HYBRID (WATER AND INERT GAS) EXTINGUISHING SYSTEMS

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1.0 SCOPE

This data sheet contains recommendations related to FM Approved hybrid (water and inert gas) fire extinguishing systems, including for their design, installation, acceptance testing, inspection, and maintenance.

Hybrid fire extinguishing systems are special protection systems consisting of dual extinguishing agents (water and inert gas). They are used as sole protection for a specific equipment hazard or to supplement sprinkler protection.

1.1 Hazards

1.1.1 Hybrid System Applications

A hybrid fire extinguishing system is a special protection system developed for the protection of a specific hazard. There are no generally accepted design criteria for these systems. Thus, their effectiveness must be proven by fire testing on a representative hazard based on the intended application, resulting in specific listing conditions and restrictions.

Hybrid fire extinguishing systems are FM Approved as either sole (primary) protection for a specific hazard, or as supplementary protection (i.e., in addition to sprinklers) for other specific hazards. Refer to occupancy- and hazard-specific FM Global data sheets for protection recommendations.

Hybrid fire extinguishing systems are FM Approved to provide protection for the following:

- Combustion turbines
- Data processing equipment rooms/halls; above-floor
- Data processing equipment rooms/halls; below-floor
- Emergency and stand-by generators
- Flight simulators
- Hydroelectric generators
- Ignitable liquid storage tanks
- Machinery in enclosures
- Oil circuit breakers (indoor)
- Steam turbines or generators
- Transformers (indoor)

Data Sheet 4-0, *Special Protection Systems*, provides a list of hazard- and occupancy-specific data sheets that recommend hybrid fire extinguishing systems.

1.1.2 Availability

Hybrid systems use a water and inert gas supply that could be exhausted before a fire is extinguished. Like other special protection systems with a limited quantity of extinguishant, hybrid systems are more susceptible to failure to extinguish a fire than automatic sprinkler systems. Hybrid systems are also inherently more complex than automatic sprinkler systems, which can impact the availability of system. See Understanding the Hazard (UTH) *Special Protection System Reliability* (P0379) for information on general deficiencies related to special protection systems.

1.2 Changes

October 2020. This is the first publication of this document.

2.0 LOSS PREVENTION RECOMMENDATIONS

2.1 Introduction

2.1.1 Provide FM Approved equipment, materials, and services whenever they are applicable. For a list of products and services that are FM Approved, see the *Approval Guide*, and online resource of FM Approvals.

2.1.2 Design and install hybrid fire extinguishing systems in accordance with the following:

A. The application associated with their listing in the *Approval Guide*

B. The manufacturer's design, installation, operation, and maintenance (DIOM) manual as identified as part of the FM Approval by document identification number and revision level

C. The relevant occupancy- or hazard-specific data sheet

D. Any specific jurisdictional requirements

2.1.3 When a component is not identified in the manufacturer's FM Approved design, installation, operation, and maintenance (DIOM) manual, provide FM Approved equipment that conforms to the hybrid fire extinguishing system's specifications (e.g., pressure rating, rate of flow, etc.) and this data sheet.

2.2 Construction and Location

2.2.1 Locate or arrange system control panels, water, and inert gas supplies so temperatures are maintained between 40°F (4°C) and 130°F (54°C) and within the system manufacturer's listed limits of Approval, and in accordance with the applicable recommendations in Data Sheet 9-18, *Protection Against Freeze-Up* (see Section 3.2).

2.2.2 When hybrid fire extinguishing system equipment is installed in a separate, stand-alone enclosure from normal building services, provide backup power to the climate control system or a supervisory alarm in case temperatures fall outside the range specified in 2.2.1.

2.2.3 Locate water and inert gas storage cylinders, control/actuating valves, regulating devices, monitoring devices, and the control panel in a room separate from the protected area.

2.2.4 Locate all equipment so it is not subject to mechanical, chemical, climatic, or other conditions that can render it inoperative or susceptible to accidental damage or operation.

2.2.4.1 For hybrid fire extinguishing systems located in 50-year through 500-year earthquake zones (as defined in Data Sheet 1-2, *Earthquakes*), anchor equipment in accordance with Data Sheet 2-8, *Earthquake Protection for Water-Based Fire Protection Systems*.

2.2.5 Locate all equipment so it is fully accessible for inspection, testing, maintenance, and removal or replacement.

2.3 Occupancy

2.3.1 Interlocks

2.3.1.1 Provide interlocks to automatically perform critical functions upon operation of the extinguishing system in accordance with the hazard-specific data sheet for the protected area. Examples include, but are not limited to, closure of dampers, shutdown of ventilation, stoppage of conveyors, and power down of electrical equipment and fuel supplies.

2.3.1.2 Provide interlocks to power down energized electrical equipment prior to the start of the discharge of the hybrid fire extinguishing system, unless protection of energized electrical equipment is listed in the FM Approval.

2.3.1.3 Provide the proper sequence for operation of an automatic interlock to interface with the discharge of the hybrid fire extinguishing system in accordance with the applicable hazard-specific data sheet to ensure effective fire extinguishment. (See Section 3.4.1.2.)

2.3.2 System Identification

2.3.2.1 Provide warning signs, in accordance with the manufacturer's instructions, for a hybrid fire extinguishing system:

A. protecting a normally occupied or occupiable enclosure or space.

B. with inert gas cylinders installed in a storage room where a reduced oxygen level would result from the discharge of a safety device or control valve leak.

C. where the sea level equivalent oxygen concentration is below the permitted limits in the protected enclosure or space (see Section 3.3).

2.3.2.2 Provide a system information sign in proximity to the storage cylinders or releasing control panel that details specifications of the hybrid fire extinguishing system for the hazard(s) being protected (see Section 3.4.1.3).

2.3.2.3 Provide nameplates or other permanent markings that indicate the following:

A. For system inert gas containers, their contents (i.e., type of inert gas) and volume, as applicable.

B. For system water containers, their contents (i.e., water quality) pressurization level, and volume, as applicable.

C. For the system, the total quantities of water and inert gas required, and pressure level of the inert gas container.

2.3.2.4 Provide nameplates/instructions in the immediate vicinity of valves, piping, and other critical system components to identify their function, operating positions, and contents (i.e., system feedback sensor, water or inert gas).

2.3.2.5 Provide operating instructions that indicate the location and purpose of the actuation controls.

2.3.2.6 Provide signage on the proper shutdown sequence of valves and equipment after the hybrid fire extinguishing system has activated.

2.3.3 Occupancy Safeguards

Provide the following for hybrid fire extinguishing systems protecting occupiable enclosures or spaces where the hybrid media design concentration could result in an oxygen concentration below the limit for use in a normally occupied enclosure or space:

- Supervised system lockout valve(s)
- Pre-discharge alarms
- Discharge time delays
- Warning signs

2.3.4 Enclosure Strength and Pressure Relief

2.3.4.1 Ensure the protected enclosure has the structural integrity and allowable unclosable openings to contain the agent discharge.

2.3.4.2 If the pressure from the discharge of hybrid media exceeds the structural integrity of the protected enclosure and amount of free venting area, provide additional venting to prevent excessive pressure that may damage the enclosure. (See Section 2.4.2.7 and 3.4.3.4.)

2.4 Protection

2.4.1 General

2.4.1.1 Use FM Approved hybrid fire extinguishing systems to provide protection of equipment or hazards in accordance with Table 1. Additionally, provide a primary form of fire protection (typically an automatic sprinkler system) for protection of the building construction when recommended by the relevant occupancy- or hazard-specific data sheet.

Table 1. Protection of Occupancy or Specific Hazard Using Hybrid Fire Extinguishing Systems

FM Approval Listing Category	*Equipment*	*Restrictions*	*Associated Data Sheet*
Protection of Combustion or Steam Turbines in Enclosures with Volumes ≤9175 ft^3 (260 m^3) Protection of Combustion or Steam Turbines in Enclosures with Volumes >9175 ft^3 (260 m^3)	• Enclosures with combustion turbines • Enclosures with steam turbines	• Maximum enclosure volume • Ceiling height -Do not extrapolate the design from a smaller tested enclosure to a larger, untested enclosure. • Provide protection to the enclosure based upon the gross volume. Do not make deductions for the volume occupied by equipment in the enclosure (see Section 3.3.2.2). • Maximum unclosable opening sizes - Provide protection to doorways and permanent openings based upon the dimensions specified in the FM Approved design, installation, operation, and maintenance manual. • Install nozzles for turbine protection in accordance with the manufacturer's FM Approved design, installation, operation and maintenance manual to prevent the possibility of warping or cracking of the turbine casing due to direct impingement of the hybrid media on the turbine. • Interlock ventilation for shutdown.	7-79 7-101
Protection of Machinery in Enclosures with Volumes ≤9175 ft^3 (260 m^3) Protection of Machinery in Enclosures with Volumes >9175 ft^3 (260 m^3)	Enclosures with: • Internal combustion engines • Engine test cells without forced ventilation • Oil pumps • Oil tanks • Fuel filters • Indoor transformers vaults • Gear boxes • Drive shafts • Lubrication skids • Hydraulic press pits • Similar equipment using liquid hydrocarbon fuel • Hydraulic, heat transfer, and lubrication fluids • Incidental use, storage or release of hydrocarbon ignitable liquids	Maximum enclosure volume • Ceiling height - Do not extrapolate the design from a smaller tested enclosure to a larger, untested enclosure. • Provide protection to the enclosure based upon the gross volume. Do not make deductions for the volume occupied by equipment in the enclosure. (See Section 3.3.2.2) • Maximum unclosable opening sizes -Provide protection to doorways and permanent openings based upon the dimensions specified in the FM Approved design, installation, operation and maintenance manual. • Interlock ventilation for shutdown.	5-3 5-19 5-23 7-3 7-32 7-37 7-88

Table 1. Protection of Occupancy or Specific Hazard Using Hybrid Fire Extinguishing Systems (continued)

FM Approval Listing Category	*Equipment*	*Restrictions*	*Associated Data Sheet*
Protection of Data Processing Equipment Rooms/Halls: Above-floor Protection	Rooms/areas with forced ventilated and propagating cables: • Control rooms • Data center processing equipment rooms/halls • Diagnostic equipment rooms • Process control rooms • Telecommunication rooms	Intended to provide equipment protection • Maximum volume • Maximum ceiling height • Maximum nozzle spacing • Minimum 30-minute fire resistance rating of the wall and/or ceiling • Interlock ventilation for shutdown or recirculation • Energized electrical equipment, verify FM Approval or isolate power from equipment	5-32
Protection of Data Processing Equipment Rooms/Halls: Below-floor Protection	Concealed areas below raised floors with forced ventilation and propagating cables in: • Control rooms • Data center processing equipment rooms/halls • Diagnostic equipment rooms • Process control rooms • Telecommunication rooms	Usage in conjunction with above-floor protection • Maximum volume • Maximum nozzle spacing • Interlock ventilation for shut-down or recirculation. • Energized electrical equipment, verify FM Approval or isolate power from equipment	5-32 5-14

2.4.1.2 Provide hybrid fire extinguishing systems in accordance with their FM Approval listing limitations and the manufacturer's FM Approved design, installation, operation, and maintenance manual.

2.4.2 Design of Hybrid Fire Extinguishing Systems

2.4.2.1 Hybrid Media Nozzles

2.4.2.1.1 Design hybrid media nozzles in accordance with the limitations of their Approval listing and the manufacturer's FM Approved design, installation, operation, and maintenance manual. Limitations include but not limited to, the following:

A. The number of hybrid media nozzles based on to the equipment hazard being protected

B. Allowable nozzle size(s) or type(s) on distribution system

C. Maximum enclosure volume

D. Maximum height specification of the protected enclosure or hazard

E. Maximum volume per nozzle

F. Maximum nozzle area of coverage

G. Proper nozzle orientation (e.g., pendent or upright)

H. Nozzle spacing including distance from walls and each other

I. Nozzle distance from the ceiling

J.Nozzle location relative to obstructions (see Section 2.4.2.2)

K. Nozzle pressure, minimum or pressure range

L. When used in corrosive atmospheres, use nozzles of corrosion-resistant materials or coatings suitable for the application

2.4.2.1.2 Obstructions

2.4.2.1.2.1 When obstructions are present, evaluate the installation of hybrid media nozzle(s) to verify they are in accordance with the manufacturer's specifications for the following:

- Position
- Clearance
- Maximum allowable percentage of discharge pattern disruption

2.4.2.1.2.2 Provide additional hybrid nozzles or adjust placement of the hybrid nozzles in accordance with the manufacturer's FM Approved design, installation, operation, and maintenance manual when there are obstructions that affect their performance in the distribution of the hybrid media.

2.4.2.1.2.3 When available, use the manufacturer's calculation method to determine the maximum nozzle obstruction percentage of the discharge pattern in accordance with the manufacturer's design, installation, operation and maintenance manual.

2.4.2.1.3 Open Nozzles

2.4.2.1.3.1 If open nozzles are exposed to vapor or fumes that could cause clogging (e.g., plating operation) or internal corrosion to the discharge piping, provide frangible disks, blow-off caps, or other suitable devices that are specifically FM Approved as a component of the system.

2.4.2.2 Discharge Duration

2.4.2.2.1 Provide a water and inert gas supply to provide a minimum discharge duration of 10 minutes or in accordance with the applicable hazard-specific data sheet and the manufacturer's FM Approved design, installation, operation, and maintenance manual.

2.4.2.2.2 When the discharge duration is less than 10 minutes for total flooding applications, provide a duration of protection within the protected enclosure maintaining the minimum hybrid media design concentration for at least 10 minutes, or longer where necessary to ensure effective emergency response by trained personnel.

Determine the duration of protection using door fan and/or discharge testing (refer to Section 2.6). Note that for energized electrical fires, if the electrical equipment is not de-energized, re-ignition is expected once the hybrid media concentration dissipates.

2.4.2.3 Water and Inert Gas Quantity

2.4.2.3.1 Provide a water supply and inert gas supply, to meet the following:

- The number of nozzles in accordance with the applicable hazard-specific data sheet and/or the manufacturer's FM Approved DIOM manual
- The inert gas quantity adjusted to compensate for ambient atmospheric pressures that vary from standard sea level pressures in accordance with the manufacturer's FM Approved DIOM manual
- Discharge duration per the applicable hazard-specific data sheet
- Hydraulic demand per Section 2.4.2.5

2.4.2.3.2 When a single system is protecting multiple hazards, provide a supply of water and inert gas adequate for at least the largest single hazard or group of hazards to be protected simultaneously.

2.4.2.3.3 When main and reserve systems have a limited supply of inert gas and/or water, include the lengths of water and inert gas supply pipe from the valves in the manifold to the tee that joins the distribution piping in the water and inert gas calculation.

2.4.2.4 Connected Reserve

2.4.2.4.1 If the hybrid fire extinguishing system has a limited supply of water and/or inert gas, provide a connected reserve supply equivalent to the in-service supply if any of the following conditions exist:

A. The system is protecting two or more hazards using a single supply through selector valves.

B. The system cannot be restored to service within 24 hours from an outside source.

2.4.2.4.2 Design the reserve supply as follows:

A. Provide a manually actuated switchover arrangement to activate the main or reserve supply (e.g., a manually actuated main/reserve switch at the control panel).

B. Provide a check valve or similar device to segregate the connected reserve supply from the pressure of the main hybrid fire extinguishing system. Install the check valve or device with the arrow pointing in the direction of flow.

C. Provide a manifold vent plug and safety burst disc or pressure relief in each manifold section where pressure maybe trapped that produces an overpressure condition by:

- a check valve
- a closed valve
- failure of a regulating device

D. Provide reserve and main water supply piping so the waterflow and pressure at the most remote nozzle remain within the operating pressure range specified in the FM Approved design, installation, operation, and maintenance manual.

E. Provide the connected reserve circuit to the fire alarm control panel for operation of all accessory equipment in the same manner as with the main supply.

2.4.2.5 Hydraulic Design

2.4.2.5.1 Calculate water flow, inert gas flow and nozzle pressure to be within the operating pressure range specified in the FM Approved design, installation, operation, and maintenance manual for the given application.

2.4.2.5.2 For pre-engineered systems, limit the pipe diameter and length, number of fittings and number of nozzle in the distribution system to that specified in the FM Approved design, installation, operation, and maintenance manual.

2.4.2.5.3 For engineered systems, hydraulically design and calculate the system in accordance with one of the following:

A. FM Approved design, installation, operation, and maintenance manual

B. Software program version of the hydraulic flow calculation program identified in the FM Approval listing.

2.4.2.5.4 In calculations, include the friction loss or equivalent lengths for valves, check valves, selector valves, strainers, cylinder manifolds, and other devices in the distribution system to determine the water flow and nozzle pressure.

2.4.2.5.5 Verify the discharge of inert gas and water at every hybrid nozzle is provided in 30 seconds or less from the time of system activation, unless a longer delivery time is allowed in the occupancy-specific data sheet.

2.4.2.6 Oxygen Level

2.4.2.6.1 Ensure calculations are performed in accordance with the manufacturer's instructions to determine the oxygen level for:

A. classification of the protected enclosure type and egress time limit. (See Sections 3.3.1 and 3.3.2)

B. classification of an enclosure and egress time limit with a test connection discharging into an occupied space. (See Sections 3.3.1 and 3.3.2)

C. classification of the inert gas storage cylinder supply enclosure type and egress time limit. (See Sections 3.3.1 and 3.3.2)

2.4.2.7 Unclosable Openings

2.4.2.7.1 Verify the number and area of unclosable openings or equivalent leakage area of the enclosure does not exceed the number and area in accordance with the FM Approved design, installation, operation and maintenance manual.

2.4.2.8 Relief Venting

2.4.2.8.1 Provide relief venting in accordance with the hybrid fire extinguishing system manufacturer's FM Approved design, installation, operation, and maintenance manual for the given application.

2.5 Equipment and Processes

When a component is not identified in the manufacturer's design, installation, operation, and maintenance manual, provide FM Approved equipment that conforms to the hybrid system's specifications (e.g., pressure rating, rate of flow, etc.) and this data sheet.

Install only new system components. Do not use repurposed equipment for installation of the hybrid fire extinguishing system.

2.5.1 Water Supply

2.5.1.1 Provide a water supply as specified in the manufacturer's FM Approved design, installation, operation, and maintenance manual.

2.5.1.2 Provide water quality (e.g., particulate and dissolved solids) as specified in the manufacturer's FM Approved design, installation, operation, and maintenance manual.

2.5.1.3 Do not add chemical cleaners, corrosion inhibitors, emulsion-breaking chemicals, or other additives to the water supply.

2.5.2 Check Valves

2.5.2.1 Install FM Approved check valve(s) from connection of the water supply to the distribution system.

2.5.3 Strainers and Filters

2.5.3.1 Provide FM Approved strainer(s) or filter(s) in the water supply piping. Locate the strainer(s) and filter(s) in an area accessible for cleaning or flushing.

2.5.3.2 Provide strainer(s) with a blow down/off valve connection or similar outlet connection to enable cleaning (flushing) while maintaining system discharge during an emergency.

2.5.3.3 Provide the strainers of corrosion-resistant material compatible with the piping and fittings.

2.5.4 Regulators

2.5.4.1 Provide regulators as a component of the hybrid fire extinguishing system from the inert gas supply to the water supply storage container when used for pressurization to prevent exceeding the design pressure of the container.

2.5.4.2 Verify the regulator set point is in accordance with the hybrid fire extinguishing system manufacturer's calculation or specification.

2.5.4.3 Verify the regulator set point adjustment mechanism is sealed or secured to be tamper resistant.

2.5.5 Water Storage Tank Systems

2.5.5.1 Water Storage Pressurized Tank System

2.5.5.1.1 Provide devices (e.g., sight glass, liquid level indicator, pressure gauge, pressure transducer) to identify and supervise the water storage container for water level and pressure, respectively. It is unnecessary to provide supervision of pressure for water storage containers that only become pressurized during system activation.

2.5.5.1.2 Provide a safety relief device with the water supply storage container to prevent exceeding the design pressure of the container.

2.5.5.1.3 When flexible hoses are used, provide connection or manifold hoses that are FM Approved as a component of the hybrid fire extinguishing system for connection to the distribution system.

2.5.5.1.4 When multiple water tanks are used, provide an automatic closure device (e.g., check valve) installed in the correct direction of flow to prevent leakage from the manifold when the tank is removed.

2.5.5.2 Water Storage Container Valves

2.5.5.2.1 Secure the water fill valve and provide a cap plug to the valve outlet used to fill the water supply storage container.

2.5.6 Inert Gas Supply

2.5.6.1 Inert Gas Supply Cylinders

2.5.6.1.1 Provide a device (e.g., pressure gauge, pressure transducer) to identify the pressure in the inert gas supply cylinder or manifold.

2.5.6.1.2 Provide a device to supervise for pressure below the operable pressure of the hybrid fire extinguishing system.

2.5.6.2 Manifolded Inert Gas Cylinders

2.5.6.2.1 Use inert gas cylinders of the equivalent size and interchangeability unless specifically FM Approved otherwise.

2.5.6.2.2 Provide an automatic closure device (e.g., check valve) installed in the correct direction of flow to prevent leakage from the manifold when an inert gas cylinder is removed.

2.5.6.2.3 Use manifold hoses that are FM Approved as a component of the hybrid fire extinguishing system to provide connection from the high-pressure inert gas cylinder to the manifold.

2.5.6.2.4 Provide a safety burst disc or pressure safety relief on:

A. the manifold where excessive pressure can be trapped from a closed valve in a section of closed piping.

B. each location on in the piping where a failure of a regulating device could result in an overpressure condition.

2.5.6.2.5 Design the pressure relief devices to operate at a pressure in accordance with the manufacturer's design, installation, operation, and maintenance manual and any applicable national or international codes and standards.

2.5.6.2.6 When pressure operated inert gas cylinders are used, provide a manifold vent plug for inert gas leakage from the cylinders to vent from the manifold to an open space, but also prevent loss of inert gas when the system operates.

2.5.6.2.7 If a master refill connection is used on the inert gas manifold, provide a check valve on the connection used to refill inert gas cylinders.

2.5.7 Valves

2.5.7.1 Provide indicating-type control valves (e.g., isolation valves) on connections to water supplies of the indicating type.

2.5.7.2 Secure valves (e.g., control valves, drain valves, and isolation valves) on connections to water supplies for normal operation in accordance with Data Sheet 2-81, *Fire Protection System Inspection*.

2.5.7.3 When electrical supervision of isolation valves is used, provide supervision to identify a "trouble/fault" in the abnormal position at the fire alarm control unit.

2.5.7.4 Ensure all valve types installed are:

A. in the proper orientation and direction of flow,

B. accessible for operation, inspection and maintenance, and

C. protected from damage that would prevent their operation.

2.5.7.5 Ensure a manually operated lockout valve is installed:

A. to prevent the flow of inert gas and water to the hybrid nozzle during maintenance of the system.

B. with electrical supervision to notify when the lockout valve is not in the open position.

C. located in accordance with the manufacturer's FM Approved design, installation, operation and maintenance manual.

2.5.7.6 When selector valves are used for multi-hazard zone protection, do the following:

A. Provide an actuation device (e.g., electrical solenoid, pneumatic actuator) compatible with the automatic release module from the fire alarm control unit. Confirm the number, type, and electrical specifications for operation in accordance with the manufacturer's FM Approved design, installation, operation, and maintenance manual.

B. Identify the zone or area being protected by the selector valve.

2.5.8 Test Connections

2.5.8.1 When discharge testing cannot be conducted for acceptance testing and inspection, testing, and maintenance, provide a metering device (e.g., orifice plate) or nozzle(s) on the test connection to produce an equivalent pressure loss (K-factor of the system) for the number of hybrid nozzles and piping on the hybrid fire extinguishing system (see Figure 1 and Figure 2).

A. Size the test connection piping to accommodate the design flow of the pressurized water and inert gas.

B. Install the test connection in the discharge piping downstream of the water supply container and inert gas supply.

C. Provide isolation valves for each discharge outlet of the water supply and inert gas, as applicable, and on the test connection piping with valve supervision and valve securement in accordance with Data Sheet 2-81.

2.5.8.2 Arrange the test connection(s) piping from the water supply and inert gas connections to a drain area capable drain area of handling the maximum anticipated discharge.

2.5.8.3 Arrange the test connection(s) piping from the water supply and inert gas connections to discharge in an area that will not pose a risk to personnel from a reduced oxygen environment (see Section 3.3).

2.5.9 Distribution System

2.5.9.1 When hybrid fire extinguishing systems are installed in 50-year through 500-year earthquake zones (as defined in Data Sheet 1-2, *Earthquakes*), install pipe connections, support, and bracing in accordance with Data Sheet 2-8, *Earthquake Protection for Water-Based Fire Protection Systems*.

2.5.9.2 Provide an FM Approved pressure relief device as a component of the hybrid fire extinguishing system to vent closed sections of water and inert gas piping from pressure beyond its strength rating. Locate pressure-relief devices on the piping so discharge will not pose a hazard to equipment or personnel.

2.5.9.3 Internally clean pipe or tube sections to be free of particulate matter and oil residue before assembly. Clean in accordance with the instructions from the manufacturer's FM Approved design, installation, operation, and maintenance manual.

2.5.9.4 When threaded pipe is used and specified by the manufacturer, provide joint compound, tape, or thread locker only to the pipe threads.

2.5.9.5 Install couplings, joints, and fittings or bending of tube and pipe as follows:

A. Use fabrication equipment in accordance with the manufacturer's recommendations.

B. As rated for the diameter and material of construction in accordance with the manufacturer's FM Approved design, installation, operation, and maintenance manual.

C. For pipe and tube ¾ in. (20 mm) and smaller, use hand bench or power bending tools with the correct radius dies.

D. For pipe and tube larger than ¾ in. (20 mm), use power bending tools with the correct radius dies.

2.5.9.6 Water Supply

2.5.9.6.1 Provide drawn or seamless copper or stainless steel for the water distribution system in accordance with the manufacturer's FM Approved design, installation, operation, and maintenance manual for the working pressure of the system.

2.5.9.6.2 Do not use any of the following materials for the water distribution system (see Section 3.5.8):

- Galvanized pipe or fittings
- Aluminum tubing or fittings
- Cast-iron pipe or fittings
- Combustible material pipe or fittings
- Other materials that are not corrosion-resistant

2.5.9.6.3 Use fittings as follows:

A. Screw unions only on pipe less than 2 in. (51 mm)

B. One-piece reducing fitting wherever at change in pipe diameter

2.5.9.6.6 For water distribution piping that is dry in the standby condition (e.g., open nozzle systems), install the following:

A. Flushing and drainage valves/connections.

B. A means of draining and a minimum pitch towards the drain of ¼ in. (6 mm) per 10 ft (3 m).

C. A tethered threaded plug to seal the drain valve outlet when it is not being used.

D. Securement at each drain valve in the closed position.

E. A weldolet downstream of the test connection isolation valve or alarm valve for determining if hybrid media nozzles are clogged. Plug the weldolet when it is not being used for inspection and testing.

2.5.9.7 Inert Gas Supply

Provide inert gas piping and tubing, fittings for Schedule and Grade as specified in the manufacturer's FM Approved design, installation, operation, and maintenance manual for the working pressure of the inert gas supply.

2.5.9.8 System Feedback Sensors

2.5.9.8.1 When needed, provide the FM Approved system feedback sensor, (e.g., pressure transducer assembly, specified as a component(s) of the hybrid fire extinguishing system) in accordance with the manufacturer's design, installation, operation and maintenance manual.

2.5.9.8.2 Provide the proper number of system feedback sensors in conjunction with the automatic regulation valve(s) for the inert gas supply.

2.5.9.8.3 Provide an automatic pressure relief valve to protect the system feedback sensor from over-pressurization.

2.5.9.8.4 Locate the system feedback sensor exterior to the protected enclosure or alternate location in accordance with the manufacturer's installation requirements.

2.5.9.8.5 Provide the electrical signal wiring type and gauge for the system feedback sensor is in accordance with the manufacturer's specification.

2.5.9.8.6 Verify the maximum length of signal wire from the system feedback sensor to the control panel is not exceeded.

2.5.9.8.7 Route the electrical signal wire to outside the protected area and protect from fire or mechanical damage.

2.5.9.9 Hydraulic/Pneumatic Actuation Supply

2.5.9.9.1 Provide actuation supply piping and tubing, fittings, braided stainless steel hose(s) to the inert gas or water supply as specified in the manufacturer's FM Approved design, installation, operation, and maintenance manual for the working pressure of the actuation supply.

2.5.9.10 Piping Support

2.5.9.10.1 Mount and space FM Approved pipe supports (hangers) in accordance with Data Sheet 2-0, *Installation Guidelines for Automatic Sprinklers*, and as specified in the manufacturer's FM Approved design, installation, operation, and maintenance manual.

2.5.9.10.2 If galvanized clamps or supports are used with stainless steel pipes, provide galvanic isolation from the pipe by elastomeric elements, coating or similar isolation methods.

2.5.9.11 Distribution System Cleaning and Flushing

2.5.9.11.1 Ensure each pipe or tube section in the distribution system is internally cleaned after preparation and before assembly in accordance with standard piping practices or the manufacturer's instructions.

2.5.9.11.2 After installation of the distribution piping and before installation of the hybrid nozzles, flush the water distribution piping using the system's normal water supply. Clean by flushing for a time sufficient for the water to run clear. After flushing, reopen the valve connections to their normal operating position.

2.5.9.11.3 If complete flushing of the water distribution piping cannot be accomplished, do one of the following, shown in order of preference:

A. Install plugs at hybrid media nozzle connections and flush the system at the flushing connection and remote inspector's test connection. Following flushing, remove all plugs and verify there is no debris prior to the installation of the hybrid media nozzles.

B. Pneumatically purge the water and inert gas piping from a weldolet installed on the riser downstream of the manifold isolation valve as a test connection.

2.5.9.12 Pressure Test of Distribution Piping

2.5.9.12.1 Install test blanks for the pressure tests in lieu of the hybrid nozzles. Ensure the test blanks are:

- Brightly colored or painted to clearly indicate their presence.
- Numbered so all test blanks used can be accounted for.

Use a documentation method to verify the removal of the test blanks and installation of the hybrid nozzles after the test is complete.

2.5.9.12.2 Verify all water distribution piping has been hydrostatically tested as follows:

A. Use a test pressure of 200 psi (13.8 bar) or 50 psi (3.4 bar) in excess of the maximum static pressure where the maximum static pressure exceeds 150 psi (10.3 bar).

B. Maintain the hydrostatic test pressure without a drop in gauge pressure or visual leakage for 2 hours.

2.5.10 Actuation and Control

2.5.10.1 General

2.5.10.1.1 Provide FM Approved detection, initiating device(s), and fire alarm systems that are compatible with the hybrid fire extinguishing system.

2.5.10.1.2 When protecting hazardous location areas, verify the electric detection equipment and any auxiliary equipment has been specifically designed and rated for such areas.

2.5.10.2 System Initiation

2.5.10.2.1 Provide **both** of the following:

A. Manual release device from at least one remote location

B. Emergency manual mechanical release device at a location not exposed to the effects of the hazard

2.5.10.2.2 Use an FM Approved electrical, mechanical, or pneumatic manual release device that is a component of, or compatible with, the hybrid fire extinguishing system. If operation of the manual release device is electrical, provide the following:

A. A reliable primary source of power

B. Automatic transfer to a source of emergency backup power with a minimum of 24 hours standby power and 10 minutes of alarm power

2.5.10.2.3 Provide a manual release device(s) and emergency mechanical release device that:

A. is clearly marked.

B. is secure from unauthorized operation.

C. clearly identifies each hazard being protected.

D. is mounted 42 in. (1.1 m) above the finished floor.

E. is in a location that is accessible at all times.

F. results in operation of all associated interlocks with the system discharge.

2.5.10.2.4 For emergency manual mechanical release operation, provide a discharge pressure switch or a flow switch to provide an alarm-initiating signal to the fire alarm control unit.

2.5.10.3 Control/Actuation Devices

2.5.10.3.1 Provide an FM Approved fire alarm control panel with a compatible FM Approved automatic release for extinguishing system module that is electrically compatible (voltage/current) as a release circuit for the following devices, as applicable:

- Actuation controls and actuation device (e.g., solenoid) of the water and inert gas control valve(s)
- Other system-control equipment

2.5.10.4 Supervision

2.5.10.4.1 Provide electrical supervision in accordance with Data Sheet 9-1, *Supervision of Property*.

2.5.10.4.2 Provide electrical supervision of the circuitry from the fire alarm control unit to the following devices, as applicable:

- Detection device
- Releasing circuit
- Automatic water supply and inert gas supply control valves
- Water supply level
- Manual release devices
- Actuating devices
- Lock-out valves
- Disconnect or manual bypass switch

2.5.10.4.3 Where disconnect or manual bypass switches are provided to prevent accidental discharge of a hybrid fire extinguishing system during testing or servicing of the system, provide supervised keyed lock-out devices at the control panel.

A. Arrange these device so they do not disable the alarm circuit.

B. Establish and follow written impairment procedures.

C. Put the key(s) under the control of a responsible management or fire protection person.

2.5.10.4.4 Provide supervisory alarm signals that are different from fire alarm signals at the fire alarm control panel.

2.5.10.5 Detection

2.5.10.5.1 Provide detection and actuation circuitry in accordance with Data Sheet 5-48, *Automatic Fire Detection*, in conjunction with the recommendations in this section.

2.5.10.5.2 Select the type of FM Approved automatic detection (pneumatic, optical, heat, or smoke) in accordance with the applicable occupancy or equipment hazard data sheet.

2.5.10.6 Alarms

2.5.10.6.1 Provide alarm and actuation circuitry in accordance with Data Sheet 5-40, *Fire Alarm Systems*, in conjunction with the recommendations in this section.

2.5.10.6.2 Provide hybrid fire extinguishing system alarm signals that:

A. are configured as a pre-discharge alarm with a time delay for egress of personnel (see Section 3.3).

B. are distinct from other alarm signals (e.g., building fire alarm system).

C. will continue to operate after hybrid media discharge until a positive action has been taken to acknowledge the alarm and to proceed with appropriate action to the alarm operation.

2.5.10.6.3 Provide trouble/fault alarms that are distinct from those indicating operation of the hybrid fire extinguishing system.

2.5.10.6.4 When multiple hybrid fire extinguishing systems are installed, provide separate alarms to indicate operation of each system.

2.5.11 Plan Review

2.5.11.1 General

2.5.11.1.1 Confirm the contractor/installer is an authorized distributor or representative of the hybrid fire extinguishing system manufacturer and trained to design and install the system in accordance with the manufacturer's FM Approved design, installation, operation, and maintenance manual.

2.5.11.1.2 Confirm the hybrid fire extinguishing system is designed in accordance with the following:

A. The system's listing in the *Approval Guide*

B. The manufacturer's FM Approved design, installation, operation, and maintenance manual(s)

C. The original equipment manufacturer (OEM) equipment specification sheets

D. The applicable hazard- or occupancy-specific FM Global data sheet(s)

2.5.11.1.3 If alterations on the as-built area or equipment have been carried out (e.g., structural changes) from the original submitted design, revise the documentation and resubmit it to a designated representative of FM Global.

2.5.11.2 Working Drawings

2.5.11.2.1 Submit one set of drawings, hybrid fire extinguishing system hydraulic and pneumatic calculations, specifications, manufacturer's literature (i.e. catalog specification sheets) and any other documentation as described in Sections 2.5.11.2.2 through 2.5.11.3 to a designated representative of FM Global for review and acceptance prior to the start of any hybrid fire extinguishing system installation.

If revisions are recommended as a result of the FM Global review, submit revised documentation to a designated representative of FM Global for review and acceptance prior to the start of installation.

2.5.11.2.2 Provide the following information for review and acceptance:

A. The location and description of hazards being protected.

B. The application of the hybrid fire extinguishing system.

C. Information on the protected enclosure, including hazard classification, enclosure dimensions, number and size of unclosable openings.

D. System bill of materials indicating component details, including each component's name, manufacturer, model or part number, quantity, and description, as well as additional information on specific equipment, as follows:

1. Water and inert gas storage (capacity, storage pressure, securement method)
2. System feedback sensor(s), as needed
3. Nozzles (orifice size)
4. Pipe and fittings (material, grade, pressure rating)
5. Pipe supports (spacing, size, securement)
6. Detectors (type, number, location)

E. Drawings of the distribution system, including the following:

1. Water and inert gas storage containers
2. System feedback sensor(s), as needed
3. Piping (layout, length, diameter, pipe hangers/supports)
4. Fittings (e.g., reducers, strainers, tees)
5. Nozzles (layout, size, equivalent orifice area)

F. Wiring diagrams, including the following:

1. Actuation circuit connections to the system control panels, (system feedback sensor(s))
2. Detectors, number and location
3. Audible and visual indicating devices, number and location
4. Controlled devices (dampers, doors, other auxiliary equipment)
5. Relays
6. Graphic annunciator panels

G. Description of the system sequence of operations, including functioning of maintenance switches, ventilation, dampers, doors, fuel interlocks, and power shutdown.

H. Individual and integrated system tests to be conducted for system acceptance.

2.5.11.3 Calculations

2.5.11.3.1 Document the following design factors:

A. Volume/size of the protected enclosure or design area

B. Location of any areas where the ambient temperature of the occupancy or hazard of expected to be less than 40°F (4°C) or more than 130°F (54°C).

C. Hazard or fuels to be protected

D. Fuel temperature

E. Fuel configuration

F. Nozzle(s)orifice size or model number, as applicable

G. Flow rate of the controller or regulator, as applicable

2.5.11.3.2 Hydraulic flow calculations do not need to be provided for pre-engineered hybrid fire extinguishing systems. Review the isometric view of the distribution system (see 2.5.11.2.2, item H) for compliance with the pipework specifications in the manufacturer's FM Approved design, installation, operation, and maintenance manual.

2.5.11.3.3 When a computer program is used for hydraulic calculation, provide the name and version number of the program.

2.5.11.3.4 Provide calculations to determine the following:

A. Quantity of water

B. Quantity of inert gas

C. Number of nozzles

D. Flow rates of the water and inert gas media

E. Nozzle pressure, minimum or allowable range

F. Discharge time in accordance with Section 2.4.2

2.5.11.3.5 Calculation of oxygen level for egress time of an occupied enclosure from the system discharge (see Section 3.3).

2.5.11.3.6 If enclosure pressure relief venting is needed, provide calculations of the pressure relief area to maintain the structural integrity of the protected enclosure.

2.5.11.3.7 If seismic restraint is needed per Data Sheet 1-2, *Earthquakes*, provide calculation of seismic loads on seismic building joints.

2.5.11.3.8 When detection is used, provide calculations to determine the size of backup batteries for the fire alarm control panel. See Data Sheet 5-40, *Fire Alarm Systems*, for further information.

2.5.12 System Restoration

2.5.12.1 After acceptance tests are completed, or following system discharge, restore the hybrid fire extinguishing system, alarms, and interlocks to operational condition.

2.5.12.2 Follow the proper shutdown sequence of valves and equipment in accordance with the manufacturer's recommendations.

2.5.12.3 Perform appropriate cleanup and salvage of the protected enclosure.

2.5.12.4 Adhere to established impairment procedures. Refer to Data Sheet 10-7, *Fire Protection Impairment Management*, for details.

2.5.12.5 Flush and drain piping that is normally empty.

2.5.12.6 Inspect, clean, and place strainer and filters into operational condition.

2.5.12.7 Restore valves to their operational position.

2.5.12.8 Follow the manufacturer's procedure(s) to restore the installed equipment to service, including replenishment of water and inert gas.

2.6 Acceptance of Hybrid Fire Extinguishing Systems

2.6.1 Acceptance Test Plan

2.6.1.1 Provide a designated representative of FM Global with a complete step-by-step description of the proposed acceptance test procedure(s), identifying each and all devices, controls, and functions to be tested and inspected, and how any tests will be conducted prior to scheduling the acceptance test. Include any individual and interconnected system tests to be conducted for acceptance with an integrated hybrid fire extinguishing system(s).

2.6.1.2 Verify the installation companies have furnished written documentation and FM Global form(s) completed in accordance with the recommendations for system acceptance with specified hydrostatic pressure tests, hybrid fire extinguishing system operational and discharge tests for final acceptance. Submit the following forms (see Appendix D), as applicable:

Contractor's Application for Acceptance of Hybrid Fire Extinguishing System Installations (Engineering Form 5580)

2.6.2 Acceptance Testing

2.6.2.1 Provide testing by a contractor who is an authorized distributor or representative of the hybrid fire extinguishing system manufacturer and trained to test the system in accordance with the manufacturer's FM Approved design, installation, operation, and maintenance manual.

2.6.2.2 When multiple systems are installed, operate the maximum number of systems that are expected to operate at the same time.

2.6.2.3 When multiple equipment hazards are being protected with a single hybrid fire extinguishing system zoned for each hazard, conduct an operational test of each protected area.

2.6.3 Visual Inspection

Verify the hybrid fire extinguishing system has been installed to the submitted working drawings and specifications (see Section 2.5.11, Plan Review) as well as any applicable national or international codes and standards by conducting a visual inspection in accordance with the *Contractor's Application for Acceptance of Hybrid Fire Extinguishing System Installations (Engineering Form 5580)*

2.6.4 Discharge Test

2.6.4.1 Conduct a full discharge test to confirm the following:

A. Complete coordinated system operation (e.g., automatic detection and manual activation devices)

B. The water storage tank is pressurized and the design pressure is attained

C. Proper development of the discharge pattern

D. Unobstructed flow from the nozzles over the minimum discharge duration

E. Nozzle pressure is in accordance with hydraulic calculations, as confirmed at the most remote hybrid media nozzle or test node with a pressure gauge or pressure transducer.

F. Adequacy of the water and inert gas supply duration and pressure when multiple hybrid fire extinguishing systems are expected to operate simultaneously.

G. Operation of pressure relief vent(s), if provided.

2.6.4.2 Provide appropriate safeguards for the oxygen level from the discharge test into the protected enclosure or test connection in accordance with local personnel safety regulations.

2.6.4.3 Provide collection and disposal of the discharged water in accordance with local and/or national regulations and the authority having jurisdiction.

2.6.5 Operation of Components

2.6.5.1 Verify all mechanical and electrical components and systems interconnected with the hybrid fire extinguishing system operate in accordance with the commissioning documentation (see Section 3.6.1).

2.6.5.2 Conduct operational tests to verify the hybrid fire extinguishing system responds as designed from both automatic detection and manual actuation devices. At a minimum, confirm the following:

- Visual and audible local alarms
- Time delays
- Remote annunciation at the fire alarm control panel
- Releasing devices and valves
- Operation of auxiliary devices (equipment shutdown, fuel interlock, door or damper interlocks, etc.)
- Manual pull stations
- Operation in accordance with the system design specification

2.6.5.3 Confirm functionality of the system components listed in 2.6.5.2 during one of the following operational tests:

A. Full discharge test (Section 2.6.4)

B. Flow through the test connection

2.6.5.4 For open nozzle systems, when using the test connection, set the position of the isolation valves to discharge from the test connection in order not to discharge water and inert gas into the distribution system piping.

2.6.6 Alarm and Detection Devices

2.6.6.1 Inspect and test alarm and detection devices in accordance with Data Sheet 5-40, *Fire Alarm Systems*, and Data Sheet 5-48, *Automatic Fire Detection*.

2.6.7 Documentation

2.6.7.1 Maintain the following documents for reference (see Section 3.6.4):

A. Manufacturer’s literature describing the correct operation, inspection, and maintenance of the hybrid fire extinguishing system and its components

B. As-built piping layout drawings, electrical schematics, and hydraulic and pneumatic calculations

C. Schematic of the set position of operating valves and devices

D. Procedure(s) on the proper manual shutdown sequence of valves and equipment for the hybrid fire extinguishing system(s) after activation

E. Manufacturer's design, installation, operation, and maintenance manual

F. Acceptance test report that includes the results of the following, at a minimum:

1. Distribution system cleaning and flushing (Section 2.5.9.11)
2. Pressure test of distribution piping (Section 2.5.9.12)
3. Visual inspection (Section 2.6.3)
4. Acceptance testing
   a. Discharge test (Section 2.6.4)
   b. Operation of components (Section 2.6.5)
5. Alarm and detection device (Section 2.6.6)

2.7 Inspection, Testing, and Maintenance

2.7.1 Inspect, test, and maintain the hybrid fire extinguishing system in accordance with Data Sheet 2-81, *Fire Protection System Inspection*.

2.7.2 Provide a valve supervision program for water supply and inert gas control valve(s) in accordance with Data Sheet 2-81, *Fire Protection System Inspection*.

2.7.3 Manage system impairments in accordance with Data Sheet 10-7, *Fire Protection Impairment Management*.

2.7.4 Provide annual inspection to any installed pressure relief vents.

2.8 Training

2.8.1 Provide training for all personnel responsible for the operation and maintenance of the system, addressing the following at a minimum:

A. Review of the manufacturer's FM Approved design, installation, operation, and maintenance manual.

B. The purpose of the hybrid fire extinguishing system relative to the protected equipment and enclosure.

C. Functionality of the system and major system components.

D. Associated equipment and interlocks, if applicable (enclosure venting, dampers, power and ventilation shutdown, etc.)

E. Operation of the system under normal and emergency circumstances (i.e., automatic and manual operation), including the location of manual release devices.

F. Necessary inspection, testing, and maintenance of the hybrid fire extinguishing system and protected enclosure or equipment.

2.9 Contingency Planning

2.9.1 Maintain a 100% spare supply of water and inert gas cylinders on site when a connected reserve supply is not used and if the system needs to immediately be restored after operating to address the conditions in Section 2.4.2.4.

2.9.2 Maintain a spare supply of system components on site, as follows:

A. Spare hybrid nozzles of each type installed, based on the largest equipment hazard or enclosure volume.

B. Spare strainers or filters for hybrid media nozzles, if replaceable, for all types and sizes installed.

C. Any specialized equipment required for installation of the nozzles, strainers or filters.

2.9.3 Develop a plan to bring the hybrid fire extinguishing system and protected equipment to working order following a system discharge, including the following at a minimum:

A. Adherence to established impairment procedures. Refer to Data Sheet 10-7, *Fire Protection Impairment Management*, for additional details.

B. Cleanup and salvage of the enclosure, particularly if it includes sensitive equipment.

C. Replenishment of water container(s) and inert gas cylinder(s), particularly if a reserve supply is not available on site.

D. Adherence to other items listed in the manufacturer's FM Approved design, installation, operation, and maintenance manual.

3.0 SUPPORT FOR RECOMMENDATIONS

3.1 General

3.1.1 Hybrid Fire Extinguishing System Origins

Water mist systems are classified as either single fluid or twin fluid systems. Single fluid systems employ only one fluid: water. Twin fluid systems use water and an additional fluid, typically compressed air or inert gas. The gas in twin fluid water mist systems does not play a role in fire extinguishment. The gas serves only to atomize the water into small droplets and does not directly aid in fire extinguishment.

As water mist evolved, some systems supplied larger quantities of inert gas, so oxygen depletion from the discharged gas became a primary fire extinguishing mechanism. Thus, the category of hybrid fire extinguishing system was created to differentiate twin fluid water mist systems from systems in which inert gas contributes to fire extinguishment.

3.1.2 Extinguishing Mechanisms

Single and twin fluid water mist systems extinguish fires by three primary mechanisms: oxygen depletion, cooling, and radiant heat attenuation. Relative to oxygen depletion, heat from a fire evaporates the small water mist droplets, and the expanded water vapor displaces oxygen.

The inert gas used in hybrid systems more directly reduces the oxygen levels within a compartment, similar to gaseous fire extinguishing systems. The oxygen concentration at fire extinguishment will therefore be lower for a hybrid system than for a water mist system.

FM Global conducted research to quantify the resulting oxygen concentration in a fire test compartment for water mist, hybrid, and inert gas extinguishing systems. Various ignitable liquid spray fire tests were conducted, with the following conclusions:

A. For a twin fluid water mist system, the oxygen concentration at fire extinction will typically exceed 16%.

B. For a hybrid system, the oxygen concentration at fire extinction will be between 12.5 and 16% for a hybrid system. While cooling still occurs from the water component of the system, the inert gas plays a more dominant role in fire extinguishment, resulting in reduced oxygen levels at fire extinguishment.

C. For a gaseous system, inerting is the primary extinguishing mechanism, resulting in an oxygen concentration at fire extinction of less than 12.5%.

3.1.3 Applications for Which Hybrid Fire Extinguishing Systems are Not Recommended

Hybrid fire extinguishing systems are not suitable for protecting the following:

- Energized electrical equipment, enclosed or unenclosed (Class C)
- Storage of ignitable liquids (>110 gal [>420 L])

- Chemicals, such as cellulose nitrate, that release sufficient oxygen or other oxidizing agents to sustain combustion
- Liquefied or compressed gas
- Cascading fuel fires
- Combustible metals, such as aluminum and magnesium
- Water-reactive metals, such as lithium, sodium, potassium, titanium, zirconium, uranium, plutonium and sodium-potassium alloys
- Hazardous, water-reactive materials such as triethyl-aluminum and phosphorous pentoxide.
- Metal alkoxides, materials such as sodium methoxide
- Metal amides, materials such as sodium amide
- Carbides, materials such as calcium carbide
- Cyanates, materials such as methylisocyanate
- Halides, materials such as benzoyl chloride and aluminum chloride
- Hydrides, materials such as lithium aluminum hydride
- Silanes, such as trichloromethylsilane
- Sulfides, such as phosphorus pentasulfide

3.2 Construction and Location

Ambient temperature of the storage location should be a minimum of 40°F (4°C) as these are water-based protection systems. The maximum temperature evaluated for operability of components as part of the certification for FM Approval is 130°F (54°C). Alternate temperature ranges are acceptable if identified as part of the FM Approval listing. Heating, ventilation and cooling should be maintained for normal building service areas and when installed in a separate stand-alone enclosure.

When considering the installation of a water storage tank and inert gas cylinders, provide enough space around the tank and cylinders so it can be removed or replaced for inspection, testing or maintenance.

3.3 Personnel Safety

3.3.1 The following considerations should be made with respect to personnel where hybrid fire extinguishing systems are used:

- **Oxygen level.** A hybrid fire extinguishing system uses an inert gas that will reduce the oxygen atmosphere when discharged. Avoid unnecessary exposure to atmospheres flooded by a hybrid system resulting in low oxygen atmospheres. Consider providing suitable safeguards to provide prompt evacuation from and prevent entry into hazardous atmospheres and also consider providing a means for prompt rescue of any trapped personnel. Safety items such as personnel training, warning signs, discharge alarms, self-contained breathing apparatus (SCBA), evacuation plans, and fire drills are options to address personnel safety.

  Unprotected personnel are not to enter the protected enclosure during or after the discharge. Entrance to the protected enclosure should only be considered after ventilation returns the enclosure to the normal atmosphere of approximately 21% oxygen or an oxygen level acceptable to the authority having jurisdiction (e.g., United States Occupational Safety and Health Administration (OSHA) accepts >19.5% oxygen). (See Section 3.3.2.)

- **Temperature/visibility.** Discharge of a hybrid media can cause reduction in temperature and visibility. Visibility will return to a pre-discharge state when the temperature in the protected enclosure rises above the dew point temperature. Alternatively, the protected enclosure can be ventilated to restore visibility.

- **Wetting of surfaces.** Caution is advised when walking on surfaces that may have been wetted by the discharge. Electrical energy could be conducted across wetted surfaces. Wetting of surfaces is possible particularly if there is little heat present to evaporate the hybrid media.

3.3.2 Use Restrictions

3.3.2.1 Use of a hybrid fire extinguishing system is restricted to normally occupied areas only where one of the following conditions is applicable:

A. Where exposure times are limited to 5 minutes for sea-level equivalent oxygen concentrations above 12%.

B. Where exposure times are limited to 3 minutes for sea-level equivalent oxygen concentrations above 10% and at or below 12%.

3.3.2.2 Use of hybrid fire extinguishing systems is restricted to normally unoccupied areas with an exposure time limit of 30 seconds where the sea-level equivalent oxygen concentrations is above 8% and at or below 10%.

3.3.2.3 Use of hybrid fire extinguishing systems is restricted to unoccupiable areas with sea-level equivalent oxygen concentrations of 8% or lower.

3.3.2.4 Use “Warning” and instruction signs at entrances to and inside protected areas. The warning signs should be affixed in a conspicuous location in every protected space; at every entrance to protected spaces; at every remote manual actuation station; at every entrance to inert gas storage rooms; and where inert gas might collect and result in a reduced oxygen atmosphere in the event of a discharge from a safety device or control panel leak.

3.4 Protection

No general design method is recognized for hybrid fire extinguishing systems. Performance objectives need to be proven by fire testing for the types of fire scenarios expected in the intended installation. Applicable tests are identified in FM Approval Standard Class Number 5580, *Approval Standard for Hybrid (Water and Inert Gas) Fire Extinguishing Systems*.

FM Approval testing involves the completion of a series of fire tests that replicate the type of fuel, configuration, and severity that will be created by the specific hazard. Approval Standard 5580 also includes functionality testing of the integral components that comprise the hybrid system. The fire tests prove the hybrid system will perform effectively in the event of a fire, while the functionality testing verifies the system and components will operate properly.

3.4.1 System Limitations

The fire tests described in Section 3.4 confirm the successful performance of a hybrid system on a specific fire hazard. It is not possible to determine system performance on fire hazards beyond the scope of the tests that have been conducted. For example, a hybrid system that has demonstrated successful performance on ignitable liquid spray and pool fires associated with the Class 5580 fire test protocol for gas turbines can be installed to protect gas turbine compartments. However, the performance of this same system for cables under a raised floor in a data processing equipment room is unknown until fire testing specific to that occupancy has been conducted.

Limiting the use of hybrid fire extinguishing systems to hazards that have been proven through fire testing, as outlined herein, is critical. Additionally, all system limitations, as outlined in the manufacturer’s FM Approved design, installation, operation, and maintenance (DIOM) manual, must be met. Failure to do so may negatively impact the system’s performance in a fire event.

3.4.1.1 System Configuration

Fire testing is conducted using the anticipated system configuration and limitations, as stated by the system manufacturer. This includes but is not limited to maximum nozzle spacing, nozzle coverage volume, protected enclosure height, enclosure volume, and maximum area of enclosure openings. Performance of the system beyond these tested limitations is unknown.

For instance, extrapolation of a hybrid fire extinguishing system design from a smaller tested compartment to a larger, untested compartment will not result in equivalent performance. For example, if fire testing was done on a compartment 10,000 ft^3 (283 m^3) in volume, it cannot be assumed that a 20,000 ft^3 (568 m^3) volume compartment could be successfully protected using twice the number of nozzles and twice the amount of water or inert gas.

3.4.1.2 Interlocks

To the greatest extent possible, hybrid fire extinguishing system installations must align with the ambient conditions in which they were fire tested. This includes consideration of any auxiliary interlock functions that must occur to provide effective fire control or extinguishment. Examples of auxiliary functions include power disconnect, fuel shut off, HVAC control, damper closure, door closure and similar devices.

The interaction of the hybrid fire extinguishing system with auxiliary functions and environmental control systems should be carefully evaluated to determine which systems should be shut down, the sequence of any shut-down relative to a hybrid system discharge and which should continue to operate when the hybrid fire extinguishing system is activated. For example, the Class 5580 fire test protocol for machinery spaces only includes natural ventilation. To provide successful performance, therefore, any forced ventilation systems should be interlocked to shut down prior to hybrid system activation.

3.4.1.3 System Identification

The system information sign provides a readily accessible summary of the protection being provided by the hybrid fire extinguishing system when the following information is included, as applicable:

- Location of the protected area or areas
- Description of the hazard protected
- Design type application
- System manufacturer and system designation
- Volume or area protected, depending on application
- Total number of nozzles protecting the hazard
- Design water and inert gas flow rate and duration
- Total inert gas agent and water requirements, as calculated
- Description of any compartment or enclosure characteristics that are essential to system performance
- Name of installing contractor and contact information
- Date of installation
- Date of modification
- Plan identification number or project number of the submitted as-built plans

3.4.2 Equipment Protection

3.4.2.1 Enclosure Protection

Hybrid media has proven to be effective in extinguishing high heat release rate fires in enclosures, including rooms or compartments containing gas turbines, indoor transformers, and similar equipment with an ignitable liquid fire hazard in lieu of providing automatic sprinklers for protection of the hazard. Automatic sprinkler protection, though, is still to be provided for those areas outside the hybrid fire extinguishing system protected enclosure (i.e., the building).

These systems are fire tested with openings present in the enclosure. The openings are intended as a fault condition to prove the hybrid fire extinguishing system performance under limited natural ventilation. The intent is that the systems are installed with all openings being closed via interlocks/dampers when the hybrid fire extinguishing system is activated to provide a sealed enclosure.

If unclosable openings are present in an enclosure they may be tolerated if the size and location of the openings are similar to those included in the fire testing protocol. The opening size and location is important to the performance of the system as the heat generated in the enclosure enhances the hybrid media ability to extinguish a fire as hybrid media is turned to steam as it is heated in the enclosure thus providing cooling and reducing the oxygen concentration in the enclosure. Openings in the fire testing protocol are at ground level. If openings of similar size are located in the ceiling or near ceiling level the impact on performance will be significant as heat rises and will be lost from the enclosure as opposed to openings near ground level.

Gross volume of the enclosure should be used to determine the volume of protection. If net volume is used, the same net volume could have a large variation of total surface area. That variation in surface area could have an impact on heat transfer and loss of discharged droplets to provide protection.

3.4.2.2 Local Application

Local application systems can extinguish ignitable liquid pool and spray fires. Critical features are nozzle spacing and height above the hazard, as well as containment of the ignitable liquid (e.g., via curbs or dikes). Local application systems work largely by flame cooling, with inerting providing less of a contribution as for enclosure fires.

This application of a hybrid fire extinguishing system is similar to a local application carbon dioxide system. Automatic sprinkler protection at ceiling level is usually needed as well.

3.4.3 Design of Hybrid Fire Extinguishing Systems

Hybrid fire extinguishing systems consist of specialized equipment designed specifically by the manufacturer to be part of this type of special protection system.

Hybrid fire extinguishing system components include, but are not limited to, the following:

• *Nozzles (deluge)*	• *Hangers and bracing pipe support*
• Inert gas cylinder(s)	• Actuation controls
• Water supply container(s)	• Check valves
• Actuation/control valves	• Discharge alarms
• Pressure regulating valve	• Pressure gauges/transducers
• Piping/tubing	• Drain valves
• Pipe connections (fittings)	• Relief valves
	• Regulators

Hybrid fire extinguishing systems are listed in the Fire Protection volume of the *Approval Guide* under Fixed Extinguishing Systems. The Hybrid Fire Extinguishing Systems sections are categorized to the type of hazard or hazard enclosure type with the critical limitations to be used in the application of the protection.

Hybrid fire extinguishing systems are deluge-type special protection systems and therefore must be paired with compatible detection and fire alarm control units. The following components are listed in the Electrical Signaling section in the Fire Protection volume of the *Approval Guide*:

- Alarm Signal Initiating Devices
  - Fire Detection; Flame, Heat, Smoke
  - Manual Stations
- Automatic Release for Extinguishing Systems
- Notification Appliances
- Signaling Systems (Fire)

3.4.3.1 Nozzle Size or Type on Distribution System

Do not mix nozzle sizes or types on the distribution system unless it has been identified in the FM Approved manufacturer's DIOM manual. Nozzle sizes may have different penetration distances based upon the momentum of the discharge, which could impact performance for fire extinguishment.

3.4.3.2 Obstructions to Discharge From Nozzle

3.4.3.2.1 Obstructions will affect the performance of the hybrid fire extinguishing system protection. The impact of the obstruction will vary according to the type of spray technology and the type of application. Hybrid nozzles have a wide range of projection distances, spray velocity and spray patterns.

3.4.3.2.2 Spray from nozzles that impinge too close on obstructions will not fully atomize, and a portion of the water mass will be removed from suspension. Such losses diminish the extinguishing effectiveness of total flooding or local application systems. For combustibles where prewetting is an important factor in preventing fire growth, obstructions to spray development prevent wetting of unburned materials and diminish the performance of the hybrid media.

3.4.3.2.3 Additional nozzles may be required to overcome the presence of obstructions and provide adequate system performance when obstructions and maximum coverage distances to obstructions are not evaluated as part of the FM Approval.

3.4.3.3 Ambient Atmospheric Pressure Compensation

Adjust the design quantity of inert gas in accordance with the manufacturer's FM Approved DIOM manual for ambient pressures that vary more than 11 percent [equivalent to approximately 3000 ft (915 m) of elevation change] from standard sea level pressures[29.9 in. Hg at 70oF (760 mm Hg at 0oC)]. Atmospheric air is 21 percent oxygen. The partial pressure of oxygen in ambient air and air diluted with inert gas from the hybrid media needs to considered in determining the quantity of inert gas to determine the permissible exposure times for egress. (See Section 3.3.2)

3.4.3.4 Discharge Duration

3.4.3.4.1 A limited agent supply is provided for hybrid fire extinguishing system for most applications, particularly those where it serves as supplementary protection to automatic sprinklers. If the fire has not been extinguished before the water or inert gas is exhausted, the fire will continue to grow. The fire testing conducted by FM Approvals examines the time to extinguish test fires. The quantity of water and inert gas supplied is based on these extinguishment times, including an appropriate safety factor.

3.4.3.4.2 The hazard specific data sheet may also provide a discharge duration, based on the expected fire hazard, that exceeds the duration listed in the hybrid fire extinguishing system manufacturer's design, installation, operation, and maintenance manual.

3.4.3.5.3 If water discharge continues after the inert gas supply has been exhausted, it is not effective for fire suppression.

3.4.3.5 Hydraulic Design

3.4.3.5.1 A pre-engineered system simply means the system is limited to very specific combinations of pipe sizes and lengths, including the total number of tees (flow splits), elbows, and nozzles, and does not involve flow calculations. Typically, pre-engineered systems are restricted to balanced piping configurations (i.e., 50-50 flow splits).

3.4.3.5.2 An engineered system is a designed/flow-calculated system that normally involves the use of a proprietary flow calculation program. The flow calculation program is evaluated/verified through testing as part of the FM Approval process for each fire equipment manufacturer's system. Output Reports with "errors" from the hydraulic calculation program are not within the limitations of the FM Approved specification for Plan acceptance.

3.4.3.6 Enclosure Integrity and Pressure Relief Venting

The successful performance of a hybrid fire extinguishing system is not dependent on the integrity of the enclosure. A tight enclosure to prevent the discharged hybrid media escaping from the space is not essential to achieve and maintain fire extinguishment. Enclosure integrity can initially be confirmed with a simple visual check of the protected enclosure for any obvious penetrations or openings that might allow the escape of agent for compliance to the allowable number of openings and area in the FM Approved design, installation, operation and maintenance manual. Once any obvious openings have been addressed, final confirmation of the room's integrity can be determined via a door fan test and/or a full discharge test.

When a hybrid extinguishing system is discharged, a positive pressure maybe created within the enclosure dependent upon the discharge time and the integrity of the enclosure, since an inert gas is a component of the hybrid media. The change in ambient pressure following discharge could impact the structural strength of the space if the enclosure is overly tight.

In many cases, natural ventilation (free efflux) occurs such that the structural strength of the enclosure is not exceeded. However, if the peak pressure developed during a hybrid discharge exceeds the enclosure strength, additional venting for positive may be required to limit enclosure damage. Vents include gravity vents, counter weighted flap vents, electrically operated vents, and pneumatically operated vents. These vents remain closed, keeping the discharged hybrid media within the enclosure, until a specifically designed opening pressure is reached.

Guidance for determining the necessary free vent area, selecting an appropriate type of vent, correctly sizing the vents, and determining the appropriate opening pressure is provided in several publications, including the following:

- ISO TS 21805 (E), *Guidance on Design, Selection and Installation of Vents to Safeguard the Structural Integrity of Enclosures Protected by Gaseous Fire-Extinguishing Systems*
- Fire Suppression Systems Association (FSSA) *Guide to Estimating Pressure Relief Vent Areas*

3.5 Equipment and Process

Typical hybrid fire extinguishing systems are identified in Figure 1 and Figure 2.

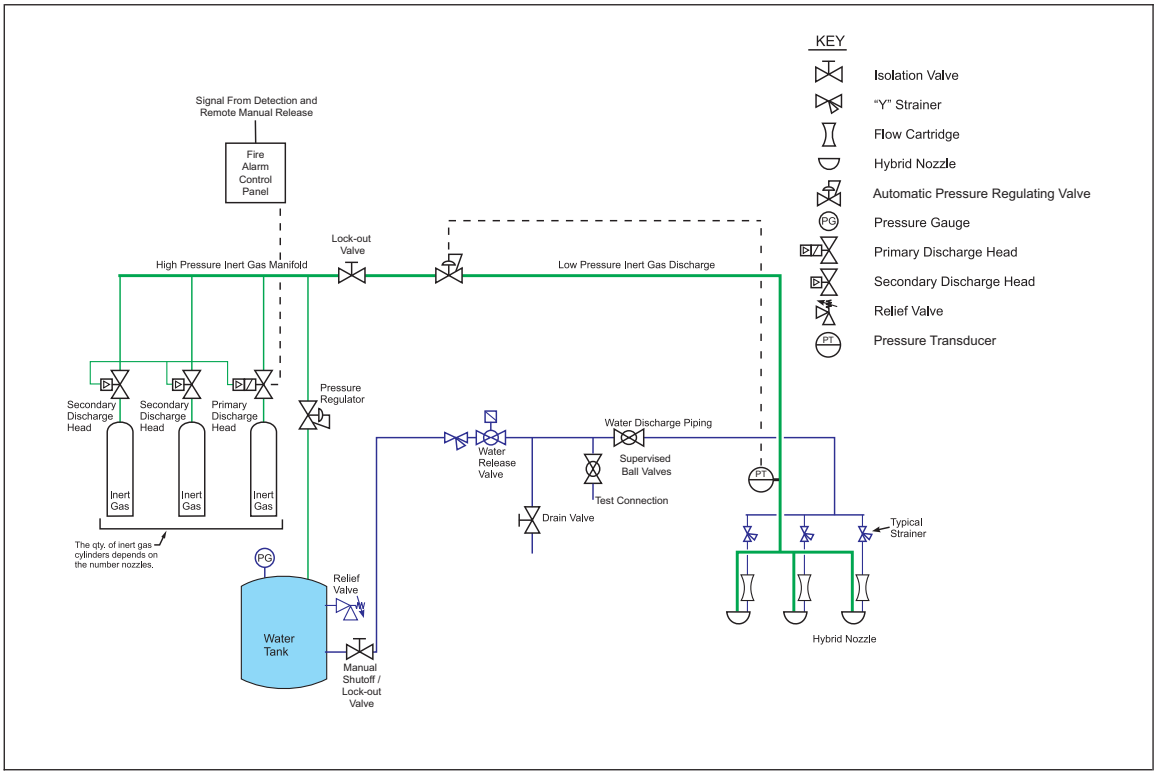

Fig. 1. Schematic of engineered hybrid fire extinguishing system

3.5.1 Water Supply

3.5.1.1 Strainers

The use of a strainer with corrosion resistant material compatible to the piping and fittings will prevent galvanic corrosion that can enter into the water supply and clog the hybrid nozzle.

3.5.2 Connected Reserve

Reserve supplies are necessary to permit prompt restoration of the system after a discharge, to minimize interruption of the process and the interval of impaired protection.

3.5.3 Valves

When selector valves are used for multi-hazard protection, the effect of migrating hybrid media into adjacent zones could activate unwanted releases with standard smoke detection. Care needs to be given to match detection devices to the environment in both normal and release conditions.

The use of a pressure relief valve or burst disc is recommended where the failure of a manifold valve or selector valve to open or failure of a regulating valve could result in an over pressure condition.

3.5.4 Test Connections

Location of the test connection may need to consider access for disposal if the discharged water is to be collected and removed the water from the premise and discharge into an area that with not reduce the oxygen level in a enclosure that pose a risk to personnel.

3.5.5 Distribution System

3.5.5.1 Pipe and tubing are used interchangeably as part of the distribution system terminology. Pipes though typically accommodate applications with nominal sizes for the large flow of liquids and a low internal pressure. With higher pressures the wall thickness (Schedule) of the pipe increases along with the weight per unit

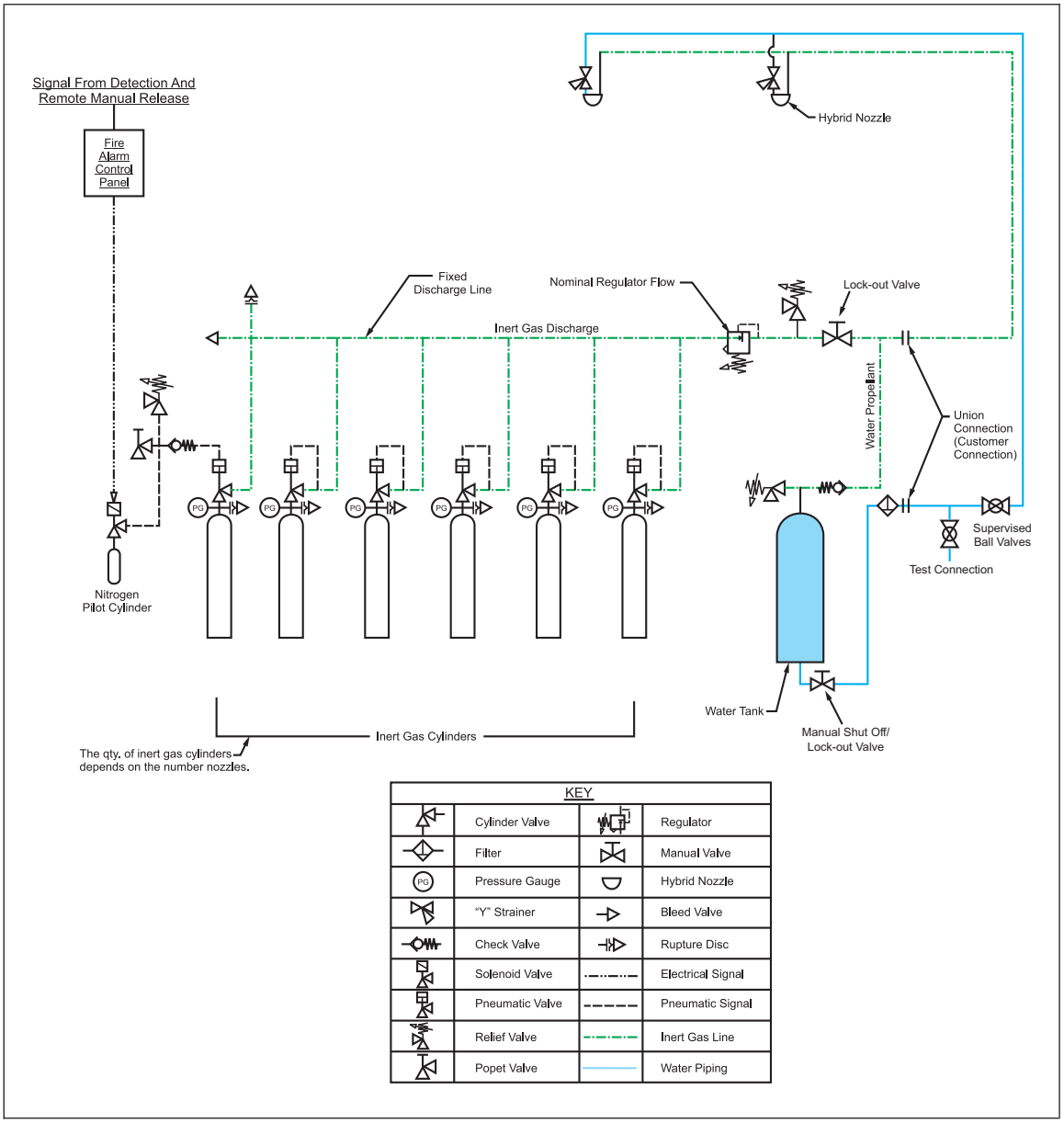

Fig. 2. Schematic of pre-engineered hybrid fire extinguishing system

length due to the materials of construction. Tubing is generally used in applications with smaller rates of flow with medium to high internal pressure. The stability of the tubing is dependent upon high strength materials of construction, which allows for a reduced wall thickness and weight per unit length. The usage of either pipe or tubing will be specified as part of the manufacturer's design, installation, operation and maintenance manual.

3.5.5.2 Teflon tape or the hybrid fire extinguishing system manufacturer's thread locker compounds at the pipe joints may be used to prevent leakage from the pipe joints. It is essential that pipe sealants, Teflon tape or lubricants not be allowed to enter into the pipe network. Applying sealant, tape or lubricant, only to the pipe threads reduces the possibility of these substances entering the pipe network and plugging small orifices in control devices or discharge nozzles, the possibility of such material entering the pipe network is greatly reduced.

3.5.5.3 Using installation equipment to connect pipe or tubing that is not rated for their material of construction could lead to leaks of the distribution system.

3.5.5.4 Galvanized steel pipe and fittings or aluminum tubing and fittings are not recommended for the water supply line in hybrid fire extinguishing systems. Small orifice nozzles have the potential for blockage due to corrosion, water quality and flaking of pipe coatings. Current standards for galvanized piping cannot ensure the internal coating will not flake and obstruct nozzles and strainers. Hence it is critical to select hybrid fire extinguishing system pipe or tubing that exhibits minimal corrosion. This will reduce the possibility of a blockage to the small orifices in the open nozzle by degradation of the internal pipe coating from corrosion.

3.5.5.5 Using compatible pipe materials will limit the occurrence of galvanic corrosion between piping, fittings and different materials of construction that can promote leakage.

3.5.5.6 System Feedback Sensor

Verification of the connection between the device and the pipe can be achieved by visual inspection or test. Sensors installed in nitrogen piping can be verified by a pneumatic test of the piping system or an abbreviated discharge using inert gas only.

3.5.5.7 Piping Support

The piping should be supported and braced to restrict movement due to nozzle reaction and water surges so that system performance and integrity is maintained. Consideration should be given to areas subject to earthquake damage by using piping supports specifically listed to secure the distribution system from damage.

3.5.5.8 Hydrostatic Pressure Test of Distribution Piping

To prevent the risk of water damage in the case of a break, use a small-capacity pump to maintain pressure.

Use standardized test procedures to conduct the hydrostatic pressure test (such as Section 137, *Pressure Tests* of the ASME B31.1. Power Piping Code) that include requirements on the following:

- Temperature of the test medium
- Personnel protection
- Preparation for testing
- Water quality

3.5.6 Operation and Control of Systems

3.5.6.1 Actuation

For large hazard areas and/or where access may be limited, consider installing additional manual actuation devices both local to, and remote from the emergency mechanical manual actuating device of the hybrid media (water and inert gas) agent supply.

Auxiliary interlock functions include any functions that must occur to provide effective control or extinguishment of fire based upon limitations of the hybrid fire extinguishing systems. Examples of auxiliary functions may be power disconnect, fuel shut off, HVAC control, damper closure, door closure and similar devices.

The interaction of the hybrid fire extinguishing system with auxiliary functions and environmental control systems should be carefully evaluated to determine which systems should be shut down and which should continue to operate when the hybrid fire extinguishing system is activated. For example, fuel supplies, lubrication oils, ignition sources, and ventilation systems should be evaluated to determine their impact on the performance of the hybrid fire extinguishing system and the equipment being protected.

3.5.6.2 Supervision

Many valves, if left in the incorrect position, can compromise or even disable the hybrid fire extinguishing system. Examples of valves critical to operation of the hybrid fire extinguishing system include valves from the water supply tank, valves in the inert gas manifold supply and isolation valves on the test connection.

3.5.6.3 Alarms

Provide suitable alarms to initiate egress and prevent entry into areas with fire conditions. Locate warning and safety instruction signs so they will be readily visible to personnel. In addition to the recommendations for alarms, safety procedures such as personnel training, evacuation plans, and fire drills should be considered.

A pre-discharge alarm and time delay can be used to prevent human exposure to the discharge and allow egress from areas with reduced visibility. Where a pre-discharge time delay is installed, it should delay the discharge of the system only for time sufficient to allow evacuation of personnel from areas within the spaces most remote from the exits.

3.6 Acceptance of the Hybrid Fire Extinguishing Systems

3.6.1 Commissioning and Integrated Testing

Hybrid fire extinguishing systems are complex special protection systems that may include both active and passive fire protection equipment and systems, along with critical support equipment to protect the hazard. A total commissioning and integrated test program may be warranted to assist in the quality control for operational functionality of the equipment or occupancy. The following documents provide guidance in the development of a program to verify that integrated fire protection and life safety systems perform as intended:

- NFPA 3, *Standard for Commissioning and Integrated Testing of Fire Protection and Life Safety Systems*
- NFPA 4, *Standard for Integrated Testing of Fire Protection and Life Safety Systems*

3.6.2 Acceptance Test Plan

A mutually agreed upon test plan is recommended to be developed between the owner, installing contractor and FM Global representative to document the expected results in validating operation of the hybrid fire extinguishing system and associated alarms and interlocks.

3.6.3 Acceptance Testing

In order to guarantee the hybrid fire extinguishing system is designed and installed properly for the application for which it was intended, it is imperative that an operational test be conducted. Most hybrid fire extinguishing system equipment is installed at the job site. In order to make sure all the correct equipment has been installed properly and in the correct arrangement, an acceptance test must be performed that indicates operability as specified in the manufacturer's FM Approved design, installation, operation and maintenance manual.

Acceptance Testing also makes sure all components are installed in their proper orientation and pressure settings. It is advisable to note the performance of the system at its acceptance test and then compare the results of annual testing to flag any potential problems.

3.6.4 Documentation

The documentation recommended to be kept on file by the client is to allow for verification of proper operation of the hybrid fire extinguishing system over it's intended life cycle to provide protection should the installing contractor or manufacturer of the hybrid fire extinguishing system no longer directly support the product, it is no longer is FM Approved, or there be a need to modify the protection being provided.

3.7 Inspection, Testing, and Maintenance

Since field conditions cannot be fully controlled, Inspection, Testing, and Maintenance (ITM) activities are needed at regular intervals to provide the following:

A. Degradations or faults due to any deviation from specified environmental/operating conditions (e.g., due to human errors) are corrected

B. Any unanticipated failures (e.g., due to design/manufacturing process deficiencies or overstresses or aging) or other issue causing the component or system not meet its design intent with respect to functionality and performance.

4.0 REFERENCES

4.1 FM Global

Data Sheet 2-81, *Fire Protection System Inspection*
Data Sheet 4-0, *Special Protection Systems*
Data Sheet 5-3, *Hydroelectric Power*
Data Sheet 5-14, *Telecommunications*
Data Sheet 5-19, *Switchgear and Circuit Breakers*
Data Sheet 5-23, *Emergency and Standby Power Systems*
Data Sheet 5-32, *Data Centers and Related Facilities*
Data Sheet 5-40, *Fire Alarm Systems*
Data Sheet 5-48, *Automatic Fire Detection*
Data Sheet 7-3, *Flight Simulator Systems*
Data Sheet 7-32, *Ignitable Liquid Operations*
Data Sheet 7-37, *Cutting Fluids*
Data Sheet 7-79, *Fire Protection for Gas Turbines and Electric Generators*
Data Sheet 7-88, *Ignitable Liquid Storage Tanks*
Data Sheet 7-101, *Fire Protection for Steam Turbines and Electric Generators*
Data Sheet 10-7, *Fire Protection Impairment Management*

UTH: *Failure of Special Protection Systems* (P0379)

4.1.1 FM Approvals

Class 5580, *Approval Standard for Hybrid (Water and Inert Gas) Fire Extinguishing Systems*

4.2 Other

American National Standards Institute (ANSI). ANSI/ASME B31.1, *Power Piping Code*.

Manufacturers Standardization Society (MSS) of the Valve and Fitting Industry. Standard Practice SP-58, *Pipe Hangers and Supports-Materials, Design, Manufacturer, Selection, Application and Installation*.

National Fire Protection Association (NFPA). NFPA 3, *Standard for Commissioning and Integrated Testing of Fire Protection and Life Safety Systems*.

National Fire Protection Association (NFPA). NFPA 4, *Standard for Integrated Testing of Fire Protection and Life Safety Systems*.

National Fire Protection Association (NFPA). NFPA 770, *Standard on Hybrid (Water and Inert Gas) Fire Extinguishing Systems*.

APPENDIX A GLOSSARY OF TERMS

Approval Guide: An online resource of FM Approvals, the *Approval Guide* provides access to a fully searchable database of the most up-to-date information on approximately 50,000 FM Approved fire protection products, building materials, electrical equipment, and services that conform to the highest property protection standards.

Atomizing media: Inert gas that is used to produce hybrid media by mechanical mixing with water.

Dv_f: A water drop diameter such that the cumulative volume, from zero diameter to this respective diameter, is the fraction, f, of the corresponding sum of the total distribution.

Dv_{50}: The volume median water drop diameter; that is 50% of the total volume of liquid is in drops of smaller diameter and 50% in drops of larger diameter.

Deluge hybrid system: A hybrid fire extinguishing system utilizing open (nonautomatic) nozzles attached to a piping network to the water and inert gas supply through a valve. Controlled by an independent detection system installed in the same hazard area as the hybrid media nozzles.

Emergency mechanical manual release: A mechanical manual discharge control that can function on the absence of electrical power or other energy sources other than stored pressure.

Emergency power: Power source (UPS, batteries, electric generators connected to rotating equipment [diesel engine, gas turbine] or fuel cells) and associated distribution and control systems that is available for reliable electric power in the event of interruption of the normal power, that is adequate in size and quality for the correct operation of the systems to which it is connected.

Enclosure: A confined or partially confined volume.

Engineered systems: A system requiring individual hydraulic calculation and design to determine the flow rate, pipe size and pressure at each individual nozzle. These calculations analyze the entire piping system, taking into account variables such as friction loss in valves, piping, nozzles and other components.

FM Approved: References to FM Approved in this data sheet mean a product or service has satisfied the criteria for FM Approval. Refer to the *Approval Guide*, an online resource of FM Approvals, for a complete listing of products and services that are FM Approved.

Gas: Compressed gas used as prime mover to push water out of storage containers, through pipe networks, or distribution components.

Hybrid Fire Extinguishing System: A distribution system connected to a supply of hybrid media that is equipped with one or more nozzles capable of delivering the media intended to extinguish fires.

Hybrid Media: An agent used for fire extinguishment that is comprised of water and inert gas, consisting of one or more of the gases helium, neon, argon, nitrogen, or carbon dioxide. Both components are critical factors in fire extinguishment. For the water component the medium, the $Dv_{0.99}$, for the flow weighed cumulative volumetric distribution of water droplets, is less than 1,000 microns at the minimum design operating pressure of the nozzle.

Ignitable liquid: Any liquid or liquid mixture that will burn. A liquid will burn if it has a measurable fire point. Ignitable liquids include flammable liquids, combustible liquids, inflammable liquids, or any other term for a liquid that will burn.

Inert Gas: An agent that contains as primary components one or more of the gases helium, neon, argon, or nitrogen. Inert gases that are blends of gases can also contain carbon dioxide as a secondary component of the blend.

Inspection: A visual examination that determines if a condition, device, equipment, or system is suitable for service.

Integrated system: A combination of sub-systems that are required to operate together as a whole to achieve overall fire protection and life safety objectives.

Interconnected system: An integrated system that has component systems or devices physically connected to achieve fire protection and life safety objectives.

Isolation valve: A manually operated valve with supervision in the distribution piping between the nozzles and water supply or test connection piping that in the closed position prevents the flow of water to the protected area or test discharge area, respectively.

Listed: Equipment or materials included in a list published by a nationally recognized testing laboratory, e.g. FM Approvals, UL, or VdS, that maintains periodic inspection of production and whose listing states the equipment or material meets designated standards for specified purpose.

Local application systems: A hybrid fire extinguishing system arranged to discharge on the protected hazard and within the containment or confinement area around the hazard.

Lockout Valve: A manually operated valve that can be locked in the closed position and that is supervised.

Lowest Observable Adverse Effect Level (LOAEL): The lowest concentration of inert gas at which an adverse physiological or toxicological effect has been observed.

Low-pressure system: A hybrid fire extinguishing system where the distribution system piping is exposed to pressures of 175 psi (12.1 bar) or less.

Maintenance: Work conducted to ensure the continued satisfactory operation of a device or system.

Manual release: An actuation device or arrangement of devices that requires action by a human operator. The manual release may be initiated either mechanically or electrically.

Maximum operating pressure: The maximum pressure to which pipe or components will be subjected.

No Observed Adverse Effect Level (NOAEL): The highest concentration of inert gas at which no adverse toxicological or physiological effect has been observed.

Normally Occupied Enclosure or Space: An enclosure or space where one or more persons are present under normal conditions.

Occupiable Enclosure or Space: An enclosure or space that has dimensions and physical characteristics so it could be entered by a person.

Pre-engineered systems: A system having predetermined flow rates, nozzle pressures, and quantities of agent regardless of installation to protect specific hazards of predetermined volume and fuel loading. These systems have specific pipe sizes, maximum and minimum pipe lengths, flexible hose specifications, number of fittings, and number and types of nozzles as listed by FM Approvals.

Pressure-reducing valve: A valve that will reduce the downstream pressure of the fire suppression agent under both flowing and non-flowing conditions.

Primary protection: See sole protection

Sea Level Equivalent of Oxygen: The oxygen concentration (volume percent) at sea level for which the partial pressure of oxygen matches the ambient partial pressure of oxygen at a given altitude.

Selector valve: An automatic operated valve in the distribution piping between the nozzles and the water and inert gas supply that controls the flow of water and inert gas to a particular protected zone (e.g. room, space, area) in multiple zoned application system. This valve may also be designated as a “section valve” by a manufacturer.

Single fluid system: A water mist system utilizing a single piping system to supply each nozzle. Nozzles may be supplied with water or a mixture of gas and water.

Sole protection: A protection system that provides adequate protection in accordance with the occupancy data sheet.

Special protection system: A protection system suitable to provide adequate fire suppression or extinguishment for hazards in which either (1) adequate fire suppression cannot be provided by automatic ceiling sprinklers due to the nature of the hazard or inherent elements that restrict sprinkler water from being effective (e.g., water spray obstructions); or (2) as supplementary protection. Special protection systems include CO_2, clean agent, dry chemical, foam-water, hybrid and water mist systems. Equipment hazard and occupancies suitable for protection by special protection systems are described in FM Global data sheets.

Supervision: A automatic means of monitoring a system or a device status and indicating abnormal conditions.

Supplementary protection: A special protection system provided in addition to an automatic sprinkler system (i.e. primary protection) where property damage or business interruption objectives can be adequately reduced from a sustained fire (e.g., computer rooms or clean rooms) or as an alternative to emergency drainage in ignitable liquid storage and use occupancy.

Test: To physically operate a device or system to verify its working condition.

Test connection: A device consisting of a manual control valve, a section of piping that allows discharge to a safe location, and a smooth-bore corrosion-resistant orifice equivalent to the simultaneous discharge of all the open nozzles on the special protection system. It is used to test the alarm mechanisms and operability of a special protection system.

Total flooding system: A system designed to protect a fire hazard that is enclosed sufficiently by fixed partitions (walls, floor, ceiling) to retain the fire extinguishing agent for an adequate time at an adequate density or concentration to affect adequate fire suppression or fire extinguishment.

Unoccupiable enclosure or space: An enclosure or space that has dimensions and physical characteristics so it could not be entered by a person.

Water mist: A water spray for which the Dv 0.99, for the flow weighted cumulative volumetric distribution of water droplets, is less than 1,000 microns at the minimum design operating pressure of the water mist nozzle.

Water mist nozzle: A special purpose device containing one or more orifices designed to produce and deliver an atomized water spray meeting the definition of “water mist” or meeting the specific requirements of an FM Approved water mist fire test protocol. Nozzles can be designed to operate independently of other nozzles, as a group of nozzles, or a combination of the two.

Working pressure: The maximum pressure applied to the system components, exclusive of pressure surges

Zoned application system: A system designed to protect multiple hazards in a predetermined portion of an enclosure.

APPENDIX B DOCUMENT REVISION HISTORY

The purpose of this appendix is to capture the changes that were made to this document each time it was published. Please note that section numbers refer specifically to those in the version published on the date shown (i.e., the section numbers are not always the same from version to version).

October 2020. This is the first publication of this document.

APPENDIX C COMPARISON WITH OTHER HYBRID FIRE EXTINGUISHING SYSTEM INSTALLATION STANDARDS

Currently (October 2020), there is only one code or standard on hybrid (water and inert gas) fire extinguishing systems. In the United States, the National Fire Protection Association has created NFPA 770, *Standard for the Installation of Hybrid Fire Extinguishing Systems*. This standard was published in August 2020.

There is relative agreement between this data sheet and the NFPA 770, *Standard on Hybrid Fire Extinguishing Systems*, 2020 Edition (Draft), with the following exceptions:

A. One significant area of disagreement is with the discharge time duration. The NFPA 770 draft proposes a reduced discharge time corresponding to oxygen levels to allow for installation in occupied areas. For supplementary protection systems, the hybrid media agent supply (water and inert gas) should be based on the discharge times as defined by the FM Approval listing. If all fire scenarios are extinguished, the water and gas supply is a multiple, usually twice, that needed to extinguish the worst fire scenario.

B. Data Sheet 4-6, *Hybrid Fire Extinguishing Systems*: Protection duration is based on the FM Approval for which fire scenarios are extinguished or controlled during representative test scenarios. NFPA 770 has included cursory fire tests for protection that may or may not be representative of the hazard for which protection is to be provided.

C. Local application hybrid systems are referenced in NFPA 770, but these applications are not currently included in the Class 5580 Approval Standard.

APPENDIX D FORMS

The following form may be used to assist in the commissioning of a hybrid fire extinguishing system:

- Contractor’s Application for Acceptance of Hybrid Fire Extinguishing System Installations (Engineering Form 5580)

APPENDIX E BIBLIOGRAPHY

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