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References are in agreement with UMRL dated January 2021
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DIVISION 21 - FIRE SUPPRESSION

SECTION 21 13 25

HIGH-EXPANSION FOAM SYSTEM, FIRE PROTECTION

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SECTION 21 13 25

HIGH-EXPANSION FOAM SYSTEM, FIRE PROTECTION
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NOTE: This guide specification covers the requirements for optical flame detection and high-expansion foam fire suppression systems for aircraft hangars for the Army and Air Force.

Tailoring Options are used upon opening this section to select Army or Air Force. The unselected service will be hidden. Notes are provided to describe the tailoring options.

Adhere to UFC 1-300-02 Unified Facilities Guide Specifications (UFGS) Format Standard when editing this guide specification or preparing new project specification sections. Edit this guide specification for project specific requirements by adding, deleting, or revising text. For bracketed items, choose applicable item(s) or insert appropriate information.

Remove information and requirements not required in respective project, whether or not brackets are present.

Comments, suggestions and recommended changes for this guide specification are welcome and should be submitted as a Criteria Change Request (CCR).
****

PART 1 GENERAL

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NOTE: The Designer will edit this section for either a performance designed system or a fully designed system as applicable.

This section is primarily intended for performance designed systems, i.e., systems where the foam generators, foam and sprinkler risers, foam tanks, foam pumps and proportioning, fire water entrance piping, and releasing panels are shown on the plans. The size, layout, and support of branch

lines and cross mains will be designed by the Contractor.

The Designer will provide the following design, and indicate the following information in the contract documents, for performance designed systems. This design and information will be in accordance with UFC 3-600-01, Fire Protection Engineering for Facilities, and UFC 4-211-01, Aircraft Maintenance Hangars.

1. Perform calculations in accordance with UFC 4-211-01 to determine the required number of foam generators and locations, foam spread calculations, amount of foam concentrate and storage capacity.

2. Size and locate on the plans, and provide detailed drawings of, the foam system risers, foam generators, foam pumps (Army only), foam proportioning equipment, and foam storage tank. Provide drawing schedules showing capacity and quantity of foam generators, foam pumps (Army only), and foam concentrate storage tank. Sprinkler plans are to be provided under the UFGS 21 13 XX series.

3. The contract drawings shall include a detailed sprinkler riser diagram which is submitted under the UFGS 21 13 13 series.

4. Area(s) of foam system coverage, with zone designations (if multiple zones). Do not show layout of pipes smaller than 6 inches. Include basis of design for generator sizing so contractor can compare with the product they are using.

5. For pipe larger than 152.4 mm 6 inches, routing of pipe on the plans.

6. Show locations of foam system releasing panels, annunciator(s), beacons for foam system, foam start stations, and foam stop stations. For Army: Show locations of diverter valve control panels, diverter valve location on civil site plans, and underground containment tank on site plans.

7. Provide locations for mounting of optical flame detectors and cone of vision within the hangar bay, and location of associated foam releasing panel by the flame detector manufacturer.

8. Show single line riser diagram, and matrix, for all detection, activation, and alarm circuits for the foam system. Connection of equipment shall be indicated by circuit runs and not conduit runs. Do not indicate number and size of conductors for interconnection of fire alarm components.

9. Specify fire waterflow data.

10. Provide a foam generator schedule on the drawings, with unique tags on the plans for each generator. Indicate the generator minimum output (CFM), maximum weight (LBS), maximum water flow (GPM), maximum required pressure (PSI), with a maximum size (height and diameter).

11. Provide a foam concentrate tank schedule on the drawings, with minimum tank capacity (gallons), maximum diameter (inches), and maximum height (inches), and the amount of high-expansion foam required in the tank (gallons).

12. For Army: Provide a foam concentrate pump schedule, and foam concentrate jockey pump schedule (if required), showing the rated flow (GPM), rated pressure (PSI), and electrical requirements.

****

1.1 REFERENCES

****

NOTE: This paragraph is used to list the publications cited in the text of the guide specification. The publications are referred to in the text by basic designation only and listed in this paragraph by organization, designation, date, and title.

Use the Reference Wizard's Check Reference feature when you add a RID outside of the Section's Reference Article to automatically place the reference in the Reference Article. Also use the Reference Wizard's Check Reference feature to update the issue dates.

References not used in the text will automatically be deleted from this section of the project specification when you choose to reconcile references in the publish print process.

****

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

AMERICAN SOCIETY OF MECHANICAL ENGINEERS (ASME)

ASME A13.1	(2020) Scheme for the Identification of Piping Systems
ASME B40.100	(2013) Pressure Gauges and Gauge Attachments

ASTM INTERNATIONAL (ASTM)

ASTM A53/A53M	(2020) Standard Specification for Pipe, Steel, Black and Hot-Dipped, Zinc-Coated, Welded and Seamless

ASTM A183	(2014; R 2020) Standard Specification for Carbon Steel Track Bolts and Nuts
ASTM A193/A193M	(2020) Standard Specification for Alloy-Steel and Stainless Steel Bolting Materials for High-Temperature Service and Other Special Purpose Applications
ASTM A449	(2014) Standard Specification for Hex Cap Screws, Bolts, and Studs, Steel, Heat Treated, 120/105/90 ksi Minimum Tensile Strength, General Use
ASTM A536	(1984; R 2019; E 2019) Standard Specification for Ductile Iron Castings
ASTM A563M	(2007; R 2013) Standard Specification for Carbon and Alloy Steel Nuts (Metric)
ASTM F436	(2011) Hardened Steel Washers
ASTM F436M	(2011) Hardened Steel Washers (Metric)

INTERNATIONAL ELECTROTECHNICAL COMMISSION (IEC)

IEC 61508	(2010) Functional Safety of Electrical/Electronic/Programmable Electronic Safety-Related Systems

NATIONAL ELECTRICAL MANUFACTURERS ASSOCIATION (NEMA)

NEMA 250	(2018) Enclosures for Electrical Equipment (1000 Volts Maximum)

NATIONAL FIRE PROTECTION ASSOCIATION (NFPA)

NFPA 11	(2016; ERTA 2016) Standard for Low-, Medium- and High- Expansion Foam
NFPA 13	(2019; Errata 19-1; Errata 19-2; TIA 19-1; TIA 19-2; TIA 19-3; TIA 19-4; Errata 19-3; Errata 20-4; TIA 19-5; TIA 19-6) Standard for the Installation of Sprinkler Systems
NFPA 20	(2018; ERTA 1 2018; TIA 18-1; TIA 18-2) Standard for the Installation of Stationary Pumps for Fire Protection
NFPA 24	(2019; TIA 19-1) Standard for the Installation of Private Fire Service Mains and Their Appurtenances
NFPA 70	(2020; ERTA 20-1 2020; ERTA 20-2 2020; TIA 20-1; TIA 20-2; TIA 20-3; TIA 20-4) National Electrical Code
NFPA 72	(2019; TIA 19-1; ERTA 1 2019) National Fire Alarm and Signaling Code

NFPA 101	(2021) Life Safety Code
NFPA 170	(2018) Standard for Fire Safety and Emergency Symbols
NFPA 704	(2017) Standard System for the Identification of the Hazards of Materials for Emergency Response

NATIONAL INSTITUTE FOR CERTIFICATION IN ENGINEERING TECHNOLOGIES (NICET)

NICET 1014-7	(2012) Program Detail Manual for Certification in the Field of Fire Protection Engineering Technology (Field Code 003) Subfield of Automatic Sprinkler System Layout

SOCIETY FOR PROTECTIVE COATINGS (SSPC)

SSPC SP 11	(2012) Power Tool Cleaning to Bare Metal

U.S. DEPARTMENT OF DEFENSE (DOD)

UFC 3-301-01	(2019) Structural Engineering

UNDERWRITERS LABORATORIES (UL)

UL 864	(2014; Reprint May 2020) UL Standard for Safety Control Units and Accessories for Fire Alarm Systems

1.2 SUMMARY

Design and provide a new automatic low-level high-expansion foam fire extinguishing system, including optical flame detection, control, and releasing system, as indicated on the drawings and in accordance with applicable codes and standards. The system(s) shall provide a uniform distribution of high-expansion foam solution for complete coverage over the protected area as indicated on drawings. The system(s) 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 SYSTEMS, FIRE PROTECTION][Section 21 13 18 PREACTION SPRINKLER SYSTEMS, FIRE PROTECTION] [Section 21 13 16 DRY PIPE SPRINKLER SYSTEMS, FIRE PROTECTION].

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.

The design, equipment, materials, installation, and workmanship shall comply with the NFPA 11, NFPA 13, NFPA 70, and NFPA 72, except as modified herein. Each system shall include all materials, accessories and equipment necessary so that it is 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. Devices and equipment shall be listed by a Nationally Recognized Testing Laboratory unless otherwise specified. In the publications referred to herein, reference to the "authority having jurisdiction" shall be [Air Force Civil Engineer Center Operations Directorate (AFCEC/CO)] [Naval Facilities Engineering Command Fire Protection Engineer [ATLANTIC (_____)][PACIFIC (_____)]] [USACE_____]. Begin work at the point indicated.

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

The Contractor is responsible for the installation, testing, and acceptance testing of the High-Expansion Foam systems as required by this specification section and the plans. The contractor is also responsible for portions of the design per this specification section and the plans.

1.3 GENERAL DESIGN REQUIREMENTS

1.3.1 Definitions

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

Review Stamp. A "review stamp" certifies that the fire protection specialist has reviewed the documents and finds that it meets all contractual requirements. A "review stamp" is not a professional engineer stamp or seal.

1.3.2 Performance Requirements

****

NOTE: Locate generators to discharge within close proximity, but not directly upon the aircraft. Mount generators in the overhead roof support structure and/or high on the walls just below the roof support structure. Initial discharge of foam shall protect under aircraft and underwing area and then spread to the remaining hangar floor area. Do not provide generators in locations which block exits from the hangar bay within the first minute of discharge.

****

Foam application shall be from foam generators by aeration specified herein and as indicated on the drawings.

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 releasing 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 rotary winged aircraft, the

rotor sweep is considered part of the silhouette.

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-expansion foam to a depth of 1 meter 3.2 ft. within four minutes.

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

1.3.3 Rate of Foam Discharge

The rate of discharge shall be as shown on the drawings.

1.3.4 Foam Concentrate Proportioning System

****

NOTE: Air Force requires proportioning by foam inductor. Army requires proportioning by a foam concentrate pumping system and ILBP.

****

Foam proportioning shall be by a foam inductor taking suction from an atmospheric high-expansion foam concentrate storage tank located directly beneath/adjacent the inductor.

Provide a foam concentrate pumping system, with an atmospheric foam concentrate storage tank. Provide In-Line Balanced Pressure Proportioner Assembly (ILBP) that is listed.

1.3.5 Concentrate and Water Supply

System shall 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 21 13 13 WET PIPE SPRINKLER SYSTEMS, FIRE PROTECTION] [Section 21 13 18 PREACTION SPRINKLER SYSTEMS, FIRE PROTECTION] [Section 21 13 16 DRY PIPE SPRINKLER SYSTEMS, FIRE PROTECTION]. Reduction of the discharge duration based on a discharge rate higher than the specified minimum is not permitted.

A concentrate storage tank with a supply of concentrate to support a 15 minute discharge at the hydraulically calculated waterflow rate and 130 percent of the nominal concentrate injection rate shall be provided.

1.3.6 Activation

System activation shall be controlled by an addressable foam system control panel listed for releasing service.

The following will release the low-level high-expansion foam systems:

****

NOTE: For Air Force: Provide manual foam releasing

stations within each zone for the release of that zone, as stated below.
****

a. Manual foam releasing stations located as shown on drawings. Provide manual foam releasing stations within each zone for the release of that zone.

****
NOTE: For Army: Zoned manual foam release stations are not permitted. Program the foam release stations to simultaneously release the foam/water discharge from all zones viewable from the foam release station as stated below.
****

a. Manual foam releasing stations located as shown on drawings. Zoned manual foam release stations are not permitted. Program the foam release stations to simultaneously release the foam/water discharge from all zones viewable from the foam release station.

****
NOTE: For Army: Automatic release of high expansion foam will occur when two optical flame detectors are simultaneously activated. Automatic release of high expansion foam will also occur when an optical flame detector activates simultaneously with a sprinkler flow switch. See paragraph below.
****

b. The operation of one water flow switch simultaneous with one optical flame detector, or two simultaneous optical flame detectors. Actuation of the fire sprinkler system shall not activate the high-expansion foam system, unless an optical flame detector alarms simultaneously. The first automatic initiating device shall activate the general fire alarm, blue beacons, and report to the fire department. The second automatic initiating device shall activate the foam system, and report to the fire department.

****
NOTE: For Air Force: Automatic release of high expansion foam will occur by activation of two simultaneous optical flame detectors, as stated below.
****

b. The simultaneous operation of two optical flame detector 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, the blue beacons, and report to the fire department. The second optical flame detector shall activate the foam system, and report to the fire department.

1.3.7 Hydraulic Calculations

Design of low-level high-expansion foam systems shall be by hydraulic calculations for uniform distribution of HIGH-EXPANSION FOAM solution over

the protected area as defined on the drawings and shall conform to the NFPA standards listed above and to the requirements specified herein.

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

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

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 30 00 FIRE PUMPS].

Hydraulically design the system as follows:

a. Calculations shall include pressure discharge graphs or tables showing pressure discharge relationship for foam generators. [Design shall be such that operating pressure of foam solution nozzles is maintained between (the foam generator's manufacturer's minimum operating pressure plus 5 psig and the foam generators' maximum pressure minus10 psig during system discharge.] Hydraulic calculations shall include the manufacturer’s minimum pressure drop across flow control valve for the features indicated. Include "Demand Calculations" and "Supply Calculations".

b. 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, as indicated on the drawings. Demonstrate the combined fire water demand calculation does not exceed the available fire water supply. Confirm that the resulting foam/water supply from this calculation does not exceed the quantity of foam concentrate shown on the plans.

****

NOTE: Army requires foam concentrate pumps as stated below.

****

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

****

NOTE: Air Force requires foam inductors as stated below.

****

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.

c. Provide a Foam Spread/Coverage Calculations/diagram demonstrating the performance requirements to cover the aircraft silhouette are met within one minute. 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:

1. Time for the FSCP to open the flow control valve after initiation.

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

3. 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.

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

1.3.8 Flow Control Valves

****
NOTE: Air Force: The reference to "(inductor)" below applies to Air Force. Air Force uses inductors for foam proportioning.
****

****
NOTE: Army: The reference below "(and in corridors)" and also "(ILBP proportioner)" applies to Army. Army provides foam stop stations in the corridors and uses ILBP proportioners.
****

Water flow through the foam concentrate proportioning system (ILBP proportioner) (inductor)and to the foam generator system shall be controlled by flow control valves. Flow control valves include control of the opening and closing speed of the valve, and provide pressure regulation to the discharge devices, and provide for remote closing of the valve from foam stop stations. Once activated, the system shall remain activated. However, foam flow will be interrupted/stopped momentarily by depressing and holding a manual foam stop station button which are placed on the hangar bay walls (and in corridors) as shown on the plans.

1.3.9 Foam Concentrate Pump and Foam Jockey Pump Control

****
NOTE: Army: This paragraph applies to Army. Foam concentrate pumps are only used by Army.
****

Upon activation of the foam/water system, remote start the foam concentrate pump from the Foam System Control Panel (FSCP). Do not start the foam concentrate pump upon a drop in pressure. Upon depressing the manual foam stop station, stop the foam concentrate pump and the foam concentrate jockey pump to prevent excessive concentrate from being pumped into the foam solution piping. As long as the foam/water system is in alarm, releasing the manual foam stop station will restart the foam concentrate pump and foam concentrate jockey pump.

1.3.10 Manual Foam Stop Station Operation

****
NOTE: Army: The portion of the sentence below; "(and stop the foam concentrate pump and foam concentrate jockey pump)" applies to Army. Foam concentrate jockey pumps are only used by Army.
****

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. Program the stop stations to simultaneously stop the foam/water discharge from all zones viewable from the depressed stop station. Unless the FSCP 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 (and stop the foam concentrate pump and foam concentrate jockey pump) 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.

1.3.11 Hose System

Hose systems including hose reels shall not be provided.

1.3.12 System Hydraulic Surge Analysis

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

a. 457 meters1,500 feet for a system not exceeding a working pressure of 175 psi.

b. 305 meters1,000 feet for a system not exceeding a working pressure of 250 psi.

c. 152 meters500 feet for a system not exceeding a working pressure of 175 psi, and plastic piping is used (e.g. PVC, HDPE).

d. 91 meters300 feet for a system not exceeding a working pressure of 250 psi, and plastic piping is used (e.g. PVC, HDPE).

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.

1.3.13 Controls to Activate Diverter Valve

****

NOTE: Army: This paragraph on diverter valve controls applies to Army.

Consider the local environmental regulations to determine the control, treatment and/or remediation measures for the discharge of fire suppression effluent from the hangar bay. Discharge effluent from the containment system as directed by the department overseeing environmental policy for the installation. Base the conditions for disposal upon the capability and location of the facility that would treat the effluent from the containment system. Verify fire suppression effluent containment discharge requirements with the appropriate installation environmental engineer, including local and state environmental requirements.

Route the wet pipe, dry pipe, preaction or foam/water system runoff from the hangar bay to automatically discharge to an underground containment tank, unless required otherwise by the local environmental regulations.

Provide capacity to contain 15 minutes of the hydraulically calculated demand from the overhead sprinkler system in the hangar bay, plus the hose stream demand. Do not include the Hi-Ex foam system fire flow in the containment capacity. Design the containment system to accommodate the entire calculated fire suppression effluent discharge volume for the duration noted. Do not use the trenches, piping to the containment system, etc. to contain any of the required volume.

Empty tank in accordance with environmental regulations. Install the sump pump inside the tank and operate the pump manually. Discharge the fire suppression effluent from the sump pump in accordance with environmental regulations. Locate controls for the sump pump near the inspection port to the containment tank.

****

Trench Drainage Diverter Valve Controls. Design and install controls to activate diverter valve in site sanitary drainage system. This valve diverts hangar bay trench drain flow to the underground containment tank when the foam system is activated. In normal operation (when the foam system is not activated) trench drain flow is through the oil water separator to the waste water treatment plant. Activation shall be initiated by the fire alarm system. See civil site plans for location of motorized diverter valve, which will be outside the hangar on the site.

1.3.14 Foam System Control

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NOTE: Air Force: The reference below "(which is

Det-tronics)" applies to the Air Force. Air Force requires Det-tronics.

****

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NOTE: Consider the local environmental regulations to determine the control, treatment and/or remediation measures for the discharge of fire suppression effluent from the hangar bay. Do not provide a containment system for the collection of fire suppression effluent, unless required by local environmental regulations.

****

Provide a foam system alarm and control consisting of an addressable foam system control panel (FSCP), optical flame detectors, manual foam releasing stations, manual foam stop stations, signage panels, visual notification appliances, and miscellaneous appurtenances and circuit wiring in conduit, as required for a complete, operational, and fully functioning system. All components comprising the foam system alarm and control shall be sourced through the manufacturer of the FSCP and optical flame detectors (which is Det-tronics), to ensure compatibility.

1.4 SUBMITTALS

****

NOTE: Review submittal description (SD) definitions in Section 01 33 00 SUBMITTAL PROCEDURES and edit the following list, and corresponding submittal items in the text, to reflect only the submittals required for the project. The Guide Specification technical editors have classified those items that require Government approval, due to their complexity or criticality, with a "G." Generally, other submittal items can be reviewed by the Contractor's Quality Control System. Only add a “G” to an item, if the submittal is sufficiently important or complex in context of the project.

For Army projects, fill in the empty brackets following the "G" classification, with a code of up to three characters to indicate the approving authority. Codes for Army projects using the Resident Management System (RMS) are: "AE" for Architect-Engineer; "DO" for District Office (Engineering Division or other organization in the District Office); "AO" for Area Office; "RO" for Resident Office; and "PO" for Project Office. Codes following the "G" typically are not used for Air Force projects.

The "S" classification indicates submittals required as proof of compliance for sustainability Guiding Principles Validation or Third Party Certification and as described in Section 01 33 00 SUBMITTAL PROCEDURES.

Choose the first bracketed item for Air Force projects, or choose the second bracketed item for

Army projects.
****

Government approval is required for submittals with a "G" or "S" classification. Submittals not having a "G" or "S" classification are [for Contractor Quality Control approval.][for information only. When used, a code following the "G" classification identifies the office that will review the submittal for the Government.]

****
NOTE: Air Force: Air Force requires the review stamp of the fire protection specialist as stated below.
****

Shop drawings and calculations shall be prepared by the sprinkler system designer and reviewed by the fire protection specialist. The fire protection specialist must review the shop drawings, hydraulic calculations and material submittals. The shop drawings must bear the Review Stamp of the fire protection specialist.

****
NOTE: Army: Army requires the registered professional engineering seal of the fire protection specialist on shop drawings as stated below. The shop drawings may be prepared by the sprinkler system designer or the fire protection specialist.
****

Shop drawings, product data and calculations shall be developed under the supervision of the fire protection specialist. The fire protection specialist shall place their registered professional engineer stamp on all drawings and the cover sheet for the product data and calculations prior to submittal to the Government.[Shop drawings and calculations shall be prepared by the [sprinkler system designer][fire protection specialist].]

The following shall be submitted in accordance with [Section 01 33 00 SUBMITTAL PROCEDURES] [_____].

The [AFCEC/COSM fire protection engineer, Judy Biddle, judy.biddle.1@us.af.mil] [Naval Facilities Engineering Command [ATLANTIC] [PACIFIC] fire protection engineer] [USACE fire protection engineer] will review and approve all submittals in this section requiring Government approval.

SD-01 Preconstruction Submittals

OPTICAL FLAME DETECTOR AND FOAM/WATER DISCHARGE TESTING, SAFETY, AND ENVIRONMENTAL PLAN; G[, [_____]]

Submit high-expansion foam solution containment and disposal plan as required under paragraph entitled "PRELIMINARY ACCEPTANCE TEST (PAT) AND FINAL ACCEPTANCE TEST (FAT) CHECKLIST FOR THE HIGH-EXPANSION FOAM SYSTEM."

SD-02 Shop Drawings

High-Expansion Foam Systems; G[, [_____]]

Prepare shop drawings 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. Drawings shall be the same size as the contract drawings or minimum 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 Fire Protection Specialist.

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. Foam generators and system piping layout annotated with reference points for design calculations. Piping plan for high-expansion foam system incorporating that 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. Piping plan and isometric drawing of the concentrate system and details of all associated valves, fittings, and other components.

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. 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.

e. 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.

****

NOTE: Air Force: Air Force requires proportioning by foam inductor which is described below.

****

f. Shop drawings of each inductor. Shop drawings shall 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.

****

NOTE: Army: Army requires a foam concentrate pumping system and ILBP proportioner which is described below.

****

f. Piping plan and isometric drawing of the concentrate pumping system, ILBP proportioner, and details of all associated valves, fittings, and other components. Drawing shall incorporate that shown.

g. Location of control panels, detectors, manual foam start stations, manual foam stop stations, supervisory switches, solenoids, notification appliances, and other electrical devices. Incorporate that shown. In addition, conduit routing and sizes, and the number of conductors contained in each shall be indicated.

h. Longitudinal and transverse building sections showing typical pipe routing and elevation above finished floor.

i. Equipment room layout drawings drawn to a scale of not less than 1:20 1/2 inch equals 1 foot to show details of each system component, clearances between each other and from other equipment and construction in the room.

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 operation of the high-expansion foam 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 Foam System Control Panel (FSCP) 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.

o. Details of each foam generator and mounting details, High-Expansion foam system control valve header and related components.

SD-03 Product Data

Pipe, Fittings and Couplings; G[, [_____]]

Valves, including gate, check, and globe; G[, [_____]]

Pipe hangers and supports; G[, [_____]]

Waterflow Pressure Alarm Switch; G[, [_____]]

Surge Arresters; G[, [_____]]

Foam System Control Panel (FSCP); G[, [_____]]

Battery Chargers; G[, [_____]]

Batteries; G[, [_____]]

Annunciator Panel; G[, [_____]]

FOAM SYSTEM BEACONS; G[, [_____]]

Battery Chargers; G[, [_____]]

Manual Foam Releasing Stations; G[, [_____]]

Manual Foam Stop Stations; G[, [_____]]

Manual Foam Stop Station Operation; G[, [_____]]

Optical Flame Detectors and Controller; G[, [_____]]

In-Line Balanced Pressure Proportioner Assembly; G[, [_____]]

FOAM GENERATORS; G[, [_____]]

Sway Bracing; G[, [_____]]

Water Tight Junction Boxes; G[, [_____]]

Foam/Water Flow Control ValvesG[, [_____]]

Strainer; G[, [_____]]

Foam Concentrate; G[, [_____]]

CONCENTRATE STORAGE TANK; G[, [_____]]

Foam System Control Panel (FSCP); G[, [_____]]

****

NOTE: Army: Army requires a foam concentrate pumping system, ILBP, containment, diverter valve, and optical flame detector supervised disconnect, with required submittals below.

****

Containment Tank Remote Capacity Monitoring and Diverter Valve Panel - Army; G[, [_____]]

Foam Concentrate Pump; G[, [_____]]

Foam Concentrate Jockey Pump; G[, [_____]]

FOAM/WATER PROPORTIONING BY ILBP PROPORTIONER; G[, [_____]]

Trench Drainage Diverter Valve Controls; G[, [_____]]

OPTICAL FLAME DETECTION SUPERVISED DISCONNECT IN HANGAR BAY; G[, [_____]]

****
NOTE: Air Force: Air Force requires proportioning by foam inductor with submittal required below.
****

FOAM/WATER PROPORTIONING BY INDUCTOR; G[, [_____]]

Surge Arresters; G[, [_____]]

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, for instance model, size, and options, proposed for installation. In addition, a complete equipment list with equipment description, model number, and quantity shall be provided.

Spare Parts; G[, [_____]]

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.

Foam Systems; G[, [_____]]

A copy of the proposed diagrams and instructions for the overall foam system, prior to posting.

Sprinkler System Designer; G[, [_____]]

Fire Protection Specialist; G[, [_____]]

The name and documentation of certification of the proposed Fire Protection Specialist and Sprinkler System Designer, no later than 14 days after the Notice to Proceed and prior to the submittal of the system drawings and hydraulic calculations.

Installer's Qualifications; G[, [_____]]

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.

Post-discharge Test Requirements; G[, [_____]]

Details of method proposed for post-discharge testing.

SD-05 Design Data

Standby Battery Power requirements calculations; G[, [_____]]

Substantiating standby power calculations showing battery capacity, supervisory and alarm power requirements.

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.

System hydraulic surge analysis; G[, [_____]]

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

Flow Test Data; G[, [_____]]

Hydraulic Calculations; G[, [_____]]

Provide hydraulic calculations complying with the requirement of this section.

Foam Spread/Coverage Calculations; G[, [_____]]

Seismic Calculations; G[, [_____]]

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.

SD-06 Test Reports

Tests; G[, [_____]]

Test Plan: Test plan shall be complete in describing what measurements are to be made and how they will be collected. 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.

Provide an initial test plan with test procedures prior to final acceptance test. Include the following information:
a. Schedule of tests for each day, Example: Day 1, Day 2, Day 3 .

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

Submit the preliminary acceptance test report to the Contracting Officer and AFCEC/COSM before requesting a Final Acceptance Test. Provide the complete preliminary acceptance test report, to include digital recording (video) of the preliminary test, a "Punch List" (list of deficiencies prepared at the completion of preliminary test) to AFCEC/COSM for review. AFCEC requires 10 working days to review a complete PAT report. After the review of the complete package is acceptable, AFCEC or their designated representative will be present for the Final Acceptance Testing. The FAT will be scheduled no sooner than two weeks after the acceptance of the complete PAT report.

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 recording 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.

Reports for tests, as follows:

a. Reports as outlined in NFPA 13 documenting results of flushing and hydrostatic tests.

b. Trip tests of 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 or refractive index readings for foam samples taken from the high-expansion foam proportioner. Report shall be signed by the factory-trained technical representative 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. Digital recording of preliminary and final Hi-Ex foam discharge test.

f. Submit pressure discharge graphs or tables showing pressure discharge relationship for foam generators.

SD-07 Certificates

INSTALLER'S QUALIFICATIONS; G[, [_____]]

Submit installer and systems technician qualifications as required under paragraph entitled Qualifications of Installer.

Materials and Equipment; G[, [_____]]

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

a. Control panel. Certification that the foam system control panel is electrically compatible with the solenoid on the electrically-actuated automatic water control valve, and the solenoid is compatible with the electrically-actuated valve.Electronic solenoids used for release of the suppression system must be listed for use with both the Foam System Control Panel and the foam/water flow control valve.

b. Gaskets. Certification from the manufacturer and Fire Protection Specialist that gasket material is listed or approved for dry-pipe service on all foam/water solution piping.

c. Compliance with foam system control panel ground fault detection requirement.

SD-10 Operation and Maintenance Data

Foam System; G[, [_____]]

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.

SD-11 Closeout Submittals

As-built Drawings for the fire extinguishing system; G[, [_____]]

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.

1.5 SUBMITTAL PREPARER'S QUALIFICATIONS AND GENERAL RESPONSIBILITIES

1.5.1 Fire Protection Specialist

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.

1.5.2 Sprinkler System Designer

The sprinkler system designer shall be certified as a Level [III] [IV] Technician by National Institute for Certification in Engineering Technologies (NICET) in the Water-Based Systems Layout subfield of Fire Protection Engineering Technology in accordance with NICET 1014-7.

1.6 INSTALLER'S QUALIFICATIONS

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 three 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.

1.7 QUALITY ASSURANCE

1.7.1 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 shall have been in satisfactory commercial or industrial use for 2 years prior to bid opening. The 2-year use shall include applications of equipment and materials under similar circumstances and of similar size. The product shall have been for sale on the commercial market through advertisements, manufacturers' catalogs, or brochures during the 2 year period.

1.7.2 Source Limitations

Obtain foam concentrate, proportioning system, foam generators, and major accessories through one manufacturer. All components shall be listed for use together as single system.

1.7.3 Code Compliance

1.8 SPARE PARTS

Provide six (6) complete sets of system keys. Keys shall be [CAT 60] [_____]. Also, furnish 10 percent of each type of device below but no less than two:

a. Detectors (including optical flame detectors).

b. Notification appliances

c. Fuses required by the system.

d. Initiating devices(including Manual foam releasing station and stop stations.)

PART 2 PRODUCTS

2.1 REQUIREMENTS FOR FIRE PROTECTION SERVICE

****
NOTE: Air Force: A Pressure Reducing Valve (PRV) is commonly needed for wet pipe sprinkler systems in high expansion foam (HEF) designs. Also, a small pressure relief valve is typically required downstream of the PRV as a requirement of its FM approval. Due to the high pressures that are frequently needed in HEF systems a PRV is used to reduce the pressure to the wet pipe sprinkler system. A typical wet pipe sprinkler system wouldn't need a PRV but a note is added here in the HEF spec for consideration to include in the wet pipe sprinkler system spec and design.
****

All equipment and material shall be listed, unless otherwise noted in this section. Listed, as used in this section, shall mean listed or approved by a Nationally Recognized Testing Laboratory (NRTL) as defined by OSHA.

2.2 NAMEPLATES

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

2.3 ABOVEGROUND PIPING SYSTEMS HANDLING WATER OR FOAM/WATER SOLUTION

2.3.1 General Requirements for Piping Handling Water or Foam/Water Solution

Galvanized piping is not permitted.

Pipe shall conform to ASTM A53/A53M. 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.

2.3.2 Piping Handling Water

Piping 50 mm 2 inches and less shall be minimum schedule 40. Piping

larger than 50 mm 2 inches shall be minimum schedule 10.

2.3.3 Piping Handling Foam/Water Solution

Provide schedule 40 black steel foam/water solution piping.

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

2.3.4 General Fitting Requirements

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.

Plain end fittings with mechanical couplings and fittings that use steel gripping devices to bite into the pipe are prohibited.

Saddle tees using rubber gasket fittings are not permitted.

Fittings, mechanical couplings, and rubber gaskets shall be from the same manufacturer.

2.3.5 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 A536. 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 A183 and shall be cadmium plated or zinc electroplated.

2.3.6 Non-Grooved Fittings

Non-grooved fittings shall be threaded or flanged. Do not use fittings that couple plain-end pipe, welded sprinkler fittings or outlets for foam-water solution. Threaded fittings shall be cast iron or malleable iron.

2.3.7 Flanges and Gaskets

Flanges shall conform to NFPA 13. Flanges shall be the type that are welded or threaded to the pipe. Listed and approved grooved flange adapter fittings are also acceptable. Flange 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.

2.3.7.1 Bolts

Bolts shall be ASTM A449, Type 1 or 2. Bolts shall extend no less than three full threads beyond the nut with bolts tightened to the required torque.

2.3.7.2 Nuts

Nuts shall be ASTM A193/A193M, Grade 5ASTM A563M .

2.3.7.3 Washers

Washers shall meet the requirements of ASTM F436M ASTM F436. Flat circular washers shall be provided under all bolt heads and nuts.

2.3.8 Pipe Hangers

Hangers shall be suitable for the application, construction and size pipe involved.

2.3.9 Valves Affecting the Flow of Foam Solution or Concentrate Throughout the System

Unless otherwise indicated, valves shall be indicating type in accordance with NFPA 13.

Gate valves shall open by counterclockwise rotation.

2.3.9.1 Tamper Switches

Provide tamper switches to supervise in the normal position all foam system valves including foam generator isolation valves and drain valves.

2.3.9.2 Exception

Drain valves serving foam generators in aircraft hangars may be supervised by locking or sealing in the normal position as allowed by NFPA 11.

2.3.10 Check Valve

Check valves 100 mm 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 50 mm 2 inch drain.

2.3.11 Foam System Test Header

Provide a linear test header to meet the demand of the foam/water system.

****

NOTE: Air Force: For Air Force, the foam/water test system header and fire pump test header (when provided) may be combined as stated below.

****

The foam/water test system header and fire pump test header (when provided) may be combined. When a common test header is used, provide valving to permit independent testing of each foam/water riser and each fire pump.

Provide one 64 mm2-1/2 inch hose valve connection for each 1420 Lpm375 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 6.1 m 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 30.5 m 100 ft. hose lay.

In geographic locations having a 99.6 percent dry bulb temperature less than 0 degrees C 32 degrees F per UFC 3-400-02 Engineering Weather Data, provide test header with automatic ball drip routed to the exterior.

2.3.12 Pressure and Vacuum Gauges

Gauges shall conform to ASME B40.100 and shall be provided with throttling type needle valve or a pulsation dampener and shut-off valve. Gauge shall be a minimum of 89 mm3-1/2 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.

2.4 FOAM CONCENTRATE PIPING AND FITTINGS

2.4.1 Pipe

Pipe shall be schedule 40 stainless steel.

2.4.2 Fittings

Foam concentrate fittings shall be stainless steel. Fittings shall be of the same material as the pipe. Acceptable pipe joining methods are roll grooved fittings, welded joints and fittings, or flanged joints and fittings. If using welded joints and fittings, consideration must be given to the maintenance of the system and provide flanged joints at certain locations to allow for the ease of maintenance and equipment removal. Gasket material must be approved by the foam concentrate manufacturer.

2.4.3 Pipe Hangers

Hangers shall be listed or approved.

2.5 STRAINER

Provide strainer baskets with stainless steel mesh sized no greater than 1.59 mm1/4 inches.

Welded steel body fire main basket-type pipeline strainer. ASTM A53/A53M pipe and class 150 steel flanges.

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.

2.6 FOAM/WATER FLOW CONTROL VALVES

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. For hydraulic calculations, include the manufacturer’s minimum pressure drop across flow control valve for the

features indicated.

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 shall be brass with compatible fittings. Trim piping shall be factory configured and installed. Gaskets shall be made of EPDM. Valves shall be operated by a control system listed for releasing service and independent of the building fire alarm system. Valves located in electrical classified locations shall be listed for the classification of the area where located. Flow control valves shall include the following features as standard elements of the valve and trim package:

a. Solenoid valve shall be of the normally closed, de-energized type, which opens when energized upon receipt of an electrical signal from the releasing control panel to which it is connected. Solenoids used for release of the high-expansion foam must be listed for use with the foam system control panel and the foam/water control valve.

b. Flow control valves shall gradually open upon receipt of power from the foam system releasing panel and shall slowly close upon interruption of power. Speed control setting shall be such that valve closure occurs within 15 seconds after depression manual foam stop station, and will fully open the flow control valve within 5 seconds upon release of the manual stop station.

****

NOTE: Air Force: For Air Force, the field adjustable pressure reducing trim and constant pressure at the inductor is required as stated below.

****

c. Provide field adjustable pressure reducing trim.

d. Pressure regulation shall maintain a constant pressure at the inductor and the discharge device (foam generator). Pressure deviation shall not exceed plus or minus 0.34 bar/70 Kpa 10 psig.

2.7 EMERGENCY FOAM/WATER SYSTEM SHUTDOWN

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 12.7 mm1/2 inch wide blue border with red lettering not less than 25.4 mm1 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 require for shutdown.

2.8 HIGH-EXPANSION FOAM LIQUID CONCENTRATE

Foam Concentrate

Concentrate shall be the product of one manufacturer that is listed or approved for use with the foam generator system, and shall not contain PFOS/PFOA components. Concentrate shall have a minimum 20-year shelf life. Manufacture date shall be no more than six months before ship date

to site. Mixing of non-identical specification concentrate will not be permitted.

2.9 CONCENTRATE STORAGE TANK

****
NOTE: Air Force: Air Force requires a double wall foam storage tank, and no taps on the bottom or sides of the tank, as described below.
****

Provide a vertical, closed cell double wall polyethylene concentrate storage tank compatible with the required concentrate. Enter the tank only through the top with no taps on the bottom or sides of the tank. There shall be no taps in the bottom or sides of the tank. Inductor dip tube shall enter through the top of the tank.

****
NOTE: Army: Army requires a single wall foam storage tank as described below.
****

Provide a vertical, closed cell single 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.

2.9.1 Tank Marking

Permanently label each tank with its capacity, concentrate manufacturer, and concentrate type and percentage of concentrate induction. The label shall specifically identify the required concentrate manufacturer's name, concentrate name, concentrate identifying product numbers/codes, concentrate manufacturer's contact information including process to obtain 24-hour concentrate re-supply. The label shall include a warning statement indicating only this specific concentrate is permitted to be used in this system.

Tank shall have a NFPA 704 diamond sign indicating Health = 1; flammability = 2; and instability = 0.

2.10 FOAM/WATER PROPORTIONING BY INDUCTOR

****
NOTE: Air Force: This paragraph is for Air Force. Air Force requires proportioning by single foam inductor as described below.
****

Foam proportioning shall be by a single foam inductor for each foam-water riser.

a. Tune the inductor specifically for the system required flow rate, inlet pressure, back pressure, concentrate type,

proportioning ratio, and lift height of a near empty concentrate tank. Off the shelf pre-tuned generic model inductors are not permitted.

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

c. Size inductor for the exact orifice of foam/water pipe.

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

e. Potential manufacturers at the time of this publication include Fomtec, Skum, Matre Maskin, Wilson Foam, Ansul, Chemguard, and Delta Fire. Inductors from these manufacturers are approved.

2.11 FOAM/WATER PROPORTIONING BY ILBP PROPORTIONER

****

NOTE:Army: This paragraph is for Army. Army requires proportioning by ILBP proportioner and pumped concentrate system.

Proportioning foam concentrate through the use of a ratio flow controller and bladder tank, or a foam inductor is not permitted. Provide a foam concentrate pumping system, with an atmospheric foam concentrate storage tank. Provide a foam concentrate pumping system in compliance with NFPA 11, NFPA 20, and NFPA 409, except as modified by UFC 3-600-01 and UFC 4-211-01.

****

2.11.1 Foam Concentrate Pump

****

NOTE: Pump capacity shall be sufficient to supply foam concentrate under design conditions with operation of sprinklers as provided. Pump pressure should be approximately 206 kPa 30 psi above maximum system water pressure.

Use UFC 3-600-01 for reliable power requirements. Where reliable power is not available, provide diesel driven concentrate pumps

****

Foam concentrate pump shall be electric motor driven. Pump shall be a positive displacement rotary gear or vane type operating at a speed not greater than 1800 rpm. Pump capacity shall be as shown on the plans. Pump discharge pressure shall be as shown on the plans. Metallic pump components in contact with foam concentrate shall be of bronze or stainless steel construction. Each pump shall be furnished with suction strainer, relief valve, and suction and discharge gauges. Pump shall be mounted on a carbon steel base and shall have guards over couplings. Pump shall be direct-connected to electric motor with drip-proof enclosure. Motor size shall be as shown on plans.

Provide a reserve foam concentrate pump of equal capacity. Automatically

operate the reserve pump upon failure of the primary pump. Arrange concentrate supply piping to meet the foam concentrate demand from either the primary or reserve foam pump.

2.11.2 Foam Concentrate Jockey Pump

****

NOTE: When the foam concentrate line to the proportioner exceeds a linear distance of 15.2 m 50 ft., provide a positive displacement foam concentrate jockey pump to maintain pressure in the foam concentrate piping.

****

Foam concentrate jockey pump shall be bronze construction, TEFC motor, horizontal close coupled regenerative turbine pump. Mechanical seal with stainless steel metal parts. Buna elastomers, ceramic seat, carbon washers. Stainless steel shaft or shaft sleeve. Vertically split pump casing, end suction. Motor shall prevent overloading at the highest head condition.

2.11.3 Pump Controller

****

NOTE: The foam concentrate pump shall only start and stop from a signal from the Foam System Control Panel (FSCP). The pressure switch in the fire pump controller shall be disabled.

****

Controller shall be a full Service Electric Fire Pump Controller, with NEMA 2 Enclosure. Controller shall be the automatic type and listed for fire pump service and shall be arranged for starting from the manual foam releasing stations or automatic fire detection system, and stopping from manual foam stop stations, all via signals from the Foam System Control Panel (FSCP). The controller shall monitor the status of the foam concentrate pump it controls(by voltage or other suitable means), and shall start the back-up foam pump upon failure of the primary foam pump. Controller shall be completely terminally wired, ready for field connections, and mounted in a NEMA Type 2 drip-proof enclosure arranged so that controller current carrying parts will not be less than 300 mm 12 inches above the floor. The controller shall be equipped with an externally operable isolating switch which manually operates the motor circuit. Means shall be provided in the controller for measuring current for all motor circuit conductors. Controller shall monitor and provide individually displayed audible and visual alarms on the front panel for loss of a phase or line power, phase reversal, low foam concentrate level, and pump room temperature. Each alarm lamp shall be labeled with rigid etched plastic labels. The controller shall be equipped with the following:

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

b. The pressure switch for automatic starting of foam concentrate pump shall be disabled. The foam concentrate pump shall only start and stop from a signal from the Foam System Control Panel.

c. Thermostat switch with adjustable setting to monitor the pump room temperature and to provide an alarm when temperatures falls below 5

degrees C 40 degrees F.

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

2.11.4 Power Supply

****
NOTE: Verify that project drawings indicate power supply in accordance with NFPA 20 requirements.
****

The source and arrangement of power supply to the pumps shall be as shown on the drawings and in accordance with NFPA 20.

2.11.5 In-Line Balanced Pressure Proportioner Assembly

Provide In-Line Balanced Pressure Proportioner Assembly (ILBP) that is factory assembled and tested by the manufacturer. Disassembly, reassembly, or modification of the ILBP by the installing contractor is prohibited.

The ILBP shall contain all necessary components including foam proportioner; pressure balancing spool valve; duplex gauge; control, drain and check valves; interconnecting brass pipe; and valve identification nameplates. The proportioner shall consist of a body, inlet nozzle, and metering orifice, all of which are corrosion resistant brass. Clearly marked on the proportioner shall be the flow direction arrow, as well as the type and percentage of concentrate the proportioner was designed. The metering orifice will be sized according to the type and percentage of concentrate used. The proportioner body shall be brass, bronze, or stainless steel. Balancing shall be accomplished through the use of a spool-type pressure balancing valve. This valve shall sense foam concentrate and water inlet pressures at the outer ends of a dumbbell-shaped piston and shall react to pressure changes by covering or uncovering the foam supply port to the proportioner. The balancing valve shall be of 83600 brass construction with a phosphor-bronze piston and Buna-N rubber O-rings and seals. The in-line balanced pressure proportioner shall be completely pressure tested by the manufacturer. Interconnecting foam concentrate piping shall be of brass construction. Pressure sensing hoses shall be Teflon® with stainless braid cover and permanently attached brass couplings. Valve nameplates shall be provided and shall specify valve function and normal operating position.

2.12 FOAM GENERATORS

****
NOTE: Air Force: The reference below, "(except for upstream of the inductor)" applies to the Air Force.
****

Generator shall be capable of producing not less than [_____] cubic feet of high expansion foam-water solution per minute.

Generator discharge characteristics shall not result in any foam solution being discharged on aircraft fuselage and wing components from direct impingement or misting. Generator operating pressure shall be such that high pressure fittings and system components shall not be used(except for upstream of the inductor).

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

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 an outside power source, such as electricity. A stainless steel screen shall be provided for maximum reliability under fire conditions.

System shall be designed to provide at each generator the [manufacturer's minimum operating pressure] [plus 10 psi] [plus or minus 5 psi] [_____ psi].

2.13 CONTROLS TO ACTIVATE DIVERTER VALVE - ARMY

****
NOTE: Army: This paragraph is for Army. Army requires diverter valve. Locate diverter valve panel in the Maintenance Bay adjacent to the containment system monitoring panel.
****

Provide a Containment Tank Remote Capacity Monitoring and Diverter Valve Panel - Army. Provide monitoring panel with audible and visual (yellow strobe or beacon) alarms. Automatically activate audible and visual alarms when the capacity level exceeds 5 percent. Provide a silence switch for the audible alarm. Constantly illuminate visual alarms at the panel until the level condition is returned to normal.

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

The containment system monitoring panel and diverter valve panel may be combined. At a minimum, provide NEMA 250 Type 4 panel(s).

Rate any devices, conduits, or electrical enclosures installed below grade or within the containment tank for prolonged submersion, minimum NEMA 250 Type 6P.

2.14 FOAM RELEASING SYSTEM

2.14.1 General

Provide a separate Fire Alarm Control Unit (FACU) and Foam System Control Panel (FSCP) for each building. Where multiple releasing systems are provided within a single building, they may be combined into a single FSCP. Combining the FACU and FSCP into a common control unit is not permitted.

Provide a FSCP for the control and release of the foam/water system. Design the system so the loss of a FACU or another FSCP does not prohibit

the FSCP from functioning as intended. Do not connect the FSCP to other control unit through the use of a network cable. Communicate functionality between panels through addressable modules only. A common FSCP may control multiple releasing systems or agents.

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.

2.14.2 Foam System Control Panel (FSCP)

****

NOTE: Army: This paragraph is for Army. Army does not require a specific manufacturer of the FSCP.

****

The Foam System Control Panel (FSCP) shall be addressable and listed for "Releasing Device Service". 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.

2.14.3 Foam System Control Panel (FSCP)

****

NOTE: Air Force: This paragraph is for Air Force. Air Force requires the Det-tronics Eagle Quantum Primier Fire Detection/Releasing System.

****

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

FSCP drawings must be provided by the manufacturer (Det-Tronics), and the contractor must provide funding to the manufacturer as required to provide these drawings.

FSCP alarm, supervisory, and trouble signal reporting to the Fire Alarm Control Panel shall 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. All detectors shall be listed for use with that panel.

IR detectors shall be networked with the panel so that during commission IR detectors can be calibrated from the releasing panel.

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

FSCP shall be electro-magnetic interference/radio frequency interference (EMI)/(RFI) tolerant at all frequenciesand rated to SIL level 2 capability (IEC 61508), a safety assessment evaluation which evaluates critical fault paths, redundancies, and statistical measurement/prediction to ensure a specific level of long term reliable performance and stability to co-exist with aircraft radar systems.

The control panel shall be a neat, compact, factory-wired assembly containing all parts and equipment required to provide specified operating and supervisory functions of the system. Panel cabinet shall be finished on the inside and outside with factory-applied enamel finish. Provide main annunciator located on the exterior of the cabinet door or visible through the cabinet door. Provide audible trouble signal. 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 shall 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 shall be electrically supervised on all circuits. A ground fault condition or a single break in any circuit which prevents the required operation of the system shall result in the operation of the system trouble signal. Loss of AC power, a break in the standby battery power circuits, or abnormal AC power or low battery voltage shall result in the operation of the system trouble signals. The abnormal position of any system switch in the control panel shall result in the operation of the system trouble signals. Trouble signals shall operate continuously until the system has been restored to normal at the control panel. System trouble shall also be annunciated on the appropriate zone of the building fire alarm and mass notification control panel. The manual foam releasing stations, abort stations, optical flame detectors, and all associated wiring shall be connected to and supervised by the foam system control panel. Control panel shall be equipped with a NEMA Type 4 enclosure. System control panel shall be [UL][FM][LPC][Vds][JFRA] listed, approved, or type accredited for extinguishing system control (releasing device service). Permanently label all switches. Provide panel with the following switches:

a. Trouble silencing switch which transfers audible trouble signals (including remote trouble devices, if provided) to an indicating lamp.

Upon correction of the trouble condition, audible signals will again sound until the switch is returned to its normal position, or the trouble signal circuit shall be automatically restored to normal upon correction of the trouble condition. The silencing switch may be a momentary action, self-resetting type.

b. Alarm silencing switch which when activated will silence all associated alarm devices without resetting the panel, and cause operation of system trouble signals.

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

d. 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.

e. Lamp test switch.

f. 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 shall transmit a non-latching supervisory alarm signal to the building fire alarm control panel. Switch shall be provided within a lockable control panel.

2.14.4 Annunciator Panel

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 shall have an alpha-numeric display and provide the description of the device.

2.14.5 Primary Power Supply

Power to the control panel shall be as indicated. Panel shall be permanently marked "FOAM FIRE PROTECTION SYSTEM".

2.14.6 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.

2.14.6.1 Batteries

Provide sealed, maintenance-free, [sealed lead acid] [lead-calcium] [gel cell] batteries as the source for emergency power to the FSCP. 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.

2.14.6.1.1 Capacity

Sufficient capacity to operate the FSCP under supervisory and trouble conditions, including audible trouble signal devices for 48 hours and

under alarm conditions for an additional 15 minutes. Include full current draw of solenoid in battery calculations.

2.14.6.2 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.

2.14.7 Optical Flame Detection Inhibit Switch

Provide a 2-position non-key operated switch located within the FSCP enclosure, that when activated disables the releasing function of all optical flame detectors in the hangar bay through programming at the FSCP. When the switch is placed in inhibit mode, only the releasing functions of the optical flame detectors are disabled while leaving all other functions of the FSCP operational. Monitor the inhibit switch at the FSCP. Provide a supervisory signal to the receiving station indicating the optical flame detectors are inhibited, a trouble signal is not permitted. Label the switch "INHIBIT OPTICAL FLAME DETECTION." Provide engraved labels on the inhibit switch indicating when the optical flame detectors are in "NORMAL" or "INHIBIT" mode.

2.15 ALARM

2.15.1 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 76 INTERIOR FIRE ALARM AND MASS NOTIFICATION SYSTEM. Arrange so that actuation of any alarm initiating device (OFD or manual foam releasing station), trouble and supervisory conditions shall cause activation of the fire alarm and reporting systems.

2.15.2 Waterflow Pressure Alarm Switch

Unit shall include a 13 mm 1/2 inch NPT male pipe thread, two 13 mm 1/2 inchconduit knockouts, and two sets of SPDT (Form C) contacts. The switches shall be factory adjusted to transfer the contacts at 27.6 to 55.1 kPa 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.

2.16 CONTROL VALVE SUPERVISORY (TAMPER) SWITCH

Electrically supervise normally open control valves.

Tamper switches shall be UL listed as "Extinguishing 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 FACU 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.

2.17 FOAM SYSTEM BEACONS

Blue rotating beacons will not be less than 400 cd (208/120VAC) powered from a dedicated emergency panel.

2.18 MANUAL FOAM RELEASING STATIONS

****

NOTE: Provide detail on drawings showing manual foam releasing station design as depicted in UFC 4-211-01.

****

Manual Foam Releasing Stations shall be as shown on the plans, and shall be weatherproof.

Provide conventional manual foam releasing stations. 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.

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.

2.19 MANUAL FOAM STOP STATIONS

****

NOTE: Provide detail on drawings showing manual foam stop station design as depicted in UFC 4-211-01.

****

Provide NEMA 250 Type 4 manual foam stop stations of the "dead-man" type. Provide manual foam stop stations with distinctive signage at each device. Provide a red mushroom type push button and include the word “PUSH”. Provide the colored portions of the tamper cover in blue and lettering on the cover stating “STOP”; the words “FIRE”, “ALARM”, or “AGENT” are prohibited to appear on the cover or station.

2.20 OPTICAL FLAME DETECTORS

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 for both the signaling line circuit (SLC) and power circuit

from the optical detectors to the Foam System Control Panel (FSCP) and ground shielding in accordance with the optical flame detector manufacturer.

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

The optical detection system shall be interfaced with the building fire alarm and reporting system, but shall not rely on it for operation.

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.

2.20.1 Manufacturer of Optical Flame Detectors and Controller

****
NOTE: Air Force. This paragraph is for Air Force . Air Force requires Det-tronics X3301 IR flame detectors and EQP releasing/control unit
****

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

PART 3 EXECUTION

3.1 INSTALLATION

3.1.1 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 3-301-01, NFPA 13 and Annex A.

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.

3.1.2 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.

3.1.2.1 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. 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.

3.1.2.2 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.

3.1.2.3 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 13 mm 1/2 inch.

3.1.2.4 Valves

Provide an [OS&Y] [butterfly] valve beneath each flow control valve in each riser, when more than one valve is supplied from the same water supply pipe.

3.1.2.5 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.

3.1.2.6 Pipe Penetrations

Cutting structural members for passage of pipes or for pipe-hanger fastenings is not permitted.

3.1.2.6.1 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.

3.1.2.6.2 Pipe Sleeves

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 6.35 mm 1/4 inch space between exterior of piping and interior of sleeve. Firmly pack space with insulation and calk 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 76 mm 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.

3.1.2.6.3 Sleeves in Partitions

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

3.1.2.7 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.

3.1.2.8 Identification Signs

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

3.1.3 Surge Arresters

****

NOTE: See UFC 4-211-01 for the surge arrestor requirements for the sprinkler risers and any fire pumps, as well as those required for foam/water risers.

****

At a minimum, provide the following surge arresters. Increase the minimum capacities listed below, when manufacturer's calculations are required and demonstrate a large capacity.

a. Provide 95 liters 25 gal of capacity for each foam/water riser located on the riser manifold supplying a hangar bay.

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

c. Coordinate with surge arresters required for sprinkler riser and any fire pumps

d. Where surge arresters are 380 liters 100 gal or larger in capacity, provide floor stands.

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 arrestor during testing and maintenance. When connecting the surge arrestor to the riser, the use of piping, fittings, and valving smaller than the connecting orifice on the surge arrestor is not permitted.

After the surge arrestor 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 arrestor. Do not pressurize the surge arrestor during hydrostatic testing of the system.

3.1.4 Foam/Water Flow Control Valves

Install the manual release for the flow control valve no higher than 1524 mm 5 ft. above finished floor. For hydraulic calculations, include the manufacturer’s minimum pressure drop across flow control valve for the features indicated.

Provide pressure gages and other appurtenances at the flow control valves as required by NFPA 13.

3.1.5 Isolation Valve and Strainer

Provide an isolation valve and basket strainer in the piping ahead of foam system risers.

3.1.6 Foam Concentrate Appurtenances

****
NOTE: Air Force. This paragraph is for Air Force .
****

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 19 mm 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.

3.2 ELECTRICAL WORK

****
NOTE: Coordinate power and alarm requirements with the contract drawings and other specification sections.
****

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 28 31 60 INTERIOR FIRE ALARM SYSTEM, NON-ADDRESSABLE] [Section 28 31 66 INTERIOR FIRE ALARM AND MASS NOTIFICATION SYSTEM, NON-ADDRESSABLE] [Section 28 31 70 INTERIOR FIRE ALARM SYSTEM, ADDRESSABLE] [and] [Section 28 31 76 INTERIOR FIRE ALARM AND MASS NOTIFICATION SYSTEM, ADDRESSABLE.]] Wiring color code shall remain uniform throughout the system.

3.2.1 Panels and Component Installation

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

Where panels, devices, and appliances are subjected to water spray/runoff under normal operating conditions, provide 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 FSCP.

3.2.2 System Wiring

Signaling line circuits circuits shall be Class B wiring, No. 18 AWG size conductors at a minimum. Notification appliance and initiating device circuits shall be No. 16 AWG size conductors at a minimum. Circuits operating at [24 VDC] [_____] shall not operate at less than [21.6] [_____] volts. [Circuits operating at any other voltage shall not have a voltage drop exceeding 10 percent of nominal voltage.] Power wiring, operating at 120 VAC minimum, shall be No. 12 AWG solid copper having similar insulation. Run conduit or tubing concealed unless specifically shown otherwise on the drawings. All wiring shall 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 shall be maintained throughout the circuit.

All conductors must be installed in conduit (EMT minimum).

Pull all conductors splice free; conductors shall be continuous from device to device. The use of wire nuts, crimped connectors, or twisting of conductors is prohibited.

Run all wiring to and within control panels in the vertical or horizontal plane, make all turns at 90 degree angles, and tightly bundle and wrap conductors.

Wiring may be solid copper or stranded as permitted by NFPA 70.

All devices must have screw terminals. Where devices are only provided with pigtails from the manufacturer, pigtails must be landed on terminal strips mounted within the junction box.

All terminations must be at a terminal strip or the device screw terminals. Terminal strips are only permitted where direct connection to a device is not possible.

3.2.3 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.

3.2.4 Conductor Identification

Identify all conductors individually with permanent markings. Conductor markings shall be printed labels, permanently affixed to the conductor via shrink wrap.

All conduit, junction/back boxes, covers and couplings, when provided, must be factory painted red in unfinished areas (e.g., above ceilings, mechanical rooms).

All conduit, junction/back boxes, covers and couplings, when provided, are permitted to be painted to match the room finishing in finished areas. The inside cover of the junction box must be identified as "Fire Alarm" and the conduit must have painted red bands 20 mm 3/4-in. wide at 6 meters 20 feet intervals and on both sides of all floor, wall, and ceiling penetrations.

3.3 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). Where flexible conduit is permitted, it is limited to 1.8 meters 6 feet.

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

3.3.1 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 Water Tight 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.

3.4 SURGE PROTECTIVE DEVICES (SPD)

Provide SPDs to protect all power supply circuits to the FACU and FSCP, including any subpanels such as autonomous control units, amplifier panels, notification appliance circuit(NAC) booster panels. Provide SPD to protect all fire alarm circuits leaving or entering the building. Devices mounted on an exterior wall such as wall mounted exterior speakers do not require an SPD when lighting protection is provided on the building. Mount SPDs in a separate enclosure, unless the SPD is listed and installed in the control panel by the factory. Installing SPDs not listed with the panel is prohibited.

3.5 FOAM RELEASING SYSTEM

Install the FSCP in a location readily accessible to the emergency responders and maintenance personnel.

3.5.1 Battery Power Calculations

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

b. 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.

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

3.5.2 FSCP Supervised Disconnect

Provide a key operated FSCP 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 12.7 mm 1/2 inch wide blue border, with “DISABLE FOAM SYSTEM" or "DISABLE PRE-ACTION SYSTEM" in red lettering not less than 25.4 mm 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.

3.6 VALVE SUPERVISION

Electrically supervise normally open control valves. 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.

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.

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.

Mechanically lock or provide tamper seals such as zip-ties on trim valves, that when opened or closed are detrimental to the operation of the foam/water system such as the shutoff for the foam system pressure switch. Provide signage indicating the valve’s normal operating position.

Mechanically lock or provide tamper seals such as zip-ties on drain or trim valving in the closed position, that when opened will cause the discharge of the foam/water system such as the manual release valve on the foam/water system riser. Provide this valve with the following signage, "OPENING THIS VALVE WILL RELEASE THE FOAM SYSTEM."

3.7 SUPERVISION AND SIGNAGE

Report supervisory alarms as independent addresses as indicated on the plans. Grouped switches on common addresses are not permitted. Provide non-latching electronically supervisory devices.

3.8 FOAM SYSTEM BEACONS

Provide blue visual alarm signals (rotating beacons) within the aircraft servicing area to indicate foam system activation as shown on the plans.

Control the beacon initiation through the FSCP. A backup power supply or supervision of the power supply supplying the beacons is not required when supplied from the dedicated emergency panel. Mount beacons 6.1 - 9.1 m 20 - 30 ft. above the floor of the hangar bay. Provide a sign next to each blue beacon with a yellow or lime-yellow background matching the manual foam releasing station signage, with "FOAM RELEASE WHEN ILLUMINATED" in red lettering not less than 76 millimeters 3 inches high. Blue beacons

are in addition to any general fire alarm notification such as the general fire alarm strobes.

[[For single door hangars, provide one beacon approximately centered on each of the three walls.][For drive through hangars, provide one beacon 3.0 - 7.6 m 10 - 25 ft. from each corner of the hangar bay.]] Provide additional beacons where at least one beacon is not viewable from normally occupied areas of the hangar bay. Locate beacons to take into account building construction, aircraft configuration and positioning in the hangar bay.

3.9 FOAM GENERATOR INSTALLATION

Install Hi-Ex foam generators to provide a minimum 510 mm 20 inches clearance in front of the generator inlet. The use of all-thread rod for supporting generators is not permitted.

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

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.

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 1.5 m 5 ft. in depth. In small hangar bays where the entire floor may be covered with foam within the first minute, provide generator locations so exits are one of the last areas blocked.

3.10 INDUCTOR INSTALLATION

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NOTE: Air Force. This paragraph is for Air Force .
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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.

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 610 mm 2 ft. before and after the inductor.

3.11 IN-LINE BALANCED PRESSURE PROPORTIONER ASSEMBLY

****
NOTE: Army. This paragraph is for Army.
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Install ILBP proportioners downstream of the flow control valve, and ensure that the ILBP meets the manufacturer's recommendation with regards to horizontal or vertical installation.

3.12 FOAM RELEASING SYSTEM

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

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

Where panels, devices, and appliances are subjected to water spray/runoff under normal operating conditions, provide 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 FSCP.

3.13 FOAM RELEASING SYSTEM

****
NOTE: Air Force. This paragraph is for Air Force .
****

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

3.14 MANUAL FOAM RELEASING STATIONS INSTALLATION

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NOTE: Air Force: The sentence below, "Manual foam releasing stations are not required outside the hangar bay." applies to Air Force.
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NOTE: Air Force: The requirement below for signs indicating the zone served by the manual releasing station applies to Air Force.
****

Install manual foam releasing stations within the hangar bay so they are unobstructed, readily accessible, and located within 3.0 m 10 ft. of each required exit or exit access from the hangar bay. Manual foam releasing stations are not required outside the hangar bay. Maintain a minimum separation distance of 1.5 m 5 ft. between general fire alarm pull stations (if provided) and the manual foam releasing stations. When located at required exit doors, install the foam releasing station and the

fire alarm pull station on opposite sides of the door.

Provide low-level high-expansion manual foam releasing stations where shown. Stations shall be of a type not subject to operation by jarring or vibration. Mount station on signage panel as specified herein and detailed on drawings. Manual foam releasing stations shall be locking type that, when activated, require a key to be reset. Manual foam releasing stations shall be surface mount.

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.

Do not locate addressable monitor modules for the manual foam releasing stations in the hangar bay.

Protect foam releasing stations located in the hangar bay from mechanical damage. Provide a clear plastic tamper cover over the manual foam releasing station that when lifted emits an audible alarm. Exception: Audible alarm is not required where a manual foam releasing station is installed in a hazardous (classified) location.

Provide additional 25 mm 1 inch high black block lettering on the sign indicating which zone is served by the manual foam releasing station.

3.15 MANUAL FOAM STOP STATIONS

Provide manual foam stop stations 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. Do not locate addressable monitor modules for the manual foam stop stations in the hangar bay.

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.

3.16 MANUAL FOAM STOP STATIONS IN CORRIDORS

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NOTE: Army: This paragraph is for Army. The requirement for a manual foam stop stations outside the hangar bay in the corridors applies to Army. Coordinate the vision panel in the fire rated door with architectural trades.

****

Provide a manual foam stop station in the corridor of each required exit from the hangar bay through the support space. Locate the station on the support side of the door, such that it is within 1.5 m 5 ft. of the door and not obstructed when the door is fully open. Provide a 0.065 sq. m 100 sq. in. fire rated door vision panel in these doors, such that an occupant can view into the hangar bay while operating the manual foam stop station.

3.17 MANUAL FOAM RELEASING STATION AND STOP STATION SIGNAGE

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NOTE: Provide details on design drawings showing start and stop station signage as depicted in the relevant Figures in UFC 4-211-01, Aircraft

Maintenance Hangars.
****

Provide two separate but adjacent metal signs a minimum of 610 mm 24 inches high by 508 mm 20 inches wide. Provide no more than 305 mm 12 inches of separation between the two signs. Do not use the words "FIRE", "ALARM", or "AGENT" on these signs. Do not install backboxes or route conduit in front of sign in a manner that obstructs any lettering.

Provide the sign for the manual foam releasing station with a yellow or lime-yellow background with “START FOAM SYSTEM” in red lettering not less than 76 mm 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 25.4 mm 1 inch high green lettering placed directly above the manual foam releasing station.

Provide the sign for the manual foam stop station with a white background and a minimum 12.7 mm 1/2 inch wide blue border with “STOP FOAM SYSTEM” in blue lettering not less than 76 mm 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 25.4 mm 1 inch high red lettering placed directly above the manual foam stop station.

To the right of the stop button provide the following in minimum 12.7 mm 1/2 inch high black lettering "To stop foam system, press and continuously hold STOP button until relieved by emergency responders. There may be up to a 30 second delay after pressing the STOP button before the foam stops."

3.18 OPTICAL FLAME DETECTION SUPERVISED DISCONNECT IN HANGAR BAY

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NOTE: Army: This paragraph is for Army.
****

Provide a key operated supervised disconnect switch to disable all optical flame detectors in the hangar bay. Provide a switch that disables the releasing and notification functions of the optical flame detectors, while leaving all other functions of the Foam System Control Panel (FSCP) operational. Operation of the switch will not create a trouble signal. Monitor the disconnect at the Foam System Control Panel (FSCP). Provide a supervisory signal to the receiving station upon operation of the disconnect. While the switch is in the disable mode, the optical flame detectors will not retain any history of alarm conditions such that when the switch is placed in the enable mode the FSCP will not immediately go into alarm.

Locate the disconnect switch in the hangar bay, in a readily accessible location near a manual foam stop station. Provide a NEMA 250 Type 4 switch and backbox or house the components in a NEMA 250 Type 4 enclosure. Provide a non-flashing or rotating red indicating light not less than 400 cd (208/120VAC) powered from a dedicated emergency panel. Control light initiation through the FSCP. A backup power supply or supervision of the power supply to the light is not required when supplied from the dedicated emergency panel. Mount the light above the disconnect switch. Provide a sign with a white background and a minimum 12.7 mm 1/2 inch wide blue border, with "OPTICAL FLAME DETECTION DISABLED WHEN ILLUMINATED" in red lettering not less than 25.4 mm 1 inch high. Provide engraved labels on the disconnect switch indicating when the optical flame detectors are "ENABLED" or "DISABLED". Do not install backboxes or route

conduit in front of sign in a manner that obstructs any lettering.

3.19 OPTICAL FLAME DETECTOR INSTALLATION

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 1.5 m 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. A minimum of two optical flame detectors covering the aircraft silhouette are required on each side of the fuselage.

Provide flame detector installation shop drawings directly from the manufacturer.

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 1.5 m 5 ft. outside the hangar bay, into another fire area such as through a normally open roll-up fire door, or is within the view of hot sources such as radiant heaters. Locate optical flame detectors at a sufficient distance per the manufacturer's recommendations from sources that may cause false alarms such as welding, solar glare, radiant heaters, aircraft engine exhaust, strobes, hot surfaces and other relevant sources.

Mount detectors in accordance with their listing at approximately 2.4 m 8 ft. above the finished floor of the hangar bay. Do not mount optical detectors in inaccessible locations. Provide optical flame detectors with 1.5 m 5 ft. of flexible conduit to allow for minor adjustments during testing or changes in the mission of the hangar bay.

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 detections system.

Calibrate optical flame detectors to operate upon viewing the flame signature of the expected fuel(s) to be in the hangar bay. Use a 610 mm x 610 mm 2 ft. x 2 ft. pool fire as the bases to set the sensitivity of the optical flame detectors. Upon the 610 mm x 610 mm 2 ft. x 2 ft. pool fire reaching full development, all detectors within the cone-of-vision are required to activate within 30 seconds.

3.20 PIPE PAINTING AND LABELING

3.20.1 Painting

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

Clean, prime, and paint new foam systems including valves, piping, conduit, hangers, miscellaneous metal work, and accessories. Clean the surfaces in accordance with SSPC SP 11. Immediately after cleaning, prime

the metal surfaces with one coat of SSPC Paint 25 or SSPC Paint 25 primer applied to a minimum dry film thickness of 1.5 mils. Exercise care to avoid the painting of sprinklers and operating devices. Upon completion of painting, remove materials which were used to protect sprinklers and operating devices while painting is in process. Remove sprinklers and operating devices which have been inadvertently painted and provide new clean sprinklers and operating devices of the proper type. Finish primed surfaces as follows:

3.20.2 Pipe Identification,

Mark all exposed interior piping with plastic wrap around-type pipe labels conforming to ASME A13.1. Indicate the type of fluid carried and direction of flow. Labels that stick-on (adhesive backed) or are held on with straps/adhesive tape are not permitted. Labels are not required on any fire suppression system branch lines regardless of size, or mains and cross-mains less than a nominal 64 mm 2-1/2 in. Labels are not required on piping routed below the floor line in trenches or pits. At a minimum, the following labels are required.

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

b. FOAM CONCENTRATE - Used on foam concentrate piping.

c. FIRE SPRINKLER - Used on water-only sprinkler piping.

d. HIGH-EXPANSION FOAM - Used on Hi-Ex foam/water piping.

3.21 FIRE PROTECTION SPECIALIST

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. The Fire Protection Specialist shall witness all the preliminary and final acceptance tests, and shall review and sign the test reports. After the preliminary acceptance testing has been completed, the Fire Protection Specialist shall certify in writing that the system is ready for the final acceptance 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.

3.22 FACTORY AUTHORIZED PERSONNEL

Provide a factory authorized representative for the startup and/or testing of the following systems as outlined below:

a. Fire Pump System, as applicable (Start Up)

b. Fire Alarm and Mass Notification System (FACU/ACU) (Preliminary and Final Acceptance Testing)

c. Foam Proportioning, Foam Suppression, and Foam/Water Releasing System (FSCP) (Preliminary and Final Acceptance Testing). Provide the services of representatives or technicians from the manufacturers of the low-level high-expansion foam system and foam

system control panel 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.

d. Optical Flame Detection System (Preliminary and Final Acceptance Testing). The representative from the manufacturer of the optical flame detection system shall perform all programming on, and witness and certify acceptance testing (including witnessing pan fire tests on site), on the triple IR detection system. The manufacturer's representative, who programs, and certifies and witness the acceptance tests, shall submit qualifications to the government for approval.

3.23 OPTICAL FLAME DETECTOR AND FOAM/WATER DISCHARGE TESTING, SAFETY, AND ENVIRONMENTAL PLAN

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NOTE: Consider the local environmental regulations to determine the control, treatment and/or remediation measures for the discharge of fire suppression effluent from the hangar bay. Base the conditions for disposal upon the capability and location of the facility that would treat the effluent from the containment system. Verify fire suppression effluent containment discharge requirements with the appropriate installation environmental engineer, including local and state environmental requirements

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The contractor shall prepare a plan for conducting the test, to include the duties of the test team members, as follows:

a. Who will perform the testing and who will be the onsite factory authorized representatives.

b. What are the safety precautions taken during testing. Provide a safety plan for conducting the test of the High-Expansion Foam system. The contractor shall remove any mobile / portable equipment from the hangar servicing area that is not needed for the test. 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.

c. Describe how the foam/water system will be tested to demonstrate that the performance criteria is been met.

d. How will the event be recorded for future review.

e. What are the testing procedures to demonstrate the coordination and communication of the fire protection systems associated with the foam/water discharge.

f. Provide protection for the facility, including electrical and mechanical equipment exposed to possible damage during foam discharge tests. This shall include provision of sandbags or similar means for preventing migration of foam solution into adjacent areas. The

contractor shall cover the hangar walls and surface mounted equipment with plastic sheeting from the finished floor to 6 meters 20 feet above the finished floor. Doors into adjacent areas shall 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.

g. How will the foam be captured during the discharge and disposed. 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 an [State/EPA - approved sanitary waste-water], [State/EPA - approved industrial waste-water], [installation sanitary waste water]; [installation 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.

   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.

h. The test, safety, and environmental plan shall be submitted and approved by the Contractor Officer.

i. The test plan shall be submitted and approved by the Fire Protection Specialist.

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

k. Obtain approval from Base Environmental Engineer or Base Civil Engineer.

l. Obtain approval from the fire department.

m. Provide Hi-Ex Foam Disposal Plan and Procedures.

3.24 PRELIMINARY TESTING

Provide the following preliminary testing reports before performing acceptance testing for the foam fire suppression, foam releasing system, optical flame detection system, and fire alarm and mass notification systems.

Testing reports must have been reviewed and approved by the Contracting Officer and Fire Protection Specialist.

a. Contractor's Material and Testing Certificate for Underground Piping per NFPA 13 and NFPA 24. Provide photos of installation prior to burial.

b. Contractor's Material and Test Certificate for Aboveground Piping per NFPA 13 for each riser, manifold, and fire department connection.

c. 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 NFPA 20 acceptance testing criteria.

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NOTE: Army: The following paragraph is for Army.
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d. Residual pressure test report for 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). A water only test is acceptable.

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NOTE: Air Force: The following paragraph is for Air Force.
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d. Residual pressure test report for the most remote generator with only the foam/water system operating. Include the inlet and outlet pressures of the flow control valve and inductor. A water only test is acceptable. Include verification of the hydraulic performance of the system.

e. Provide a proportioning system test report demonstrating compliance in accordance with NFPA 11.

f. 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 FSCP.

3.25 FLUSHING

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.

3.26 HYDROSTATIC TESTS

The aboveground piping systems, including foam concentrate, shall be hydrostatically tested in accordance with NFPA 13 at not less than 1379 kPa 200 psi, or 345 kPa50 psi in excess of maximum system operating pressure, whichever is greater, for 2 hours. There shall be no visible leakage from the piping when the system is subjected to the hydrostatic test.

3.27 TEST TRENCH DRAINAGE SYSTEM DIVERTER VALVE TO UNDERGROUND CONTAINMENT TANK

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NOTE: Army: The following paragraph is for Army .
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Test and verify operation of trench drainage system diverter valve to underground containment tank.

3.28 FOAM CONCENTRATE SYSTEM

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.

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:

a. Filling the foam concentrate tank.

b. Adjustment of proportioners.

c. Collection of foam samples and testing with a conductivity meter to verify proportioning accuracy.

d. Other operational checks recommended by the Hi-Ex proportioner manufacturer.

e. 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.

3.28.1 ILBP Proportioning System Tests

****
NOTE: Army: This paragraph is for Army.
****

The in-line balanced pressure proportioning system (ILBP) shall be flow tested to determine that proportioning accuracy is within specified limits. The ILBP proportioner shall be tested at the design flow rate with the overhead sprinkler flow being simulated using the test header. Foam samples from ILBP 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.

3.28.2 Inductor Tests

****
NOTE: Air Force: This paragraph is for Air Force .
****

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.

3.29 BREAK-IN PERIOD FOR FACU AND FSCP

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

3.30 FIRE ALARM, MASS NOTIFICATION AND FOAM RELEASING SYSTEM PRELIMINARY ACCEPTANCE TESTING (PAT) AND FINAL ACCEPTANCE TESTING (FAT)

****
NOTE: Perform the testing below on the fire alarm and mass notification system at the same time as testing of the foam releasing system. Coordinate with the specification section on fire alarm and mass notification systems.
****

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

The contractor and foam system manufacturer's representatives shall conduct these test under the direction of [USACE][NAVFAC] and the fire department. The PAT and FAT shall be witnessed by the Contracting Officer's Representative, the fire department, [USACE][NAVFAC], and the fire protection specialist. Additionally, after successful PAT, the AHJ (USACE FPE)(AFCEC FPE), Fire Protection Specialist, and fire protection designer of record, shall witness and approve the FAT.

At a minimum, operation and supervision of the following functions and devices shall be demonstrated:

a. All operational and supervisory functions of the control and annunciator panels.

b. Each foam system manual foam releasing station 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.

c. All optical flame detectors and associated circuits.

d. Each general alarm initiating device (manual pull stations, flow

switches, pressure switches, and associated circuit(s).

e. Each supervisory initiating device or function (for instance valve tamper switch, tank level supervisory panels, fire pump controllers) and associated circuit(s).

f. All alarms and associated circuits.

g. All actuator circuits and system control valve(s) (without foam discharge).

h. Activation of the building fire evacuation alarm system.

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

****
NOTE: Army: The following paragraph is for Army .
****

j. Automatic and manual operation of the HIGH-EXPANSION FOAM containment system diverter valve. Not Used.

k. All of the above tests shall then be repeated with the system on battery power only.

l. Annunciator lamp and notification appliance. This shall include bells, horns, electronic signaling, and similar devices.

m. Test of each function of the control panel.

n. Test of each circuit in both trouble and normal modes.

****
NOTE: Coordinate the battery tests below with the specification section on fire alarm and mass notification and adjust accordingly.
****

o. Tests of the battery charger and batteries. For this test, the batteries shall operate the fire alarm, mass notification, and foam releasing system, for 72 hours under supervisory conditions. After 48 hours in standby, the shall operate the solenoid at full current draw for 15 minutes. The actuating solenoid shall be removed from the foam system control valve, and a bolt placed in it to indicate when it receives power. Coordinate this testing with Section 28 31 76 INTERIOR FIRE ALARM AND MASS NOTIFICATION SYSTEM.

p. Opening the circuit at each alarm initiating device and notification appliance to test the wiring supervisory feature.

q. Visual inspection of wiring connections.

r. Ground fault testing.

s. Short circuit fault testing.

t. Demonstrate the functionality of the fire alarm system is in compliance with the FACU and FSCP functional matrixes.

u. Verify the proper operation of the Low Level Auto Disable Switch in the FSCP, if provided.

v. Verify whether the foam start and stop stations, associated conduit and back boxes, meet watertight and NEMA 4 requirements to prevent moisture entry.

w. Verify whether power supplies to FSCP panels are provided and identified in accordance with NFPA 72.

x. Verify that wire-nuts are not used in the fire alarm, mass notification, and releasing systems. Perform random checks by opening junction boxes to verify that screw type terminal blocks have been used throughout.

y. Verify that conduit routing for alarm systems are in accordance with NFPA 72 for conduit separation distances for horizontal and vertical runs.

z. 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 per NFPA 72. Presence of TS should be noted on Tamper Switch matrix.

aa. 100 percent Circuit Integrity Testing of devices (open, short, ground on 100 percent of devices) will be completed at the PAT (not necessary to repeat at FAT).

3.31 FOAM/WATER FLOW CONTROL VALVE (FCV) FUNCTIONAL TESTING

Foam/Water 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 powerplants. Wire seals shall prohibit casual movement of valves. Permanently record the final FCV discharge pressure setting on each valve.

3.32 FINAL ACCEPTANCE TESTING WITNESS AND APPROVAL

****

NOTE: Air Force: Air Force requires final acceptance testing to be witnesses and approved by a delegated representative of the Air Force Civil Engineer Center, Operations Director (AFCEC/CO

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****

NOTE: Army: Army requires a Fire Protection Engineer from the Corps of Engineers who is a registered professional engineer who has passed the NCEES test in FPE with relevant experience.

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The Final Acceptance Test (FAT) shall be a repeat of Preliminary Acceptance Tests (FAT).

The Contractor shall provide written notification from the Fire Protection Specialist requesting the Final Acceptance Test, at least 14 days prior to date of Final Test, that preliminary tests have been successfully completed. The Contracting Officer shall notify immediately the [USACE district fire protection engineer][NAVFAC] and AHJ (USACE FPEAFCEC FPE)and Fire Protection Specialist.

Final testing of the high expansion foam system, optical flame detection system, and fire alarm & mass notification system shall be witnessed and approved in writing by a delegated representative of the Air Force Civil Engineer Center, Operations Director (AFCEC/CO). the Army Corps of Engineers Fire Protection Engineer 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.

Additionally, the manufacturer's representative (including the representatives for fire alarm, releasing, optical flame detection, and foam systems), Fire Protection Specialist, and fire protection designer of record, shall witness and approve the FAT.

3.33 PRELIMINARY ACCEPTANCE TESTING (PAT) AND FINAL ACCEPTANCE TESTING (PAT) OF THE OPTICAL FLAME DETECTION SYSTEM

The contractor and optical flame detector manufacturer's representative shall conduct pan fire testing under the direction of the fire protection specialist, [USACE][NAVFAC] and the fire department.

Post suitable signs the day prior to and during testing indicating the date and time fire detection testing is to occur.

During testing, all suppression systems shall be disconnected. The foam system shall be deactivated prior to beginning testing, to prevent accidental discharge. Remove solenoid from the foam/water control valve.

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.

Demonstrate the performance requirements of the optical flame detector coverage has been met through pan fire acceptance testing.

****

NOTE: Air Force: The following paragraph is for Air Force. The Air Force requires the cleaner burning fuel, and test pan, designed by the optical flame detector manufacturer (Det-tronics) to simulate the expected aviation fuel.

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Use a clean burning fuel in a 2 foot x 2 foot test pan, all of which is approved and provided by the optical flame detector manufacturer to

simulate the expected fuel.

****
NOTE: Army: The following paragraph is for Army . Choose whether to require a cleaner burning fuel such as propane, with the test apparatus and fuel approved by the optical flame detector manufacturer as equivalent to the expected aviation fuel, or whether to use the expected aviation fuel. The cleaner burning fuel will limit smoke and soot, and will allow for easier testing. However, requiring the cleaner burning fuel may increase cost and limit the manufacturers.
****

[Use a clean burning fuel in a 2 foot x 2 foot test pan, all of which is approved and provided by the optical flame detector manufacturer to simulate the expected fuel.] [Use the expected fuel in a 2 foot by 2 foot test pan. Obtain fuel from the Government. Provide a liquid tight welded steel fire pan, with closable lid, and steel sub-frame with rollers/casters to allow for convenient relocation, or equivalent. 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.]

****
NOTE: Army: The following requirement is for Army .
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At a minimum, place the test fire in each designated aircraft parking position (minimum of three).

****
NOTE: Air Force: The following requirement is for Air Force.
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Place the test fires at locations provided by AFCEC.

To pass, all detectors within the cone-of-vision of this test fire shall activate within 30 seconds of fuel ignition.

Center the test fire 3 m 10 ft. outside the hangar bay opening. To pass, no detectors should active after 30 seconds of full fire development.

****
NOTE: Army: The following requirement is for Army .
****

Disconnect the signal to the foam concentrate pump and foam jockey pumps.

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

a. Activate each optical flame detector manually (e.g. using a magnet per manufacturer's recommendation) and individually, and confirm that blue beacons are activated, and confirm that a single optical detector does not activate the foam system.

b. Simultaneously manually activate each optical flame detector with each

of the other optical flame detectors individually, and confirm that blue beacons are activated, that the disconnected foam/water control valve solenoid is activated, that the start signal is sent to the foam concentrate pump and fire water pump (Army only), and that fire alarm speakers and strobes are turned on via the fire alarm mass notification control panel.

c. 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.

****

NOTE: Army: The following requirements to perform welding activities is for Army. Include as appropriate.

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[d. 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.

e. 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.]

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

The contractor shall properly dispose of fire testing materials.

3.34 PRELIMINARY ACCEPTANCE TEST (PAT) AND FINAL ACCEPTANCE TEST (FAT) FOR THE HIGH-EXPANSION FOAM SYSTEM

All high-expansion foam concentrate, instruments, and equipment for testing shall be furnished by the Contractor. 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. 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.

The contractor shall have provided written documentation of a successful PAT for the optical flame detection, fire alarm, mass notification, and foam releasing system PAT before scheduling the High-Expansion Foam System FAT and state that these systems are fully functional in accordance with all criteria.

Preliminary Acceptance Test reports, including the required video of the Preliminary Acceptance Tests, have been submitted and approved by the Contracting Officer, [USACE district fire protection engineer][NAVFAC] and AHJ (USACE FPEAFCEC FPE), Fire Protection Specialist, and fire protection specialist before scheduling the Final Acceptance Test.

When all of these systems operate to the satisfaction of the system

manufacturer's technical representative and the [NAVFAC] [USACE] [AFCEC] Fire Protection Engineer; the contractor shall conduct a full complete discharge test of the each system servicing each separated fire area. The test shall be performed to demonstrate satisfactory performance, proper high expansion foam concentration,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.

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

a. Conduct a safety meeting(s) with attendance required for all witnesses (government and non-government personnel)immediately before the test.

b. Provide a safety plan as described in this specification in the applicable paragraph 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. During the discharge test, no one is permitted on the floor of aircraft servicing area. Persons witnessing the test will be required to view from an elevated position (or equivalent) that does not require them to exit the building through the foam. Ensure that there is adequate egress off the elevated position (or equivalent) which complies with NFPA 101. The foam blanket will reach a level above the average person's height causing spatial and acoustic disorientation possibly resulting in injury. Provide procedures for taking protective measures to avoid damage to life and property during and after the test, as described in the applicable paragraph in this specification section. Obtain approval from the Base Safety Manager, Contracting Officer, and the fire department.

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

d. The contractor shall have a countdown commencing an adequate time prior to the test, to allow all witnesses to get into position. Time points shall be announced for all witnesses in the hangar vicinity.

e. Provide environmental permits as described in this specification section in the applicable paragraph.

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

g. One hundred percent testing will be done during PAT and FAT. Simultaneously conducting more than one test is not permitted. The contractor and foam system manufacturer's representatives shall conduct these test under the direction of [USACE][NAVFAC] and the fire department. The PAT and FAT shall be witnessed by the Contracting Officer's Representative, the fire department, [USACE][NAVFAC], and the fire protection specialist. Additionally, after successful PAT, the FAT shall be witnessed and approved by the personnel stated in the paragraph above.

h. Provide a procedure for each test.

i. Provide blank test data recording form for each test. The attendee-sign-up sheet shall be separate from test data recording

form. Use NFPA forms when available.

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

k. Obtain and provide test procedures (from the equipment manufacturer and NFPA) for the following equipment:

   1. Foam System.
   2. Foam proportioner test.
   3. Foam System Control Panel (FSCP).

l. Provide names and credentials of manufacturers' representatives who will be conducting the tests.

m. 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.

n. Measure foam tank level at the beginning and end of the foam test. Calculate concentrate volume required to flow the foam for 15 minutes. The foam tank levels shall be checked by foam manufacturer's representative.

****
NOTE: Army: The following requirement is for Army .
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o. Provide a procedure for simulating maximum sprinkler system demand based on sprinkler hydraulic calculations. The flow shall be measured by using calibrated equipment such as liquid-filled gages and pitot tubes. Prior to the foam test, with the foam system disconnected, simulate the overhead sprinkler system and hose demand (as applicable) through the test header, using fire hose, hose monsters, pitot measurements and liquid filled pressure gages, or equivalent. The overhead foam generators in the hangar should be simultaneously flowing water only. The fire protection specialist shall witness the flow simulation. When the test is complete, and before the foam test, the hangar floor shall then be cleared of any water and shall be dry.

o. Not Used.

p. Provide liquid filled test gages at each foam generator and at the foam system riser. This information is used 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. Alternately, pressure transducers may be used to take readings. Note that there may be difficulty transmitting signals from pressure transducers through the high expansion foam.

****
NOTE: Air Force: The following requirement is for Air Force only.
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q. Measure the residual pressure at the most remote generator with only the foam/water system operating. Measure the inlet and outlet pressures of the flow control valve and inductor. A water only test is acceptable. Use this information to verify the hydraulic performance of the system.

****

NOTE: Army: The following requirement is for Army only.

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r. Measure 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). Measure 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.

5. Mark aircraft outline (silhouette) on the floor with bright red tape and 1 meter cones. This is to determine the amount of time required to cover the aircraft silhouette from the activation of manual foam releasing 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.

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

u. 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 3 feet.

v. The High-Expansion foam system discharge test is to begin with the fire pump(s) not running.

w. Record the amount of time required to cover the entire floor area with foam to a depth of 1 meter 3 feet 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 shall close not faster than 5 seconds and not more than 15 seconds. Upon release of the "foam stop" button, the foam/water control valve shall completely open within 5 seconds.

x. Foam Test:

****

NOTE: Army: The requirement below, "of the combined system flowing simultaneously (with foam)" is for Army only.

****

1. Perform foam flow test of the combined system flowing simultaneously (with foam) to verify both one minute criteria and 4 minute criteria.
2. Develop Foam Spread diagrams if not available from the manufacturer.

y. Provide values of design parameters including:

1. Design pressure at the base of foam system riser.
2. Design pressure at hydraulically most remote foam generator.
3. Value of maximum fire water demand.
4. Value of maximum foam solution flow.
5. Limits of foam solution concentration in accordance with the UL listing of foam and contract requirements.

****
NOTE: Air Force: The requirement below is for Air Force only.
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6. Design inlet and discharge pressures at the inductor.
6. Not Used.

****
NOTE: Adjust the requirement below as needed.
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z. Designate a person to stop the foam test (e.g. by appropriate means such as closing the manual control valve) based on radio communications, etc. when receiving notification that the 1 meter 3 feet depth has been achieved or in case of an emergency. In case of a loss of communication, this person should be given instructions that the foam test should be stopped no later than 4 minutes after the foam test has commenced.

****
NOTE: Army: The following requirement is for Army only.
****

aa. Sprinkler Flow Test:

1. Provide the number of playpipes used for each flow test.
2. Indicate GPM per playpipe.
3. Indicate pitot pressure for each playpipe.

aa. Not Used

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

****
NOTE: Army: The following requirement is for Army only.
****

cc. 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 foam test. Repeat this test during the foam test.

****

NOTE: Air Force: The requirement below is for Air Force only.

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dd. Test the foam inductor 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 inductor is performing as intended prior to the full foam test. Repeat this test during the foam test.

ee. The foam 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.

ff. 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.

gg. Designate personnel to witness test readings, and video record (digitally) each test as follows:

1. Provide an adequate number of cameras in the hangar area to facilitate complete coverage without panning across the hangar floor. At least one video view will be from a ceiling mounted camera. Use stationary overhead cameras 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.

2. Video the tests in disc (or digital)format and 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 several 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. 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 60 seconds and the foam depth of one meter in four minutes.

4. A 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.

****
NOTE: Army: The following requirement is for Army only.
****

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.

5. Provide a camera in foam room and pump house to record gage pressures, fire pump start time, foam water control valve opening time, and the foam water control valve is closed at the end of the test.

****
NOTE: Air Force: The requirement below is for Air Force only.
****

Record gauge pressures at the inlet and outlet of the inductor.

6. All cameras shall show the elapsed time on the video.

****
NOTE: Army: The following requirement is for Army only.
****

hh. Verify and and record whether a fire pump start signal is provided from the foam system control panel to fire pump and foam pump controllers
hh. Not used.

****
NOTE: Army: The following requirement is for Army only.
****

ii. Verify and specifically note that under no circumstances the fire suppression system pressure exceeds 175 psi.
ii. Not Used.

jj. Verify and specifically note that surge arrestor pre-charge pressure is indicated on surge arresters.

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

****
NOTE: Army: The following requirement is for Army only.
****

ll. Verify that a tamper switch is provided for foam concentrate shutoff

valve. Presence of TS should be noted on Tamper Switch matrix.

38. Not Used.

mm. 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.

nn. 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.

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

pp. 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.

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

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

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

tt. Preliminary Test Report:

1. 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.
2. Include copies of all test reports required by the specifications and NFPA codes such as NFPA 11, NFPA 13, NFPA 20, NFPA 24, and NFPA 72.
3. Include copies of test procedures for each fire protection related specification section.
4. Include copies of forms to record test readings.
5. Include copies of credentials of manufacturer's representatives who will actually be present at the site.

uu. Final Acceptance Test Plan:

1. Please include table of contents.
2. Please submit hard copy of Final Acceptance Testing Plan and Procedures, and forms for recording test data in a three ring binder with tabs. This will be very help full during final acceptance test.
3. Provide electronic copy of Final Acceptance Testing Plan and Procedures.
4. 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 loop resistance tests.

vv. General:

1. Determine the status of each item prior to commencing final

acceptance test.
2. Take appropriate action to make this a successful test.
3. Determine the status of each item after the completion of final acceptance test.

ww. Any and all tests which are left as incomplete after the FAT shall be corrected then successfully retested in the presence of the [USACE district fire protection engineer][NAVFAC] and AHJ (USACE FPEAFCEC FPE), Fire Protection Specialist, and fire protection designer of record.

xx. 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 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 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.

3.35 POST-DISCHARGE TEST REQUIREMENTS

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NOTE: Discharge tests using foam solution are necessary in order to verify proportioner accuracy as well as to demonstrate performance of the overall system at final acceptance. The collection and disposal of the solution is often a problem in many areas due to the real and perceived environmental effects of the solution. Thus it is important that the project design or the existing site addresses the need to collect and dispose of the solution. If adequate means are not otherwise available or provided, the responsibility for collection and disposal will have to be placed on the Contractor. This needs to be made clear in the project documents to preclude problems and misunderstandings at time of final testing.

****

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. The 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.

3.36 DISPOSAL PLAN AND PROTECTION

Provide Foam Containment Plan and Procedures. Provide Foam Disposal Plan and Procedures.

3.36.1 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.

3.37 PRELIMINARY ACCEPTANCE TEST REPORT

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

3.38 FINAL ACCEPTANCE TEST REPORT AND AS-BUILT DRAWINGS

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

3.39 FLUSHING AND RINSING

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.

3.40 POSTED INSTRUCTIONS

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.

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.

3.41 TRAINING

Prior to final acceptance, the Contractor shall provide two sessions of at least 8 hours each of operation and maintenance training to the installation [Public Works Department][Installation Engineering Activity][Civil Engineering]; [Installation Fire Emergency Service]; [Installation Ground Safety Activity] personnel on two different days to accommodate both shifts of the Installation Fire Emergency Services. Each training session shall include a walk-through of the facility while describing the operation of the equipment and system, and video of this

description for future review by maintenance personnel. Each training session shall also include emergency procedures, and demonstrate how to perform all the routine maintenance, and unique maintenance and safety requirements. The contractor or subcontractor (e.g. foam contractor, optical flame detector contractor, fire pump contractor) shall demonstrate (on or at the equipment itself), and video for future review by maintenance staff, all the routine maintenance (e.g. weekly, monthly, yearly,) in the equipment manuals and cut sheets, and required by military criteria or NFPA standards. The contractor or subcontractor, during walk thru of the facility, shall describe the warning signs of equipment failure, but the contractor is not required to demonstrate how to repair equipment. 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.

A lessons plan shall be submitted prior to the training, that will outline the scope of the training. 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 --