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. The valve body shall include plugged pipe thread connections for a 2 inch drain.

K. Foam System Test Header: Provide a linear test header to meet the fire water demand of the foam/water system. Provide one 2-1/2 inch hose valve connection for each 375 gpm of flow, rounding up. Provide a control valve to isolate the test header from the remainder of the system. Locate test header inside the aircraft servicing area within 20 ft. of an exterior door or directly outside the fire protection equipment room on an exterior wall. Locate test header to discharge effluent to a hard surface within 100 ft. hose lay. In geographic locations having a 99.6% dry bulb temperature less than 32ºF (0ºC ) per UFC 3-400-02 Engineering Weather Data, provide test header with automatic ball drip routed to the exterior.

L. Pressure and Vacuum Gauges: Gauges shall conform to ASME B40.1 and shall be provided with throttling type needle valve or a pulsation dampener and shut-off valve. Gauge shall be a minimum of 3-1/2 inches in diameter with a range from 0 psig to approximately 1.5 times the maximum system working pressure. Each gauge range shall be selected so that at normal operating pressure, the needle is within the middle-third of the range. Gauge shall be liquid-filled type.

M. Surge Arrestors: At a minimum, provide the following surge arrestors. Increase the minimum capacities listed below, when manufacturer’s calculations are required and demonstrate a larger is required.

1. Provide 10 gallons of capacity for each dry-pipe or pre-action riser located on the riser manifold.
2. Provide 25 gal of capacity for each foam/water riser located on the riser manifold.
3. For each riser room, combine the surge capacity of the risers in the room into a single common surge arrester. Connect this common surge arrester to the riser manifold immediately upstream of the protected risers.

4. Where the fire pump is not located in the same room as the risers it serves, provide 100 gal capacity surge arrestors for each fire pump. Locate this surge arrester immediately downstream of the fire pump discharge check valve.

5. The cumulative minimum capacity of each required fire pump surge arrester may be combined into a single common surge arrester. Connect this common surge arrester to the fire pump header immediately downstream of the most remote fire pump.

6. Where surge arrestors are 100 gal or larger in capacity, provide floor stands.

7. Provide each arrestor with an indicating isolation valve to separate it from the system. Electrically supervise this valve 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 arrester to the riser, the use of piping, fittings, and valving smaller than the connecting orifice on the surge arrester is not permitted. After the surge arrester is installed and pressurized in the field with nitrogen per the manufacturer’s written directions, provide a permanent label indicating the set pressure of the arrester. Do not pressurize the surge arrester during hydrostatic testing of the system.

2.7 FOAM CONCENTRATE PIPING AND FITTINGS

A. Pipe: Pipe shall be schedule 40 stainless steel. Pipe and fittings in contact with high expansion foam concentrate shall be material resistant to the corrosive effects of high expansion foam concentrate as approved by the manufacturer of the proportioning system.

B. Fittings: Foam concentrate fittings shall be stainless steel. Fittings must be of the same material as the pipe. Acceptable pipe joining methods are TIG welded, or gasketed welded flanges.

C. Pipe Hangers: Hangers shall be listed by NRTL and be of the type suitable for application, construction, and size pipe involved.

D. Control Valves: Valve shall be indicating type with full port ball and operating handle that indicates the on/off position of the valve. Unit shall be socket weld or flanged type. Valve body and ball shall be of 316 stainless steel complying with ASTM A 351/A 351M. The valve handle shall be provided with a suitable and substantial means for securing the valve open with a key-operated locking device.

2.8 STRAINER

A. Provide an isolation valve and wye or basket strainer in the piping ahead of foam system risers. Provide strainer baskets with stainless steel mesh sized no greater than $\frac{1}{4}$ in (1.59 mm).

B. Welded steel body fire main basket-type pipeline strainer, UL listed for fire service. ASTM A53 pipe and class 150 steel flanges.

C. The strainer shall be designed to permit removal of the strainer screen for replacement and repair without removing the body from the line. A flush outlet shall be provided with each
strainer. Open screen area shall be at least 6 times greater than the nominal pipe size open area. Friction loss shall not exceed 1 PSI at design flow when tested with clean strainer screen and clean water.

2.9 FOAM/WATER FLOW CONTROL VALVES

A. Provide a flow control valve with remote resetting capability for each foam/water system. Provide flow control valve with automatic re-closing feature and adjustable speed control. Install the manual release for the flow control valve no higher than 5 ft. above finished floor. For hydraulic calculations, include the manufacturer’s minimum pressure drop across flow control valve for the features indicated.

B. Arrange valve for manual release at the valve. Provide pressure gages and other appurtenances at the flow control valves as required by NFPA 13. All trim piping must be brass with compatible fittings. Trim piping must be factory configured and installed. Gaskets must be made of EPDM. Valves must be operated by a control system listed for releasing service and independent of the building fire alarm system. Valves located in electrical classified locations must be listed for the classification of the area where located. Flow control valves must include the following features as standard elements of the valve and listed /approved trim package:

C. The electrical solenoid valve used to actuate the water control valve must be an integral component of the valve releasing control panel manufacturer. Solenoid valve must be of the normally closed, de-energized type, which opens when energized upon receipt of an electrical signal from the releasing control panel to which it is connected. Solenoid valves used with diaphragm-type valves must be rated for a maximum pressure differential of 175 psi. Electronic solenoids used for high expansion foam release must be listed for fire service applications and approved by the flow control valve manufacturer for use with the specific valve, and approved by the releasing panel manufacturer for use with the specific panel. Water control valve must be capable of recycling to the closed position at an adjustable speed.

D. Opening/closing speed control - Provide manufacturer's optional valve opening/closing speed control. Flow control valves must gradually open upon receipt of power from the foam system releasing panel and must slowly close upon interruption of power. Speed control setting must be adjusted such that valve closure occurs between 15 seconds and 30 seconds.

E. Flow control valve must be 8-inch Viking J-1 with trim package for electric releasing, remote re-setting, and opening/closing speed control (www.vikingcorp.com).

F. Where an inductor is used for foam/water proportioning, provided field adjustable pressure reducing trim.

G. Pressure regulation maintaining a constant pressure at the inductor and the discharge device (foam generator). Pressure deviation must not exceed ± 10 psig.

2.10 EMERGENCY FOAM/WATER SYSTEM SHUTDOWN
A. Provide sequential signage on the control valves for the emergency shutdown of the foam/water system. Locate these signs so they are readily visible near each valve used in the shutdown sequence. Provide signs with white background and a minimum 1/2 inch wide blue border with red lettering not less than 1 inch 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 FOAM/WATER RISER CONTROL VALVE"). Continue the sequence as required for shutdown.

2.11 HIGH EXPANSION FOAM LIQUID CONCENTRATE

A. Provide 2% high expansion foam concentrate listed by a Nationally Recognized Testing Laboratory (NRTL) for use with the foam generation system.

B. Concentrate must be the product of one manufacturer and must not contain PFOS/PFOA components. Concentrate must have a minimum 20-year shelf life. Manufacture date must be no more than six months before ship date to site. Mixing of non-identical specification concentrate will not be permitted.

C. Provide concentrate for primary tank based on the design as specified herein adequate to support 15 minute discharge at the hydraulically calculated water flow rate and 130% continuous system discharge.

2.12 CONCENTRATE STORAGE TANK

A. Provide a vertical, closed cell double wall polyethylene concentrate storage tank compatible with the required concentrate. Provide a reverse float level gauge with minimum 50 gallon increments permanently marked on the tank or gauge. Indicate on the 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.

B. Provide a concentrate storage tank with a supply of concentrate to support a 15 minute discharge at the hydraulically calculated water flow rate and 130% of the nominal concentrate injection rate.

C. Provide 1/4 inch layer of mineral oil on top of concentrate, after storage tank has been filled.

D. Enter the tank only through the top with no taps on the bottom or sides of the tank. Tank capacity must be 500 gallons or the volume required to fully submerge the inductor dip tube plus the design volume to operate the foam generators for not less than 15 minutes plus 60 gallons whichever is greater. There must be no taps in the bottom or sides of the tank. Inductor dip tube must enter through the top of the tank.

E. Tank Marking: Permanently label each tank with its capacity, concentrate manufacturer, and concentrate type and percentage of concentrate induction. The label must 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 must include a warning statement indicating only this specific concentrate is permitted to be used in this system. Tank must have a NFPA 704 diamond sign indicating Health = 1; flammability = 2; and instability = 0.

F. Concentrate Fill Pump: Provide one pump system to fill the foam concentrate tank. Pump must be positive displacement having a flow rate between 7 gpm and 10 gpm. Pump must be complete with 120 VAC, 60 HZ motor, fused switch, power cord with US plug. Two clear hoses not less than 10 foot for suction and discharge.

2.13 FOAM/WATER PROPORTIONING SYSTEM

A. Foam proportioning must be by a single foam inductor for each foam-water riser. Inductor must be a model BFZ as provided by Fomtec® or USAF AFCEC approved equal.

1. Use a venturi to induct concentrate and proportion such concentrate into the flow stream reliably at the design system flow rate.
2. 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 concentrate tank. Off the shelf pre-tuned generic model inductors are not permitted.
3. Design inductor to 115% of the nominal injection rate.
4. Size inductor for the exact orifice of foam/water pipe.
5. 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.
6. Provide a design that indicates the inductor's flow rate, inlet pressure, back pressure, and concentrate lift height for a near empty concentrate 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.
7. Known manufacturers of such products include:

a. Fomtec
b. Skum
c. Matre Maskin
d. Wilson Foam
e. Ansul, Chemguard
f. Delta Fire

B. Foam Concentrate Piping: Provide a brass, bronze, or stainless steel full bore quarter turn ball valve with an electrically supervised tamper switch in the concentrate line. The use of automatically controlled valves in the 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 test foam concentrate. Cap auxiliary tank connection at all times, except when testing. Provide a 3/4 inch copper line with ball valve from the fire water supply, that is used for flushing the concentrate line after use. Provide sign with the following instructions, "Flush concentrate line after discharge or testing. Close concentrate tank shut-off valve prior to opening this valve. After flushing, drain concentrate line through test connection prior to re-opening concentrate tank shut-off valve."
2.14 FOAM GENERATORS

A. Generator shall be capable of producing not less than 14,490 cubic feet of expand foam-water solution per minute.

B. Generator discharge characteristics shall not result in any foam solution being discharged on aircraft fuselage and wing components from direct impingement or misting. Generator operations pressure shall be such that high pressure fittings and system components must not be required.

C. Total nozzle obstruction shall not negatively impact the distribution system hydraulics or foam induction capabilities.

D. The foam generator shall be listed for use with the foam concentrate. The 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 foam generator shall not require and outside power source, such as electricity. A stainless steel screen shall be provided for maximum reliability under fire conditions.

E. A dedicated pressure gauge shall be installed at each foam generator for system testing, with readouts available at floor level. Pressure gauges and installation shall comply with testing portion of this specification.

F. System must be designed to provide at each generator the manufacturer’s minimum operating pressure of plus 10 psi (plus-or-minus 5 psi).

G. Generator nozzle hydraulics shall be compatible with simple inductor proportioning.

2.15 SURGE ARRESTER

A. Equip every foam riser with a bladder type surge arrestor sized by the manufacturer to prevent damage to the fire protection system. Minimum size is 10-gallon capacity. Units must be listed by an NRTL for fire service and have a working pressure of not less than 275 psi or design pressure whichever is greater. Provide pressure gauge for bladder/shell pressure reading. Provide wall-mount brackets for 10-gallon units. Provide sizing calculations performed by the manufacturer as a part of the submittal process.

2.16 FOAM RELEASING SYSTEM

A. The Releasing Service Fire Alarm Control Unit (RSFACU) shall be an addressable listed for "Releasing Device Service" or shall have modules approved for this purpose. 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. Control panel shall be a clean, uncluttered, and orderly factory assembled and wired unit. 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. Control 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 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.

B. Provide a separate FACU and RSFACU. Combining the FACU and RSFACU into a common control unit is not permitted.

C. Install the FACU and RSFACU in a location readily accessible to the emergency responders and maintenance personnel.

D. Provide a RSFACU for the control and release of the foam/water system. Design the system so the loss of a FACU or another RSFACU in the fire alarm system does not prohibit the RSFACU from functioning as intended (e.g. release or stop the foam/water system, alert the receiving station). Do not connect the RSFACU to other control unit through the use of a network cable. Communicate functionality between panels through addressable modules only. A common RSFACU may control multiple releasing systems or agents.

E. Connect and supervise only initiating and notification devices used by the foam/water system. Release the foam/water system only by the initiating devices. Additional devices are not permitted to release the foam/water system. (E.g. Do not release the foam/water system from the pressure switch on the foam/water riser.)

F. Locate the RSFACU, releasing modules, and monitor modules integral to the releasing and stopping of the foam/water system in a conditioned space with the following parameters: temperature between 60-80°F (15.6-26.7°C) and a relative humidity of 85% at 86°F (29.5 ºC). Do not install these components in the hangar bay.

G. 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.

H. 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 RSFACU.

I. RSFACU shall include, multi-spectrum infrared (IR) flame detectors, manual releasing stations, manual stop (abort) 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 must be sourced through Det-Tronics, the manufacturer of the required RSFACU and optical flame detectors.
detectors, to ensure compatibility. For the purposes of this Contract, all Det-Tronics installation recommendations must be considered as mandatory requirements. All devices must be grounded in strict accordance with the Det-Tronics installation instructions. All circuit wiring must be installed as part of shielded cable assemblies, in rigid galvanized steel conduit, and grounded in strict conformance with the Det-Tronics installation instructions.

1. Releasing Service Fire Alarm Control Unit (RSFACU):

   a. RSFACU must be Det-Tronics Eagle Quantum Premier Fire Detection/Releasing System, must be equipped with redundant controllers and must 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. RSFACU alarm, supervisory, and trouble signal reporting to the Fire Alarm Control Panel must be via discrete dry contact output points. Modular type panel installed in a surface mounted NEMA Type 4 painted steel cabinet with hinged door and cylinder lock. Switches and other controls must not be accessible without the use of a key. The control panel must be a neat, compact, factory-wired assembly containing all parts and equipment required to provide specified operating and supervisory functions of the system. Panel cabinet must 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.

   b. Provide audible trouble signal. Provide prominent engraved rigid plastic or metal identification plates, or silk-screened labels attached to the rear face of the panel viewing window, for all lamps and switches. System power must be 120 volts AC service, transformed through a two winding isolation transformer and rectified to 24 volts DC for operation of all system initiating, actuating, signal sounding, trouble signal and fire alarm tripping circuits. System must 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 must result in the operation of the system trouble signal. Loss of AC power, a break in the standby battery power circuits, or abnormal AC power or low battery voltage must result in the operation of the system trouble signals. The abnormal position of any system switch in the control panel must result in the operation of the system trouble signals. Trouble signals must operate continuously until the system has been restored to normal at the control panel. System trouble must also be annunciated on the appropriate zone of the building fire alarm and mass notification control panel. The foam system manual releasing stations, abort stations, optical flame detectors, and all associated wiring must be connected to and supervised by the releasing system control panel. Control panel must be equipped with a NEMA Type 4 enclosure. System control panel must be UL listed or FM approved, for extinguishing system control (releasing device service). Permanently label all switches. 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 must 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 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 panel while leaving all detection and other functions of the panel operational. Activation of this switch must transmit a non-latching supervisory alarm signal to the building fire alarm control panel. Switch must be provided within a lockable control panel.

J. Conduit Installation: Flexible conduit is only permitted when connecting to the following devices and appliances. Devices located on fire suppression equipment such as flow/pressure switches, solenoids, and tamper switches. Devices and appliances located in removable ceiling tiles, and where flexible conduit is specifically noted in this UFC (e.g. optical flame detectors). A maximum of two conduit penetrations are permitted into a secured area. Most areas only require one penetration. Provide self-amplified speakers or dedicated amplifiers within the secured area to meet the requirements.

1. Conduit and Enclosure Installation within the Hangar Bay: Provide NEMA 250 Type 4 wall mounted devices and appliances within the hangar bay (including backboxes). Provide watertight conduit and junction boxes throughout the hangar bay. Route conduit into the bottom of the backbox for manual foam releasing stations, stop stations, and flame detectors. Provide the low point of this conduit with a 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.

K. Surge Protective Devices (SPD): Provide SPDs to protect all power supply circuits to the RSFACU, including any subpanels. Provide SPD to protect all circuits leaving or entering the building. Mount SPDs in a separate enclosure, unless the SPD is listed and installed in the control panel by the factory (e.g. Installing SPDs not listed with the panel is prohibited).

L. Main Annunciator: Provide integral with the main control 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 must have an alpha-numeric display and provide the description of the device.

M. System Zoning: The system shall be a single zone for foam discharge.
N. Primary Power Supply: Primary power and trouble alarm. Power to the control panel shall be as indicated. Panel shall be permanently marked “FOAM FIRE PROTECTION SYSTEM.”

O. Secondary Power Supply: Provide for system operation in the event of primary power source failure. Transfer from normal to auxiliary (secondary) power or restoration from auxiliary to normal power shall be automatic and shall not cause transmission of a false alarm.

1. Batteries: Provide sealed, maintenance-free, sealed lead acid batteries as the source for emergency power to the RSFACU. Batteries shall contain suspended electrolyte. The battery system 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 to the batteries in the event of the failure of primary power.

   a. Capacity: Battery size shall be the greater of the following two capacities:

      1) Sufficient capacity to operate the fire alarm system under supervisory and trouble conditions, including audible trouble signal devices for 48 hours and audible and visual signal devices under alarm conditions for an additional 60 minutes.

   b. Battery Power Calculations: Verify that battery capacity exceeds supervisory and alarm power requirements.

      1) Substantiate the battery calculations for alarm, alert, and supervisory power requirements. Include ampere-hour requirements for each system component and each panel component, and compliance with UL 864.

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

      3) A voltage drop calculation to indicate that sufficient voltage is available for proper operation of the system and all components, at the minimum rated voltage of the system operating on batteries.

   c. For battery calculations use the following assumptions: Assume a starting voltage of 24 VDC for starting the calculations to size the batteries. Calculate the required Amp-Hours for the specified standby time, and then calculate the required Amp-Hours for the specified alarm time. Calculate the nominal battery voltage after operation on batteries for the specified time period. Using this voltage perform a voltage drop calculation for circuit containing device and/or appliances remote from the power sources.

2. Battery Chargers: Provide a solid state, fully automatic, variable charging rate battery charger. The 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 dc), the 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.
P. RSFACU Supervised Disconnect: Provide a key operated RSFACU Supervised Disconnect switch to physically disable the solenoid for each foam/water and pre-action riser (if provided). Provide switch that disables the releasing functions without the use of programming, while leaving all other functions of the panel operational. Do not provide a trouble signal upon operation of the disconnect. Locate the disconnect switch in the riser room, in a readily accessible location near the solenoid. Provide a sign near the disconnect switch with a white background and a minimum 1/2 inch wide blue border, with “DISABLE FOAM SYSTEM" in red lettering not less than 1 inch high. Provide engraved labels on the disconnect switch indicating when the system is "ENABLED" or "DISABLED". Do not install backboxes or route conduit in front of sign in a manner that obstructs any lettering.

2.17 ALARM

A. Fire Alarm: Provide equipment and interconnections for the automatic transmittal of an alarm over the building fire alarm system as specified in Section 28 31 11 “Digital, Addressable Fire-Alarm and Mass Notification System.” Arrange so that actuation of any alarm initiating device (OFD or manual release station), trouble and supervisory conditions shall cause activation of the fire alarm and reporting systems.

B. Waterflow Pressure Alarm Switch: Unit shall include a 1/2 inch NPT male pipe thread, two 1/2 inch conduit knockouts, and two sets of SPDT (Form C) contacts. The switches shall be factory adjusted to transfer the contacts at 4 to 8 psi on rising pressure. Unit shall include a water-tight NEMA 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. Units 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.

2.18 CONTROL VALVE SUPERVISORY (TAMPER) SWITCH

A. Electrically supervise normally open control valves.

B. Electrical or mechanical supervision is not required for normally closed control valves, unless opening the valve is detrimental to the system operation. When supervision is required on normally closed valves, provide electrical supervision (e.g. cable type monitoring).

C. Provide an addressable tamper switch for each fire protection system control valve. This includes, but is not limited to, providing tamper switches on all manual valves in the foam concentrate system and In-line Balanced Pressure Proportioning System. Tamper switches shall be UL listed as "Extinquishing System Attachment" for the location and type of valve supervised. The device shall contain double pole, double throw contacts. Operation of the switch shall cause a supervisory signal to be transmitted to the FACP upon not more than two complete turns of the valve wheel or a closure of 10 percent, whichever is less. Tamper switches shall be equipped with screw terminals for each conductor.
D. All valves which control alarm functions or the flow of water, foam, foam concentrate, or that when closed will disrupt the proper operation of a system shall be electronically supervised. This includes, but is not limited to, deluge valve alarm isolation valve, foam concentrate tank outlet line valve, foam concentrate tank water inlet valve, and water operated foam mixing valve pilot line valve.

2.19 TRIM VALVES
   A. Mechanically lock or provide tamper seals (e.g. zip-ties) on trim valves, that when opened or closed are detrimental to the operation of the foam/water system (e.g. foam system pressure switch shutoff). Provide signage indicating the valve’s normal operating position.

2.20 DRAIN VALVES
   A. Mechanically lock or provide tamper seals (e.g. zip-ties) on drain or trim valving in the closed position, that when opened will cause the discharge of the foam/water system (e.g. manual release valve on the foam/water system riser). Provide this valve with the following signage, “OPENING THIS VALVE WILL RELEASE THE FOAM SYSTEM.”

2.21 FOAM SYSTEM BEACONS AND PERFORMANCE BASED DESIGN
   A. Provide blue visual alarm signals (rotating beacons) within the aircraft servicing area to indicate foam system activation. Mount signals 10 to 20 feet above the finished floor and located to be visible from all parts of the aircraft maintenance and servicing area. Beacons shall be circuited to Releasing Service Fire Alarm Control Unit (RSFACU) only. Provide performance based design per NFPA 72 for visible notification appliance in Maintenance Bay, as described in section 28 31 11.
   B. Surface mounted industrial visual warning devices complying with UL 167. Devices must be a flashing rotary beacon (150 watt), strobe (300 candelas) or equivalent LED type and powered from the facility power and controlled by the foam system control panel. Flash rate shall be between 60 and 120 flashes per minute. Device must be blue.

2.22 MANUAL FOAM RELEASING STATIONS
   A. Manual Foam Releasing Stations shall be as shown on the plans, and shall be weatherproof.
   B. Provide distinctively different NEMA 250 Type 4 manual foam releasing stations and signage from the manual fire alarm pull stations. Provide tamper cover with colored portions in yellow and lettering on the cover reading “FOAM”; the words “FIRE”, “ALARM”, or “AGENT” are prohibited to appear on the cover. Provide locking type manual foam releasing stations that when activated require a key to be reset. Provide conventional manual foam releasing stations.
C. Protect foam releasing stations located in the hangar bay from mechanical. Provide a clear plastic tamper cover over the manual foam releasing station that when lifted emits an audible alarm

2.23 MANUAL FOAM STOP STATIONS

A. Provide NEMA 250 Type 4 manual foam stop stations of the "dead-man" type at each manual foam releasing station. Use stop stations in conjunction with valves and equipment that stop the discharge of foam/water from the suppression system. 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”, “ALARM”, or “AGENT” are prohibited to appear on the cover or station. Do not locate addressable monitor modules for the manual foam stop stations in the hangar bay.

B. Once depressed, and so long as the button is held down, design the system so the 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 stop station is pressed and held. Unless the RSFA CU has been reset and all activation alarms (manual and automatic) have been cleared; restore the foam/water system operation when the foam stop station button is released. Do not exceed 15 seconds to fully close the flow control valve when the foam stop station button is depressed under full flow. Where the foam/water system is still in alarm, do not exceed 5 seconds to fully open the flow control valve upon release of the foam stop station button.

C. Protect manual foam stop stations located in the aircraft servicing area from mechanical damage. Provide a clear plastic tamper cover (without audible alarm) over the manual foam stop station

2.24 MANUAL FOAM RELEASING AND STOP STATION SIGNAGE

A. Provide two separate but adjacent metal signs a minimum of 24 inches high by 20 inch 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.

B. Provide the sign for the manual foam releasing 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 releasing station with tamper cover on the lower portion of the sign. Provide the word “START” in minimum 1 inch high green lettering placed directly above the manual foam releasing station.

C. 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 station 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.
D. To the right of the stop 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."

2.25 OPTICAL FLAME DETECTORS

A. Optical Flame Detectors and Controller: Provide triple infrared (IR) optical flame detectors that
are listed/approved for the expected fuel hazards in the hangar bay. Provide detectors that are
immune to radar and radio frequency emissions from hand held equipment or equipment on-
board the aircraft. Provide shielded circuiting from the optical detectors to the Releasing
Service Fire Alarm Control Unit (RSFACU) and ground shielding at one end.

B. In order to reduce false foam activations from short circuits, ensure that components for in the
hangar bay as follows: watertight back boxes, enclosures, and conduit/connections; and NEMA
4 junction boxes. All wiring serving the triple IR optical flame detectors shall be in conduit
and enter the detector from the bottom. Provide shielding for the optical flame detectors and
their circuits from radio frequency interference. Provide shielded circuiting from the optical
detectors to the Releasing Service Fire Alarm Control Unit (RSFACU) and ground shielding at
one end. Class X circuits per NFPA 72 shall be provided.

C. 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 detectors that are immune to radar and radio frequency emissions.

D. The control panel will be directly connected to, and monitored by, the Releasing Service Fire
Alarm Control Unit (RSFACU). The optical detection system shall be interfaced with the
building fire alarm and reporting system, but shall not rely on it for operation. At least three
separate dedicated zones shall be provided for reporting the status of the optical detection
system to the remote location. One dedicated zone for the first optical detector in alarm, a
second dedicated zone for the second optical detector in alarm, and a third dedicated zone for a
fault signal in the optical detection system.

E. The system shall provide continuous and automated detection, while monitoring system
operation through continuous supervision of its inputs/outputs. The detectors shall include
continuous automatic periodic self-testing and calibration during operation, including lens
cleanliness check, and IR sensor testing and automatic calibration. The detector shall have
manual testing capability of the lens and sensors, that is easily performed and verified at the
detector, without disassembly of the detector. Each detector shall have an integral indicator
lamp, visible from the hangar floor, indicating whether it is in alarm (red), fault (amber), normal
(green) status.

F. Optical Flame Detectors: Optical flame detectors must be Det-Tronics X3301 Series and no
other, complete with laser holder and laser for aiming. Detector lens heating option must be
set to zero

PART 3 - EXECUTION
3.1 INSTALLATION

A. Aboveground Piping: Piping shall be installed straight and bear evenly on hangers and supports. Piping shall be concealed in areas with suspended ceiling and shall be inspected, tested and approved before being concealed.

1. Joints: Pipe joints shall conform to NFPA 13. 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. Flanged joints or mechanical groove couplings shall be provided where indicated or required by NFPA 13. Pipe grooves shall be made by the cut-groove method. Grooved pipe and fittings shall be prepared in accordance with the manufacturer's latest published installation instructions. All grooved couplings and fittings shall be from the same manufacturer. Grooved joints shall not be used in concealed locations, such as behind solid walls or ceilings, unless an access panel is shown on the drawings for servicing or adjusting the joint.

2. Fittings: Use flanged or welded fittings to transition the fire protection water service entrance from horizontal to vertical as it enters the building. Do not use gasketed compression fittings (including locking type) or flanged fittings with set screws.

3. 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.

4. Valves: Provide a butterfly valve beneath each flow control valve in each riser, when more than one valve is supplied from the same water supply pipe.

5. Pipe Supports and Hangers: Installation methods outlined in NFPA 13 are mandatory. Protection of piping and all foam equipment including foam tanks and generators against damage from earthquakes shall be provided. Longitudinal and lateral sway bracing shall be provided for piping.

6. Foam/Water Solution Piping Seismic Bracing: Seismically brace foam/water solution piping regardless of geographic location. Base bracing calculations on an Ss of 0.95 or as indicated in the seismic analysis, whichever is greater.

7. Pipe Penetrations: Cutting structural members for passage of pipes or for pipe-hanger fastenings will not be permitted.

   a. Escutcheon Plates: Escutcheons shall be provided at finished surfaces where exposed piping passes through floors, walls, or ceilings except in boiler, utility, or equipment rooms. Escutcheons shall be fastened securely to pipe and shall be chromium-plated iron or chromium-plated brass, either one-piece or split-pattern, held in place by internal spring tension or setscrew.

   b. Pipe Sleeves: Refer to Section 210517 “Sleeves and Sleeve Seals for Fire-Suppression Piping.” Pipes penetrating concrete or masonry walls or concrete floors shall be provided with pipe sleeves fitted into place at the time of construction through its respective wall or floor, and shall be cut flush with each surface. Sleeve sizes and clearance between pipe and sleeve shall be in accordance with NFPA 13. Provide not less than 1/4 inch space between exterior of piping and interior of sleeve. Firmly pack space with insulation and caulk at both ends of the sleeve with plastic waterproof cement. ASTM A53/A53M, schedule 40 or
standard weight, zinc-coated steel pipe sleeves. Extend sleeves in floor slabs 3 inches above the finished floor. Where pipes pass through fire walls, fire partitions, or floors, a fire seal shall be placed between the pipe and sleeve in accordance with Section 07 84 00 “Firestopping.”

c. Sleeves in Partitions: Provide zinc-coated steel sheet having a nominal weight of not less than 0.90 pounds per square foot.

d. Drains: Main drain piping shall be provided to discharge at safe points outside each building. Drains shall be of adequate size to readily receive the full flow from each drain under maximum pressure. Auxiliary drains shall be provided as required by NFPA 13 except that drain valves shall be used where drain plugs are otherwise permitted. Where branch lines terminate at low points and form trapped sections, such branch lines shall be manifolded to a common drain line. Each drain valve shall be provided with a metal sign identifying the type of drain connection or function of the valve.

e. Identification Signs: Refer to Section 210553 “Identification for Fire-Suppression Piping and Equipment.” Signs shall be in accordance with NFPA 13. Properly lettered and approved metal signs shall be suitably affixed to each control valve, inspector test valve, main drain, auxiliary drain, test valve, and similar valves as appropriate. See drawings for additional sign requirements. Identification signs shall indicate Normally Open or Normally Closed as appropriate.

3.2 ELECTRICAL WORK

A. Except as modified herein, electric equipment and wiring shall be in accordance with Section 26 20 00 INTERIOR DISTRIBUTION SYSTEM. Alarm signal wiring connected to the building fire alarm control system shall be in accordance with Section 283111 Digital, Addressable Fire-alarm and Mass Notification System. All wiring for supervisory and alarm circuits shall be minimum #16 AWG solid copper installed in metallic tubing or conduit. Wiring color code shall remain uniform throughout the system.

B. System Field Wiring: Provide control wiring and connections to fire alarm systems, under this section and conforming to NFPA 70 and NFPA 72. All wiring must be color coded. Wiring, conduit and devices exposed to water or foam discharge must be NEMA 4. Wiring, conduit and devices located in hazardous atmospheres, as defined by NFPA 70 and as shown, must be NEMA 7 (explosion proof). All conduit must be minimum 3/4 inch size.

C. Wiring Within Cabinets, Enclosures, Boxes, Junction Boxes, and Fittings” Provide wiring installed in a neat and workmanlike manner and installed parallel with or at right angles to the sides and back of any box, enclosure, or cabinet. Conductors which are terminated, spliced, or otherwise interrupted in any enclosure, cabinet, mounting, or junction box must be connected to terminal blocks. Mark each terminal in accordance with the wiring diagrams of the system. Make connections with approved pressure type terminal blocks, which are securely mounted. The use of wire nuts or similar devices must be prohibited.

D. Terminal Cabinets: Provide a terminal cabinet at the base of any circuit riser, on each floor at each riser, and where indicated on the drawings. Terminal size must be appropriate for the size of the wiring to be connected. Conductor terminations must be labeled and a drawing
containing conductors, their labels, their circuits, and their interconnection must be permanently mounted in the terminal cabinet. Minimum size is 8 inches high by 8 inches.

E. Alarm Wiring: Signaling line circuits and initiating device circuits must be Class B field wiring must be copper, No. 18 AWG size conductors at a minimum. Notification appliance circuit conductors, that contain audible alarm devices, must be solid copper No. 14 AWG size conductors at a minimum. Wire size must be sufficient to prevent voltage drop problems. Circuits operating at 24 VDC must not operate at less than 21.6 volts. Circuits operating at any other voltage must not have a voltage drop exceeding 10 percent of nominal voltage. Power wiring, operating at 120 VAC minimum, must be No. 12 AWG solid copper having similar insulation. Provide all wiring in rigid metal conduit or intermediate metal conduit minimum ¾”. Electrical metallic tubing conduit is acceptable in dry locations not enclosed in concrete or where not subject to mechanical damage. Conceal conduit in finished areas of new construction and wherever practicable in existing construction. The use of flexible conduit not exceeding a 5 foot length must be permitted in initiating device circuits. Run conduit or tubing concealed unless specifically shown otherwise on the drawings. Shielded wiring must be utilized where recommended by the manufacturer. For shielded wiring, the shield must be grounded at only one point, which must be in or adjacent to the RSFACU. All wiring must be installed splice free. Pull a dedicated earth ground conductor on all runs and bond to enclosures, boxes, and field devices which have ground terminals. Color coding is required for circuits and must be maintained throughout the circuit.

F. Conductor Terminations: Labeling of conductors at terminal blocks in terminal cabinets, RSFACU, and remote foam system control units shall be provided at each conductor connection. Each conductor or cable shall have a shrink-wrap label to provide a unique and specific designation. Each terminal cabinet, RSFACU, and foam system control unit shall contain a laminated drawing which 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, panel, or unit so that it does not interfere with the wiring or terminals. Maintain existing color code scheme where connecting to existing equipment.

G. Operating Power: Power shall be 120 volts AC service, transformed through a two winding isolation type transformer and rectified to 24 volts DC for operation of all signal initiating, signal sounding, trouble signal, and actuating (releasing) circuits. Provide secondary DC power supply for operation of system in the event of failure of the AC 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 AC operating power for control panel, and battery charger as indicated on the drawings.

H. Conductor Identification: Identify circuit conductors within each enclosure where a tap, splice or termination is made. Identify conductors by plastic coated self-sticking printed markers or by heat-shrink type sleeves. Attach the markers in a manner that will not permit accidental detachment. Properly identify control circuit terminations.

I. All conduit shall be factory painted red in unfinished areas. In finished areas, conduit may be painted to match room finish and with red painted ¾-inch wide bands every 20 feet and on both sides of walls. Comply with UFC 3-600-01.
3.3 FOAM GENERATOR INSTALLATION

A. Install Hi-Ex foam generators to provide a minimum 20 inches clearance in front of the generator inlet. Seismically brace generators regardless of geographic location. Base bracing calculations on an Ss of 0.95 or as indicated in the seismic analysis, whichever is greater. The use of all-thread rod for supporting generators is not permitted.

B. Tap the generator foam/water supply piping with a valve to allow for the attachment of a pressure gauge or sampling hose during testing.

C. Locate Hi-Ex generators to discharge within close proximity, but not directly upon the aircraft. When mounting generators in the horizontal position, take into account the throw pattern of the Hi-Ex foam discharge. Do not locate the generator where the Hi-Ex foam 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 foam generators to protect under the aircraft fuselage and underwing area, prior to spreading to the remaining hangar bay floor area.

D. Do not provide generators in locations where the developing foam blanket will block exits from the hangar bay within the first minute of discharge. Blocked exits are defined as an exit that is obstructed by a foam blanket exceeding 5 ft. in depth.

3.4 INDUCTOR INSTALLATION

A. Provide a single foam inductor per foam/water riser meeting the requirements outlined below. Where more than one foam inductor is used, they may take suction from a common concentrate tank. Do not supply more than one fire area from a single inductor.

B. Install inductor in the horizontal piping over the top of the concentrate tank. Provide the minimum straight pipe on both sides of the 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 ft. before and after the inductor.

C. The inductor must be elevated above the maximum fill level of the concentrate tank and have no automatic control valves in the concentrate line. Inductors must be installed with not less than 48 inches straight pipe up and down stream of the inductor. Provide gauge cocks with oil-filled gauges (0-200 psi, 2.5 percent accuracy) 3 feet before and after the inductor. Provide permanent engraved rigid plastic or corrosion-resistant metal constructed label for each control device.

3.5 MANUAL RELEASE STATIONS INSTALLATION

A. Provide low-level high expansion foam manual release stations where shown. Stations shall be of a type not subject to operation by jarring or vibration. 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. Station shall provide positive visible indication of operation. Restoration shall require use of a key. Place warning signs at each station indicating that operation of the station will cause immediate high expansion foam
discharge. Where a building fire alarm manual pull station is also mounted in the vicinity of a foam manual release station, separate the stations by at least 5 feet horizontally. Mount station on signage panel as specified herein and detailed on drawings. Manual releasing stations shall be locking type that, when activated, require a key to be reset. Manual releasing stations shall be surface mount. Manual releasing stations shall be yellow in color, distinctly different from manual fire alarm stations, and shall be mounted on a signage panel. Manual releasing stations shall have the word "FOAM" on the front exterior of the enclosure. No other words shall appear anywhere on the exterior of manual releasing station enclosures. Manual releasing stations shall be equipped with clear plastic tamper covers. The tamper covers shall have the word "FOAM" on the front. No other words shall appear anywhere on the exterior of tamper covers. Stations including associated surface mount back boxes shall be weatherproof type with bottom conduit entry only. Stations with top conduit entry hubs are not acceptable.

B. Where a manual foam releasing station is installed near an exit or exit access, install it on the opposite side of the door from the general fire alarm pull station, if provided.

3.6 OPTICAL FLAME DETECTOR INSTALLATION

A. Provide a sufficient number of optical flame detectors around the perimeter of the hangar bay, such that all portions of the hangar bay are within the range and cone-of-vision of at least three detectors. Exception: The area of the hangar bay within 5 ft. 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. Where the single aircraft wing area exceeds 1,000 sf, a minimum of two optical flame detectors covering the aircraft silhouette are required on each side of the fuselage.

B. Angle 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 ft. outside the hangar bay, into another fire area (e.g. through normally open roll-up fire doors), 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 (e.g. welding, solar glare, radiant heaters, aircraft engine exhaust, strobes, hot surfaces and other relevant sources.)

C. Mount detectors in accordance with their listing at approximately 8 ft. above the finished floor of the hangar bay. Do not mount optical detectors in inaccessible locations. Provide optical flame detectors with 5 ft. of flexible conduit to allow for minor adjustments during testing or changes in the mission of the hangar bay.

D. Permanently mark on each detector the horizontal and vertical axis determined during testing. 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 bay.

E. Calibrate optical flame detectors to operate upon viewing the flame signature of the expected fuel(s) to be in the hangar bay. Use a 2 ft. x 2 ft. pool fire as the bases to set the sensitivity of the optical flame detectors. Upon the 2 ft. x 2 ft. pool fire reaching full development, all detectors within the cone-of-vision are required to activate within 30 seconds.
F. The representative from the manufacturer of the optical flame detection system shall perform all programming on, and witness and certify acceptance testing (including witnessing panel fire tests on site), on the triple IR detection system. The manufacturer's representative, who programs, and certifies and witnesses the acceptance tests, shall submit qualifications to the government for approval.

3.7 PIPE PAINTING AND LABELING

A. Painting: Paint all exposed interior piping (color will be the same 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.

B. Clean, prime, and paint new foam systems including valves, piping, conduit, hangers, miscellaneous metal work, and accessories. Apply coatings to clean dry surfaces using clean brushes. 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 sprinkler heads and operating devices. Upon completion of painting, remove materials which were used to protect sprinkler heads and operating devices while painting is in process. Remove sprinkler heads and operating devices which have been inadvertently painted and provide new clean sprinkler heads and operating devices of the proper type. Finish primed surfaces as follows:

1. Foam Systems in Unfinished Areas: Unfinished areas are defined as attic spaces, spaces above suspended ceilings, crawl spaces, foam rooms, pump rooms, pipe chases, and other spaces where ceilings are not painted or not constructed of a prefinished material. Paint primed surfaces with two coats of CID A-A-2962 red enamel applied to a minimum dry film thickness of 1.5 mils.

2. Foam Systems in All Other Areas: Paint primed surfaces with two coats of paint to match adjacent surfaces, except paint valves and operating accessories with two coats of CID A-A-2962 red enamel applied to a minimum dry film thickness of 1.5 mils. Provide piping with 2 inch wide red bands spaced at maximum 20 foot intervals throughout the piping systems. Bands shall be red enamel or self-adhering red plastic tape.

C. 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 branchlines regardless of size, or mains and cross-mains less than a nominal 2-1/2 in. Labels are not required on piping routed below the floor line in trenches or pits. Refer to Section 210553 “Identification for Fire-Suppression Piping and Equipment.” At a minimum, the following labels are required.

1. FIRE PROTECTION WATER - Used on dedicated potable and non-potable fire protection water supply piping.

2. FOAM CONCENTRATE - Used on foam concentrate piping.
3. FIRE SPRINKLER - Used on water-only sprinkler piping.
4. HIGH EXPANSION FOAM - Used on Hi-Ex foam/water piping.

3.8 INSPECTION BY FIRE PROTECTION SPECIALIST

A. The Fire Protection Specialist shall inspect the system periodically during the installation to assure the system is being provided and installed in accordance with the contract requirements and the approved sprinkler system submittal(s). This Fire Protection Specialist shall attend all the preliminary and final tests, and shall sign the test results. After the preliminary testing has been completed, the Qualified Fire Protection Engineer shall certify in writing that the system is ready for the final inspections and tests. This report shall document any discrepancies found and what actions will be taken to correct. Any discrepancy noted during the periodic site visits or the preliminary testing shall be brought to the attention of the Contracting Officer in writing, no later than three working days after the discrepancy is discovered.

3.9 FORMAL INSPECTION AND TESTING REQUESTS

A. Submit the request for formal inspection and testing at least 30 working days prior to the date the inspection is to take place.

1. All Certification that preliminary testing has been completed and a copy of the preliminary test report shall accompany the request for formal inspection.
2. The control panel(s) and detection system(s) shall be in continuous service for a "break-in" period of at least 15 consecutive days prior to the formal inspection.
3. Experienced technicians regularly employed by the Contractor in the installation of both the mechanical and electrical portions of such systems shall be present during the inspection and shall conduct the testing.
4. All HIGH EXPANSION FOAM concentrate, instruments, including optical flame detector test lamp and function test kit, personnel, appliances and equipment for testing shall be furnished by the Contractor. All necessary tests encompassing all aspects of system operation shall be made including the following, and any deficiency found shall be corrected and the system retested at no cost to the Government.
5. The Contractor shall submit the Final Acceptance Test.
6. Provide protection for all electrical fixtures and equipment exposed to possible damage during tests and protect doors and other openings leading from the protected area(s), to prevent migration of foam solution into other areas or spaces. Install plastic sheeting over all wall and door surfaces from the finish floor to not less than 20 feet above the finish floor.

3.10 TESTING PERSONNEL

A. The Qualified Fire Protection Engineer shall witness and/or review of testing/reports as outlined in this section.

B. At a minimum, provide a factory authorized representative for the startup and/or testing of the following systems as outlined below:
1. Fire Suppression System (Preliminary and Final Testing)
2. Foam Proportioning System (Preliminary and Final Testing)
3. Fire Pump System, When Provided (Start Up)
4. Fire Alarm and Mass Notification System (FACU/ACU) (Preliminary and Final Testing)
5. Foam/Water Releasing System (RSFACU) (Preliminary and Final Testing)
6. Optical Flame Detection System (Preliminary and Final Testing)

3.11 FOAM/WATER DISCHARGE TESTING PLAN

A. Contractor must prepare a plan for conducting the test and the duties of the test team. Contractor must remove any mobile / portable equipment from the hangar servicing area. Contractor must cover the hangar walls and surface mounted equipment with plastic sheeting from the finished floor to 20 feet above the finished floor. Doors into adjacent areas must be protected to prevent foam-water solution leaking into the adjacent areas during the test and subsequent clean-up. The 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 contractor's clean-up team.

B. Provide a testing plan certified by the QFPE that includes the following:

1. Who will perform the testing and who will be the onsite factory authorized representatives.
2. What are the safety precautions taken during testing.
3. How will the foam/water system be tested to demonstrate the performance criteria has been met.
4. How will the event be recorded for future review.
5. What are the testing procedures to demonstrate the coordination and communication of the fire protection systems associated with the foam/water discharge.
6. How will the hangar bay be protected during the discharge of foam.
7. How will the foam be captured during the discharge and disposed.

3.12 PRELIMINARY TESTING REPORTS

A. Provide acceptance testing for the fire suppression and fire alarm systems. At a minimum, provide the following preliminary testing reports.

2. Contractor's Material and Test Certificate for Aboveground Piping per NFPA 13 for each riser, manifold, and fire department connection. (Reviewed by the QFPE)
3. Fire pump test report demonstrating compliance with NFPA 20 acceptance testing criteria. Where a concentrate pumping system is also provided, demonstrate compliance with NFPA 11 and 20 acceptance testing criteria. (Reviewed by the QFPE)
4. Provide the residual pressure at the most remote generator with the simultaneous operation of the foam/water system, overhead hangar bay sprinkler system simulation, and exterior hose demand (when applicable). Simulate the overhead sprinkler system and hose demand through the test header. Provide pitot measurements and type of equipment used for this simulation. Provide the inlet and outlet pressures of the flow control valve. A water only test is acceptable. Use this information to verify the hydraulic performance of the system. (Reviewed by the QFPE)

5. Provide a proportioning system test report demonstrating compliance in accordance with NFPA 11. (Reviewed by the QFPE)

6. System record of Inspection and Testing, Notification appliance supplementary Record of Inspection and Testing, Initiating Device Supplementary Record of Inspection and Testing, Interface Component Supplementary Record of Inspection and Testing, and Mass Notification System Supplementary Record of Inspection and Testing per NFPA 72 for the FACU and RSFACU. (Reviewed by the QFPE)

3.13 FLUSHING

A. Underground water mains shall be flushed in accordance with NFPA 13 and NFPA 24. This includes the requirement to flush the lead-in connection to the fire protection system at a flow rate not less than the maximum water demand rate of the system.

3.14 HYDROSTATIC TESTS

A. The aboveground piping systems, including foam concentrate, shall be hydrostatically tested in accordance with NFPA 13 at not less than 225 psi, or 50 psi in excess of maximum system operating pressure, for 2 hours. There shall be no visible leakage from the piping when the system is subjected to the hydrostatic test.

3.15 HIGH EXPANSION FOAM CONCENTRATE SYSTEM

A. The contractor shall provide high expansion foam concentrate for all testing (initial and acceptance) and any required retesting. Concentrate tanks shall be full (not less than that shown in the contract, or not less than the minimum quantity intended to provide the 15 minute operating time, whichever is greater) for all tests. Foam concentrate removed from the 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 Contracting Officer and completion of all "punch list items" the contractor shall replenish the concentrate storage tank with not less than the minimum design quantity shown on the contract, or at least enough to provide 15 minutes of operating time, whichever is greater.

B. Tests shall be conducted under the supervision of a technical representative employed by the foam concentrate manufacturer. The complete 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 manufacturer's representative.
certifying that the system is in compliance with contract requirements and the manufacturer's recommended practices. Testing shall include, but not be limited to, the following:

1. Filling the foam concentrate tank.
2. Adjustment of proportioners.
3. Collection of foam samples and testing with a conductivity meter to verify proportioning accuracy.
4. Other operational checks recommended by the Hi-Ex proportioner manufacturer.
5. Readings of 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.

C. Inductor Tests: The inductor shall be flow tested to determine that proportioning accuracy is within specified limits. The inductor shall be tested at the design flow rate with the overhead sprinkler flow being simulated using the test header. Foam samples from inductor shall be accomplished in accordance with NFPA 11 and the approved test plan. Foam solution concentrations shall be determined using a refractometer or conductivity measurements and the methods outlined in NFPA 11.

3.16 BREAK-IN PERIOD FOR FACU AND RSFACU

A. Provide a break-in period of at least 14 consecutive days after the FACU and RSFACU have been enabled, prior to any formal testing. Provide a written request for a final test from the QFPE, after preliminary testing is complete, adjustments have been made to the system, and the system is ready for service.

3.17 FIRE ALARM/MNS AND RELEASTING SYSTEMS FUNCTIONAL PRELIMINARY ACCEPTANCE TESTING (PAT) AND FINAL ACCEPTANCE TESTING (FAT)

A. Every feature and function of the FACU and RSFACU, including initiating, alarm, and actuation systems shall be operated.

B. The contractor and foam system manufacturer's representatives shall conduct these tests under the direction of the fire department. The PAT and FAT shall be witnessed by the Contracting Officer's Representative, the fire department, AHJ, and the fire protection specialist. Additionally, after successful PAT, the AHJ, QFPE, and fire protection designer of record, shall witness and approve the FAT.

C. As a minimum, operation and supervision of the following functions and devices shall be demonstrated:

1. All operational and supervisory functions of the control and annunciator panels.
2. Each foam system manual start and manual stop stations and associated circuit(s) without foam discharge. For this test, the actuating solenoid shall be removed from the foam system control valve, and a bolt placed in it to indicate when it receives power.
3. All optical flame detectors and associated circuits.
4. Each general alarm initiating device (manual pull stations, flow switches, pressure switches, and associated circuit(s).
5. Each supervisory initiating device or function (valve tamper switch, tank level supervisory panels, fire pump controllers, etc.) and associated circuit(s).
6. All alarms and associated circuits.
7. All actuator circuits and system control valve(s) (without foam discharge).
8. Activation of the building fire evacuation alarm system.
9. Activation of the installation fire alarm reporting system (receipt of fire alarm, trouble, supervisory signals at receiving station).
10. All of the above tests shall then be repeated with the system on battery power only.
11. Annunciator lamp and notification appliance. This shall include bells, horns, electronic signaling, and similar devices.
12. Test of each function of the control panel.
13. Test of each circuit in both trouble and normal modes.
14. Tests of the battery charger and batteries.
15. Opening the circuit at each alarm initiating device and notification appliance to test the wiring supervisory feature.
17. Ground fault.

3.18 FLOW CONTROL VALVE (FCV) FUNCTIONAL TESTING

A. Flow control valve (FCV) functional testing. Operate flow control valves 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 the system abort station to stop and restart 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 power plants. Wire seals shall prohibit casual movement of valves. Permanently record the final FCV discharge pressure setting on each valve.

3.19 FINAL TESTING

A. Final testing to be witnessed by the Authority Having Jurisdiction (AHJ). The final testing may be witnessed by a delegated representative at the discretion of the AHJ. With the exception of system flushing and hydrostatic testing, repeat preliminary tests during the final testing at the discretion of the AHJ. Correct system failures or other deficiencies identified during the final testing and retest in the presence of the AHJ, at their discretion.

3.20 PRELIMINARY ACCEPTANCE TESTING (PAT) AND FINAL ACCEPTANCE TESTING (FAT) FOR THE OPTICAL FLAME DETECTION SYSTEM

A. Contractor and optical flame detector manufacturer's representative shall conduct these tests under the direction of USACE and the fire department. The PAT and FAT shall be witnessed by the Contracting Officer's Representative, the fire department, AHJ, and the fire protection
specialist. Additionally, after successful PAT, the AHJ, QFPE, and fire protection designer of record, shall witness and approve the FAT.

B. Corrections shall be made to triple IR detectors or controls not responding and tests repeated as necessary. If the sensitivity of a detector(s) needs to be changed to pass a test, all other tests, and certifications/qualifications for immunity against false alarms, performed up to that time need to be repeated. The Contractor shall protect the building and installed equipment from possible smoke and/or fire damage.

C. The contractor shall post suitable signs the day prior to and during testing indicating the date and time fire detection, alarm and suppression testing is to occur.

D. The Contractor shall engage the services of the optical flame detector manufacturer to conduct the actual pan fire tests.

E. The Contractor shall provide a liquid tight high welded steel fire pan with detached removable steel cover, and steel sub-frame with rollers/casters to allow for convenient relocation of the fire pan, or equivalent. The Contractor shall obtain JP-8/JET-A/JET-A1 fuel from the Government for use in the fire pan, and shall conduct pan fire tests to demonstrate the performance of the optical flame detectors.

F. Detector pass/fail status shall be determined by comparison of detector performance during pan fire tests relative to the detector manufacturer's published performance data for the specific type detector being tested.

G. Pan fire tests shall be conducted in up to 12 separate locations to be determined by the Government. No foam shall be discharged during pan fire tests. Coordinate with the Contractor Officer prior to conducting any pan fire tests.

H. Demonstrate the performance requirements of the optical flame detector coverage has been met through pan fire acceptance testing. Use the expected fuel in a 2 ft. x 2 ft. test pan, with closable lid.

I. The use of a cleaner burning fuel and/or alternate test pan design may be used where acceptable to the Authority Having Jurisdiction (AHJ).

J. At a minimum, place the test fire in each designated aircraft parking position (minimum of three). To pass, all detectors within the cone-of-vision of this test fire must activate within 30 seconds of fuel ignition. The fuel oil in the fire pan shall be pre-heated to its flash point temperature prior to each test, for a rapid full fire development in the pan.

K. Centered the test fire 10 ft. (3.0 m) outside the hangar bay opening. To pass, no detectors should active after 30 seconds of full fire development.

L. During testing, all suppression systems shall be disconnected. The foam system shall be deactivated prior to beginning testing, to prevent accidental discharge.

M. In addition to the pan fire test, the following tests shall be performed in the hangar bay:
1. At each aircraft parking location, and one additional location determined by the COR, perform arc welding of plate steel inside the hangar bay, at 125 amps for five minutes, and confirm that the detectors do not activate.

2. Perform welding activities on the facility for a maximum of five minutes, at one location determined by the COR, and confirm there is no feedback through the building ground to the triple IR detection system.

3. Activate existing strobes and rotating beacons inside the hangar, and confirm that optical detectors do not activate the system.

4. Ensure that the following outputs from the triple IR controller are received by the releasing panel, fire alarm control panel, and fire reporting receiving station: triple IR first alarm, triple IR second alarm, and triple IR fault. Confirm that the triple IR bypass switch disables the triple IR system.

N. The contractor shall provide written documentation of tests and state that the system is fully functional in accordance with all criteria.

O. The contractor shall properly dispose of fire testing materials.

3.21 PRELIMINARY ACCEPTANCE TEST (PAT) AND FINAL ACCEPTANCE TEST (FAT) CHECKLIST FOR THE HIGH EXPANSION FOAM SYSTEM

A. The contractor shall have provided written documentation of a successful optical flame detector system PAT before scheduling the High Expansion Foam System PAT and state that the Optical Flame Detection System is fully functional in accordance with all criteria. All optical testing has been performed to specification.

B. When all of the initiating, alarm, actuation, and supervisory functions of the system operate to the satisfaction of the system manufacturer's technical representative and the AHJ; the contractor must conduct a full complete discharge test of the each system servicing each separated fire area. The test must be performed to demonstrate satisfactory performance, proper HIGH EXPANSION FOAM concentration, mechanical operation and operation of valves, release devices, alarms, and interlocks which control the protected areas. These tests shall be conducted by experienced personnel according to the equipment and HIGH EXPANSION FOAM manufacturers' recommendations.

1. Develop a check list prior to commencing preliminary and final acceptance tests which includes the following:

2. The intent is to streamline the preliminary and final acceptance testing procedures and to accomplish a successful and quality acceptance test.

3. This check list is used in assigning action items to the subcontractors by the CQC manager.

4. During the discharge test, no one is permitted on the floor of aircraft service area. Persons witnessing the test will be required to view from an elevated position that does not require them to exit the building through the foam. Ensure that there is adequate egress off the elevated position 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.
5. Provide a safety plan for conducting test of High Expansion Foam System (Hi-Ex). Provide a sketch of safe egress path for persons conducting and witnessing the test to exit the building without entering the foam blanket. Obtain approval from the Base Safety Manager.

6. Environmental Permits:
   a. Obtain local, state or US environmental permits as applicable.
   b. Obtain approval from Base Environmental Engineer or Base Civil Engineer.
   c. Provide Hi-Ex Foam Containment Plan and Procedures.
   d. Provide Hi-Ex Foam Disposal Plan and Procedures.

7. Provide procedures for taking protective measures to avoid damage to life and property during and after the test.

8. Discuss the testing procedure with the fire department and obtain approval.

9. Provide test procedures for each specification section separately.

10. Provide a list of tests to be performed for each specification section.

11. Provide a test plan for each day of the test such as Day 1, Day 2, etc.

12. Allocate adequate time for each test. One hundred percent testing will be done during PAT and FAT. Simultaneously conducting more than one test is not permitted. Do not mix training with testing. The contractor and foam system manufacturer's representatives shall conduct these tests under the direction of the AHJ and the fire department. The PAT and FAT shall be witnessed by the Contracting Officer's Representative, the fire department, and the fire protection specialist. Additionally, after successful PAT, the AHJ, QFPE, and fire protection designer of record, shall witness and approve the FAT.

13. Ensure that CQC fire protection engineer is present at for PAT and FAT.

14. Ensure that manufacturer's representatives are present and have adequate time.

15. Provide a procedure for each test per attached testing procedure form format.

16. Provide blank test data recording form for each test. The attendee-sign-up sheet if needed shall be separate from test data recording form. Use NFPA forms when available.

17. Provide calibration certificates for each instrument used for testing. The testing equipment must be calibrated within previous 12 months from the date of testing. The flow tests are invalid without calibration certificates.

18. Obtain and Provide test procedures (from the equipment manufacturer and NFPA) for the following equipment:

   a. Foam System.
   b. Foam proportioner test IAW NFPA 11.
   c. Releasing Service Fire Alarm Control Unit (RSFACU).
   d. Fire Alarm Control Panel (FACP).
   e. Not Used.
   f. AHU shutdown.
   g. AHU Manometer Test.
   h. Hangar Power Supply test.
   i. Hangar Door Track Heater Test.
   j. Rollup Door Test.
   k. Not Used.

19. Provide names and credentials of manufacturers' representatives who will be conducting the tests IAW the contract.
20. Provide foam tank volume graph indicating volume in gallons corresponding to foam concentrate level in foam tank. This information will be used to calculate concentrate volume required to flow the foam for 15 minutes. The foam tank levels shall be checked by foam manufacturer's representative.

21. Measure foam tank level at the beginning and end of the foam test. This information will be used to calculate concentrate volume required to flow the foam for 15 minutes. The foam tank levels shall be checked by foam manufacturer's representative.

22. Provide a procedure for simulating maximum sprinkler system demand based on supply side calculations. The flow shall be measured by using calibrated equipment such as liquid-filled gages, listed play pipes and Pitot tube. The fire protection specialist shall measure the flow. The foam discharge test is incomplete without this flow. Please note that foam discharge test will be considered invalid without this simulated flow.

23. Provide liquid filled test gages at each foam generator and at the foam system riser. This information is needed to substantiate the hydraulic calculations and to determine actual flow from each generator. It is recommended that sufficient length of hose or tube is provided to take pressure reading at the floor during water only flow. Pressure transducers may be used to take readings.

24. Flow water only thru the generators while also flowing simulated sprinkler flow and observe pressure at each generator and general overall performance of each generator. It is customary and most efficient that hoses or tubing be attached to the gage outlet at the generator and gages themselves be at floor level. Flow rates shall be based on supply side calculations.

25. Mark aircraft outline (silhouette) on the floor with bright red tape and 1 meter cones. This is needed to determine the amount of time required to cover the aircraft silhouette from the activation of manual foam discharge station. Mark the floor with additional colored tape as required to subdivide the aircraft outline into sections to assist in determining the foam coverage percent during the test and review of the video. Ensure that the tape can be readily seen in the video used during the test.

26. The amount of time required to cover 90% of the aircraft silhouette from the activation of manual foam start station shall not exceed 60 seconds. No foam shall fall from the foam generators within the projected aircraft silhouette.

27. Mark the walls or place 1 meter cones or posts at or near the walls, and along and within the aircraft silhouette. Ensure that the 1 meter cones do not interfere with the flow of foam. This is needed to determine the amount of time needed to cover the hangar floor to a depth of 1 meter.

28. Record the amount of time required to cover the entire floor area with foam to a depth of 1 meter which shall not exceed 4 minutes. Once the test director indicates the 1 meter depth has been achieved, depress a "Foam Stop" button on a station remote to the activation station used to initiate the discharge. The foam control valve must close not faster than 5 seconds and not more than 15 seconds.

29. Verification of Hydraulic Calculations: Perform actual flow test of the combined systems while simultaneously flowing water only. Record pressure reading at each foam generator and at base of sprinkler system risers and foam system risers using calibrated liquid filled gages.

30. Verification of Foam Spread Diagram:
   a. Perform actual flow test of the combined system flowing simultaneously (with foam) to verify both one minute criteria and 4 minute criteria.
   b. Develop Foam Spread diagrams if not available from the manufacturer.
31. Provide values of design parameters including:
   a. Design pressure at the base of foam system riser.
   b. Design pressure at hydraulically most remote foam generator.
   c. Value of maximum fire water demand based on supply side calculations.
   d. Value of maximum foam solution flow based on supply side calculations.
   e. Limits of foam solution concentration IAW UL listing of foam and contract requirements.
   f. Design inlet and discharge pressures at the inductor.

32. Provide sufficient quantity of calibrated 3-½" liquid filled pressure gages of proper ranges IAW NFPA 291. List quantity of pressure gages for each range.

33. Flow Test:
   a. Provide the number of playpipes used for each flow test.
   b. Indicate GPM per playpipe.
   c. Indicate pitot pressure for each playpipe.

34. Demonstrate that the foam test header isolation valve is working properly.

35. Test the foam proportioner prior to the full foam test at a flow and for a time recommended by the manufacturer. The intent is to ensure that the foam proportioner is performing as intended prior to the full dump test. This could be a major cost saving to the contractor in case of defective foam proportioner.

36. Actual foam discharge test shall not be conducted with standing water on the hangar floor. Crews and equipment shall be provided to remove standing water. The hangar floor shall not be wet at the start of the test.

37. Provide equipment used for the test such as radios, stop watch, foam fill pump, foam to top the foam tank, lifts, ladders, extension pole, smoke generator, manometer, sufficient cameras and tripods etc.

38. Designate personnel for taking test readings.

39. Test Procedures:
   a. Video-record each test.
   b. Provide adequate number of cameras in the hangar space to facilitate complete coverage without panning across the hangar floor. Ideally stationary overhead cameras are installed with a full view of the aircraft silhouette during the foam test, to use for later determination of the percent aircraft silhouette coverage at 60 seconds and 1-meter depth in 4 minutes. Cameras shall have a full view of the bright red tape on the floor to outline the aircraft silhouette, and additional bright red tape on the floor to subdivide the silhouette into sections. The subdivision will assist in reviewing the video for percent silhouette coverage with foam at 60 seconds.
   c. Sound an air horn or equivalent from the location of the foam start station used to activate the system. This horn shall be sounded when the system is activated. The government shall bear witness that the horn is sounded simultaneously with activation of the foam start station, and shall note and record any time difference in seconds. The horn shall be capable of being heard in the video and by all witnesses throughout the hangar, for time zero determination. This air horn will be used to establish the start time in the video to evaluate the foam coverage of the silhouette in the first minute and the foam depth at four minutes.
d. A second government witness at the foam start station shall radio a government witness in the foam room the exact moment the start station is enabled, so that the government witnesses in the foam room and fire pump room can provide a visible or audible signal for the recording cameras indicating time zero. The government witness in the foam room shall record how many seconds after the test start time before the sprinkler test header valve is fully open.

e. Provide a camera in foam room and pump house to record such things as gage pressures and exact moment foam mixing valve opens at the start of the test and the exact moment the foam outline line valve is closed at the end of the test. For Air Force projects record gage pressures at the inlet and outlet of the inductor.

f. The video will be very useful in trouble shooting in case of a failed test.

g. The video is an efficient tool for training purposes.

h. Provide (DVD) videos.

i. All cameras shall provide a time stamp on the video.

40. Provide a device lay out plan on 11"x17" sheets for all devices connected to the Releasing Service Fire Alarm Control Unit (RSFACU). Indicate device number.

41. Provide a device lay out plan on 11"x17" sheets for all devices connected to Fire Alarm Mass Notification Control Panel (FMCP). Indicate device number.

42. Provide a riser diagram identifying all tamper switches with device numbers.

43. Demonstrate the functionality of the fire alarm system is in compliance with the FACU and RFSACU functional matrices.

44. Performance Matrix of Signaling Line Circuit (SLC): Provide a matrix for recording test data for SLC IAW NFPA 72. The fire alarm test will be considered invalid if this test is not done.

45. Performance Matrix of Notification Appliance Circuit (NAC): Provide a matrix for recording test data for NAC IAW NFPA 72. The fire alarm test will be considered invalid if this test is not done.

46. The location of each of the tests (open, ground, short) shall be noted on the matrix and as built drawings.

47. Make sure alarm initiating device address as shown on FACP and RSFACU are a specific location along with device address. Simply stating "Pull Station 2-16" is insufficient. An example of appropriate notation is "Pull Station 2-16, NE Corner Hangar Bay Exit Door".

48. Verify the proper operation of the Low Level Auto Disable Switch in the RSFACU.

49. Test and record sound level of notification appliances IAW NFPA 72 and record the dBA reading for each device near its location on the 11" x 17" device location plan.

50. Test and record MNS system intelligibility and record the CIS reading for each device near its location on the 11" x 17" device location plan. Test the mass notification system in accordance with the requirements of UFC 4-021-01. At a minimum provide sound power levels (Decibel A Weighted Scale (dBA)) and intelligibility scores (CIS) throughout the facility. (Reviewed by the QFPE)

51. Verify and specifically note mounting height of fire alarm devices IAW NFPA 72.

52. Verify and specifically note that the electrical supply for power-operated doors is independent of the building power supply to permit isolation of power to the facility during a fire without interrupting power to door motors.

53. Verify and specifically note that a key-operated or other access-controlled switch on the exterior of the facility for operation of power operated doors is provided.
54. Verify and specifically note whether the foam start and stop stations, associated conduit and back boxes, meet watertight and NEMA 4 requirements to prevent moisture entry.

55. Verify and specifically note that power supplies to RSFACU, FACP and MNS panels are provided and identified IAW NFPA 72. Check to verify and specifically note that wire-nuts are not used. Perform random checks by opening junction boxes to verify that screw type terminal blocks have been used throughout. Report findings.

56. Verify and specifically note that surge arrestor pre-charge pressure is indicated on surge arrestors.

57. Verify and specifically note that a pressure gage with isolation valve is provided at surge arresters to monitor pressure. Record pressure.

58. Verify that megger tests and loop resistance tests have been completed and test reports provided.

59. Verify that a tamper switch is provided for foam concentrate shutoff valve. Presence of TS should be noted on Tamper Switch matrix.

60. Demonstrate the performance criteria for opening and closing the flow control valve is met upon actuation of the manual foam stop stations. A water only test is acceptable. (Witnessed by the government fire protection engineers)

61. Verify that any and all valves in the system that when closed will disrupt or stop the flow of foam solution, foam concentrate, water, or that will disrupt or prevent an alarm signal or disrupt or prevent the opening of the deluge valves are electronically supervised. Presence of TS should be noted on Tamper Switch matrix.

62. Verify that if a valve is installed in the connection between an alarm initiating device intended to signal activation of a fire suppression system, the valve is supervised IAW NFPA 72. Presence of TS should be noted on Tamper Switch matrix.

63. Verify and specifically note that conduit routing for alarm systems are IAW NFPA 72 for conduit separation distances for horizontal and vertical runs.

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

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

66. Provide system restoration and flushing procedure after the completion of acceptance test.

67. Ensure sufficient quantity of foam is available to top the foam tank at the end of the tests.

68. Provide a pump for filling the foam tank from the foam drums.

69. Preliminary Test Report:

   a. Provide preliminary test report for all fire protection related specification sections with table of contents in a binder for approval prior to scheduling final acceptance test.

   b. Include copies of all test reports required by the specifications and NFPA codes such as NFPA 11, NFPA 13, NFPA 20, NFPA 24, NFPA 72 etc.

   c. Include copies of megger test and loop resistance test data. Please note that FACP, RSFACU and MNS tests will be incomplete without loop resistance and meggar test data.

   d. Include copies of test procedures for each fire protection related specification section.

   e. Include copies of forms to record test readings.

   f. Include copies of credentials of manufacturer's representatives who will actually be present at the site.
70. Final Acceptance Test Plan:
   a. Include table of contents.
   b. Submit hard copy of Final Acceptance Testing Plan and Procedures, and forms for recording test data in a three ring binder with tabs.
   d. Note that the Final Acceptance Test is a repeat of the Preliminary Acceptance Test, with the exception of hydrostatic tests of aboveground and underground pipe, underground pipe flush, and meger and loop resistance tests.

71. Training Lessons Plan: Provide training lesson-plan for systems for each specification section.

72. General:
   a. Determine the status of each item prior to commencing final acceptance test.
   b. Take appropriate action to make this a successful test.
   c. Determine the status of each item after the completion of final acceptance test.

73. Any and all tests which are left as incomplete after the FAT must be corrected then successfully retested in the presence of the AHJ, QFPE, and fire protection designer of record.

74. It is critical that the electrical disciplines (alarm and MNS) and mechanical disciplines (sprinkler and HEF) both have a responsible QC person involved in the project. It is equally essential that these two individuals coordinate their efforts, or actually be the same person.

75. The purpose of the PAT is to ensure that the FAT is conducted flawlessly. It is the contractor's responsibility to perform tests and make repairs to the system until they can conduct a "perfect" PAT completely and without incident or failure. If a failure is noted during any portion of what the contractor calls the PAT, the item shall be corrected and then the entire testing process shall be repeated until it is completed flawlessly from start to finish. Then, and only then, can it be claimed that a successful PAT has been completed. Only after a successful PAT is completed and the report reviewed and accepted by government can a FAT be scheduled.

76. Provide equipment used for the test such as radios, stop watch, foam fill pump, foam to top the foam tank, lifts, ladders, extension pole, smoke generator, manometer, sufficient cameras and tripods etc.

77. Provide sufficient quantity of calibrated 3-1/2" liquid filled pressure gages of proper ranges IAW NFPA 291. List quantity of pressure gages for each range.

3.22 PRELIMINARY AND FINAL FOAM TEST

A. Requirements: The Final Acceptance Test (FAT) shall be a repeat of Preliminary Acceptance Tests (FAT), except that flushing and hydrostatic tests shall not be repeated. In addition, the system shall be automatically actuated and allowed to discharge for a period long enough to verify compliance with design requirements prior to shutting the system off. The Contractor shall correct system failures and other deficiencies identified during testing and shall retest portions of the system affected by the required corrections.
1. Pretest Requirements for Final Acceptance Testing: The system will be considered ready for Final Acceptance Testing (FAT) only after the following have been accomplished.

a. The required test plan has been submitted and approved by the Contractor Officer.

b. Preliminary Acceptance Tests have been completed, including Preliminary Acceptance Testing of the Optical Flame Detection System, Fire Alarm/MNS and Releasing System, and deficiencies determined to have been corrected to the satisfaction of the equipment manufacturer's technical representatives and the Contracting Officer.

c. Preliminary Acceptance Test reports, including the required video of the Preliminary Acceptance Tests, have been submitted and approved by the Contracting Officer, AHJ, QFPE, and fire protection designer of record.

d. The control panels shall have been in service for a break-in period of at least 14 consecutive days prior to the final test.

e. The Contractor has provided written notification to the Contracting Officer, at least 21 days prior to date of Final Test, that preliminary tests have been successfully completed. Contracting Officer shall notify immediately the AHJ and fire protection designer of record.

2. Video: Contractor shall video the tests in disc (or digital) format and shall record the date and time-lapse, in seconds, from start to finish of each portion of the test as directed by the Contracting Officer. The high expansion foam (HEF) discharge test will most likely require multiple cameras for complete documentation. The cameras filming the high expansion foam discharge on the hangar floor cannot pan. Four copies of the disc (or digital) shall be submitted before the system will be considered accepted.

3. Manufacturer's Services: Provide the services of representatives or technicians from the manufacturers of the low-level high expansion foam generators system, foam system control panel, and optical flame detectors experienced in the installation and operation of the type of system being provided, to supervise installation, adjustment, preliminary testing, and final testing of the system and to provide instruction to Government personnel. The foam system control panel manufacturer shall provide a minimum of 4-days startup assistance.

4. Materials and Equipment: Contractor shall provide concentrate, gauges, sample collection apparatus, instruments, hose, personnel, elevating platforms, scaffolding, ladders, appliances and any other equipment necessary to fulfill testing requirements specified.

5. Facility and Environmental Protection:

a. Provide temporary measures to prevent high expansion foam solution or high expansion foam concentrate from entering storm drains, sanitary sewers, drainage ditches, streams and water courses. Do not allow high expansion foam concentrate or solution to come in contact with earth. Contain all discharged HIGH EXPANSION FOAM on paved surfaces. Collect all discharged high expansion foam solution; all rinse and flushing water and dispose of it in a State/EPA - approved sanitary waste-water, State/EPA - approved industrial waste-water, treatment facility which provides secondary (biological) treatment. Prior
to the start of construction, submit written plan for high expansion foam containment and disposal methods(s) to the Contracting Officer for approval.

b. Provide protection for the facility, including electrical and mechanical equipment exposed to possible damage during discharge tests. This shall include provision of sandbags or similar means for preventing migration of foam solution into adjacent areas. Temporary measures shall be provided to prevent foam solution from entering storm drains, sanitary sewers, drainage ditches, streams and other water sources. Discharged foam shall be contained on paved surfaces and shall not be allowed to come in contact with the earth.

B. Post-Discharge Test Requirements: Following the successful completion of the tests, the contractor shall completely drain any water or foam water solution between foam system control valves and foam generators. Thus all piping between the foam control deluge valves and foam generators is dry. Contractor shall remove the foam solution from the site as indicated on the approved foam waste containment and disposal plan. Contractor shall replenish foam concentrate consumed during the tests. The entire fire protection system shall be returned to automatic operation and the facility restored to operational capability. Discharged solution shall be contained and disposed of in a manner acceptable to local authorities and as identified on the approved test plan. Once tests are completed, systems shall be returned to fully operational status, including filling of High Expansion Foam concentrate tanks with concentrate and filling of solution piping with premix as required.

3.23 PRELIMINARY AND FINAL HIGH EXPANSION FOAM TESTS

A. The High Expansion Foam hangar fire suppression system flow tests shall include the following:

1. Simultaneous flow of simulated overhead sprinkler system maximum demand and foam generators flowing water only. Take pressure readings at each foam generator and risers with calibrated liquid filled gages.
2. Simultaneous flow of simulated overhead sprinkler system maximum demand and foam generators flowing foam for one minute. Simulated overhead sprinkler system flow is to be based on supply side calculations. All water flow testing shall be done in accordance with NFPA 291. Verify that 90% of the aircraft silhouette is covered in one minute (no depth is specified), and that the entire hangar floor is covered to a depth of one meter in 4 minutes. Foam discharge will continue until these criteria are deemed to be satisfied. Take foam tank level readings at beginning and at end. Overhead sprinkler system maximum demand shall be simulated by using a simulation test header, listed play pipes and liquid filled pressure gages.
3. Foam tank level readings shall be recorded at the beginning and at the end.
4. The high expansion foam system discharge test is to begin with the fire pump not running.

3.24 SAFETY PLAN
A. Provide a safety plan for conducting the test of the High Expansion Foam system. Provide a sketch of safe egress path for persons conducting and witnessing the test to exit the building without entering the foam blanket. Obtain approval from the installation Safety Manager.

3.25 DISPOSAL PLAN AND PROTECTION

A. Provide Foam Containment Plan and Procedures.
B. Provide Foam Disposal Plan and Procedures.
C. Protective Measures: Provide procedures for taking protective measures to avoid damage to property during and after the test protection of property during the Final Acceptance Test.

3.26 PRELIMINARY ACCEPTANCE TEST REPORT

A. Submit the Preliminary Acceptance Test report, and video recording of the event, to the Contracting Officer Representative, before requesting a Final Acceptance Test. Provide the “Punch List” (list of deficiencies prepared at the completion of preliminary test), and a Final Acceptance Test plan 15 days prior to final acceptance test.

3.27 FINAL ACCEPTANCE TEST

A. The Final Acceptance Test shall begin only after approval of the Preliminary Acceptance Test report. The Final Acceptance Test will be a repeat of all Preliminary Acceptance Test requirements except do not repeat flushing and hydrostatic tests. The PAT and FAT shall be witnessed by the Contracting Officer's Representative, the fire department, AHJ, and the fire protection specialist. Additionally, after successful PAT, the AHJ, QFPE, and fire protection designer of record, shall witness and approve the FAT. The Final Acceptance Test and shall provide a complete demonstration of the operation of the system.

B. Video tape of preliminary and final Hi-Ex foam discharge test. A professional videographer will record or video the Final Acceptance Test. A failed FAT will be treated as a PAT. Correct and retest all system failures or other deficiencies identified during the testing in the presence of the Contracting Officer's Representative, the fire department, the fire protection specialist, AHJ, QFPE, and fire protection designer of record.

3.28 FINAL ACCEPTANCE TEST REPORT AND AS-BUILT DRAWINGS

A. Provide the Final Acceptance Test Report within 15 days after the completion of the Final Acceptance Test. Provide the final acceptance test report in booklet form showing field tests performed with the digital or videotape of the final test to document compliance with the specified performance criteria. Provide documentation of readings, test results, and indicate the final position of control valves. Include all required Final Acceptance Test NFPA forms. The Final Acceptance Test report shall include the resolution of punch list items developed during preliminary acceptance testing. Submit As-built Drawings.
3.29 FLUSHING AND RINISING
    A. After completion of tests flush all piping carrying HIGH EXPANSION FOAM solution with fresh water. Rinse with fresh water all equipment and building surfaces exposed to HIGH EXPANSION FOAM discharge.

3.30 POSTED INSTRUCTIONS
    A. Framed description of system operation, instructions and schematic diagrams of the overall foam system and each subsystem, shall be posted where directed. Condensed operating instructions explaining the system for normal operation, refilling the foam storage tank, and routine testing shall be included.
    B. Provide instructions for operating the fire extinguishing system at control equipment and at each remote control station. Instructions shall clearly indicate all necessary steps for the operation of the system. Submit the proposed legend for operating instructions for approval prior to installation. 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.

3.31 TRAINING
    A. Prior to final acceptance, the Contractor shall provide two sessions of 4 hours each of operation and maintenance training to the installation personnel on two different days to accommodate both shifts of the Installation Fire Emergency Services. Each training session shall include emergency procedures, and unique maintenance and safety requirements. Training areas will be provided by the Government in the same building as the protected areas. The training conducted shall use operation and maintenance manuals specified in paragraph entitled "Operations and Maintenance Manuals". Dates and times of the training period shall be coordinated through the Contracting Officer not less than two weeks prior to the sessions.
    B. Lesson plans, operating instructions, maintenance procedures, and training data shall be furnished in manual format for the training courses. The operations training course shall familiarize designated government personnel with proper operation of the fire protection systems. The maintenance training course shall provide designated government personnel adequate knowledge required to diagnose, repair, maintain, and expand functions inherent to the system. The training sessions shall be given for two different work shifts. The schedule of training shall be approved by the Contracting Officer. Training sessions shall start after successful completion of the Final Acceptance Test. The field instruction shall cover all of the items contained in the approved O&M manual. Film or tape all training sessions and provide to the Government.

END OF SECTION 21 13 25