METRIC/INCH-POUND

KSC-STD-F-0004F
MARCH 9, 2010

Supersedes
KSC-STD-F-0004E
October 24, 2003

NASA KSC Export Control Office (ECO)
Export/SBU Determination Record

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Title of Document:
FIRE PROTECTION DESIGN, STANDARD FOR
KSC-STD-F-0004F, MARCH 9, 2010 (Supersedes KSC-STD-F-0004E, October 24, 2003)
Center Operations Directorate
(SBU designation: James D. Miller, TA-B3B, 3-9-2010)

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EFF	Title KSC-STD-F-0004F, Fire Protection Design Standard For	
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DOCUMENTS

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TECHNICAL REMARKS

This is Revision F to KSC-STD-F-0004

APPROVALS

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FIRE PROTECTION DESIGN, STANDARD FOR

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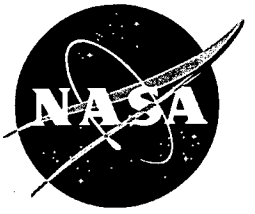

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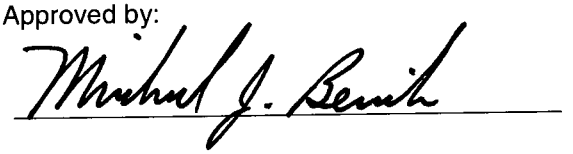

Michael J. Benik
Director, Center Operations

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FIGURES

FIRE PROTECTION DESIGN, STANDARD FOR

1. SCOPE

1.1 Purpose

This document provides additional fire protection design standards to be used in conjunction with National Aeronautics and Space Administration (NASA)-Standard (STD)-8719.11, Safety Standard for Fire Protection, for the design or modification of facilities and systems under the design jurisdiction of the John F. Kennedy Space Center (KSC), NASA. Where this design jurisdiction extends beyond facilities at KSC (Cape Canaveral Air Force Station, Vandenberg Air Force Base, etc.), local requirements (e.g., local fire alarm reporting methods) and the requirements of local Authorities Having Jurisdiction (AHJ) shall apply.

1.2 General

The minimum basic requirements for the design of a fire protection system shall be in accordance with the applicable provisions of the latest revision of the National Fire Code published by the National Fire Protection Association (NFPA). If there are inconsistencies or conflicts between these requirements and other NASA documents, then the more stringent requirements shall be followed.

Throughout this Standard, reference is made to "Designer shall consult" with the KSC AHJ or another party on specific fire protection requirements. For purposes of this Standard, "consult" is the exchange of ideas between the Designer and the applicable party, typically the KSC AHJ. The KSC AHJ shall be either the NASA official or his designee. The agreements that take place during these consulting sessions between Designer and the applicable party shall be documented as meeting minutes, e-mail, correspondence, or engineering review comments.

Monitoring systems installed for monitoring a particular hazard, such as systems using hydrogen and hypergolic fuel leak detectors, are of a specialized nature and are not within the scope of this Standard.

General facility fire protection system design shall consist of the following elements:

a. Full coverage sprinkler protection serving as the primary automatic fire detection means using flow switches.

b. Modular fire alarm control panel (FACP) with initiation and auxiliary control devices being individually addressable.

c. Manual pull station placement in accordance with the Americans with Disabilities Act (ADA) and NFPA requirements.

d. Audible and visual evacuation appliance placement in accordance with ADA and NFPA requirements.

e. Additional automatic fire detection and auxiliary control devices as required by NFPA standards, NASA standards, or the KSC AHJ. Common examples include duct smoke detection and elevator system smoke/heat detection.

f. Looped "Class A" wiring systems in diverse routed raceways for all circuit types where such equipment is available for the purpose, unless otherwise approved by the KSC AHJ.

g. Standardized operating requirements and sequences including evacuation alarm operation, maintenance bypasses, auxiliary control operation, and Central Fire Monitoring System (CFMS) reporting.

Specialized systems that may be incorporated into or integrated with the basic protection strategy may include, but are not limited to the following:

a. Computer room or essential electronic equipment area smoke detection.

b. Additional fire suppression systems and their related Underwriters Laboratory (UL)-listed or Factory Mutual (FM)-approved releasing system controls, including preaction sprinkler, deluge, and wet/dry chemical, etc.

c. High bay, clean room, or hazardous area fire detection.

d. Emergency power disconnecting systems.

e. Fire pump systems.

1.3 Questions and Conflict Resolution

The coordination and the resolution of questions and conflicts concerning the application of this Standard to a design shall be the responsibility of the NASA Lead Design Engineer, with support from the NASA Fire Protection System Engineer and the KSC AHJ. Any clarifications to the design requirements in the statement of work (SOW) should be documented and followed up with a contract modification, if applicable.

Significant issues, including existing system deficiencies or any issue that affects SOW design requirements or delays turnover of a system for normal operations and maintenance, shall be brought to the attention of the applicable NASA management required to facilitate resolution. In general, the following issues shall be discussed with concurring or dissenting opinions summarized in writing for disposition by the KSC AHJ and/or NASA management:

a. Statement of the issue.

b. Primary stakeholders and their positions on the issue.

c. Synopsis of NFPA code, NASA standard, law or consensus standard, or listing agency (UL or FM) requirements regarding the issue.

d. Assessment of life-safety risk caused by the issue.

e. Other impacts caused by the issue (e.g. maintenance).

f. Construction document and contract requirements regarding the issue.

g. Project impact relative to available budget and schedule.

h. Methods to fund and correct the issue, both short and long term.

i. Proposed alternatives for mitigating the issues.

2. APPLICABLE DOCUMENTS

The following documents form a part of this document to the extent specified herein. When this document is used for procurement, including solicitations, or is added to an existing contract, the specific revision levels, amendments, and approval dates of said documents shall be specified in an attachment to the Solicitation/Statement of Work/Contract.

2.1 Governmental

Federal (FED)

29 CFR, Subtitle B, Chapter XVII, Part 1910	Occupational Safety and Health Standards
FED-STD-595	Colors Used in Government Procurement

John F. Kennedy Space Center (KSC), NASA

KSC-STD-E-0002	Hazard Proofing of Electrically Energized Equipment, Standard for
SPECSINTACT	NASA KSC Shelf Masters
79K32573	Water Deluge Activation Station Standard Assembly

Military (MIL)

MIL-STD-101	Color Code for Pipelines and for Compressed Gas Cylinders
UFC 3-600-01	Unified Facilities Criteria (UFC) Design: Fire Protection Engineering for Facilities
ETL 01-18	Fire Protection Engineering Criteria – Electronic Equipment Installations

NASA

NASA-STD-8719.11	Safety Standard for Fire Protection
NPR 8715.3	NASA Safety Manual w/changes through Change 1, 6/19/02
NASA-STD-5008	Protective Coating of Carbon Steel, Stainless Steel, and Aluminum on Launch Structures, Facilities, and Ground Support Equipment

(Copies of specifications, standards, drawings, and publications required by suppliers in connection with specified procurement functions should be obtained from the procuring activity or as directed by the Contracting Officer.)

2.2 Non-Governmental

National Fire Protection Association (NFPA)

All volumes of NFPA fire codes, including appendices and recommended practices.

(Application for copies should be addressed to the National Fire Protection Association, One Batterymarch Park, Quincy, MA 02169-7471.)

National Institute of Standards and Technology (NIST)

NIST TN 1423	Analysis of High Bay Hangar Facilities for Fire Detector Sensitivity and Placement

(Applications for copies should be addressed to the Building and Fire Research Laboratory, National Institute of Standards and Technology, Gaithersburg, MD 20899.)

Underwriters Laboratories Inc. (UL)

UL FPED	UL Fire Protection Equipment Directory

(Application for copies should be addressed to Underwriters Laboratories Inc., 333 Pfingsten Road, Northbrook, IL 60062-2069.)

American Society of Mechanical Engineers (ASME)

ASME A17.1	Safety Code for Elevators and Escalators

(Application for copies should be addressed to The American Society of Mechanical Engineers, Three Park Avenue, New York, NY 10016-5990.)

3. GENERAL REQUIREMENTS

3.1 Criteria

Fire alarm systems shall be designed, installed, tested, and maintained in accordance with the provisions of NFPA (e.g., NFPA 70, 72, 75, 90A, 101) and 29 CFR Part 1900. A complete fire alarm and detection system shall be required in facilities meeting any of the following conditions:

a. Subject to having 50 or more occupants as determined using the Life Safety Code (NFPA 101) criteria.

b. Floor area greater than 279 square meters (m^2) (3,000 square feet [ft^2]).

c. A facility with one or more floors above or below the level of exit discharge.

d. Temporary and permanent sleeping quarters, including all access corridors.

e. Computer rooms and essential electronic equipment areas as designated by the KSC AHJ.

f. Facilities with partitions that prevent occupants from readily identifying the effects of fire and the subsequent need to evacuate.

g. Areas within the facility that require a fixed suppression system and those with automatic suppression systems where flow switches and tamper switches are required.

h. Areas where heating, ventilating, and air conditioning (HVAC) systems are required by NFPA 90A to have duct smoke detectors for air handler shutdown.

i. Where rooftop air handler units require shutdown and there is no ductwork to allow installation of duct smoke detectors (typical in trailer complexes).

j. Other instances as determined by the KSC AHJ.

3.2 Fire Alarm and Detection Systems

3.2.1 General

The KSC fire alarm detection and reporting system shall be composed of local systems and a Center-wide proprietary protective signaling system as described in NFPA 72. Alarm, supervisory and trouble signals report to KSC's CFMS for fire or maintenance dispatch. All system components shall be listed or approved for use with each other by a recognized independent testing laboratory such as UL or FM; modification of existing facility fire alarm systems require sole-sourcing of components only as required to meet these listing requirements. New facility installations do not require the sole-sourcing of equipment unless the new system is required to connect to existing fire alarm control panel networks as detailed in 3.2.12.2.c.

Fire alarm system components and system integration shall meet the material and installation requirements of the KSC Master SPECSINTACT section titled FIRE DETECTION AND ALARM. Air sampling smoke detection systems and components shall meet the requirements of the KSC Master SPECSINTACT section titled FIRE DETECTION AND ALARM INTERFACES.

3.2.2 Facility Fire Alarm Systems

Generally only one fire alarm control panel shall be installed per facility. The Designer shall consult with the KSC AHJ on requirements of large facilities or if other specialized control panels for elevator or suppression systems are being considered. Facility fire alarm control panels should not control suppression systems unless the suppression system covers most or all of the facility area.

a. The facility fire alarm system shall be a fully addressable, microprocessor-based, expandable modular type unless approved otherwise by the KSC AHJ.

b. Fire alarm systems shall be stand-alone systems and shall not be combined with a security system, paging and area warning system (PAWS), energy management and control system, or any other control system. Fire alarm systems may be connected to other control systems for monitoring and control purposes after consultation with the KSC AHJ on a case-by-case basis.

c. Drawings shall include a programming matrix that fully defines system operation by cross-referencing all fire alarm panel inputs (rows) to all fire alarm panel outputs (columns).

d. Fire alarm control panel shall be custom-programmable. Software operating sequences shall adhere to the KSC standard operating practice as follows:

   (1) See 3.2.12 for detailed CFMS reporting requirements.

   (2) Activation of any alarm initiation device, automatic or manual, shall annunciate a fire alarm at the fire alarm control panel and report fire to the CFMS using relay contact or serial data interface methods.

   (3) Activation of any supervisory device (valve tamper switch, maintenance bypass switch, etc.) shall annunciate supervisory at the fire alarm control panel and report supervisory to the CFMS.

   (4) Activation of alternating current (AC) power shunt trip systems for essential electronic equipment rooms shall annunciate supervisory at the fire alarm control panel and report supervisory to the CFMS. When provisions to bypass the shunt trip system are approved by the KSC AHJ, then this supervisory condition shall also be separately reported.

   (5) Elevator control shall be done in accordance with NFPA 72 and American National Standards Institute (ANSI) A17.1.

   (6) Any AC power circuit that is not monitored by the fire alarm control panel, but is performing a required life safety function, such as a power shunt trip, shall be monitored for trouble by the fire alarm control panel using a power fail relay. The fire alarm control panel shall be programmed to delay the trouble report at the CFMS for at least 30 minutes, with a specific time delay included in the specifications.

(7) Activation of a CFMS-reporting radio-trouble contact (antenna cut or loss of communications) shall annunciate supervisory at the fire alarm control panel and shall be self-clearing. When connection of this contact to the fire alarm control panel is not practical, then a separate audible and visual annunciation shall be provided at the radio location.

(8) Any NFPA 72-defined trouble condition (wiring problem, loss of power, flame detector trouble, etc.) shall annunciate trouble at the fire alarm control panel and report trouble to the CFMS. Loss of AC power shall report a trouble signal to CFMS with a time delay of at least 30 minutes; the specific time delay shall be included in the specification (maximum time delay varies by panel type and manufacturer).

(9) Activation of any manual pull station, heat detector, flame detector, or suppression system flow (or discharge) switch shall sound the facility evacuation.

(10) Activation of any ceiling or under-floor mounted spot type smoke detector shall sound the facility evacuation alarm only if it is the primary protection (i.e., the area is not covered by other automatic detection devices such as sprinkler system flow switches, heat detectors, or flame detectors).

(11) Activation of air sampling smoke detection system Alarm Level 1 (Alert) and Alarm Level 2 (Action) shall annunciate supervisory at the fire alarm control panel and report supervisory to the CFMS.

(12) Activation of air sampling smoke detection system Alarm Level 3 (Fire 1) shall annunciate fire at the fire alarm control panel, flash strobes in the affected area, and report fire to the CFMS.

(13) Activation of air sampling smoke detection system Alarm Level 4 (Fire 2) shall annunciate fire at the fire alarm control panel, and shall report as a silent alarm if the area is protected with a suppression system (air sampling system shall sound the evacuation if it is the primary protection). An Alarm Level 4 signal shall report fire to the CFMS.

(14) For fire alarm control panels serving multiple buildings, evacuation alarms shall be activated for alarm devices in the same building only.

(15) An audible evacuation alarm shall be programmed for or hardware provided for temporal three-bell tone. Multiple strobes visible from the same location shall be synchronized unless otherwise approved by the KSC AHJ.

(16) Activation of any alarm initiation device, automatic or manual, shall release all door holders in the same building as the initiation device.

(17) Activation of any duct smoke detector shall shut down the respective air handling unit only or, as required by NFPA 90A, multiple air handling units for integrated or common area systems, but shall not sound the facility evacuation

alarm, causing only an alarm signal at the FACP and CFMS to initiate a fire department response.

(18) Designer shall consult with the KSC AHJ on the operation of all electrically controlled suppression systems.

e. To facilitate testing, software-programmed maintenance bypass functions shall be provided for the following functions as applicable. Activation of any bypass function shall annunciate supervisory at the fire alarm control panel and report supervisory to the CFMS.

(1) Evacuation Signal Bypass (audible and visual) – Bypasses all audible and visual evacuation appliances. Provide a separate bypass for each facility (building number) controlled by the fire alarm control panel.

(2) Air Handling Unit (AHU) Shutdown Bypass Control – Bypasses AHU shutdown relay(s) generally provide a separate bypass function switch for each individual AHU. For large facilities or facilities with many AHUs or for multiple AHUs serving a common area, the Designer shall consult with the KSC AHJ regarding the grouping of multiple AHUs on a single bypass switch.

(3) Central Fire Monitoring System Bypass – Bypasses remote reporting signals (except the supervisory signal for bypass switch operation).

(4) Elevator Interface Bypass Control – Bypasses elevator recall and shutdown relay(s). Generally provide a separate bypass function switch for each individual elevator. For multiple elevators in a common area, the Designer shall consult with the KSC AHJ regarding the grouping of multiple elevators on a single bypass switch.

(5) Suppression System Discharge Bypass – Bypasses an electrically controlled suppression system discharge output, typically to a solenoid valve. Provide a supervised, hard-wired key switch bypass at the releasing device and a separate software function switch bypass for each suppression system releasing device (solenoid valve). Specify that these bypasses must generate a supervisory signal at the FACP and CFMS in addition to any trouble signals generated.

(6) Flame detector test function – Activates a software addressable relay wired to the test input function on one or more flame detectors. Activation of this test function initiates an alarm on the flame detector(s).

3.2.2.1 Retrofitting/Expansion of Existing Fire Alarm Systems

During field investigations for planning, studies, preliminary engineering reports, and designs that require existing fire alarm systems to be modified (i.e., replacing fire alarm control panels, adding fire alarm initiation/signaling/control devices, modifying or adding space to a facility, adding or modifying sprinkler systems), Designers shall fully review the existing hardware documentation, software documentation, and CFMS reporting information for the system to be modified. The Designer shall consult with the KSC Fire Alarm Operations and Maintenance

Organization to obtain existing system data and arrange any equipment inspections required. Designers shall ensure the existing FACP meets the following guidelines or documents in writing to the NASA Lead Design Engineer of any deficiencies.

a. Ensure the fire alarm system meets current code and standards requirements.

b. Ensure the fire alarm system communicates the required alarm, supervisory, and trouble reporting information to the CFMS.

c. Ensure the fire alarm control panel sequence of operations meets current standards.

d. Ensure the existing FACP has adequate expansion capability and expansion hardware is available by the original equipment manufacturer.

e. Ensure new fire alarm equipment specified is compatible with and UL-listed or FM-approved for use with existing fire alarm equipment.

f. Ensure there is adequate space to install additional fire alarm terminal cabinets at the designated locations.

g. Verify the existing secondary power supply and conductors are adequate to handle the additional load associated with the modifications.

h. Determine location and size for any new AC circuits required for new systems (e.g., air sampling system, preaction air compressor, audio amplifiers, etc.).

i. If the new criteria for the retrofitting/expansion of the existing fire alarm system exceed the expansion capabilities of the FACP, a new fire alarm system or new FACP shall be provided. In addition, the Designer shall obtain approval of the KSC AHJ for continued use of the fire alarm system with any known deficiencies related to the above.

3.2.2.2 Fire Alarm Control Panel Location

The fire alarm control panel shall be installed in an air-conditioned room such as the communication rooms located on the floor of exit discharge. Location shall take into account CFMS connection method, radio or telephone cable plant. Location of the FACP inside the communication room allows for easier connection to the cable plant while location near an outside wall simplifies antenna installation for radio systems. In multistory or large buildings, remote cabinets containing electronic components also will need to be installed in air-conditioned rooms.

For all but small systems, a wiring terminal cabinet shall be installed immediately adjacent to the fire alarm control panels. This terminal cabinet shall be the interface point for all field wiring connections to the fire alarm control panel modules. Where site or system arrangement conditions necessitate the installation of additional wiring cabinets, they shall be specifically indicated by location on the drawings.

3.2.3 Annunciators

The Designer shall consult with the KSC AHJ on the requirement for, type, and location(s) of fire alarm system annunciator(s). The minimum functions of the lobby annunciator shall include reporting alarms, silent alarms, and supervisory signals; trouble signals shall not annunciate at the annunciator(s). Capability to silence, acknowledge, or reset the facility fire alarm system from the annunciator panel shall be determined by the Designer following consultation with the KSC AHJ.

3.2.4 FACP Wiring

Wiring shall be provided in accordance with NFPA 70 and NFPA 72. Fire alarm system circuits shall be installed in dedicated raceway (conduit) systems. The 60 hertz power circuits shall not enter enclosures containing fire alarm circuits except where required to connect to the fire alarm control panels.

Generally, all initiating device, signaling line, notification appliance, and control circuits shall be "Class A type" using separate and diverse routed raceways in accordance with NFPA 72. The following "Class B type" wiring is acceptable:

a. Between a Class B addressable zone module and the connected initiation device when installed in the same box. The construction documents shall specifically indicate this configuration and required components.

b. Between Class B CFMS Radio Transceiver monitor zones and corresponding fire alarm control panel relays.

c. Where Class A hardware such as suppression release circuit modules is not available from the equipment manufacturer.

d. Other instances where approved by the KSC AHJ.

3.2.4.1 Circuit Color Coding

Circuit color coding and labeling shall meet the requirements of the KSC Master SPECSINTACT section titled FIRE DETECTION AND ALARM. The Lead Designer shall consult with the KSC AHJ as required for clarifications or guidance based on the particular design.

3.2.4.2 Surge Suppression

Line voltage and low-voltage surge suppression devices to suppress all voltage transients that may damage the fire alarm control panel components shall be provided. Line voltage surge suppressors shall be installed on the load side of a lockable fused disconnect switch that is servicing fire alarm control equipment. Low voltage surge suppressors shall be installed on any circuit, including those for communications to the CFMS, entering or leaving a facility.

Where a radio transceiver with an externally mounted antenna is used for central fire monitoring, a surge suppressor shall be installed between the antenna and electronic equipment. Also, external antennas shall be located to minimize the probability of a direct lightning strike.

Provisions for connecting all surge suppressors to an earth ground must be specifically indicated on the contract documents. For new facilities, connection locations shall be coordinated with plans showing earth grounding. For existing facilities, existing and accessible earth ground connection points shall be indicated or new connection points bonded to existing grounding shall be installed.

3.2.5 Wet and Corrosive Location Requirements

Conduit in exterior (outdoor) unfinished areas shall be designed in a manner that will minimize water intrusion into exterior-mounted devices and enclosures. Drawings shall provide necessary details showing conduit entering device junction boxes from the bottom and leaving the device junction boxes from the sides. Indicate conduit shall be sloped away from the device junction boxes and towards an automatic or manual drain.

Equipment mounted in exterior, corrosive, or wet locations shall be National Electrical Manufacturers Association (NEMA) 4X, protected from corrosion, and gasketed. Where severe corrosion conditions exist such as at launch pads or near the ocean, special paint coatings shall be used in accordance with NASA-STD-5008.

3.2.5.1 Installation in Hazardous Locations

Local fire alarm systems installed in hazardous areas shall comply with NFPA 70, including Chapter 5, NFPA 497, and KSC-STD-E-0002.

Drawings shall indicate all hazardous areas by geographic area and hazardous class-division-group type. Conduit, enclosures, and devices installed in hazardous locations shall conform to the requirements of UL or FM for the hazardous location classification indicated. When the device is not factory-sealed, conduit seal-off fittings suitable for the hazardous classification shall be indicated at each conduit connection to the explosionproof enclosure in accordance with NFPA 70.

The operating current of explosionproof devices (bells, strobes, speakers) may be significantly higher than that for standard devices. The design shall specify the basis of component selections and incorporate the necessary special provisions, including but not limited to additional power supplies, additional circuits, fewer devices on a circuit, and larger conductor sizes, etc.

3.2.5.2 Fire Stopping

Through-penetrations in fire walls, partitions, or any floors to allow passage of cables, ducts, pipes, and conduits shall be sealed with a "fire stopping assembly" that is UL-listed or FM-approved with a fire-resistance rating equal to the fire resistance rating of the walls, partitions, or floors in accordance with NFPA 251. For sealing purposes, all floors shall be considered to have a fire-resistance rating of 2 hours. Openings no longer required shall be sealed with a material having equal or greater fire resistance as the walls, partitions, or floors.

3.2.6 Initiating Devices

This shall include all devices that initiate an alarm by either manual or automatic means. The automatic devices are designed to respond to measurable quantities of heat, smoke, energy radiation, or other detectable by-products of fire.

Unless otherwise prohibited by existing system limitations, initiating devices shall be made individually addressable by using addressable devices or by connecting the device to addressable modules. Initiating device circuits and power supplies shall have sufficient capacity to operate all devices connected, plus 25 percent minimum spare capacity per circuit.

3.2.6.1 Manual Pull Stations

Place and install manual pull stations in accordance with NFPA and ADA requirements. Locate additional manual pull stations at the exits of kitchens, electronic equipment areas, or other locations as required by the KSC AHJ.

Manual pull stations using spring-loaded contacts, including many addressable types, are not permitted at KSC. Non-addressable pull stations are generally made addressable by installing an addressable module with the pull station in an extended depth back-box. Design and construction documents shall clearly indicate the construction method used to make pull stations individually addressable.

3.2.6.2 Heat Detectors

Heat detectors shall not be installed in areas protected by sprinkler systems unless specifically required by code;e.g., elevator shafts and machine rooms.

Locate and space heat detectors in accordance with NFPA 72 requirements. Design and construction documents shall indicate spacing reductions due to ceiling heights or the use of fixed temperature detectors. Construction documents shall clearly indicate the type of each heat detector used (including the fixed temperature rating and the use of the rate-of-rise feature).

Electronic and addressable heat detectors shall only be used in air conditioned spaces. Construction documents shall indicate restrictions in locating these detectors near fluorescent lighting fixtures or other equipment that may interfere with the operation of the detectors. Non-addressable type heat detectors are generally made addressable by installing an addressable module in an extended depth back-box with the detector. Construction documents shall clearly indicate the construction method used to make heat detectors individually addressable.

3.2.6.2.1 Line-Type Fixed Temperature Heat Detector

Line-type heat detection cable for the protection of interior cable trays shall be provided. Cable shall operate on a fixed temperature principle only.

3.2.6.2.2 Rate Compensation Heat Detectors

Rate compensation heat detectors shall be of a hermetically sealed and automatically resetting type that will operate when the ambient air temperature reaches the detector setting regardless of the rate-of-temperature rise. This type of detector is used to protect certain types of hazardous locations in accordance with NFPA 72.

3.2.6.3 Spot-Type Smoke Detectors

Smoke detectors shall be the photoelectric type with individually addressable bases. In general, the application of spot-type smoke detectors should be limited to small areas or rooms; air sampling type detection systems should be used for large areas or areas housing essential electronic equipment.

Locate and space detectors in accordance with NFPA 72 requirements and generally limit application to air conditioned spaces.

In locations where photoelectric-type smoke detectors are installed beneath raised floors, the detectors shall be installed in accordance with Figure 1, using a Z-bracket and centering beneath the floor tile.

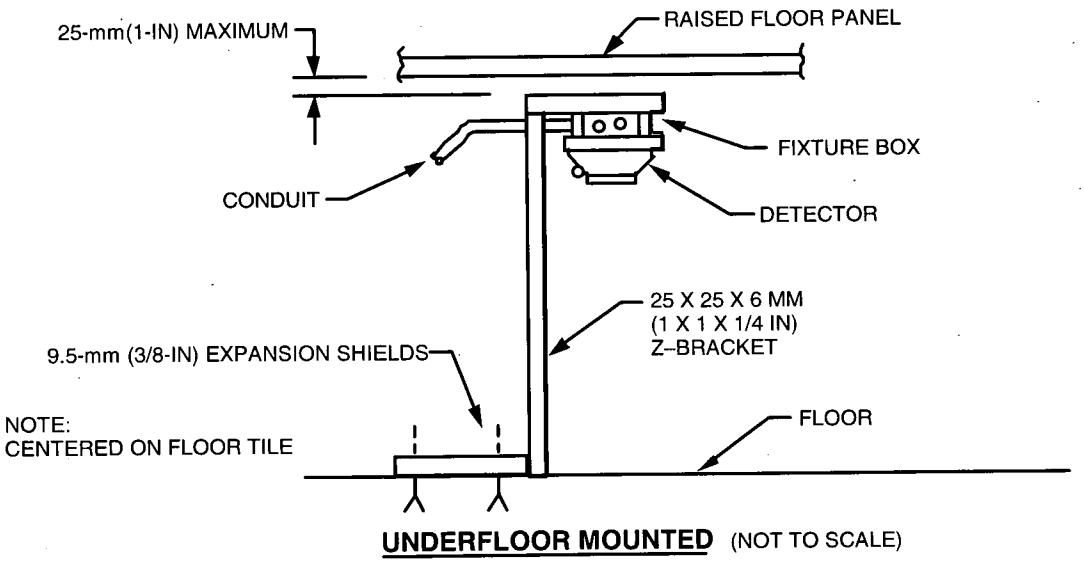


Figure 1. Typical Smoke Detector Mounting

3.2.6.3.1 Duct Smoke Detectors and Shutdown Relays

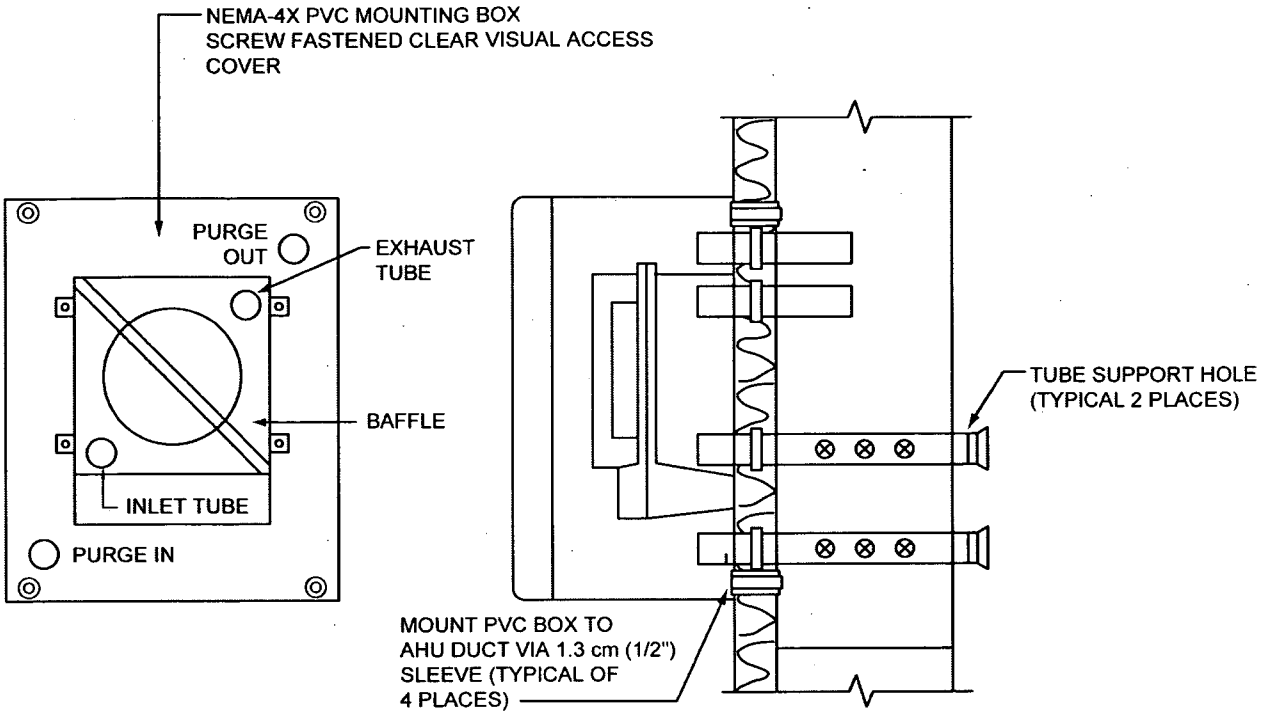
Duct smoke detectors shall be a photoelectric type listed by UL Fire Protection Equipment Directory (FPED) or FM approval guide and installed in accordance with NFPA 90A. Duct

smoke detectors shall be an addressable type connected to an addressable FACP with the ability to perform sensitivity testing in accordance with NFPA 72.

Where duct smoke detectors are installed outdoors, in unconditioned mechanical or electrical rooms, or in areas with high ambient temperatures and humidity, the detector housing shall be installed in an additional polyvinylchloride enclosure with an additional set of supply and exhaust sampling tubes to prevent condensation from forming within the detector housing (see Figure 2).

AHU shutdown relays shall be mounted within 0.92 m (3 ft) of the AHU's starter (or motor control center), but shall not be grouped with other fire alarm system electronic modules in order to maintain isolation from the AHU's control power source. In general, normally closed, held-open relay contacts shall be wired in series to the starter control coil. Drawings shall depict necessary detail to ensure correct connections. Fire system designers shall coordinate with electrical power designers to ensure such connection provisions are incorporated into motor control centers, combination starters, etc.

A separate remote test/light assembly shall be installed for each duct smoke detector. Where multiple duct smoke detectors are installed, the remote test switches shall be grouped together at a common location.



ELEVATION
NO SCALE

SECTION
NO SCALE

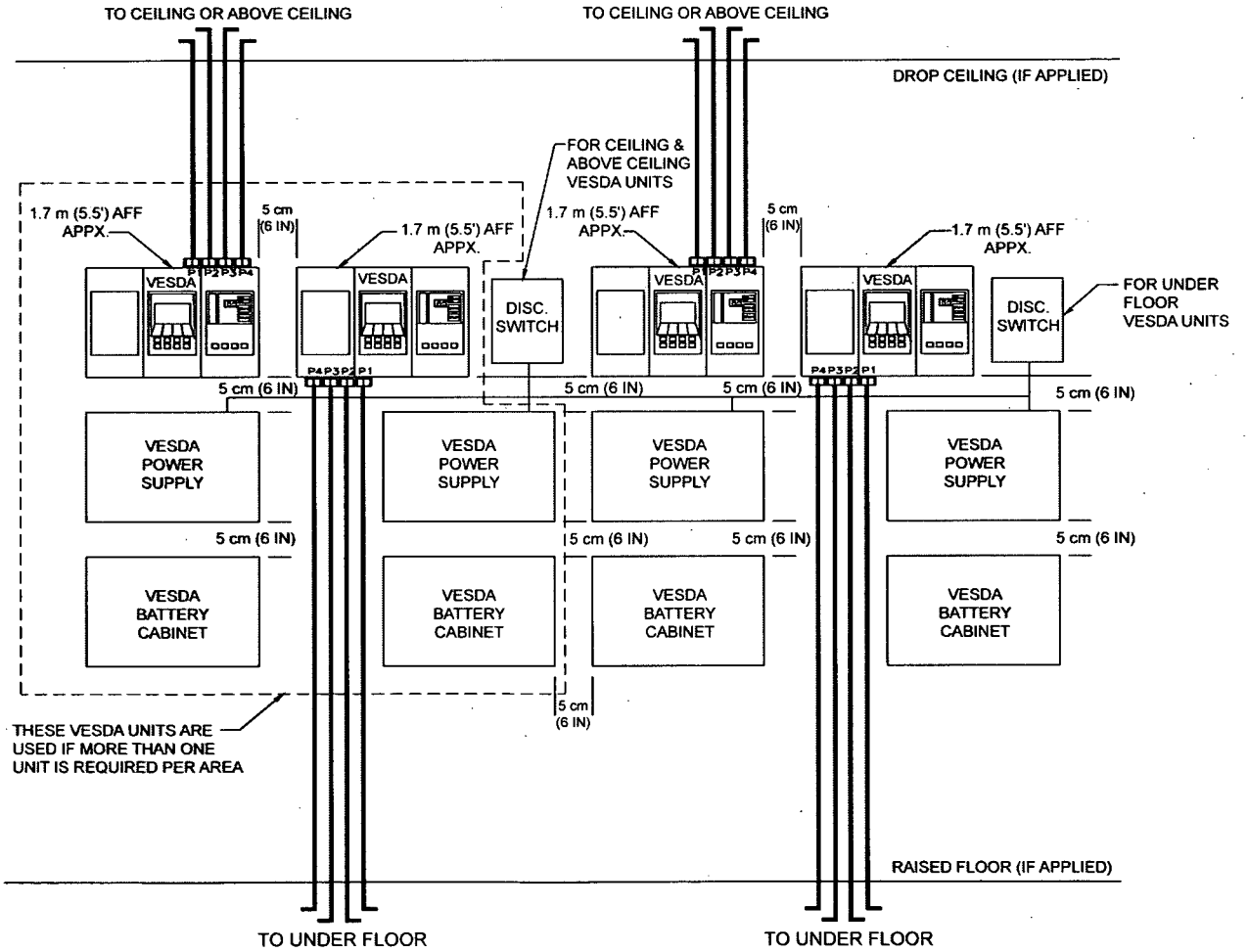
NOTES:

1. ALL MANUFACTURERS INSTALLATION RECOMMENDATION PROCEDURES AND TEST METHODS SHALL BE OBSERVED UNLESS OTHERWISE STATED. REFERENCE MANUFACTURERS INSTALLATION INSTRUCTIONS
2. ALL DUCT WORK PENETRATIONS SHALL BE AIR TIGHT AND WATER TIGHT.
3. A DIFFERENTIAL PRESSURE GAUGE SHALL BE USED TO ADJUST THE SAMPLING AND REFERENCE TUBES IN ORDER TO OBTAIN MAXIMUM PRESSURE DIFFERENTIAL.
4. DUCT WORK HOLE PENETRATIONS SHALL BE PER MFG SPECIFICATIONS.
5. 41 cm x 41 cm (16"x16") WATERTIGHT, AIRTIGHT ACCESS DOOR, MATERIAL TO MATCH DUCT MATERIAL, SHALL BE PROVIDED TO BE USED FOR CHECKING AND ADJUSTING AIR SAMPLING TUBES. IT SHALL NOT WEAKEN DUCTWORK.
6. PVC MOUNTING BOX SHALL NOT BE ATTACHED DIRECTLY TO DUCTWORK.

Figure 2. Outdoor AHU Duct Detector Housing

3.2.6.4 Air Sampling Detection Systems

An approved high-sensitivity Air Sampling Detection System, such as VESDA or equivalent, shall be installed to provide early detection of smoke in areas where mission-critical and essential electronic equipment is used, where flight hardware is processed, or as designated by the KSC AHJ. This type of smoke detection system shall be installed under raised floors and at the ceiling level. Unique applications, such as clean rooms, may require protection directly above the return air intakes of the computer room air conditioning (CRAC) units and above the false ceiling in locations where combustible materials are present. The air sampling detection systems can be used in conjunction with preaction sprinkler systems, wet pipe sprinkler systems, special suppression systems, or as a stand-alone alarm and detection system. The maximum recommended spacing for sampling ports shall not exceed 23 m^2 (250 ft^2) per port. See Figure 3 for typical mounting of VESDA cabinets.



TYPICAL MOUNTING OF VESDA CABINETS

Figure 3. VESDA Cabinet Mounting

Air sampling detection system components and system integration shall meet the material and installation requirements of the KSC Master SPECSINTACT section titled FIRE DETECTION AND ALARM INTERFACES.

The following alarm conditions for each air sampling detection system shall be separately connected to the facility fire alarm or preaction control panel as applicable and annunciate as follows:

a. "Alarm Level 1 (Alert)" – Supervisory Alarm

b. "Alarm Level 2 (Action)" – Supervisory Alarm

c. "Alarm Level 3 (Fire 1)" – Silent Alarm

d. "Alarm Level 4 (Fire 2)" – Alarm. Level 4 (Fire 2) will report as a silent alarm if the area is protected with a suppression system.

e. Summary trouble alarms indicating any trouble conditions such as low airflow, high airflow, and malfunctioning circuit board

f. Air sampling detection system has been bypassed for maintenance

See 3.3.4.2 for use of the various alarm levels in the control of preaction sprinkler systems.

3.2.6.5 Flame Detectors

Flame detectors shall be installed in high-bay areas; i.e., areas where the ceiling height is more than 9 m (30 ft) and where flight vehicles or payloads are processed. Detector type(s) (ultraviolet [UV], infrared [IR], UV/IR, Triple-IR) specified shall be based on optimizing detector capabilities with probable fire and false alarm source spectrums. The type of flame detector required will be identified in the first phase of design. Generally, Triple-IR detectors are preferred. Detectors shall be tested by UL, FM or other acceptable testing laboratory for the fuel detected (i.e., hydrazine, hydrogen, and hydrocarbon fuels).

Flame detectors shall be individually addressable for both alarm and trouble conditions. Detectors shall have their own self-test capability and the ability to remotely test the optical integrity of the detector from the fire alarm control panel using addressable relay(s). Remote test detector groups shall generally be grouped by common fire area (platform levels, different rooms, etc.).

The design shall provide the necessary details associated with flame detector installation including but not limited to the following:

a. Mounting and other installation details such as sealing for explosionproof installations.

b. Aiming and detector field of views in both plan and elevation views to ensure full fire detection coverage. Obstructions, range of the detector for the fire fuel source, and sensitivity settings shall be considered in detector placement.

c. Wiring details showing typical connections for alarm, trouble, and remote test functions; location and installation of addressable modules required for flame detector installations; and details showing the grouping of detectors for remote test purposes.

d. Direct current (DC) power circuit wiring design and additional power supplies, including remote power supplies, to power the detectors.

3.2.6.6 Suppression System Devices

Suppression system activation alarm and supervisory switches shall be connected to the fire alarm control panel and shall be individually addressable. Such switches are generally made addressable by installing a Class A wired zone addressable module(s) nearby in a separate back-box or grouped together in a cabinet. Construction documents shall clearly indicate the construction method used make suppression system flow and supervisory switches individually addressable.

The fire alarm designer shall coordinate with the mechanical system fire protection designer regarding the locations and types of alarm, supervisory, and tamper switches.

Where fire alarm control panels are used for suppression system release, they shall be UL-listed or FM-approved for the purpose. Each releasing appliance circuit shall include a supervised key switch that shall disconnect the circuit conductors from the solenoid releasing valve. When operated, in addition to any trouble signal, the point associated with any key switch shall be programmed to generate a supervisory signal at the FACP and CFMS. These disconnect switches shall be located on building walls or structures adjacent to the solenoid valve disconnected. Solenoid valves used for releasing service shall be UL-listed or FM-approved for use both with the releasing circuit hardware and the suppression system mechanical release valve.

3.2.7 Elevator Recall

Elevator recall systems shall be designed and installed in accordance with ANSI A17.1 and NFPA 72. The smoke detectors and heat detectors located in elevator lobbies, elevator hoistways, and elevator machine rooms used to initiate a firefighters' service recall or shunt trip power shall be connected to the building fire alarm system control panel or to a dedicated fire alarm control panel, which shall be designated as "Elevator Recall Control and Supervisory Panel." Unless otherwise required by the KSC AHJ only elevator lobby, elevator hoistway, and elevator machine room smoke detectors shall be used to recall elevators for firefighters' service. All smoke detectors for elevator recall shall be the photoelectric type. On elevator recall from a smoke detector in the elevator machine room or elevator hoist way, a "fire hat" indicator shall light on the elevator control switches at each landing indicating that it is not safe for the fire department to use the elevator.

Where heat detectors are used to shut down elevator power prior to automatic sprinkler operation, the heat detector shall have a lower temperature rating and a higher sensitivity compared to the automatic sprinkler head. The heat detectors shall be installed within 0.61 m (2

ft) of each automatic sprinkler head in accordance with NFPA 13 and 72. Heat detectors shall be of the fixed temperature type. Heat and smoke detectors will not be installed in the elevator pit unless required by the KSC AHJ.

Elevator interface relays shall be mounted within 1 m (3 ft) of the elevator controller or power disconnection point as applicable. Relays or addressable relays shall not be grouped with other fire alarm system electronic modules in order to maintain isolation from the elevator's control power source. Generally normally open, held-closed relay contacts shall be wired to the elevator control points. Drawings shall depict necessary detail to ensure correct connections. Fire system designers shall coordinate with electrical power designers to ensure such connection provisions are incorporated into elevator power and control components.

3.2.7.1 Emergency Disconnect Means

A manually activated emergency disconnect means shall be provided in accordance with NFPA 75 and NFPA 70, Article 645, to disconnect power to all essential electronic equipment. There shall also be a similar means to disconnect the power to all dedicated HVAC systems serving the room and cause all required fire/smoke dampers to close. The control for these disconnecting means shall be grouped and identified and shall be readily accessible at the principal exit doors. A single means to control both the electronic equipment and HVAC systems shall be permitted unless otherwise directed by the Lead Design Engineer. Where a push button is used as a means to disconnect power, pushing the button inwards shall disconnect the power. Manually activated mushroom push-button stations shall be installed within 457 millimeter (mm) (18 inches (in)) of the latch side of the exit doors and approximately 1219 mm (48 in) above the finished floor measured from the finished floor to the top of the plastic protective enclosure. Where both a manual pull station and mushroom push-button station are required, mounting locations shall be approved by the KSC AHJ prior to installation. The protective enclosure shall prevent accidental activation and be capable of accepting a metal wire with lead seal or a plastic integrity seal.

Requirements for automatically activated shunt-trip circuits in areas other than computer and essential electronic equipment rooms shall be specified by the KSC AHJ. Automatically activated shunt-trip circuits shall only be installed in locations approved by the essential electronic equipment owner and the KSC AHJ. Automatically activated shunt-trip circuits shall not be installed where the KSC AHJ agrees that activation of a shunt-trip system during hazardous operations would introduce greater hazards. In this case, a means for bypassing the shunt-trip system shall be provided.

Activation of AC power shunt trip systems for essential electronic equipment rooms shall annunciate a supervisory signal at the fire alarm control panel and report supervisory to the CFMS. When provisions to bypass the shunt-trip system are approved by the KSC AHJ, this supervisory condition shall also be separately reported. Relays used to generate these signals shall be dedicated for connection to fire alarm equipment and segregated from other shunt-trip wiring components.

3.2.8 Notification Appliances

The standard evacuation signal at KSC is a temporal three-bell tone. Bells shall produce at least 87 decibels at 3 m (10 ft); placement shall conform to NFPA 72 and ensure required audibility performance is achieved during testing. Audible notification appliance circuits and power supplies shall have sufficient capacity to operate all devices connected, plus 25 percent minimum spare capacity per circuit.

3.2.8.1 Voice Evacuation Systems

Voice evacuation systems shall be installed in all facilities required by NFPA 101, NASA-STD-8719.11, Uniform Federal Accessibility Standards, ADA, or as required by the KSC AHJ. Speaker placement shall conform to NFPA 72 and ensure required audibility and intelligibility performance is achieved during testing. Wattage tap for all speakers installed shall be indicated on the drawings. Audible notification appliance circuits, power supplies, and amplifiers shall have sufficient capacity to operate all devices connected, plus 25 percent minimum spare capacity per circuit.

Provide voice announcement evacuation message system if required by the KSC AHJ. Generally, multilingual voice announcements shall be provided in public visitor areas. Intelligibility of voice announcements shall have a common intelligibility score (CIS) of 0.70 for all areas. The tone preceding and following the voice evacuation message shall meet the "Public Mode Audible Requirements" of NFPA 72. Multilingual messages shall be in the English, Spanish, French, and Japanese languages or as specified by the KSC AHJ. For non-public facilities, English voice messages shall include the facility number, facility name, and reference to evacuation to marshalling areas.

3.2.9 Visual Evacuation Appliances

Strobe brightness (15, 30, 75, or 110 candela) shall be indicated for each unit shown on the drawings. Strobe placement shall be in accordance with NFPA 72 and ADA requirements. Strobes shall also be installed in high-noise areas and equipment rooms. All strobes shall be synchronized and shall remain flashing until the fire alarm control panel is silenced. Visual notification appliance circuits and power supplies shall have sufficient capacity to operate all devices connected, plus 25-percent minimum spare capacity per circuit.

3.2.10 Signaling Line Circuits

This shall include all circuits where simultaneous or sequential transmissions, or both, are transmitted between circuit interfaces, control devices, addressable modules, fire alarm control panels, and the central fire monitoring system. Design shall specify Style 6 or, if available, Style 7 circuit performance and include DC power circuits for addressable modules as required.

3.2.11 Networked Fire Alarm Control Panels

Network interface modules shall individually communicate with other fire alarm control panels and the CFMS using multiplexed communication techniques. Communication circuit wiring connections shall be suitable for supervised Style 7 operation. Module power shall be derived from the communication circuit or 24 VDC supervised power supply. Invalid configuration or loss of communication, component failure, or power failure shall initiate a trouble signal at the CFMS. Designs shall specify necessary hardware requirements including communications media, fiber, or copper cabling.

3.2.12 CFMS Reporting

3.2.12.1 CFMS Reporting Signals

The Designer shall consult with the KSC AHJ to determine CFMS reporting signals and transmission methods required for each new or modified facility. The general goal is to transmit the minimum number of reporting signals via the simplest method possible as described in 3.2.12.2, CFMS Reporting Methods. All new fire alarm systems shall be 100 percent addressable and, using standard or custom programming, the following devices and conditions shall be transmitted to the CFMS:

a. Summary fire alarm signal by facility number and, if available CFMS reporting zones permit, by device type. Summary fire alarm signal should not be sent to the CFMS if other more specific alarm data is being concurrently sent (e.g., suppression system discharge signals listed below).

b. Automatic sprinkler systems pressure or flow switches. Each flow or pressure switch shall be individually reported to the facility FACP, and then generally grouped into a single summary CFMS alarm signal by facility number. Consult with the KSC AHJ on additional requirements for multi-story or large facilities.

c. Special suppression systems pressure or flow switches (deluge, preaction sprinkler, wet/dry chemical, etc). Each flow or pressure switch shall be individually reported to the facility FACP, and then generally grouped into a single summary CFMS alarm signal by facility number and suppression system type. Consult with the KSC AHJ on additional requirements for facilities with multiple special suppression systems of the same type.

d. Summary supervisory and trouble conditions for the facility fire alarm control panel. Subsequent unacknowledged supervisory and trouble signals shall resend a signal to the CFMS.

e. Supervisory alarm conditions for the maintenance bypass and operation of emergency disconnect means (shunt-trip).

f. Additional supervisory alarm conditions for the suppression system isolation valves, low air pressure switches, tamper switches, or other supervisory devices as specified by the KSC AHJ.

g. CFMS reporting signals for fire pumps shall be in accordance with NFPA. Typically for diesel pumps, three separate signals for pump run, controller trouble, and not in automatic conditions are required. For electric pumps, typically three signals for pump run, loss of voltage, and phase reversal are required.

h. The following alarm conditions shall be transmitted to the CFMS for air sampling detection systems. For each air sampling detection system, the following signals shall be individually addressable at the local FACP. Consult with the KSC AHJ to determine if consolidated CFMS reporting requirements (in parenthesis) are acceptable:

(1) "Alarm Level 1 (Alert)" – Supervisory Alarm (Signals for multiple systems may be grouped if under the same facility management.)

(2) "Alarm Level 2 (Action)" – Supervisory Alarm (Signals may be grouped with Alarm Level 1 signals to provide a common supervisory signal when system is in Alarm 1 or Alarm 2 condition.)

(3) "Alarm Level 3 (Fire 1)" – Silent Alarm (Signals for multiple systems may be grouped if under the same facility management.)

(4) "Alarm Level 4 (Fire 2)" – Alarm (Signals grouped with summary alarm signal for the facility.)

(5) Summary trouble alarms indicating any trouble conditions such as low air flow, high air flow, and malfunctioning circuit board. (Signals grouped with summary trouble signal for the facility.)

(6) Air sampling detection system has been bypassed for maintenance. (Signals grouped with summary supervisory signal for the facility.)

i. Any or all addressable devices as identified by the KSC AHJ. Some launch and flight hardware processing facilities (Mobile Launcher Platforms, Mobile Launcher, and Launch Pads) may require the capability for remote control of facility fire alarm control panels from the CFMS. The KSC AHJ shall be consulted in such instances.

Reporting requirements shall be included in the programming matrix which fully defines system reporting requirements operation by cross-referencing how each fire alarm panel alarm input (row) activate the required CFMS signal (column).

3.2.12.2 CFMS Reporting Methods

Fire alarm control panels shall report to the CFMS by one of the following reporting methods:

a. Radio transceiver with zone inputs wired to fire alarm control panel relays programmed for fire, supervisory, and trouble reporting to the Central Radio Monitoring System (CRMS). See 3.2.12.2.1. This is the preferred reporting method unless the project's particular circumstances necessitate reporting using other methods indicated below.

b. Radio transceiver with serial data input wired to fire alarm control panel serial output card, printer port, or digital alarm communicator (DAC). This method may be required

for large facilities or facility complexes. The zone input to FACP relay method specified above is also required to meet UL requirements. See 3.2.12.2.2.

c. Connection to an existing fire alarm control panel network that currently reports to the CFMS. See 3.2.12.2.3. Such networks exist at the following facilities or facility complexes:

(1) Launch Complex 39A Simplex panel network.

(2) Launch Complex 39B Simplex panel network.

(3) Launch Control Center (K6-900) Simplex panel network.

(4) Vehicle Assembly Building (K6-848) Simplex panel network.

(5) Mobile Launcher Platform (MLP).

(6) Mobile Launcher.

(7) Kennedy Space Center Visitors Complex Simplex panel network.

(8) Hypergol Maintenance Facility Complex Simplex panel network.

(9) Operations and Checkout Facility (M7-355) Simplex panel network.

(10) Space Station Processing Facility (M7-360) Simplex panel network.

d. Connection to an existing "Summary Reporting" system located at the CD&SC (M6-138) or Vehicle Assembly Building Repeated (VABR) (K6-1193) via telephone cable plant. See 3.2.12.2.4.

3.2.12.2.1 Zoned Radio Transceiver

This is the preferred reporting method for facilities requiring up to 16 reporting zones. Design shall specify the AES-IntelliNet Mesh radio transceiver currently in use at KSC. Each radio has eight zones that are to be wired to the fire alarm control panel relay contacts generally programmed for the following functions.

a. Transceiver Zone 1: Fire Alarm – FACP controlled relay contacts programmed to close on any fire alarm signal except special alarm conditions on any other relays, typically relays connected to transceivers zones 4 through 8 (transmit only 1 fire alarm signal to the CRMS).

b. Transceiver Zone 2: Summary Supervisory Signal – FACP controlled relay contacts are to close on any NFPA defined supervisory signal, and are to be programmed to resend a supervisory signal to the CRMS (open, delay, and then re-close relay contacts) for each subsequent unacknowledged FACP supervisory condition.

c. Transceiver Zone 3: Summary Trouble Signal – FACP controlled relay contacts are to be closed on any NFPA defined supervisory signal, and are to be programmed to resend a trouble signal to the CRMS (open, delay, and then re-close relay contacts) for each subsequent unacknowledged FACP trouble condition.

d. Transceiver Zone 4: Summary waterflow signal activated by sprinkler system flow switches. The FACP relay to Transceiver Zone 1 is not activated if this relay is activated.

e. Transceiver Zone 5: Summary "silent" alarm signal activated by automatic initiation device that does not activate the facility evacuation alarm (e.g., duct smoke detectors). The FACP relay to Transceiver Zone 1 is not activated if this relay is activated.

f. Transceiver Zones 6 through 8 and/or use of additional radios: Designer to consult with the KSC AHJ for function assignments and need for additional radios to provide more than 8 CRMS reporting signals. The FACP relay to Transceiver Zone 1 is not activated if any of these relays are activated for fire alarm reporting purposes. Possible assigned functions can include:

(1) Fire pump running.

(2) Fire pump trouble or AC phase reversal.

(3) Fire pump not in auto or loss of AC voltage.

(4) Wet/Dry/Clean agent suppression system release.

(5) Deluge system discharge pending and water discharge.

(6) VESDA alarm, supervisory, and trouble signals.

(7) Low supervisory air pressure signal.

Design documents shall consider the following radio system installation issues:

a. Method of installation of fire alarm control panel relays that connect to the radio transceiver shall be specified, either relay card within the fire alarm control panel wired via the FACP wiring terminal cabinet (if installed) or a separate zone addressable module cabinet. The design shall indicate or specify the use of shielded cable and Class B wiring with end-of-line resistors to connect the FACP relay to the radio's transceiver zone.

b. Connection of the radio transceivers trouble relay contact to a fire alarm control panel zone for local supervisory annunciation (UL listing requirement). When connection of this contact to the fire alarm control panel is not practical, then a separate audible and visual annunciation shall be provided at the radio location.

c. Radio location; installation on exterior wall or use of external antenna may be required.

d. Separate power provisions such that radio transceiver does not power-down when the fire alarm control panel is turned off or vice versa. Typical installation includes a safety-switch and equipment enclosures as follows:

(1) Fused disconnect switch with the line-side source tapped to the fire alarm control panel's AC power ahead of its disconnect switch.

(2) Enclosure with an in-line surge suppressor, NEMA 5-20R receptacle, and plug-in power transformer:

(3) Enclosure with radio equipment with backup battery and supplied by low voltage AC power.

e. Surge suppression protection for radio transceivers shall be the same as for fire alarm control panels. Exterior-mounted antenna placement shall minimize potential for direct lightning strike and shall include a surge suppressor with direct earth ground connection.

3.2.12.2.2 Radio Transceiver with Serial Data Interface

Radio transceivers with a serial data interface shall only be considered where the amount of reporting zones required would exceed the capability of two 8-zone radios (in excess of 16 reporting zones). A typical application would be a large facility or complex of facilities with multiple fire alarm control panels networked together to achieve an integrated system. Where such requirements exist, the Designer shall consult with the KSC Fire Alarm Operations and Maintenance Organization regarding the specialized hardware and software required.

Design shall specify the AES-IntelliNet Mesh radio transceiver unit with full serial data module currently in use at KSC. The radio unit has eight zone inputs for connection to fire alarm control panel relays and a serial input for connection to a fire alarm control panel output providing Contact ID format data. Radio physical installation and zone input reporting functions shall be installed in accordance with 3.2.12.2.1. Generally, hardwired zone inputs are required to supplement the serial data input in order to meet UL requirements.

Fire alarm control panel serial output ports typically transmit all state changes resulting in an excess amount of data input to the serial input of the radio transceiver and CRMS system. Therefore, the installation of a "filtering" panel (e.g., Simplex Network Display Unit (NDU)) connected to the network of facility fire alarm control panels is required. Unless approved by the KSC AHJ, "filtering" panels may not monitor alarm initiation devices or activate evacuation or control appliances. "Filtering" panels are specifically programmed to recognize only specific alarm, trouble, or supervisory conditions generated by other fire alarm control panels on the connecting network; as a result, unwanted signals such as operator inputs at the fire alarm panel are not transmitted to the CRMS. "Filtering" panels shall be UL-listed fire alarm control equipment and the installation shall comply with all applicable requirements of this Standard. Programming of "filtering" panels shall be specified such that responding personnel are not required to acknowledge, silence, or reset alarms at the "filtering" panel that are the result of condition at another fire alarm control panel on the network.

Each CRMS reporting signal sent using zone and serial data communications methods (via the "filtering" panel) shall be included in the programming matrix for the fire alarm control panel.

3.2.12.2.3 Connecting to an Existing Fire Alarm Control Panel Network

See 3.2.12.2 (c) for the locations of existing fire alarm panels that report using a network system. The Designer shall consult with KSC AHJ regarding the connection of a new fire alarm control panel to an existing network system. The design shall incorporate the following elements:

a. Specify the network communications media (fiber, copper cabling, or KSC telephone cable plant), hardware modifications at the new and existing panels, new cable routing, and connection points.

b. Method of providing hardwired zone inputs in addition to serial data input in order to meet UL requirements.

c. Programming requirements at the existing NDU on the network. Each new or revised CFMS reporting signal sent using zone and serial data communications methods (via the NDU) shall be included in the programming matrix for the fire alarm control panel.

d. Reacceptance testing of other fire alarm systems using reporting software modified by the installation.

See 3.2.12.2.1 for radio transceiver installation (hardwired type zone input) requirements related to networked fire alarm control panels.

See 3.2.12.2.2 for radio transceiver serial data reporting requirements related to networked fire alarm control panels.

3.2.12.2.4 Connecting to an Existing Summary Reporting Panel

Existing Summary Reporting Panels are located at the CD&SC (M6-138) and VABR (K6-1193) communication hubs. Relay contacts at the facility fire alarm control panel are connected to Class B zones of the Summary Reporting Panel using KSC copper cable telephone plant cable pairs. Typically this method is limited to facility FACP's with the following limitations:

a. Number of CFMS reporting zones required is four or less, typically assigned: Alarm-Supervisory-Trouble-Waterflow.

b. Radio communication is not feasible.

c. Facility currently reports to a Summary Reporting Panel.

Designs connecting to Summary Reporting Panels for CFMS reporting shall include the following elements:

a. Specification of quantity and purpose of fire alarm control panel relays that are to connect to the Summary Reporting Panel. A 3.3K ohm, 0.5 watt end-of-line resistor shall be specified for each circuit.

b. Wiring installation from an existing or new facility telephone terminal cabinet to the facility fire alarm control panel.

c. FACP reporting relays should operate the same as for radio transceiver reporting detailed in 3.2.12.2.1.

3.2.12.3 Color Graphics Display

Unless otherwise indicated in the governing SOW or required by the KSC AHJ, color graphics displays are provided by KSC's Institutional Services Contractor and such requirements should not be included in contract construction documents.

3.2.13 Architects and Engineers (A&E) Fire Alarm Design Drawings

Unless otherwise indicated below, fire alarm system drawings shall be on separate sheets with the work of other disciplines only shown to the extent required to ensure coordination. Design drawings shall include the following content (listed in general order of presentation):

a. General notes and fire alarm symbol legend. Symbols shall be in accordance with Appendix A. For small projects, general notes and symbol legends can be combined with electrical general notes and symbols, but fire alarm content shall be grouped together on the sheet.

b. Existing condition, demolition plans, and associated details for modifications to existing systems or facilities. Design to remove all control equipment, field devices, and raceway/wiring systems that are made obsolete, in poor condition, not maintainable, not re-usable, or not required; devices and equipment may not be abandoned in place. Differentiate between all existing equipment and devices to be removed or retained. Upon completion of adequate field investigations, show existing conditions through digitized photographs or details on CAD drawings. For small projects, fire alarm demolition content can be on the same sheet(s) as electrical demolition.

c. Floor plans (with current room layout and current room numbers) showing all equipment cabinet locations, annunciator locations, device locations, sprinkler coverage, special construction characteristics (high ceiling, electronic area, etc.) impacting the fire alarm design. Device locations should consider logical conduit routing without indicating specific conduit paths. Existing devices to remain shall be shown and visually differentiated from new devices. Design wiring details for all connections to existing system circuits.

d. New facility designs that include reflected ceiling plans (as a separate CAD layer) on the fire alarm plans. Heat and smoke detectors should be located no closer than 305 mm (12 in) from a fluorescent light fixture, no closer than 1 m (3 ft) from any return air diffuser, and no closer than 2 m (6 ft) from any supply diffuser.

e. Riser diagrams showing connection of all new, removed, and remaining devices back to the originating fire alarm control panel(s) including all fire alarm terminal cabinets, remote power supplies/notification-appliance-circuit panels, addressable interface module cabinets, etc. Existing devices/equipment to remain shall be shown and visually differentiated from new devices. Major common circuits (addressable device network, DC power, etc.) shall be indicated on the riser. Indicate zone, signal circuit, or address for all devices on existing systems.

f. Operating Sequence to be defined by a programming matrix that cross-references each output and central fire monitoring signal response (columns) to each detection device, manual initiation device, maintenance bypass switch, and all other associated inputs (rows). Where inputs or outputs function in a common manner, they may be grouped into a single column (e.g., all strobes on multiple circuits operate the same way based on various inputs).

g. Installation details including:

(1) Elevations of all new cabinet locations including general arrangement, mounting details, and AC power connections.

(2) Details of special installations as required, such as outdoor or explosionproof installations.

(3) Where flame detectors are used, details including detector mounting, addressable module mounting, typical wiring connections, and field-of-view coverage provided.

(4) Details for duct smoke detectors in both conditioned and unconditioned spaces, access doors in ductwork, and fire/smoke dampers.

h. Provide the following additional information on the drawings for the areas that will be protected by air sampling detection systems:

(1) Installation details including reflected ceiling plans showing all lights, air conditioning diffusers (both supply and return), transfer grilles, PAWS speakers, exit lights, sprinkler heads, heat detectors, etc., to prevent interference with new ceiling air sampling piping; reflected raised floor plans showing the location of all new and existing essential electronic equipment, desks, workstations, floor diffusers, CRAC units, etc. to prevent interference with the new air sampling system piping;

(2) Plan view of all obstructions within the interstitial space between the true ceiling and the suspended ceiling to include, but not be limited to the following: HVAC ductwork, chilled water piping drain, sewer lines, sprinkler system piping, etc., to prevent interference with the new above ceiling air sampling system piping.

3.2.14 Fire Alarm System Specifications

Fire alarm system components and system integration shall meet the material and installation requirements of the KSC Master SPECSINTACT sections titled FIRE DETECTION AND ALARM (fire alarm control panels and components) and FIRE DETECTION AND ALARM INTERFACES (air sampling smoke detection systems). Any editing of the specification (other than deleting non-applicable selections, paragraphs, and sections) that changes these requirements shall be approved by the KSC AHJ.

3.2.15 Fire Alarm System Shop Drawings

Fire alarm system shop submittals required are detailed in the KSC Master SPECSINTACT sections titled FIRE DETECTION AND ALARM and FIRE DETECTION AND ALARM INTERFACES. The Designer shall edit the submittal requirements as appropriate based on the project scope.

Where existing fire alarm systems are modified, the Designer shall review the existing system drawings, software program, and CFMS reporting information. When the existing FACP is to be reused, the specifications shall be edited to:

a. Indicate the existing KSC drawing for the system to be modified.

b. Indicate that computer (CAD) files for the drawings will be provided for use in the generation of required shop drawing submittals, and the Contractor is to verify and revise the drawings as required in order to submit as-built drawings reflecting the as-built system configuration.

3.2.16 Battery Calculations

The Designer shall ensure that battery calculations are performed to substantiate that the batteries are sized to operate the fire alarm and detection system, including all connected devices in normal supervisory condition for 24 hours and then operate the system in the alarm condition for 5 minutes in accordance with NFPA 72. For voice evacuation systems or situations as directed by the KSC AHJ, the batteries shall be sized to operate the Fire Alarm and Detection System in normal supervisory condition for 24 hours and then operate the system in the alarm condition for 10 minutes. For unique systems such as those at the launch pads, on the new Mobile Launcher, and on the existing Mobile Launcher Platform (MLP), batteries shall operate the systems in their normal supervisory mode for a minimum of 72 hours and shall operate in alarm condition for 15 minutes.

Where existing systems are modified, the designer shall assess the existing battery system and provide for the installation of additional battery and power supply equipment as required. Existing batteries older than 2 years old shall be replaced on all fire alarm modification or refurbishment projects.

3.2.17 Fire Alarm System Acceptance Testing

Fire alarm system testing shall meet the requirements of the KSC SPECSINTACT Master Section entitled FIRE DETECTION AND ALARM and NFPA 72. Air sampling smoke detection system testing shall meet the requirements of the KSC SPECSINTACT Master Section titled FIRE DETECTION AND ALARM INTERFACES. Where fire suppression systems are installed, fire alarm system testing shall be coordinated with the testing of the fire suppression systems to ensure a proper interface between these systems.

The Designer shall ensure that the scope of fire alarm system acceptance testing requirements is incorporated in the construction contract documents. Special consideration shall be given to the

modification of existing systems to ensure that the extent of reacceptance testing required on portions of the system not modified is adequately incorporated in the construction documents. Include portions of existing system drawings as necessary to indicate the scope of the existing system requiring reacceptance testing.

3.3 Water-Based Suppression Systems

3.3.1 General Requirements

All water-based suppression systems shall be designed and installed in accordance with NFPA codes, except as specified by this document. The Designer shall consult with the KSC AHJ on the specific types of systems applicable for the design. Suppression system electrical control and detection design shall be in accordance with the applicable subsections of this Standard.

3.3.1.1 Requirements for Automatic Sprinkler Systems

Automatic sprinkler protection shall be provided for all new building/facility construction. Sprinkler protection shall be provided in renovation projects exceeding 232 m^2 (2500 ft^2) or involving over 50 percent of the building. Small building construction housing only noncombustible materials may not require automatic sprinkler protection if approved by the KSC AHJ.

A 51 mm (2 in) main drain valve shall be included on each riser. Riser main drain piping shall be extended full size to discharge outdoors in a location approved by the Lead Design Engineer.

An inspector's test valve shall be installed 1.5 m (5 ft) above the finished floor located at the most hydraulically remote portion of wet-pipe, dry pipe, and preaction systems. The inspector's test valve shall have an integral site glass, three positions (drain, test, and off), and a test orifice equivalent to the smallest orifice sprinkler used on the system. Piping shall extend from valve to discharge outdoors in a location approved by the Lead Design Engineer. For non-paved areas, a 457 mm (18 in)-long concrete splash block for the inspector's test discharge impingement shall be provided. Inspector's test connections shall not terminate in mop sinks or floor drains.

Where NFPA, other code, or KSC AHJ requires installation of additional flow switches for a wet pipe system fed from a single riser (e.g., a paint booth in a hangar, an elevator hoistway, etc.), a separate inspector's test connection will be required at the hydraulically most remote location for each of these system sections or a location approved by the KSC AHJ (or representative) to verify water flow alarms for these specific areas.

Piping shall be installed level or sloped back towards the riser or the auxiliary drains to allow for drainage. Where trapped piping is unavoidable, auxiliary drains shall be provided.

Risers shall be provided with a stamped metal tag containing the hydraulic design data. Main drain and inspector test stations shall also be identified using metal nameplates chained to the valves. The nameplates shall have lettering that is at least 51 mm (2 in) high.

3.3.1.2 Water Supply Demands

The water supply demand requirements in NFPA 13 are minimum design requirements. For all KSC facilities, the occupancy classification for the design density of a sprinkler system shall be increased by one occupancy classification for light and ordinary hazard group 1 systems, as defined by NFPA 13 (e.g., light hazard becomes ordinary hazard group 1). The KSC AHJ shall determine the need for increased water supply requirements to provide for occupancy flexibility.

3.3.1.3 Drain Systems

In areas with essential electronics and other areas protected by automatic sprinkler systems that are subject to excessive water damage, floor drain systems with sufficient capacity shall be provided to handle anticipated accumulation of sprinkler system and hose stream discharge.

3.3.1.4 Fire Department Connections

At least one Fire Department Connection (FDC) shall be provided for each facility with an automatic sprinkler system and/or standpipe system. The FDC shall serve the sprinkler system and interior standpipe system in buildings equipped with both. All standpipes and sprinkler systems shall be interconnected so that each FDC serves all fire protection systems simultaneously.

3.3.1.5 Control Valves

All control valves installed in these systems shall be the type with a visually indicating outside stem and yoke (OS&Y) and shall meet NFPA codes. Valve tamper switches shall be installed on all the system isolation valves, unless otherwise directed by the Lead Design Engineer after consultation with the KSC AHJ. Each valve tamper switch shall be monitored directly from the facility fire alarm panel as a separate supervisory signal.

A system control valve is required at the base of each riser for wet pipe, dry pipe, preaction, and deluge automatic sprinkler systems. A valve tamper switch is required for each automatic sprinkler system isolation valve. In buildings that have a looped main supply system that supplies all the automatic sprinkler systems using isolation valves and flow or pressure switches, tamper switches shall be provided with each isolation valve.

All other valves capable of isolating all or portions of a system, such as post indicator valves, backflow preventers, fire pump test header, and isolation valves, shall be locked with nonfrangible locks and/or provided with tamper switches as directed by the Lead Design Engineer after consultation with the KSC AHJ. Locks shall be provided by the Government. All systems subject to freezing shall have the capability of being isolated and drained for freeze protection or designed to mitigate problems associated with freezing.

3.3.1.6 Hydraulic Calculations, Schematics, and Fabrication Drawings

The design agency shall ensure that automatic sprinkler and standpipe system fabrication and assembly drawings be submitted for approval by the KSC AHJ or designated representative. Fabrication drawings shall meet all requirements in NFPA 13, stipulated for "working plans" to include a building cross section. The automatic sprinkler system shall be hydraulically designed to meet density and area of coverage requirements using a UL-listed or FM-approved hydraulic design program. Systems shall be designed in accordance with NFPA 13.

3.3.1.7 Fire Stopping

Through-penetrations in fire walls, partitions, or any floors to allow passage of cables, ducts, pipes, and conduits shall be sealed with a "fire stopping assembly" that is UL-listed or FM-approved with a fire-resistance rating equal to the fire resistance rating of the walls, partitions, or floors in accordance with NFPA 251. For sealing purposes all floors shall be considered to have a fire-resistance rating of 2 hours. Openings no longer required shall be sealed with a material of equal or greater fire resistance to that of the walls, partitions, or floors.

3.3.1.8 Painting

All automatic sprinkler and standpipe system piping, valves, and appurtenances shall be painted red or other color as dictated by the KSC AHJ.

3.3.1.9 Test Procedures

The design agency shall ensure that a test procedure and test record forms for conducting and recording complete tests on automatic sprinkler and standpipe systems installed in accordance with the hydraulic calculations be used to perform the final acceptance tests. The design agency shall ensure final inspection and testing forms that meet the requirements of NFPA 13 are provided upon completion of the final acceptance testing.

3.3.1.10 Testing and Acceptance Criteria

The design agency shall ensure aboveground and underground systems be tested in accordance with NFPA 13 and 24. The design agency shall ensure preapproved automatic sprinkler system test procedures are used to perform the acceptance testing. Final inspection and testing forms that meet the requirements of NFPA 13 shall be provided upon completion of the final acceptance testing.

Preaction and dry pipe systems shall require an air pressure leakage test at 276 kilopascal (kPa) (40 psi). Wet pipe systems installed or modified in existing facilities housing essential electronic equipment or flight hardware shall require an air pressure leakage test at 276 kPa (40 psi). The applied pressure shall be maintained without additional test media (compressed air or nitrogen) for at least 24 hours. Maximum allowable pressure drop shall be 10 kPa (1.5 psi). All water-based suppression systems with closed heads shall be hydrostatically tested to 200 psi (or 50 psi

above static pressure where static pressure exceeds 150 psi) except where exempt by AHJ approval for air pressure leakage test only.

3.3.2 Wet Pipe Sprinkler Systems

Wet pipe sprinkler systems shall have a riser comprised of a swing check valve with all associated trim; including a 51 mm (2 in) main drain connection port and gauges indicating supply and system side pressures at the swing check valve, above the OS&Y supply control valve. A vane-type water flow switch shall be installed on the riser piping above the swing check valve.

When wet pipe sprinkler systems are used in conjunction with air sampling detection systems for the protection of essential electronic equipment, the air sampling systems shall be monitored by the facility fire alarm control panel instead of an auxiliary control panel.

3.3.3 Dry Pipe Sprinkler Systems

Dry pipe sprinkler systems should be installed only where climate control is not adequate to prevent freezing of water in all or part of a system. Dry pipe valves shall be UL-listed or FM-approved with standard trim and alarm devices necessary to provide water flow alarm and low or high air pressure supervisory signals. A 51 mm (2 in) main drain connection port shall be provided on the dry pipe valve. A water flow alarm line with an alarm test valve and a supervised (via lock or built-in tamper) alarm bypass valve shall be provided. Low air pressure supervisory signal is tested via inspector's test valve. Pressure gauges on the supply side of the valve, system side of the valve (indicating air pressure), and the air compressor shall be provided. Optional trim includes a low air pressure supervisory test valve assembly at riser and a quick opening device (air accelerator) at riser, which expels the compressed air from the system faster after a sufficiently rapid drop in air pressure occurs.

Modern, externally resettable dry pipe valves that do not require priming water are preferred, but not required. If the dry pipe valve chosen requires priming water, verify that appropriate trim, if available from manufacturer, is included to add that priming water to the valve.

3.3.3.1 Compressed Air Supply

Riser-mounted compressed air system or independent air compressor mounted on the floor with air compressor, pressure gauges, pressure switches, air maintenance devices, desiccant air dryer, and appurtenances shall be provided. The compressed air system shall maintain the manufacturer's specified air pressure in the dry pipe system piping and comply with the fill-time requirements of NFPA 13. The pressure switch for controlling the compressor shall be field adjustable for both the "on" and "off" pressure settings. The air maintenance device with a by-pass line for fast filling the system shall be provided.

3.3.3.2 Power for Compressed Air Systems

Provide power for the floor or riser mounted air compressor from a dedicated circuit breaker. Install an independent, properly fused safety disconnect switch with provisions for locking the operating handle in either the "Power ON" or "Power OFF" positions. The disconnect switch shall be located within 1 m (3 ft) of the compressor. Provide a label on the disconnect switch that indicates what electrical panel and which circuit breaker power is being fed from.

3.3.4 Preaction Sprinkler System

3.3.4.1 General

Preaction systems shall be capable of electric-pneumatic actuation and can be of single-interlock or double-interlock configuration. In a single-interlock configuration, when the solenoid valve opens it will release water pressure from the diaphragm chamber priming line causing the preaction valve to trip. In a double-interlock configuration, when the solenoid opens, the preaction valve will not immediately trip. Water pressure is not released immediately from the diaphragm chamber priming line because it is stopped by an air actuator valve beyond the solenoid. For the preaction valve to trip in a double-interlock configuration, air pressure in the system must drop to a point where the air actuator opens, relieving water pressure from the diaphragm chamber priming line. In both types of systems, two solenoids shall be implemented where redundancy is required. The system requirement for single or double-interlock configuration will be as directed by the Lead Design Engineer after consultation with the KSC AHJ.

Both types of preaction systems shall have:

a. A water flow alarm device (pressure switch) on the alarm line.

b. An alarm test valve on alarm line.

c. A locked or supervised alarm bypass valve on alarm line.

d. A drip check valve on alarm line to verify no preaction valve seat leakage, and a drip cup for drip check valve on the alarm line flowing to the main drain line.

e. A manual release valve on the diaphragm chamber priming line.

f. A solenoid valve on the diaphragm chamber priming line and drip cups on the priming line after solenoid and after the manual release valve flowing to the main drain line.

g. An air maintenance device (air compressor) mounted on the floor or riser to supply the system with supervisory air pressure, and a low-air-pressure supervisory switch mounted between the line supplying supervisory air pressure to the system and the air maintenance device.

Double-interlock preaction systems shall have an air actuator between the air side of the system and the diaphragm chamber priming line positioned after the solenoid on the diaphragm chamber priming line. The air actuator shall not open unless system pressure drops (i.e., a head opens).

The design, equipment, materials, installation, workmanship, examination, inspection, and testing shall be in strict accordance with the required and advisory provisions of NFPA 13, 24, and 75, except as modified herein. When the facility has multiple essential electronic areas to be protected by separate preaction sprinkler systems, the control system shall contain a preaction control panel for each operational area affected and shall be separate from the facility FACP. In small facilities with an existing facility fire alarm control panel, an analysis shall be made to determine whether to provide separate panels or to utilize the facility FACP as the preaction control panel. Unique configurations shall be approved by the KSC AHJ prior to installation.

3.3.4.2 Automatic Operation

Preaction sprinkler systems shall utilize an air sampling detection system for automatic actuation in accordance with this Standard.

The following "Sequence of Operations" shall apply to all automatically operated single-interlock preaction sprinkler systems:

a. The following alarm conditions shall be transmitted to the preaction control panel (PCP) from the air sampling detection systems:
   (1) "Alarm Level 1 (Alert)" – Supervisory alarm.
   (2) "Alarm Level 2 (Action)" – Supervisory alarm.
   (3) "Alarm Level 3 (Fire 1)" – Silent alarm.
   (4) "Alarm Level 4 (Fire 2)" – Silent alarm.
   (5) Summary trouble alarms indicating any trouble conditions such as low air flow, high air flow, malfunctioning circuit board, etc.
   (6) Supervisory alarm when air sampling detection system has been bypassed for maintenance.

b. The PCP shall operate the strobes within the restricted area upon receipt of "Alarm Level 3."

c. The PCP shall operate the preaction system solenoid valve upon receipt of "Alarm Level 4." This shall cause the preaction valve to trip in the single-interlock configuration. Water will enter the system piping, but shall not discharge until any heads are activated.

d. The pressure switch shall activate and transmit an alarm to the CFMS through the facility FACP.

e. The facility notification appliances shall be activated by the facility FACP, resulting in evacuation of the facility.

f. The PCP shall interrupt power to all the fire smoke dampers that are associated with the essential electronic area upon receipt of "Alarm Level 4."

The following "Sequence of Operations" shall apply to all automatically operated double-interlock preaction sprinkler systems:

a. The following alarm conditions shall be transmitted to the PCP from the air sampling detection systems:

(1) "Alarm Level 1 (Alert)" – Supervisory alarm.

(2) "Alarm Level 2 (Action)" – Supervisory alarm.

(3) "Alarm Level 3 (Fire 1)" – Silent alarm.

(4) "Alarm Level 4 (Fire 2)" – Silent alarm.

(5) Summary trouble alarms indicating any trouble conditions such as low air flow, high air flow, malfunctioning circuit board, etc.

(6) Supervisory alarm when air sampling detection system has been bypassed for maintenance.

b. The PCP shall operate the strobes within the restricted area upon receipt of "Alarm Level 3."

c. The PCP shall operate the preaction system solenoid valve upon receipt of "Alarm Level 4." In this double-interlock configuration, water shall move past the solenoid in preaction valve diaphragm chamber priming line, but shall be stopped be the air actuator.

d. When a sprinkler head opens in the system, air pressure will drop and the air actuator shall open, allowing water to drain from the diaphragm chamber priming line. This shall cause the preaction valve to trip.

e. The pressure switch shall activate and transmit an alarm to the CFMS through the facility FACP. Water will enter system piping and discharge from the activated head(s).

f. The facility notification appliances shall be activated by the facility FACP resulting in evacuation of the facility.

g. The PCP shall interrupt power to all the fire smoke dampers that are associated with the essential electronic area upon receipt of "Alarm Level 4."

3.3.4.3 Manual Mechanical Activation Stations

In both single and double-interlock configurations, the activation of the manual activation station shall result in the following actions:

a. The preaction control valve shall open and precharge the sprinkler system.

b. The pressure switch shall activate and transmit an alarm to the CFMS through the facility FACP.

c. The facility notification appliances shall be activated by the facility FACP resulting in evacuation of the facility.

Manual activation shall leave a telltale sign of activation (broken seal) and be labeled to indicate open and closed. A manufacturer-approved manual activation valve shall be installed at the riser for manual activation of the preaction system.

3.3.5 Deluge Systems

3.3.5.1 General

The general intent of deluge systems is to quickly extinguish a fire yet limit the destruction of the facility and/or contents of the facility during a fire condition. Water on flight hardware may destroy the hardware or cause extensive damage. With this in mind, facilities where deluge systems are required shall have a Type I, Type II, or standard system as described below. Type I and Type II deluge systems shall be installed with a manual shutoff valve located outside of the hazardous area or as approved by the KSC AHJ.

For deluge systems not protecting payload/flight hardware areas, nozzle systems shall be designed in such a way that all headers can be prefilled. Deluge water control valve stations shall consist of butterfly valves with double-acting pneumatic actuators powered by compressed air or dry nitrogen as specified herein. Design densities shall be as specified in NASA-STD-8719.11, Section 7.8. The schematic drawings contained herein are representative of the requirements for these types of systems; however, modifications and enhancements to these requirements are acceptable on a case-by-case basis, as approved by the KSC AHJ.

3.3.5.2 Testing

A functional test shall be required as a condition of acceptance for all deluge systems. In systems provided with a test branch, flow through the nozzles may not be required.

3.3.5.3 Types of Deluge Systems

One of three types of fixed-deluge water systems shall be used in payload/flight hardware processing areas. Type I systems should be used in areas where the consequences of inadvertent actuation are not great (e.g., propellant transfer areas). Type II systems should be used where payload or flight hardware is exposed in the protected area, and flight hardware damage could occur due to inadvertent actuation. Flight crew egress water systems are an example of Type II. Standard deluge systems shall be used in locations where deluge systems are required, but payload/flight hardware is not processed or flight hardware cannot be damaged by inadvertent actuation (e.g., TVC De-servicing Facility). The type of fixed-deluge water suppression system to be used shall be approved by the KSC AHJ prior to installation. In areas where periodic flow testing of the deluge system cannot be accomplished through its nozzles due to facility operations, a test branch shall be provided that will properly model the flow characteristics of the system.

a. Type I Deluge Systems – Type I systems shall be configured in accordance with Figure 4 or Figure 5. Type I configurations shall have either one pneumatically actuated, normally closed butterfly valve or, two butterfly valves in parallel. Parallel valves shall be used when programmatic requirements dictate the elimination of single failure points. Operating an "Activate Arm" and "Activate Open" push button shall cause the solenoid(s) to operate, opening the butterfly valve(s). Water shall enter system piping and discharge from open nozzles and/or heads.

Solenoid valve(s) shall be housed in a weatherproof or explosionproof enclosure with nitrogen purge, if required, and located adjacent to, but not directly mounted on, the valve assembly. If the system is located in an area requiring explosionproof devices, the solenoid shall be installed in accordance with NFPA 70 requirements for explosion-proof devices. A strainer shall be installed on the system piping between the riser and open nozzles and/or heads to remove any obstructive particles. Type I systems shall have all major components electronically supervised for position indication by the FACP or Kennedy Complex Control System (KCCS), as specified in Figure 4 or Figure 5. A water pressure switch shall be installed to indicate water flow and shall be monitored by the facility FACP; it may also be monitored by KCCS. Type I systems shall be automatically activated via detection when approved by the Lead Design Engineer after consultation with the KSC AHJ. A manual shutoff OS&Y control valve shall be installed outside the processing area (15 to 30 m [50 to 100 ft]) from the facility structure where practical and shall have a valve position indicator clearly showing open or closed position. The valve shall be positively identifiable as a deluge water system valve through the use of placards, signs, or other methods approved by the Lead Design Engineer after consultation with the KSC AHJ. KCCS shall monitor low air/nitrogen pressure and position indications on the butterfly valve(s). KCCS shall be capable of operating the solenoid(s).

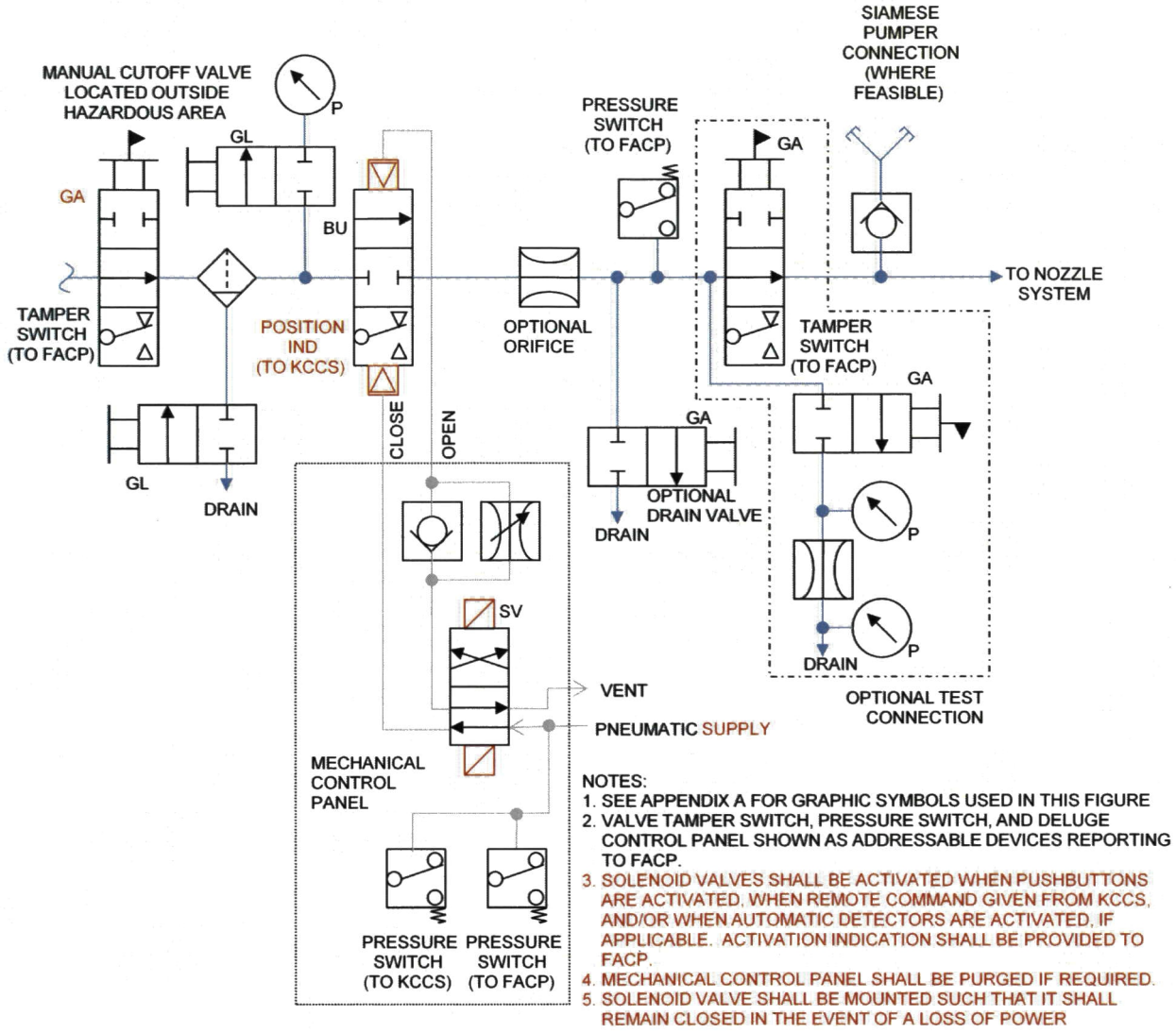


Figure 4. Type I Deluge Water System (Single Actuation Valve)

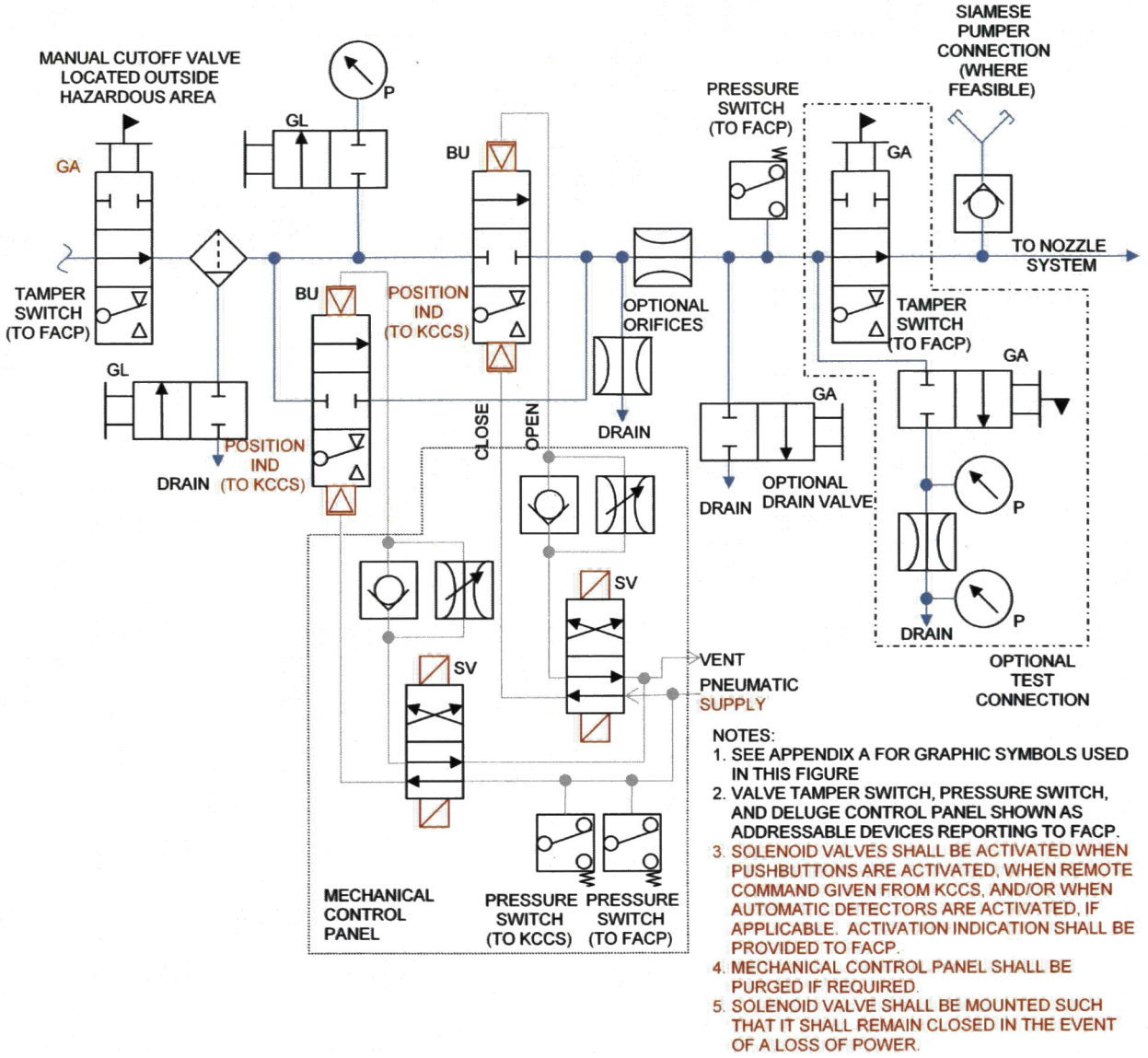


Figure 5. Type I Deluge Water System (Parallel Actuation Valves)

b. Type II Deluge Systems – Type II systems shall be configured in accordance with Figure 6.

Type II configurations shall have four pneumatically actuated, normally closed butterfly valves, configured in two parallel sets in series. The riser shall split into two branches downstream of the supply control valve, supplying each series of butterfly valves separately for system redundancy. The two parallel butterfly valves farthest downstream of supply shall open when an "Arm Open" push button is operated. No water shall move when the system is "Armed." Water hammer is prevented by opening this set farthest downstream of supply first. The two riser branches shall have a connection pipe between the two parallel sets of butterfly valves (i.e., "H" configuration) to maintain system redundancy. The two parallel butterfly valves nearest to the supply shall open when an "Activate Open" push button is operated, causing water to enter the system piping. The two branches of the riser shall flow back together above the parallel set of butterfly valves farthest downstream of supply to supply open nozzles and/or heads with water.

Solenoid valves for the Type II system shall be enclosed in an explosion-proof or nitrogen-purged enclosure if the panel is located in a hazardous area or outdoor location. Solenoids shall be located adjacent to, but not directly mounted on, the valve assembly. A water pressure switch shall be installed to indicate water flow and shall be monitored by the facility FACP; and may also be monitored by KCCS. A strainer shall be installed on system piping between the riser and the open nozzles and/or heads to remove any obstructive particles where nozzle or head orifices are 6.5 mm (1/4 in) or less. A manual shutoff OS&Y control valve located outside the hazardous area (15 to 30 m [50 to 100 ft]) from the facility structure shall be installed, where practical, and shall have a valve position indicator clearly showing open or closed position. The valve shall be positively identifiable as a deluge water system valve through the use of placards, signs, or other methods approved by the Lead Design Engineer in consultation with the KSC AHJ. If applicable, valve tamper and low air/nitrogen pressure supervisory signals shall be monitored by the facility FACP. KCCS shall monitor low-air/nitrogen pressure and position indications on the butterfly valves. KCCS shall be capable of operating the solenoids.

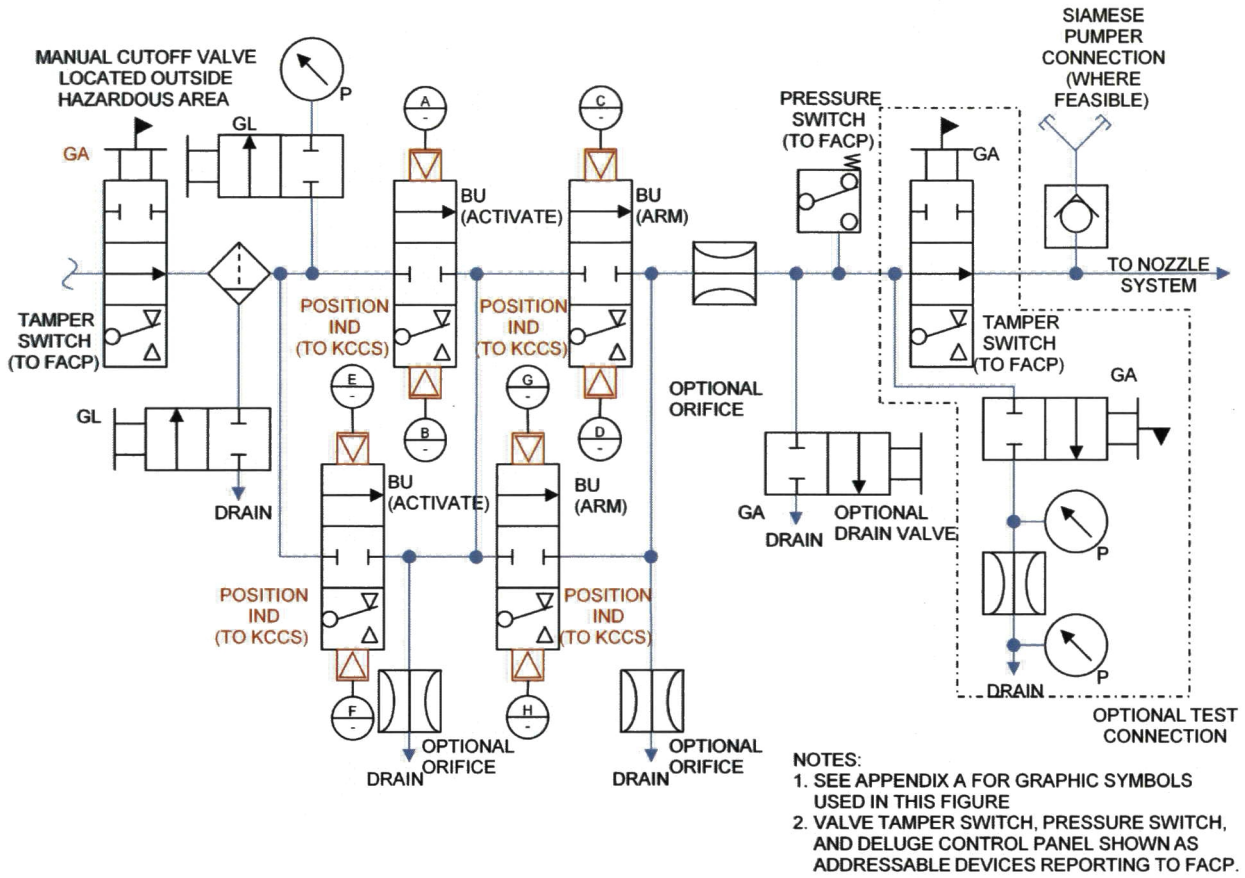
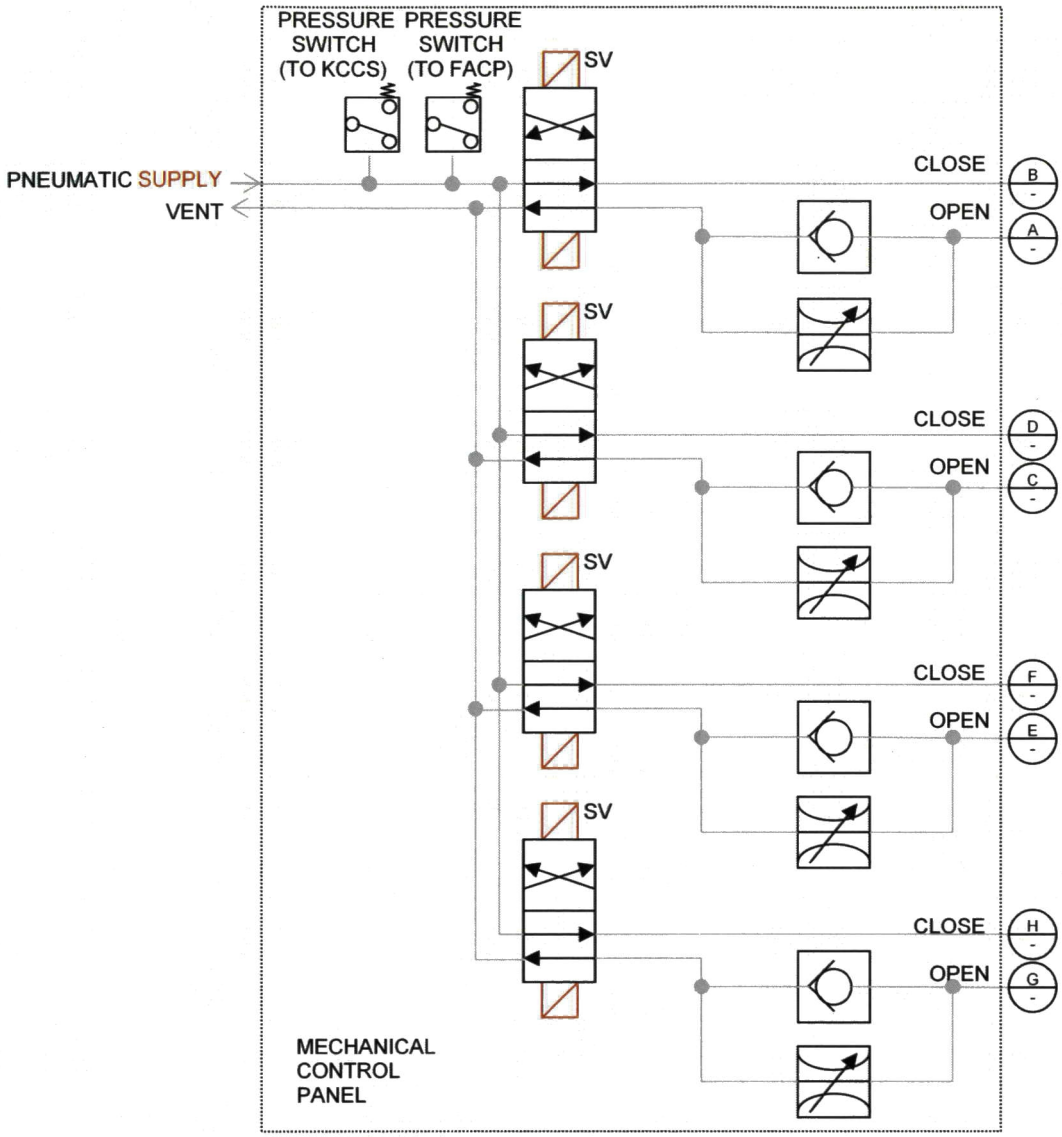


Figure 6. Type II Deluge Water Sprinkler (Mechanical) (Sheet 1 of 2)



NOTES:
1. SEE APPENDIX A FOR GRAPHIC SYMBOLS USED IN THIS FIGURE
2. PRESSURE SWITCH SHOWN AS ADDRESSABLE DEVICES REPORTING TO FACP.
3. SOLENOID VALVES SHALL BE ACTIVATED WHEN PUSHBUTTONS ARE ACTIVATED, WHEN REMOTE COMMAND GIVEN FROM KCCS, AND/OR WHEN AUTOMATIC DETECTORS ARE ACTIVATED, IF APPLICABLE. ACTIVATION INDICATION SHALL BE PROVIDED TO FACP.
4. MECHANICAL CONTROL PANEL SHALL BE PURGED IF REQUIRED.
5. SOLENOID VALVE SHALL BE MOUNTED SUCH THAT IT SHALL REMAIN CLOSED IN THE EVENT OF A LOSS OF POWER.

Figure 6. Type II Deluge Activation Panel (Mechanical) (Sheet 2 of 2)

c. Standard Deluge Systems – A standard deluge system shall have a riser comprised of a deluge valve with all associated trim. The deluge valve shall be capable of actuation via electronic solenoid or manual release valve. Two solenoids shall be implemented in parallel where redundancy is required. The deluge valve shall trip and release water into system piping when water pressure is released from the diaphragm chamber priming line either by the opening of a solenoid or the manual release valve. Water shall discharge from open, fixed spray nozzles or open sprinkler heads after the deluge valve trips. Actuation of the deluge solenoids can be by electronic push button and/or detection device, depending on facility requirements.

Deluge valves shall have a 51mm (2 in) main drain connection port. Standard deluge systems shall use water pressure switches to signal water flow alarm. The alarm test line shall include an alarm test valve, an alarm bypass valve, and a drip check valve. The alarm bypass valve shall be locked, sealed, or electronically supervised in the open position.

3.3.5.4 Deluge System Electrical Controls

Prior to deluge control system design, Fire Protection Operations and Maintenance Engineering shall be consulted to determine control system requirements. Depending on the particular circumstance, the method of control may vary from the following requirements and is subject to approval of the KSC AHJ.

Deluge electrical control systems shall incorporate a dedicated control panel. The control panel can be a relay setup or a Programmable Logic Controller (PLC) and its associated inputs and outputs. All deluge system initiation and activation devices shall be directly connected to the deluge system control panel. Control power for deluge systems shall be dedicated 24 VDC with automatic battery backup. When the command is given to begin water flow, latching-type control relays or PLC software shall keep the circuit energized until the command is given to stop water flow. Type I and Type II systems shall be controlled by manual, dual push button control stations, in accordance with drawing 79K32573, equipped with transparent protective covers to prevent accidental actuation. The covers shall be designed such that they are not self-closing. Each push button shall have double contacts. The controls shall require personnel to push two separate buttons in order to initiate water flow. The initiation shall result in the following:

a. When either the arm or activate push button is pushed:

(1) The light at the push button station illuminates. Red indicates activation and green indicated a normal status.

(2) A signal is sent to the CFMS through the facility FACP.

b. When the second push button is pushed, the deluge control panel opens the valves to discharge water and the FACP operates notification appliances and shuts down the HVAC systems.

A remote, manual, dual, push button control station shall be provided within sight of the area protected, but removed from the immediate hazard. This control station shall permit operating personnel to operate the deluge system. The location of all remote control stations shall be as directed by the Lead Design Engineer following consultation with the KSC AHJ.

Control wiring shall not be routed through communication terminal distribution racks and/or main frames. Separate dedicated wiring shall be run for these control circuits.

Three zones or addresses shall be allocated in the facility FACP to monitor the deluge system:

a. Summary of deluge control panel status.

b. Flow/pressure switch monitoring.

c. Valve tamper switch monitoring.

d. Deluge water flow pending (arm and activate switches operated).

3.3.5.5 Deluge Water Manual Shutoff/Control Valve

Control valves in deluge systems shall be of the OS&Y type for valves less than or equal to 15.24 centimeters (cm) (6 in) in diameter, reference 3.3.1.5 for OS&Y valve details. For valves larger than 15.24 cm (6 in), a butterfly valve is acceptable, reference 3.3.5.6 for butterfly valve details.

3.3.5.6 Deluge Water Activation Valves

Activation valves in Type I and II Deluge Systems shall be of the butterfly type with an offset shaft and eccentric disk. Both the shaft and disk shall be made of stainless steel. Valve bodies may be of carbon steel when environmental conditions permit. Valve seats shall be made of a single piece of reinforced tetrafluoroethylene (TFE) (type M). Valve shaft seals shall be virgin TFE (type T). Valve orientation shall be such that the upstream pressure tends to hold the valve closed (i.e., installed with the shaft upstream). Deluge water control valves shall be the wafer-sphere design by Jamesbury Corporation or an approved equal. Valves shall be clearly labeled open or shut/closed utilizing a valve position indicator.

3.3.5.7 Deluge Actuation Systems (Mechanical)

Actuation of Type I and II Deluge Systems shall be with compressed air or dry nitrogen. Actuation systems compressed air or dry nitrogen supply shall be designed in accordance with

Figure 7. The deluge control panel shall monitor pressure in the system.

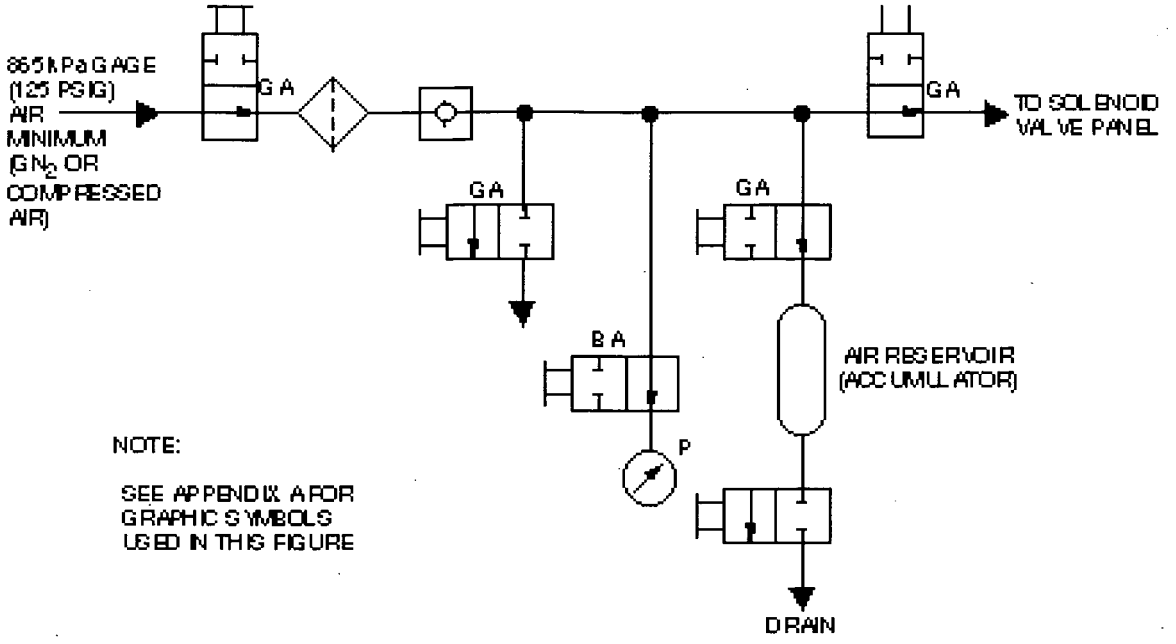


Figure 7. Deluge Compressed Air Supply Configuration

Major system components shall consist of an isolation valve, filter check valve, accumulator with an isolation valve and vent valve, flow controller, solenoid valve, pressure switch, pressure gauge with an isolation valve, and bleed valve. The accumulator shall be sized to open and close the system control valves not less than three times for a single zone from a fully charged system. Check valves shall be Circle Seal 249B or an approved equal.

3.3.5.8 Deluge Water Control Valve Actuators

Valve actuators in Type I and II Deluge Systems shall be the double-acting type, rated for at least 1.035 megapascal (150 pounds per inch (psi)). They shall be sized to open the butterfly valves under full system pressure with 690 kPa (100 psi) air/nitrogen available. Valve actuators shall be type ST 200, ST 400, or the VPVL Model B Double Acting Series by Jamesbury Corporation or an approved equal. Shutoff valves shall have manual gear actuators clearly marked OPEN and SHUT (or CLOSED) and shall have electrical supervision tied to the fire alarm system to indicate a SUPERVISORY condition when closed. Valve tamper switches shall be installed on all manual shutoff valves on the critical flow path, where practical. Valve tamper switches shall be monitored directly from the facility FACP as a separate zone (not from the deluge control panel). Tamper switches are typically not required on individual platform isolation valves inside controlled facility spaces (e.g., high bays and clean rooms).

3.3.5.9 Solenoid Valves

Solenoid valves shall be four-way with two positions and dual coils. The valves shall be designed to operate on 24 VDC. KCCS shall monitor and annunciate which valves were

operated. For Type I and II Deluge Systems, solenoids shall be mounted with the spool horizontal, so that no movement shall occur in the event of a loss of power. Consult the solenoid manufacturer's instructions for the proper use of ports.

3.3.5.10 Monitoring

The control logic shall be designed so traceability is provided to indicate how the system was activated (i.e., which push button or station was activated). The control logic is shown on drawing 79K32573.

3.3.5.11 Control Lines

Control functions that require an open/closed path between two wires shall be designed and implemented so that exposed terminals are nonadjacent and are adequately protected. If possible, separate wires with waterproof insulation should be utilized, not telephone audio grade pairs.

3.3.5.12 Routing

Control wires for arm and activate valves and other critical functions shall not be routed through uncontrolled terminal distributors and frames along with other miscellaneous systems.

3.3.6 Standpipes

Standpipes shall be provided in accordance with NASA-STD-8719.11A and in special applications as directed by the KSC AHJ.

3.3.7 Fire Pumps

Fire pump installations shall comply with NFPA 20, with the following exceptions. For extra hazard occupancy areas, as defined by the Lead Design Engineer following consultation with the KSC AHJ, fire pump installations providing primary fire protection water shall contain not less than two diesel-driven fire pumps or two electric-motor-driven fire pumps with a redundant source of power or one electric fire pump with a redundant diesel-driven backup fire pump of the same size. When multiple fire pumps are needed to meet the demand requirements, the maximum demand (flow and pressure) shall be met without the largest pump running. A single fire pump and driver may be used to provide 100 percent of the system's flow and pressure requirement for light and ordinary hazards. All fire pumps shall be monitored by UL-listed FACPs for condition and status.

3.4 Special Suppression Systems

3.4.1 Carbon Dioxide Systems

Carbon dioxide systems shall not be installed in occupied areas. Carbon dioxide systems shall be designed in accordance with NFPA 12 and the requirements established by the Lead Design

Engineer after consultation with the KSC AHJ. Systems shall be UL-listed or FM-approved except where new technologies are approved by the KSC AHJ.

3.4.2 Wet Chemical Extinguishing Systems

Wet chemical kitchen suppression systems shall be installed for protection of cooking equipment and cooking exhaust hood systems. Normally, pre-engineered wet chemical systems shall be installed. The installation and operation of wet chemical extinguishing systems shall conform to NFPA 17A and the NASA KSC Specs Intact Specification Section 21 23 00.00 98. Systems shall be UL-listed or FM-approved except where new technologies are approved by the KSC AHJ.

3.4.3 Foam Extinguishing Systems for Aircraft Hangars

Foam extinguishing systems shall be installed for the protection of NASA aircraft and research and development aircraft in specialized aircraft hangars. The installation and operation of foam extinguishing systems shall conform to NFPA 11, NFPA 11A, NFPA 16, and NFPA 409, and the NASA KSC Specs Intact Specification Section 21 13 26.00 98. Additional design guidance should be obtained from the Factory Mutual Design Data Sheets and the National Institute of Standards and Technology Technical Report NIST TN 1423, Analysis of High Bay Hangar Facilities for Detector Sensitivity and Placement. Systems shall be UL-listed or FM-approved except where new technologies are approved by the KSC AHJ.

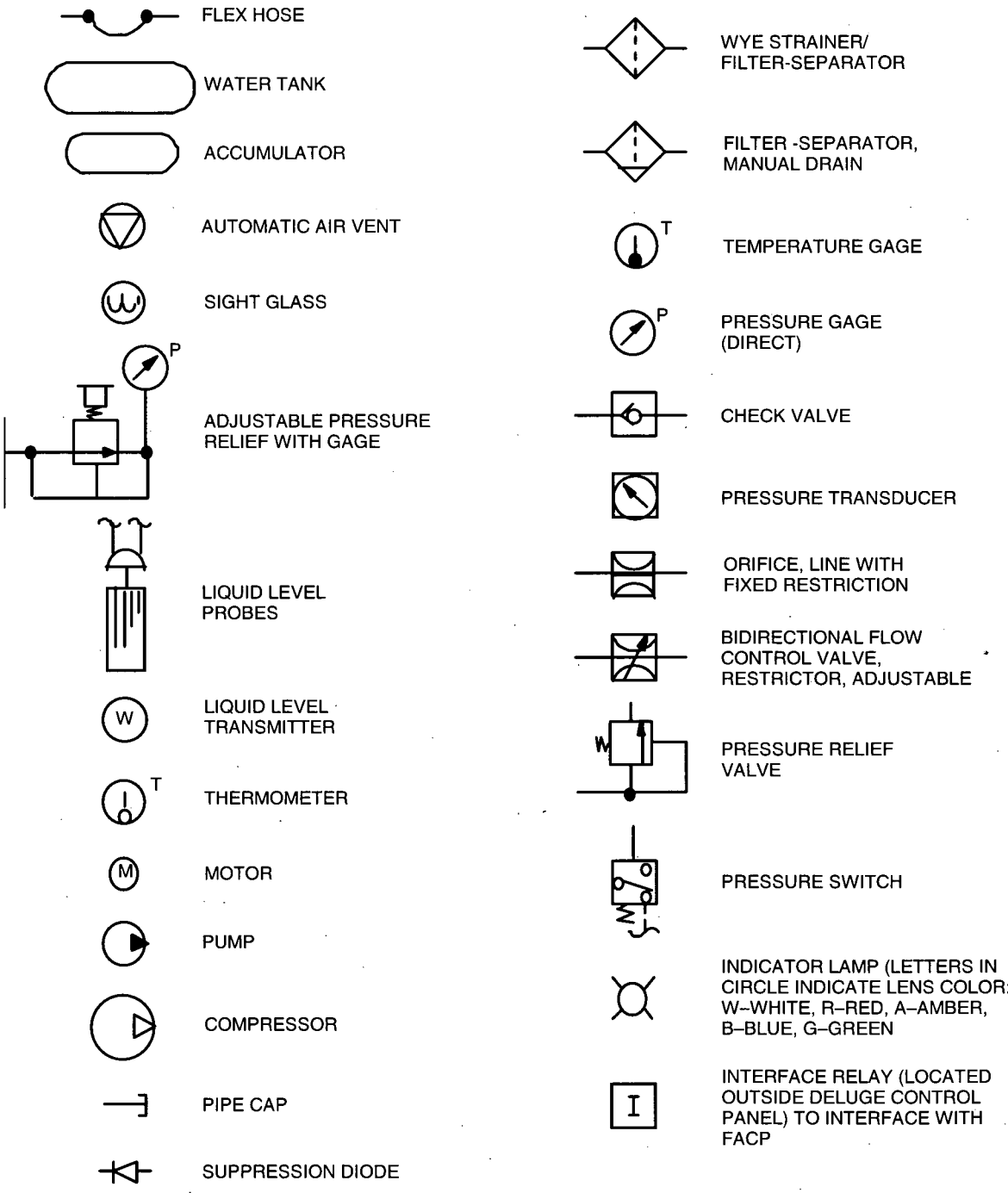
3.4.4 Halon 1301 and Clean Agent and Aerosol Extinguishing Systems

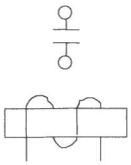
Installation of new Halon 1301 systems is prohibited. Installation of new clean agent extinguishing systems shall also require special approval by the KSC AHJ. Clean agent extinguishing systems shall be installed in accordance with NFPA 2001 and the requirements established by the Lead Design Engineer after consultation with the KSC AHJ. Aerosol systems shall be installed in accordance with NFPA 2010. Additional design guidance should be obtained from the Factory Mutual Design Data Sheets. Systems shall be UL-listed or FM-approved except where new technologies are approved by the KSC AHJ.

Custodian:
NASA – John F. Kennedy Space Center
Kennedy Space Center, Florida 32899

Preparing Activity:
John F. Kennedy Space Center
Center Operations Directorate

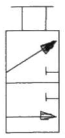
APPENDIX A. GRAPHIC SYMBOLS FOR FIRE SUPPRESSION AND ALARM SYSTEMS



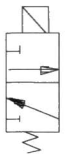


RELAY

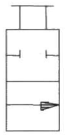
SOLENOID



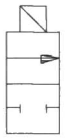
VALVE, MANUAL
3-WAY, 2 POSITION



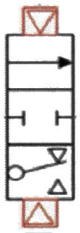
ELECTROMECHANICAL
SOLENOID VALVE,
1 WAY, SPRING RETURN



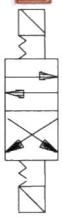
VALVE, MANUAL
(NORMALLY OPEN)



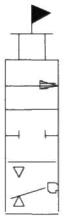
ELECTROMECHANICAL
SOLENOID VALVE,
2 WAY, 2 POSITION
(NORMALLY CLOSED)



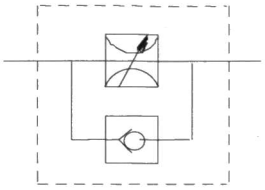
PNEUMATICALLY OPERATED BUTTERFLY
VALVE, WITH DOUBLE-ACTING
ACTUATOR AND POSITION SWITCH



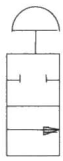
ELECTROMECHANICAL
DUAL COIL
SOLENOID VALVE



MANUAL VALVE WITH
LOCAL AND REMOTE
INDICATOR

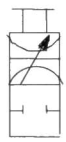


REVERSIBLE FLOW CONTROL VALVE
WITH REVERSE FLOW BYPASS

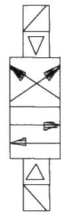


VALVE, DIAPHRAGM
OPERATED

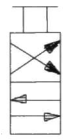
VALVE, METER, THERMOSTATIC



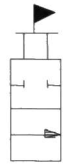
VALVE, NEEDLE, MANUAL



VALVE, SOLENOID, ELECTRICAL



VALVE, 2 POSITION,
4-WAY, MANUAL



VALVE WITH POSITION
INDICATION, MANUAL

MUFFLER

FIRE ALARM PLAN AND RISERS SYMBOLS:

——	CONDUIT ROUTED EXPOSED
◆—◆	HEAT SENSITIVE CABLE
OO	HEAT SENSITIVE CABLE TEST PORT
TYP.	TYPICAL
TX/TRANSF	TRANSFORMER
DISTRIB.	DISTRIBUTION
W/	WITH
W/O	WITH OUT
⏚	ELECTRICAL GROUND
TTB	TELEPHONE TERMINAL BOARD
AFF	ABOVE FINISHED FLOOR
A.F.G.	ABOVE FINISHED GRADE
WP	WEATHERPROOF
EP	EXPLOSIONPROOF
F	FIRE ALARM CONTROL PANEL
ACP	FIRE ALARM AUXILIARY CONTROL PANEL
WC	FIRE ALARM WET CHEMICAL CONTROL PANEL
PCP	FIRE ALARM PRE-ACTION CONTROL PANEL
H	HALON CONTROL PANEL
CO_2	CO_2 CONTROL PANEL
FSCP	FOAM SYSTEM CONTROL PANEL
MOD	FIRE ALARM MODEM CABINET
ZAM	FIRE ALARM ZAM CABINET
FATC	FIRE ALARM TERMINAL CABINET
VCP	FIRE ALARM VOICE CONTROL PANEL
TSTC	TRANSIENT SURGE TERMINAL CABINET
	ULTRA-VIOLET / INFRA-RED DETECTOR TRIPLE INFRA-RED DETECTOR
PT	PHOTO BEAM TRANSMITTER
PR	PHOTO BEAM RECEIVER
SZ	SIGNAL ZAM
MZ	MONITOR ZAM
CZ	CONTROL ZAM
SV	SOLENOID VALVE
K	KEY ISOLATE SWITCH
IAM	SUPERVISED IAM
LAPS	LOW AIR PRESSURE SWITCH
ASDS	AIR SAMPLING DETECTION SYSTEM
FSD	FIRE SMOKE DAMPERS
T	TELEPHONE JACK
	DISCONNECT SWITCH
A	ANNUNCIATOR LCD PANEL
RT	REMOTE DUCT DETECTOR TEST SWITCH / LED
R	AUXILIARY REMOTE CONTROL RELAY

FIRE ALARM PLAN AND RISERS SYMBOLS:

FIRE ALARM STROBE LIGHT

COMBINATION FIRE BELL/STROBE

COMBINATION FIRE SPEAKER/STROBE

FIRE BELL

FIRE SPEAKER

MAGNETIC DOOR HOLDER

CODED TRANSMITTER

NOTIFICATION APPLIANCE CABINET

INITIATION DEVICE NOTE:

ALL INITIATION DEVICE SYMBOLS USED ON PLANS SHALL HAVE ZONE INDICATION SUBSCRIPTS. NUMERIC ONLY SUBSCRIPTS (FOR EXAMPLE "1") INDICATE ZONE. THE LETTER "A" FOLLOWED BY A NUMBER (FOR EXAMPLE "A1") INDICATES AN INDIVIDUALLY ADDRESSABLE DEVICE AND GROUPING FOR CENTRAL FIRE MONITOR SYSTEM REPORTING PURPOSES.

PRESSURE SWITCH

FLOW SWITCH

TAMPER SWITCH

HEAT-ACTUATED DETECTOR

MANUAL PULL STATION

PHOTOELECTRIC SMOKE DETECTOR

PHOTOELECTRIC DUCT SMOKE DETECTOR (SUPPLY)

PHOTOELECTRIC DUCT SMOKE DETECTOR (RETURN)

VALVE TYPES

BU - BUTTERFLY
GL - GLOBE
GA - GATE
CO - CONE
BA - BALL
CL - CLAPPER
PL - PLUG
SV - SOLENOID
F/A - FIRE ALARM

NOTES:

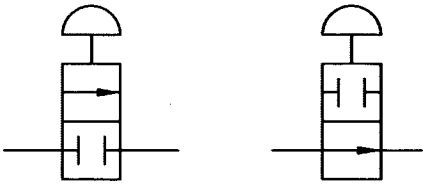
REFERENCE DOCUMENTS:
79K09579 OMD BASE LINE NO. 40200
79K29921 SYSTEM DOCUMENTATION LIST
79K29849 LRU PARTS LIST

SOLENIOD VALVES ARE DEPICTED IN THE DEENERGIZED STATE OTHER SYSTEM VALVES ARE DEPICTED IN POSITION (OPEN, CLOSED, ACTUATED, UNACTUATED) SHOWING THE WATER SYSTEM OPERATIONALLY PRESSURIZED WITH NO FLOWS.

SYMBOLOGY IS PER KSC-STD-15-2. (SPECIAL SYMBOLS FOR WATER SYSTEM ADDED AS REQUIRED.)

IN MULTIPLE ENVELOPE SYMBOLS, FLOW CONDITION SHOWN NEAREST A CONTROL SYMBOL TAKES PLACE WHEN THE CONTROL IS CAUSED OR PERMITTED TO ACTUATE.

EXAMPLE



UNACTUATED ACTUATED

APPENDIX B. DEFINITIONS

For the purpose of this Standard, the following definitions shall apply; refer to the specific NFPA standards for further clarification of definitions:

a. **Approve**: For equipment items listed for use in fire protection systems by a nationally recognized testing agency, typically UL and/or FM. For actions, acceptance by the KSC AHJ, Contracting Officer, and Lead Design Engineer as appropriate to the particular issue under consideration is required.

b. **Authority Having Jurisdiction**: The NASA individual or designee responsible for approving equipment, providing resolution to code related issues, and providing code interpretations for fire protection and life safety related issues.

c. **Central Station System**: A system or group of systems in which the operations of circuits and devices are transmitted automatically to, recorded in, maintained by, and supervised from a listed central station that has competent and experienced servers and operators who, upon receipt of a signal, take such action as required. Such service is to be controlled and operated by a person, firm, or corporation whose business is the furnishing, maintaining, or monitoring of supervised fire alarm systems.

d. **Compatible Equipment**: Equipment that interfaces mechanically or electrically as manufactured without field modification.

e. **Designer**: The individual responsible for investigating existing conditions, interpreting code requirements and designing (i.e., development of specs and drawings) the fire protection system. This individual is also recognized as the "engineer of record" for the design deliverable.

f. **Electrical Supervision**: Monitors the circuit integrity of interconnecting conductors so when a single open or a single ground condition occurs that would prevent normal operation, the condition is automatically transmitted and indicated at the appropriate location.

g. **Fire Alarm Control Panel (FACP)**: A system component that receives inputs from automatic and manual fire alarm devices and might supply power to detection devices and to a transponder or off-premises transmitter. The control unit might also provide transfer of power to the notification appliances and transfer of condition to relays or devices connected to the control unit. The fire alarm control unit can be a local fire alarm control unit or a master control unit.

h. **Firefighting**: The physical deployment of available fixed or portable extinguishing agents for the purposes of aiding escape or rescue, suppression of the fire spreading, and extinguishment.

i. **Fire Prevention**: Measures directed toward avoiding the inception of fire.

j. **Fixed Extinguishing System**: An engineered arrangement of equipment designed to provide a specified firefighting capability against a particular fire hazard within a specified area (does not include portable fire extinguishers).

k. **Fully Compatible**: Shall indicate the ability to communicate in two directions (duplex).

l. **General Fire Protection**: Everything relating to the prevention, detection, and extinguishment of a fire and to the reduction of losses by fire, including the safeguarding of human life and the preservation of property.

m. **Heat Detector**: A device that detects an abnormally high temperature or rate-of-temperature rise, or both.

n. **Initiating Device**: A fire alarm system component that originates transmission of a change-of-state condition, such as in a smoke detector, heat detector, manual pull station, or supervisory switch.

o. **Lead Design Engineer**: The individual responsible for developing the design SOW and serving as the Contracting Officer Technical Representative on the design services contract. All changes to technical requirements of design SOW require the approval of the Lead Design Engineer.

p. **Listed**: A product approved for use in fire protection systems by a nationally recognized testing agency (e.g., UL, FM).

q. **Manual Pull Station**: A manually operated device used to initiate an alarm signal.

r. **Multiplex Communication Format**: A signaling method characterized by simultaneous or sequential transmission, or both, and a reception of multiple signals on a signaling line circuit, including means for positively identifying each signal.

s. **Notification Appliance**: A fire alarm system component, such as bell, speaker, strobe, or text display, that provides audible, tactile, or visible outputs or any combination thereof.

t. **Portable Fire Extinguishers**: A device containing chemicals, fluids, or gases for extinguishing fires that can be easily moved.

u. **Signaling Line Circuit**: A circuit or path between any combination of circuit interfaces, control units, or transmitters, over which multiple system input signals or output signals, or both are carried.

v. **Smoke Detector**: A device that actuates if it detects visible or invisible particles of combustion.

w. **Water Deluge System**: A sprinkler system employing open sprinklers attached to a piping system that is connected to a water supply through a valve opened manually or by the operation of a detection system installed in the same areas as the sprinklers. When this valve opens, water flows into the piping system and discharges from all the attached open sprinklers.

x. **Water Spray**: An automatic or manually actuated fixed pipe system connected to a water supply and equipped with water spray nozzles designed to provide a specific water discharge and distribution over the protected surfaces or area.

APPENDIX C. ABBREVIATIONS AND ACRONYMS

A&E	Architects and Engineers
ac	alternating current
ADA	Americans With Disabilities Act
AHJ	Authority Having Jurisdiction
AHU	air handling unit
ANSI	American National Standards Institute
ASME	American Society of Mechanical Engineers
CFMS	Central Fire Monitoring System
CFR	Code of Federal Regulations
cm	centimeter
CRAC	computer room air conditioning
CRMS	Central Radio Monitoring System
DC	direct current
e.g.	for example
FACP	fire alarm control panel
FDC	fire department connections
FED	federal
FM	Factory Mutual
FPED	Fire Protection Equipment Directory
ft	foot/feet
HVAC	heating, ventilating, and air conditioning
i.e.	that is
in	inch
IR	infrared
KCCS	Kennedy Complex Control System
kPa	kilopascal
KSC	John F. Kennedy Space Center
m	meter
m^2	meters squared
MIL	military
ML	Mobile Launcher
MLP	Mobile Launcher Platform
mm	millimeter
NASA	National Aeronautics and Space Administration
NDU	network display unit
NEMA	National Electrical Manufacturers Association
NFPA	National Fire Protection Association
NIST	National Institute of Standards and Technology
OS&Y	outside stem and yoke
PAWS	Paging and Area Warning System
PCP	preaction control panel
PLC	programmable logic controller

psi	pound per square inch (static pressure)
SOW	statement of work
STD	standard
TFE	tetrafluoroethylene
UFC	United Facilities Criteria
UL	Underwriters Laboratories Inc.
UV	ultraviolet
VABR	Vehicle Assembly Building Repeater
VDC	volt direct current