



Engineering Specifications

**SAPPHIRE® FIRE
SUPPRESSION SYSTEM
WITH AUTOPULSE
IQ-318/IQ-636X2 AGENT
RELEASING CONTROL
PANEL AND LITHIUM ION
RISK PREVENTION SYSTEM**

**GEM®SAPPHIRE® FIRE SUPPRESSION SYSTEM WITH
AUTOPULSE IQ-318/IQ-636X-2 AGENT RELESING CONTROL PANEL
AND
LITHIUM ION RISK PREVENTION SYSTEM
ENGINEERING SPECIFICATIONS**

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PART 1 – GENERAL

1.01 DESCRIPTION OF WORK:

- A. This specification outlines the requirements for a "Total Flood" SAPPHIRE Clean Agent Fire Suppression System with an AUTOPULSE IQ-318/IQ-636X-2 Releasing Panel and the LITHIUM ION RISK PREVENTION system. The work described in this specification includes all engineering, labor, materials, equipment, design and service necessary and required to complete and test the suppression system.
- B. The contract drawings indicate the general requirements of the areas to receive detection and SAPPHIRE system protection. Contractor shall review all drawings so that all items affecting the operation of the fire detection/SAPPHIRE fire suppression system (such as equipment location, air diffusers, damper closures, and door openings) are considered in the design of the engineered system.
- C. The hazards with lithium ion batteries shall use off-gas monitoring equipment to provide early notification of battery failure prior to thermal runaway conditions. The LITHIUM ION RISK PREVENTION system integration shall be configured to communicate with the fire detection panel and the lithium ion battery management system (BMS). Additionally, a lithium ion battery shut down relay should be employed in addition to the controls provided by the BMS, in the event the BMS fails.

1.02 APPLICABLE STANDARDS AND PUBLICATIONS

- A. The following publications of the issues listed below, but referred to thereafter by basic designation only, form a part of this specification to the extent indicated by the reference thereto (latest edition):
 - 1. National Fire Protection Association (NFPA) Standards:
 - NFPA 2001: Standard on Clean Agent Fire Extinguishing Systems
 - NFPA 70: National Electrical Code
 - NFPA 72: National Fire Alarm and Signaling Code
 - NFPA 75: Standard for the Fire Protection of Information Technology Equipment
 - NFPA 76: Standard for the Fire Protection of Telecommunications Facilities
 - NFPA 855: Standard for the Installation of Stationary Energy Storage Systems
 - 2. Factory Mutual Systems (FM) Publication
 - Factory Mutual Approval Guide
 - 3. Underwriters Laboratories, Inc. (UL) Publication
 - UL 217: Smoke Detectors, Single and Multiple Stations
 - UL 228: Door Closers–Holders for Fire Protective Signaling Systems
 - UL 268: Standard for Smoke Detectors for Open Areas
 - UL 268A: Standard for Smoke Detectors for Duct Application
 - UL 521: Heat Detectors for Fire Protective Signaling Systems UL

- UL 864: Control Units and Accessories for Fire Alarm Systems
- UL 1638: Visual Signaling Appliances
- UL 1971: Signaling Devices for Hearing Impaired Fire Protection Equipment Directory with quarterly supplements
- UL 2127: Inert Gas Clean Agent Extinguishing System

4. National Electrical Manufacturers Association (NEMA) Publication Enclosures for Industrial Controls and Systems
5. U.S. Environmental Protection Agency, Protection of Stratospheric Ozone 59 FR 13044, March 18, 1994 (Final SNAP Ruling)
6. Requirements of the Authority Having Jurisdiction (AHJ)
7. Manufacturer's Design, Installation, Operation and Maintenance Manual
8. The complete system shall have the following applicable listings and approvals
 - a) Underwriters Laboratories Inc.
 - b) Factory Mutual Global
9. U.S. Environmental Protection Agency, Protection of Stratospheric Ozone 59 FR 13044, March 18, 1994 (Final SNAP Ruling)
10. ISO 9802-2
11. Requirements of the Authority Having Jurisdiction (AHJ)
12. Manufacturer's Design, Installation, Operation and Maintenance Manual

1.03 APPROVAL REQUIREMENTS

- A. The fire detection and suppression system shall be listed together and shall have the following applicable listings and approvals:
 1. UL Listed
 2. ULC Listed
 3. FM Approved
- B. The standards listed, all applicable codes, and sound engineering practices, shall be used as "minimum" design standards.

1.04 GENERAL:

- A. Furnish all engineering design and materials for a complete fire detection/SAPPHIRE fire suppression system including charged SAPPHIRE storage cylinders, nozzles, control unit, detectors, wiring, annunciators, alarm and all other equipment necessary for a complete operational system. The manufacturer of the suppression system hardware and detection components shall be ISO 9001 registered.
- B. Major system components shall be produced by Johnson Controls (no alternatives) and shall be installed by an authorized GEM Distributor certified for the design, installation, and service of SAPPHIRE fire suppression systems
- C. New and unused materials and equipment must be used for system
- D. Contractor shall, as a minimum, provide 24-hour emergency service, 7 days a week and shall be able to respond to an emergency situation within 2 hours of receiving an emergency trouble call. In addition, contractor shall maintain no less than \$2 million liability insurance

1.05 SUBMITTAL:

- A. The following shall be submitted for approval within 21 days of award and prior to delivery of materials:
1. Material and equipment information shall include manufacturer's catalog cut sheet and technical data for each component or device used in the system. This shall include, but not be limited to, the following:
 - a) Detectors
 - b) Manual discharge switches
 - c) Control unit
 - d) Release devices
 - e) Alarm devices
 - f) Agent storage cylinders
 - g) Mounting brackets
 - h) Discharge nozzles
 - i) Abort stations
 - j) Piping isometrics
 - k) Flow calculations
- B. Provide information outlining the warranty of each component or device used in the system.
- C. Provide information outlining the operation and maintenance procedures that will be required of the owner. This information shall explain any special knowledge or tools the owner will be required to employ and all spare parts that should be readily available.
- D. Drawings shall indicate locations, installation details and operation details of all equipment associated with the SAPPHIRE system. Floor plans shall be provided showing equipment locations, piping, point-to-point wiring and other details as required. Floor plans shall be drawn to a scale of not less than 1/8 in. (3.2 mm) = 1 ft 0 in. (0.3 m). Elevations, cross sections and other details shall be drawn to a larger scale as required. Isometric piping layouts shall be provided with the shop drawings. In addition, point-to-point electrical layout drawings shall be provided.
- E. Show a complete Riser diagram with specific detail on connections to all monitor and control functions.
- F. Testing plan that includes means, methods and schedules for interface testing with systems that will be interfaced to via monitor or control modules.
- G. Sequence of operation, electrical schematics and connection diagrams shall be provided to completely describe the operation of the SAPPHIRE system controls.
- H. Flow Calculations per Section 4.2

PART 2 – PRODUCTS

2.01 SYSTEM DESCRIPTION AND OPERATION

- A. The system shall be a Total Flood SAPPHIRE Fire Suppression System, AUTOPULSE Releasing Control Panel and LI-ION TAMER lithium Ion off-gas detection system supplied by Johnson Controls.
- B. The system provided shall be NOVEC 1230 with a minimum agent design concentration based on lithium ion off-gas components. The design concentration will be determined by the specific electrolyte used in the lithium ion batteries. Agent concentrations will vary but a design concentration of 6.8% by volume shall not be used for lithium Ion battery protection. A design concentration of 4.5% by volume for Class A hazards and a minimum of 5.85% by volume for Class B hazards in all areas and/or protected spaces, at the minimum anticipated temperature within the protected area. System design shall not exceed 10% for normally occupied spaces, adjusted for maximum space temperature anticipated, with provisions for room evacuation before agent release.
- C. The system shall be complete including mechanical and electrical installation, all detection and control equipment, agent storage containers, NOVEC 1230 agent, discharge nozzles, pipe and

fittings, manual release and abort stations, audible and visual alarm devices, auxiliary devices and controls, shutdowns, alarm interface, advisory signs, functional checkout and testing, training, and any other operations necessary for a functional UL listed SAPPHIRE Clean Agent suppression system.

- D. Provide two inspections during the first year of service: Inspections shall be made at 6-month intervals commencing when the system is first placed into normal service.
- E. The general contractor shall be responsible for sealing and securing the protected spaces against agent loss and/or leakage for a minimum design concentration hold time of 30 minutes or a time period sufficient to allow for cooling of the lithium ion batteries and response by trained personnel.
- F. The system(s) shall be actuated by photoelectric detectors installed for maximum area coverage of 250 ft² (23.2 m²) per detector, in the room, under the floor, and above the ceiling protected spaces. If the airflow is one air change per minute, photoelectric detectors only shall be installed for maximum area coverage of 125 ft² (11.6 m²) per detector (Reference NFPA 72).

2.02 SEQUENCE OF OPERATION

- A. Detectors shall be Cross-Zoned detection requiring two detectors to be in alarm before release. Automatic operation of each protected area shall be as follows:
 - 1. Activation of any single detector in any detection zone shall:
 - a) Energize a lamp on the activated detector, and control unit (and graphic annunciator, if included).

Note: The shutdown of electrical equipment will be optional based on requirements of the local AHJ or applicable standards.
 - 2. Activation of a detector on the second zone shall:
 - a) Transmit an alarm signal to remote monitoring or building alarm panel..
 - b) Cause a second-stage (pre-discharge) alarm to operate.
 - c) Operate auxiliary contacts for air conditioning shutdowns and automatic dampers.
 - d) Initiate a programmable time delay (SAPPHIRE agent release).
 - 3. Upon completion of the time delay the SAPPHIRE system shall:
 - a) Cause a discharge alarm to be activated.
 - b) Operate auxiliary contacts for emergency power off of all electrical equipment (excluding lighting and emergency circuits for life safety).
 - c) Energize control solenoid for SAPPHIRE cylinders releasing gaseous agent into the protected area.
 - d) Activate visual alarms (strobe) at protected area entrance
 - 4. The system shall be capable of being actuated by manual discharge devices located at each hazard exit. Operation of a manual device shall duplicate the sequence description above except that the time delay and abort functions shall be bypassed. The manual discharge station shall be of the electrical actuation type and shall be supervised at the main control panel.

2.03 AUXILIARY COMPONENTS

- A. Double action manual releasing stations shall be provided at each exit of the protected area and shall, when activated, immediately release the SAPPHIRE agent and cause all audible/visual alarms to activate. In addition, activation of the manual releasing stations shall cause immediate shutdown of air and power circuits.

- B. Abort stations shall be provided at each exit of the protected area and shall, when operated, interrupt the discharge of SAPPHIRE agent and emergency power-off functions. The abort stations shall be momentary devices (dead-man) requiring constant pressure to maintain contact closure.

Note: Manual Releasing Station activation shall override any abort station. Abort station operation shall be per FM guidelines.

2.04 LITHIUM ION OFF-GAS MONITOR INDICATING SEQUENCE OF OPERATION

- A. Notification from monitoring sensor within the LITHIUM ION RISK PREVENTIONS, shall:
 - 1. Cause a fire-stage alarm
 - 2. Activate a relay which will disconnect the specific battery rack or battery system with off-gas presence.

Note: The shutdown of the lithium ion battery that off-gassed is critical to ensure the batter stops charging or discharging and allows for the natural cooling of the battery to mitigate the probability of thermal runaway.
 - 3. Operation of Suppression system to inert environment (optional depending on customer risk)

Note: The discharge of agent is recommended to mitigate the ignition of the off-gases from the lithium ion battery while the disconnected system cools.

 - a) Transmit an alarm signal to remote monitoring or building alarm panel
 - b) Operate auxiliary contacts for HVAC shutdowns and automatic dampers
 - c) Initiate a programmable time delay (Sapphire agent release)
 - 4. Upon completion of the time-delay sequence, the Sapphire Clean Agent Fire Suppression System shall:
 - a) Cause a discharge alarm to be activated
 - b) Operate auxiliary contacts for emergency power-off of all electrical equipment (excluding lighting and emergency circuits for life safety).
 - c) Activate visual alarms (strobe) at protected area entrance
 - d) Energize control solenoid for Sapphire cylinders releasing gaseous agent into the protected area

PART 3 – MATERIAL AND EQUIPMENT

3.01 GENERAL REQUIREMENTS:

- A. The SAPPHIRE Clean Agent system materials and equipment shall be standard products of the supplier's latest design and suitable to perform all functions intended. When one or more pieces of equipment must perform the same function(s), they shall be duplicates produced by one manufacturer.
- B. All devices and equipment shall be UL Listed and/or FM approved.
- C. Each system shall have its own supply of clean agent.
- D. The system design can be modular, central storage, or a combination of both design criteria.
- E. Systems shall be designed in accordance with the manufacturer's guidelines.
- F. Each supply shall be located within the hazard area, or as near as possible, to reduce the amount of pipe and fittings required to install the system.
- G. The clean agent shall be stored in SAPPHIRE Clean Agent storage tanks. Tanks shall be super-pressurized with dry nitrogen to an operating pressure of 360 psi at 70 °F (24.8 bar at 21 °C). Tanks shall be of high-strength low alloy steel construction and conforming to NFPA 2001.

- H. Tanks (master) shall be actuated by either a resettable electric actuator or by pneumatic means from a nitrogen cartridge located in the releasing device. Explosive devices shall not be permitted.
- I. Each tank shall have a pressure gauge and low pressure switch (optional) to provide visual and electrical supervision of the container pressure. The low-pressure switch shall be wired to the control panel to provide audible and visual "Trouble" alarms in the event the container pressure drops below 290 psi (20 bar). The pressure gauge shall be color coded to provide an easy, visual indication of container pressure.
- J. Tanks shall have a pressure relief provision that automatically operates before the internal nominal pressure exceeds 730 psi (50 bar).
- K. Engineered discharge nozzles shall be provided within the manufacturer's guidelines to distribute the NOVEC 1230 agent throughout the protected spaces. The nozzles shall be designed to provide proper agent quantity and distribution. Nozzles shall be available in 1/2 in. through 2 in. pipe sizes. Each size shall be available in 180° and 360° distribution patterns.
- L. Distribution piping and fittings shall be installed in accordance with the manufacturer's requirements, NFPA 2001, and approved piping standards and guidelines. All distribution piping shall be installed by qualified individuals using accepted practices and quality procedures. All piping shall be adequately supported and anchored at all directional changes and nozzle locations.
- M. All piping shall be reamed, blown clear and swabbed with suitable solvents to remove burrs, mill varnish, and cutting oils before assembly.
- N. All pipe threads shall be sealed with Teflon tape pipe sealant applied to the male thread only.

3.02 AGENT:

- A. The fire suppression agent shall be 3M NOVEC 1230 Fire Protection Fluid manufactured by 3M Company, St. Paul, MN or their approved supplier.
- B. Agent shall not contain any Hydrofluorocarbons (HFC).

3.03 GENERAL MATERIALS – ELECTRICAL:

- A. All electrical enclosures, raceways and conduits shall be employed in accordance with applicable codes and intended use and contain only those electrical circuits associated with the fire detection and control system and shall not contain any circuit that is unrelated to the system
- B. Unless specifically provided otherwise in each case, all conductors shall be enclosed in steel conduit, rigid or thin wall as conditions dictate.
- C. Any conduit or raceway exposed to weather or other similar conditions shall be properly sealed and installed to prevent damage. Provisions for draining and/or drying shall be employed.
- D. NEMA rating and/or electrically hazardous classifications shall be observed and any equipment or materials installed must meet or exceed the requirements of service.
- E. Any wiring shall be of the proper size to conduct the circuit current but shall not be smaller than #18 AWG unless otherwise specified for a given purpose. Wire that has scrapes, nicks, gouges or crushed insulation shall not be used. The use of aluminum wire is strictly prohibited.
- F. Splicing of circuits shall be kept to a minimum and are only to be found in an electrical device suited for the purpose.
- G. Wire spliced together shall have the same color insulation.
- H. Wire splices shall be made with appropriate devices suited for the purpose.
- I. All wire terminations shall be made with crimp terminals unless the device at the termination is designed for bare wire terminations.
- J. All electrical circuits shall be numerically tagged with suitable devices at the terminating point and/or splice. All circuit numbers shall correspond with the installation drawings.
- K. The use of colored wires is encouraged but not required unless dictated by state or local authorities.
- L. White-colored wire shall be used exclusively for the identification of the neutral conductor of an alternating current circuit.

- M. Green-colored wire shall be used exclusively for the identification of the earth ground conductor of an AC or DC circuit.

3.04 CONTROL SYSTEMS

- A. All control systems shall be UL listed and FM approved utilizing listed or approved compatible operating devices be capable of the following features:
 - 1. Ground fault indication
 - 2. Supervised detection circuit(s)
 - 3. Supervised alarm circuit(s)
 - 4. Supervised manual pull circuit (if applicable)
 - 5. Supervised primary power circuit
 - 6. Alarm overrides trouble logic
 - 7. Battery standby
 - 8. Front panel indicating lamps (LEDs)
 - 9. Key lock steel enclosure
 - 10. Programmable time delay
 - 11. Programmable detection logic
 - 12. Prioritized trouble logic
 - 13. Microprocessor based logic
 - 14. History buffer

3.05 CONTROL UNIT – AUTOPULSE IQ-318 & IQ-636X-2

- A. The Fire Alarm Control Panel (FACP) shall be an GEM AUTOPULSE IQ-318 or IQ-636X-2 and shall contain a Central Processing Unit (CPU) with integral 3.0 amp of normal operation (6.0 A in alarm) power supply for the IQ-318 or IQ-636X-2 system. The CPU shall communicate with and control the following types of equipment used to make up the system: intelligent detectors, addressable modules, annunciators, and other system controlled devices.
- B. System Capacity:
 - 1. The control unit shall provide up to 318 intelligent/addressable devices per loop. The 636X-2 can add a second SLC loop with up to 318 additional intelligent/addressable devices.
 - 2. The system shall include Form-C alarm, trouble, and supervisory security relays rated at a minimum of 2.0 amps at 30 VDC. It shall also include 4 Class B (NFPA Style Y) programmable notification appliance circuits
 - 3. The control unit shall include a full featured operator interface control and annunciation panel that shall include a backlit liquid crystal display, individual, color coded system status LEDs, and an alphanumeric keypad for the field programming of the control and fire alarm system
- C. System Display: The system shall indicate the status of the following parameters:
 - 1. AC Power: Green LED
 - 2. System Alarm: Red LED
 - 3. Release: Red LED
 - 4. Supervisory: Yellow LED
 - 5. System Trouble: Yellow LED
 - 6. Circuit Trouble: Yellow LED
 - 7. Alarm Silenced: Yellow LED

8. Power Trouble: Yellow LED
- D. System General Operation:
 1. The control unit shall provide the following features:
 - a. Drift compensation to extend detector accuracy over life
 - b. Sensitivity Test, meeting requirements of NFPA 72
 - c. Maintenance Alert to warn of excessive smoke detector dirt or dust accumulation
 - d. System Status Reports to display
 - e. PAS pre-signal, meeting NFPA 72.
 - f. Rapid manual station reporting (under 2 seconds)
 - g. Non-Alarm points for general (non-fire) control
 - h. Periodic Detector Test conducting automatically by software
 - i. Pre-Alarm for advanced fire warning
 - j. Cross Zoning with the capacity of: counting 2 detectors in alarm, 2 software zones in alarm, or 1 smoke detector and 1 thermal detector in alarm
 - k. March time and temporal coding options
 - l. Walk Test with check for 2 detectors set to same address
 - m. Control-By-Time for non-fire operations, with holiday schedules
 - n. Day/Night automatic adjustment of detector sensitivity
 - o. Device Blink Control for sleeping areas
 2. The control unit shall be capable of coding Notification circuits in March Time (120 PPM), temporal (NFPA 72), and California Code.
- E. Central Microprocessor:
 1. The microprocessor unit shall communicate with, monitor, and control all external interfaces with the control panel. It shall include EPROM for system program storage, non-volatile memory for building-specific program storage, and a "watch dog" timer circuit to detect and report microprocessor failure.
 2. The microprocessor unit shall contain and execute all control-by-event programs for specific action to be taken if an alarm condition is detected by the system. Such control-by-event programs shall be held in non-volatile programmable memory and shall not be lost even if system primary and secondary power failures occurs.
 3. The microprocessor unit shall also provide a real-time clock for time annotation of system displays and history file. The time-of-day and data shall not be lost if system primary and secondary power supplies fail. The real time clock may also be used to control non-fire function at programmed time-of-day, day-of-week, and day-of-year.
- F. Display:
 1. The display (KDM-R2) shall provide all the controls and indicators used by the system operator and may also be used to program all system operational parameters.
 2. The display shall include status information and custom alphanumeric labels for all intelligent detectors, addressable modules, and software zones.
 3. The display shall provide 80-characters with life-long LED backlight alphanumeric Liquid Crystal Display (LCD) with QWERTY programming and control keypad.
 4. The display shall provide a touch pad with control capability to command all system functions, entry of any alphabetic or numeric information, and field programming. Two different password levels shall be provided to prevent unauthorized system control or programming.
- G. Signaling Line Circuit (SLC)

1. The SLC interface shall provide power to and communicate with up to 159 intelligent detectors (Ionization, Photoelectric, or Thermal) and 159 intelligent modules (monitor or control) for a system capacity of 318 devices. This shall be accomplished over a single SLC loop and shall be capable of NFPA 72 Style 4, Style 6, or Style 7 wiring. The IQ-636X-2 can add a second SLC loop.
 2. The loop interface board shall receive analog information from all intelligent detectors that shall be processed to determine whether normal, alarm, or trouble conditions exist for each detector. The software shall automatically maintain the detector's desired sensitivity level by adjusting for the effects of environmental factors, including the accumulation of dust in each detector. The analog information shall also be used for automatic detector testing and for the automatic determination of detector maintenance requirements.
 3. The detector software shall meet NFPA 72, requirements and be certified by UL as a calibrated sensitivity test instrument.
 4. The detector software shall allow manual or automatic sensitivity adjustment
- H. Serial Interfaces:
1. An EIA-232(TB12) interface between the Fire Alarm Control Panel (FACP) and UL Listed Electronic Data Processing (EDP) peripherals shall be provided.
 2. The EIA-232(TB12) interface shall allow the use of CRT monitors, and PC compatible computers.
 3. The EIA-232 interface shall include special protocol methods that allow off-site monitoring of the FACP over standard dial-up phone lines. This ancillary capability shall allow remote readout of all status information, including analog values, and shall not interfere with or degrade FACP operations when used. It shall allow remote FACP Acknowledge, Reset, or Signal Silence in this mode. It shall also allow adjustment of detector sensitivity and readout of the history file.
 4. The EIA-485 port for the serial connection of the optional annunciators and remote LCD displays shall be provided.
 5. The EIA-485 interface may be used for network connection to a proprietary receiving unit.
- I. System Control Switch Operation
1. Tone Silence Switch: Activation of the control unit tone silence switch, in response to alarms, troubles, and supervisory conditions, shall silence the local panel piezo electric signal and change the system alarm or trouble LED from flashing mode to steady ON mode. Occurrence of any new alarm or trouble conditions in the system shall cause the control unit to re-sound the local piezo sounder and repeat the alarm or trouble sequences.
 2. Alarm Silence Switch: Activation of the alarm signal silence switch shall cause all alarm notification appliances to return to the normal condition after an alarm condition.
 3. System Reset Switch: Activation of the system reset switch shall cause all electronically-latched initiating circuits, appliances as well as all associated output circuits, to return to their normal condition. Holding system reset down shall perform a LAMP TEST function and will activate the piezo sounder.
 4. Alarm Activate Switch: Operation of the alarm activate switch shall activate both notification circuits and the alarm relay. Alarm activation shall be a latching function.
- J. The control unit shall also include the following functions:
1. All interfaces and associated equipment are to be protected so they will not be affected by voltage surges or line transients consistent with UL standard 864.
 2. Optional plug-in modules shall be provided for NFPA 72, transmitters as well as a digital alarm communicator/transmitter.
 3. The control panel shall have the ability to meet the latest requirements of UL 864 for delayed AC fail reporting

4. An optional module shall provide 6 Form-C relays rated at 3.0 amps. The relays shall track programmable software zones.
- K. Power Supply
1. The power supply shall operate on 120 VAC, 60 Hz, and shall provide all necessary power for the FACP.
 2. It shall provide 3.0 amps of stand-by power and 6.0 amps in alarm for notification appliance power using a switching 24 VDC regulator. A notification expansion power supply shall be available for the demanding requirements of UL 1971 and ADA devices.
 3. It shall provide a battery charger for 24 hours of standby using dual-rate charging techniques for fast battery recharge.
 4. It shall provide a very low frequency sweep, earth detection circuit capable of detecting earth faults on sensitive addressable modules.
 5. It shall be power-limited using Positive Temperature Coefficient (PTC) resistors.
- L. Mechanical Design-Enclosure
1. The control panel shall be housed in a UL listed cabinet suitable for surface or semi-flush mounting. Cabinet and front shall be corrosion protected, given a rust-resistant prime coat, and manufacturer's standard finish.
 2. The door shall provide a key lock and include a glass or other transparent opening for viewing of all indicators.
- M. Batteries
1. Batteries shall be 12 volt, Sealed Lead-Cell type providing 24 VDC (two required)
 2. Batteries shall have sufficient capacity to power the fire alarm system for not less than 24 hours in standby, plus 5 minutes of alarm upon a normal AC power failure.
 3. The batteries are to be completely maintenance free. No liquids are required. Fluid level checks, refilling, spills, and leakage shall not be accepted.
- N. Specific System Operations:
1. Smoke Detector Sensitivity Adjust: Means shall be provided for adjusting the sensitivity of any or all analog intelligent smoke detectors in the system from the system keypad. Sensitivity range shall be within the allowed UL window.
 2. Alarm Verification: Each of the intelligent addressable smoke detectors in the system may be independently selected and enabled to be an alarm verified detector. The alarm verification delay shall be programmable from 5 to 30 seconds and each detector shall be able to be selected for verification. The FACP shall keep a count of the number of times that each detector has entered the verification cycle. These counters may be displayed and reset by the proper operator commands.
 3. Point Disable: Any device in the system may be enabled or Disabled through the system keypad.
 4. Point Read: The system shall be able to display or print the following point status diagnostic functions:
 - a. Device status.
 - b. Device type.
 - c. Custom device label.
 - d. View analog detector values.
 - e. Device zone assignments.
 - f. All program parameters.
 5. System Status Reports: Upon command from a system operator, a status report will

be generated and printed listing all system status.

6. System History Recording and Reporting: The FACP shall contain a history buffer that will be capable of storing up to 800 events. Two hundred alarm-only events, system alarms/troubles/operator actions are also included. Each of these activations will be stored and time-and-date stamped with the actual time of the activation. The contents of the history buffer may be manually reviewed, one event at a time, or printed in its entirety.
7. Although the foreground history buffer may be cleared for user convenience, a background, non-erasable buffer shall be maintained which provides the last 800 system events.
8. The history buffer shall use non-volatile memory. Systems that use volatile memory for history storage are not acceptable.
9. Automatic Detector Maintenance Alert: The FACP shall automatically interrogate each intelligent smoke detector and analyze the detector responses over a period of time.
10. If any intelligent smoke detector in the system responds with a reading that is below or above normal limits, the system will enter the trouble mode and the particular detector will be annunciated on the system display. This feature shall in no way inhibit the receipt of alarm conditions in the system nor shall it require any special hardware, special tools or computer expertise to perform.
11. Pre-Alarm Function: The system shall provide 2 levels of pre-alarm warning to give advance notice of a possible fire situation. Both pre-alarm levels shall be fully field adjustable. The first level shall give an audible indication at the panel. The second level shall give an audible indication and may also activate control relays. The system shall also have the ability to activate local detector sounder bases at the pre-alarm level to assist in avoiding nuisance alarms.
12. Software Zones: The FACP shall provide 99 software zones. All addressable devices may be field programmed to be grouped into these zones for control activation and annunciation purposes
13. Field Wiring Terminal Blocks:
 - a. For ease of service all panel I/O wiring terminal blocks shall be the removable, plug-in type and have sufficient capacity for 18 to 12 AWG wire. Permanently-affixed terminal blocks are not acceptable.

3.06 ADDRESSABLE DEVICES-GENERAL

- A. Addressable devices shall provide an address-setting means using rotary decimal switches.
- B. Addressable devices shall use simple to install and maintain decade (numbered 1 to 15) type address switches. Devices which use a binary address setting method, such as a dip switch, are difficult to install and subject to installation error. This type of device is not an allowable substitute.
- C. Detectors shall be intelligent and addressable, and shall connect with 2 wires to the fire alarm/release control panel signaling line circuits.
- D. Addressable smoke and thermal detectors shall provide dual alarm and power LEDs. Both LEDs shall flash under normal conditions indicating that the detector is operational and in regular communication with the control panel. Both LEDs shall be placed into steady illumination by the control panel indicating that an alarm condition has been detected. If required, the flashing mode operation of the detector LEDs shall be optional through the system field program. An output connection shall also be provided in the base to connect an external remote alarm LED.
- E. Smoke detector sensitivity shall be set through the FACP and shall be adjustable in the field through the field programming of the system. Sensitivity may be automatically adjusted by the panel on a time-of-day basis.

- F. Using software in the FACP, detectors shall automatically compensate for dust accumulation and other slow environmental changes that may affect their performance. The detectors shall be listed by UL as meeting the calibrated sensitivity test requirements of NFPA Standard 72.
- G. The detectors shall be ceiling-mount and shall include a separate twist-lock base with tamper-proof feature. An optional base shall be available with a built-in (local) sounder rated at 85 dBA minimum.
- H. The detectors shall provide a test means whereby they will simulate an alarm condition and report that condition to the control panel. Such a test may be initiated at the detector itself (by activating a magnetic switch) or initiated remotely on command from the control panel.
- I. Detectors shall also store an internal identifying type code that the control panel shall use to identify the type of device (ION, PHOTO, THERMAL).

3.07 PROGRAMMABLE ELECTRIC SOUNDERS

- A. Electronic sounders shall be UL Listed or FM Approved and operate on 24 VDC nominal.
- B. Electronic sounders shall be field programmable without the use of special tools to choose 1 of 8 tones with an output sound level of at least 90 dBA measured at 10 ft (3.0 m) from the device.
- C. Electronic sounders shall be flush or semi-flush mounted as shown on plans.

3.08 VISUAL NOTIFICATION APPLIANCES

- A. Strobe lights shall operate on 24 VDC nominal.
- B. Strobe lights shall meet the requirements of the ADA as defined in UL standard 1971 and shall meet the following criteria:
 - 1. The strobe intensity shall meet the requirements of UL 1971 and devices shall be multi-candela 15 cd – 110cd and higher intensity if required by the plans.
 - 2. The flash rate shall meet the requirements of UL 1971.
 - 3. The appliance shall be placed 80 in.(2.03 m) (to the bottom of the appliance) to 96 in. (2.44 m) (to the top of the appliance) above the finished floor within the space

3.09 AUDIBLE/VISUAL COMBINATION DEVICES

- A. Audible/visual combination devices shall meet the applicable requirements of Section 3.5 listed above for audibility.
- B. Audible/visual combination devices shall meet the requirements of Section 3.6 (listed above) for visibility.

3.10 SMOKE DETECTORS

- A. Smoke detectors shall be 24 VDC and shall be UL Listed and FM approved.
- B. Each detector shall include a visual status indicator, provide remote LED output, and include a built-in test capability.
- C. The sensitivity shall be factory set per UL 268.
- D. The detector cover and screen shall be easily removable for field cleaning.
- E. A special vandal-resistant locking screw shall be provided to lock the head to the base.
- F. The head-to-base connection shall be made by use of bifurcated contacts. Terminal connections to the base shall be of the screw type that are accessible with the base installed on the mounting box.
- G. Where specifically identified on the contract drawings, detector bases shall incorporate a relay with Form C contacts rated at 1 amp at 120 VAC, or 30 VDC for remote LED alarm annunciation or the detector.
- H. Photoelectric-type smoke detector shall be light reflective type and compatible with the AUTOPULSE control system. The detector shall have an LED in its base which is illuminated in a steady-on mode when in alarm and pulse mode when in standby. Reset of the detector shall be performed by the control unit reset switch.

- I. The design of the photoelectric detector compensating circuits shall provide stable operation with regard to minor changes in temperature, humidity and atmospheric conditions.
- J. Two-wire detector module shall be addressable and connect one supervised IDC zone of conventional two-wire smoke detectors or alarming initiating devices (and N.O. dry contact device)
 - 1. The two-wire monitor module shall mount in a 4 in. (102 mm) square, 2 1/8 in. (54 mm) deep electrical box or with an optional surface back box.
 - 2. The IDC zone may be wired for Class A or B (style D or B) operation. An LED shall be provided that shall flash under normal conditions indicating that the monitor module is operational and in regular communication with the control panel.

3.11 HEAT DETECTOR

- A. Heat detectors shall be analog addressable devices rated at 135 °F (57 °C) and have a rate-of-rise element rated at 15 °F (9 °C) per minute. It shall connect via 2 wires to the FACP signaling line circuit. Up to 159 intelligent heat detectors may connect to one SLC loop.
- B. The detectors shall use an electronic sensor to measure thermal conditions caused by a fire and shall, on command from the control panel, send data to the panel representing the analog level of such thermal measurements.
- C. An optional, intelligent heat detector shall be available for applications which do not require a rate-of-rise element.

3.12 ABORT SWITCH

- A. The abort switch shall be used where an investigative delay is desired between detection and actuation of the fire suppression system.
- B. This switch shall be a momentary contact "dead-man" type switch requiring constant pressure to transfer one set of contacts. Clear operating instructions shall be provided at the abort switch.
- C. This switch shall be rated for 28 VDC at 1.1 amp make/break or 6 amp continuous carry.
- D. The terminal connections shall be of the screw type.

3.13 MAINTENANCE LOCK-OUT SWITCH

- A. The maintenance lock-out switch shall be used where it is desired to disable the fire suppression system during routine maintenance.
- B. This switch shall be key operated allowing removal of the key only in "Normal" position. A red indicator lamp shall be included on the switch assembly to be illuminated when in the "Lock-Out" position. The control unit is used to indicate a supervisory condition when in the "Lock-Out" position.
- C. The switch shall include 1 set of normally open and 1 set of normally closed contacts rated at 28 VDC at 1.1 amp make/break or 6 amp continuous carry.
- D. The terminal connections shall be of the screw type.

3.14 MANUAL PULL STATION

- A. Addressable manual pull station shall, on command from the control panel, send data to the panel representing the state of the manual switch. They shall use a key operated test-reset lock and shall be designed so that after actual emergency operation, they cannot be restored to normal use except by the use of a key.
- B. All operated stations shall have a positive, visual indication of operation and utilize a key-type reset.
- C. Manual stations shall be clearly visible operating instructions provided on the cover. The word AGENT shall appear on the front and both sides of the stations.
- D. Stations shall be suitable for surface mounting or semi-flush mounting as shown on the plans, and shall be installed not less than 42 in. (1.1 m), nor more than 48 in. (1.2 m) above the finished floor.
- E. Operation shall require 2 actions

3.15 DRY CONTACT MONITOR MODULE

- A. Addressable monitor modules shall be provided to connect one supervised IDC zone of conventional alarm initiating devices (any N.O. dry contact device) to one of the control panel SLC loops.
- B. The monitor module shall mount in a 4 in. (102 mm) square, 2 1/8 in. (54 mm) deep electrical box.
- C. The IDC zone may be wired for Style D or Style B operation. An LED shall be provided that shall flash under normal conditions indicating that the monitor module is operational and in regular communication with the control panel.
- D. For difficult to reach areas, the monitor module shall be available in a miniature package and shall be no larger than 2-3/4 in. x 1-1/4 in. x 1/2 in. (69.9 mm x 31.8 mm x 12.7 mm). This version need not include Style D or an LED.

3.16 DUCT SMOKE DETECTOR

- A. In-duct smoke detector housing shall accommodate either an intelligent ionization sensor or an intelligent photoelectric sensor, which provides continuous analog monitoring and alarm verification from the panel.
- B. When sufficient smoke is sensed, an alarm signal is initiated at the FACP and appropriate action is taken to change over air handling systems to help prevent the rapid distribution of toxic smoke and fire gases throughout the areas served by the duct system

3.17 CONTROL MODULE

- A. Addressable control modules shall be provided to supervise and control the operation of one conventional Notification Appliance Circuit (NAC) of compatible, 24 VDC powered, polarized audio/visual notification appliances. For fan shutdown and other auxiliary control functions, the control module may be set to operate as a dry contract relay.
- B. The control module shall mount in a standard 4 in. (102 mm) square, 2 1/8 in. (54 mm) deep electrical box, or to a surface mounted back box.
- C. The control module NAC circuit may be wired for Style Z or Style Y (Class A/B) with up to 1 amp of inductive A/V signal, or 2 amps of resistive A/V signal operation, or as a dry contact (Form C) relay. The relay coil shall be magnetically latched to reduce wiring connection requirements and to insure that 100% of all auxiliary relay or NACs may be energized at the same time on the same pair of wires.
- D. Audio/visual power shall be provided by a separate supervised power loop from the main control panel or from a supervised, UL listed remote power supply.
- E. The control module shall provide address-setting means using decimal switches and shall also store an internal identifying code that the control panel shall use to identify the type of device. An LED shall be provided that shall flash under normal conditions indicating that the control module is operational and is in regular communication with the control panel.
- F. A magnetic test switch shall be provided to test the module without opening or shorting its NAC wiring.
- G. The control module shall be suitable for pilot duty applications and rated for a minimum of 0.6 amps at 30 VDC.

3.18 ISOLATOR MODULE

- A. Isolator modules shall be provided to automatically isolate wire-to-wire short circuits on an SLC loop. The isolator module shall limit the number of modules or detectors that may be rendered inoperative by a short circuit fault on the SLC Loop. At least one isolator module shall be provided for each floor or protected zone of the building.
- B. If a wire-to-wire short occurs, the isolator module shall automatically open-circuit (disconnect) the SLC loop. When the short circuit condition is corrected, the isolator module shall automatically reconnect the isolated section.
- C. The isolator module shall not require any address-setting and its operations shall be totally automatic. It shall not be necessary to replace or reset an isolator module after its normal operation.

- D. The isolator module shall mount in a standard 4 in. (102 mm) deep electrical box or in a surface mounted back box. It shall provide a single LED that shall flash to indicate that the isolator is operational and shall illuminate steadily to indicate that a short circuit condition has been detected and isolated.

3.19 SELECTOR SWITCH

- A. The selector switch shall be used where a connected reserve is required.
- B. This switch shall be key operated allowing removal of the key in either the "Main" or "Reserve" position.
- C. This switch shall be rated at 28 VDC @ 1.1 amp make/break or 6 amp continuous carry.
- D. The terminal connections shall be of the screw type.

3.20 WATER FLOW SWITCHES

- A. Flow switches shall be integral, mechanical, non-coded, non-accumulative retard type.
- B. Flow switches shall have an alarm transmission time delay that is conveniently adjustable from 0 to 60 seconds. Initial settings shall be 30 or 45 seconds.
- C. Flow switches shall be located a minimum of 1 ft (0.3 m) from a fitting that changes the direction of the flow and a minimum of 3 ft (0.9 m) from a valve.

3.21 SPRINKLER AND STANDPIPE VALVE SUPERVISORY SWITCHES

- A. Each sprinkler system water supply control valve riser or zone control valve, and each standpipe system riser control valve shall be equipped with a supervisory switch. Standpipe hose valves, and test and drain valves shall not be equipped with supervisory switches.
- B. Each Post Indicator Valve (PIV) or main gate valve shall be equipped with a supervisory switch.
- C. The switch shall be mounted so as not to interfere with the normal operation of the valve and adjusted to operate within 2 revolutions toward the closed position of the valve control, or when the stem has moved no more than one-fifth of the distance from its normal position.
- D. The mechanism shall be contained in a weatherproof aluminum housing that shall provide a 3/4 in. tapped conduit entrance and incorporate the necessary facilities for attachment to the valves.
- E. Switch housing to be finished in red baked enamel.
- F. The entire installed assembly shall be tamper proof and arranged to cause switch operation if the housing cover is removed or if the unit is removed from its mounting.
- G. Valve supervisory switches shall be provided and connected under this section and installed by mechanical contractor

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- B. Flow switches shall have an alarm transmission time delay that is conveniently adjustable from 0 to 60 seconds. Initial settings shall be 30 or 45 seconds.
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- A. Each sprinkler system water supply control valve riser, or zone control valve, and each standpipe system riser control valve shall be equipped with a supervisory switch. Standpipe hose valves, and test and drain valves shall not be equipped with supervisory switches.

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- E. Switch housing to be finished in red baked enamel.
- F. The entire installed assembly shall be tamper proof and arranged to cause switch operation if the housing cover is removed or if the unit is removed from its mounting.
- G. Valve supervisory switches shall be provided and connected under this section and installed by mechanical contractor.

3.24 SERIALY CONNECTED ANNUNCIATOR REQUIREMENTS

- A. The annunciator shall communicate with the fire alarm control panel via an EIA 485 communications loop and shall annunciate all zones in the system. Up to 10 annunciators may be connected to the EIA 485 communications loop.
- B. The annunciator shall need only 4 wires to connect to the FACP.
- C. The annunciator shall provide a red alarm LED per zone, and a yellow trouble LED per zone. The annunciator will also have an "ON-LINE" LED, local piezo sounder, local acknowledge/lamp test switch, and custom zone/function identification labels.
- D. The annunciator switches may be used for system control such as Global Acknowledge, Global Signal Silence, and Global System Reset

3.25 LCD ALPHANUMERIC DISPLAY ANNUNCIATOR

- A. The alphanumeric display annunciator shall be a supervised, remotely located back-lit LCD display containing a minimum of 80 characters for alarm annunciation in clear English text.
- B. The LCD annunciator shall display all alarm and trouble conditions in the system.
- C. The annunciator shall connect to a two-wire EIA 485 interface. The two-wire connection shall be capable of distances of 6,000 ft (1,828.8 m). The signal may be increased in 3,000 ft (914.4 m) increments with an optional repeater. An optional (UL 864 Listed) module shall be available which allows the EIA-485 signal to be transmitted over fiber optics.
- D. The system shall allow a minimum of 4 LCD annunciators. Each LCD shall be capable of the following system functions: Acknowledge, Signal Silence and Reset.

PART 4 – TESTING AND DOCUMENTATION

4.01 SYSTEM INSPECTION AND CHECKOUT

- A. After the system installation has been completed, the entire system shall be checked out, inspected, and functionally tested by qualified, trained personnel, in accordance with the manufacturer's recommended procedures and NFPA standards.
- B. All containers and distribution piping shall be checked for proper mounting and installation.
- C. All electrical wiring shall be tested for proper connection, continuity and resistance to earth.
- D. The complete system shall be functionally tested, in the presence of the owner or his representative, and all functions, including system and equipment interlocks, must be operational at least five days prior to the final acceptance tests.
- E. Each detector shall be tested in accordance with the manufacturer's recommended procedures and test values recorded.

- F. All system and equipment interlocks, such as door release devices, audible and visual devices, equipment shutdowns, local and remote alarms, etc. shall function as required and designed.
- G. Each control panel circuit shall be tested for trouble by inducing a trouble condition into the system.

4.02 TRAINING REQUIREMENTS

- A. Prior to final acceptance, the installing contractor shall provide operational training to each shift of the owner's personnel. Each training session shall include control panel operation, manual and (optional) abort functions, trouble procedures, supervisory procedures, auxiliary functions and emergency procedures.

4.03 OPERATION AND MAINTENANCE

- A. Prior to final acceptance, the installing contractor shall provide four complete operation and maintenance instruction manuals to the owner. All aspects of system operation and maintenance shall be detailed, including piping isometrics, wiring diagrams of all circuits, a written description of the system design, sequence of operation and drawing(s) illustrating control logic and equipment used in the system. Checklists and procedures for emergency situations, troubleshooting techniques, maintenance operations and procedures shall be included in the manual.

4.04 AS-BUILT DRAWINGS

- A. Upon completion of each system, the installing contractor shall provide four copies of system As-built drawings to the owner. The drawings shall show actual installation details including all equipment locations (i.e., control panel(s), agent container(s), detectors, alarms, manual pull station(s), and abort switch(s), etc.), as well as piping and conduit routing details. Show all room or facilities modifications, including door and/or damper installations completed. One copy of reproducible engineering drawings shall be provided reflecting all actual installation details.

4.05 ACCEPTANCE TEST

- A. At the time As-built drawings and maintenance/operations manuals are submitted, the installing contractor shall submit a "Test Plan" describing procedures to be used to test the control system(s). The Test Plan shall include a step-by-step description of all tests to be performed and shall indicate the type and location of test apparatus to be employed. The tests shall demonstrate that the operational and installation requirements of this specification have been met. All tests shall be conducted in the presence of the owner or owner's representative and shall not be conducted until the Test Plan has been approved.
- B. The tests shall demonstrate that the entire control system functions as designed and intended. All circuits shall be tested: automatic actuation and manual actuation, HVAC and power shutdowns, audible and visual alarm devices, and manual override of abort functions. Supervision of all control panel circuits, including AC power and battery power supplies, shall be tested and qualified.
- C. A room pressurization test shall be conducted in each protected space to determine the presence of openings, which would affect the agent concentration levels. The test(s) shall be conducted using the Retrotec Inc. Door Fan system, or equivalent, with integrated computer program. All testing shall be in accordance with NFPA 2001.
- D. If room pressurization testing indicates that openings exist which would result in leaks and/or loss of the extinguishing agent, the installing contractor shall be responsible for coordinating the proper sealing of the protected space(s) by the general contractor or his sub-contractor or agent. The general contractor shall be responsible for adequately sealing all protected space(s) against agent loss or leakage. The installing contractor shall inspect all work to ascertain that the protected space(s) have been adequately and properly sealed. **THE SUPPRESSION SYSTEM INSTALLING CONTRACTOR SHALL BE RESPONSIBLE FOR THE SUCCESS OF THE ROOM PRESSURIZATION TESTS.** If the first room pressurization test is not successful, in accordance with these specifications, the installing contractor shall direct the general contractor to determine, and correct, the cause of the test failure. The installing contractor shall conduct additional room pressurization tests, at no additional cost to the owner, until a successful test is obtained. Copies of successful test results shall be submitted to the owner for his record. Upon acceptance by the owner, the completed system(s) shall be placed into service.

4.06 SYSTEM INSPECTIONS

*GEM® SAPPHIRE® Clean Agent Fire Suppression System with
AUTOPULSE IQ-318/IQ-636X-2 Agent Releasing Control Panel and
Lithium-Ion Risk Prevention System*

- A. During the one-year warranty period, the installing contractor shall provide two inspections of each system installed under this contract. The first inspection shall be at the 6-month interval, and the second inspection at the 12-month interval. Inspections shall be conducted in accordance with the manufacturer's guidelines and the recommendations of NFPA 2001.
- B. Documents certifying satisfactory system(s) inspection shall be submitted to the owner upon completion of each inspection.

4.07 WARRANTY

- A. All GEM system components furnished and installed under this contract shall be warranted against defects in design, materials and workmanship for the full warranty period which is standard with the manufacturer, but in no case less than one (1) year from the date of system acceptance.

Note: The converted metric values in this document are provided for dimensional reference only and do not reflect an actual measurement.

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