Engineering Specifications

SAPPHIRE® FIRE SUPPRESSION SYSTEM WITH AUTOPULSE 542R AGENT RELEASING CONTROL PANEL AND LITHIUM-ION RISK PREVENTION SYSTEM

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GEM® SAPPHIRE® FIRE SUPPRESSION SYSTEM WITH

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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 542R Releasing Panel and the GEM® 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 GEM® 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

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. Activation of any single detector in any detection zone shall:

1. Cause a first-stage alarm.
2. Energize a lamp on the activated detector, and control unit.

Note: The shutdown of electrical equipment will be optional based on requirements of the local AHJ or applicable standards.

B. Activation of a detector on the second zone shall:

1. Transmit an alarm signal to remote monitoring or building alarm panel.
2. Cause a second-stage (pre-discharge) alarm to operate.
3. Operate auxiliary contacts for air conditioning shutdowns and automatic dampers.
4. Initiate a programmable time delay (SAPPHIRE agent release).

C. Upon completion of the time delay the SAPPHIRE system shall:

1. Cause a discharge alarm to be activated.
2. Operate auxiliary contacts for emergency power off of all electrical equipment (excluding lighting and emergency circuits for life safety).
3. Activate visual alarms (strobe) at protected area entrance.
4. Energize control solenoid for SAPPHIRE cylinders releasing gaseous agent into the protected area.Cause a discharge alarm to be activated.

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 Prevention 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.

B. 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.

1. Transmit an alarm signal to remote monitoring or building alarm panel
2. Operate auxiliary contacts for HVAC shutdowns and automatic dampers
3. 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 cylinder releasing gaseous agent into the protected area.

PART 3 – MATERIAL AND EQUIPMENT

3.01 GENERAL REQUIREMENTS: 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 LITHIUM-ION RISK MONITORING CONTROLLER

A. The controller shall be capable of comparing a reference sensor for normal environmental air conditions and a lithium-ion monitoring sensor for presence of lithium-ion off-gas materials.

B. The controller shall be capable of interfacing with the AUTOPULSE Detection system through digital output or MODBUS communication for trouble/fault and alarm signals.

C. The controller shall be capable of interfacing with the lithium-ion battery system, allowing for electrical disconnection of the lithium-ion batteries in the event of a battery cell off-gassing.

D. Each controller shall provide input for 12 monitoring sensors and 3 reference sensors (15 total).

E. The controller shall be capable of operating from 5-24 VDC.

F. The controller shall be capable of connection and expansion by connecting multiple controllers together

3.04 LITHIUM-ION RISK REFVERENCE SENSOR

A. Compact design to allow for mounting near all room openings (doors, ducts, vents, etc.)

B. Shall be capable of operation without calibration.

C. Shall provide signal to controller indicating the condition of “room” atmosphere for use as comparison to local battery rack atmosphere

3.05 LITHIUM-ION MONITORING SENSOR

A. Compact design to allow for mounting near all room openings (doors, ducts, vents, etc.).

B. Shall be capable of operation without calibration.

C. Shall provide signal to controller indicating the condition of atmosphere in close proximity to lithium-ion batteries, for use as comparison to the room atmosphere. (if lithium-ion battery off-gas materials are present)

3.06 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.

3.07 CONTROL SYSTEMS

A. All control systems shall be UL Listed and FM approved and shall be utilized with listed or approved compatible operating devices and shall be capable of the following features:

1. Ground fault indication
2. Supervised detection circuit(s)
3. Supervised alarm circuit(s)
4. Supervised release circuit(s)
5. Supervised manual pull circuit (if applicable)
6. Supervised primary power circuit
7. Alarm overrides trouble logic
8. Battery standby
9. Front panel indicating lamps (LEDs)
10. Key lock steel enclosure
11. Programmable time delay
12. Programmable detection logic
13. Prioritized trouble logic
14. Microprocessor based logic
15. History buffer

3.08 CONTROL UNIT – AUTOPULSE 542R

A. The control unit shall be an AUTOPULSE 542R and shall communicate with and control the following types of equipment used to make up the system: smoke detectors, manual release/abort stations, alarm notification appliances, releasing components and other system controlled devices.

B. System Capacity - The control unit shall include 2 Style Y/Z (Class A/B) notification circuits, 2 releasing circuits, Form- C alarm and trouble contacts, 2 Style B/D (Class A/B) initiating circuits, 1 Style B/D (Class A/B) manual release circuit, and 1 Style B/D (Class A/B) abort circuit.

C. System Display: The system display shall indicate the status of the following system parameters:

AC POWER:	Green LED
SYSTEM ALARM:	Red LED
RELEASE:	Red LED
SUPERVISORY:	Yellow LED
SYSTEM TROUBLE:	Yellow LED
CIRCUIT TROUBLE:	Yellow LED
ALARM SILENCED:	Yellow LED
POWER TROUBLE:	Yellow LED

D. 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 devices, appliances as well as all associated output devices and 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.

E. System Operation:

1. Zone Status LEDs: The alarm, supervisory or trouble LED(s) shall flash until event(s) has been acknowledged. Any subsequent new alarm, supervisory or trouble condition will re-sound all indications and flash new events.

2. Supervisory: A short circuit on this zone shall cause the supervisory LED to flash. The tone silence switch shall silence the piezo causing the supervisory LED to illuminate steady. An open circuit shall report as a zone trouble.

3. Zone Disable: Disable/enable of any initiating circuit shall be accomplished using a special sequence of operation of the 4 control switches. If a zone has been disabled, an alarm shall activate the red zone LED but not the piezo or any output circuit.

4. Last Event Recall: Last event recall shall allow the user to display the previous panel status. Last event recall may be used to diagnose intermittent trouble conditions.

F. Optional modules shall include:

1. Optional module for 10 zone/function relays
2. Optional transmitter module (shall comply with NFPA-72)
3. Optional LED interface module and supervised remote annunciator (2 modules)
4. Optional digital alarm communicator

G. The control unit shall also include the following functions:

1. Output circuits shall be protected against false activations by using a 2-step electronic activation circuit.
2. Battery/earth fault supervision shall be provided.
3. Adjustable delay timer shall be available, 0 to 30 seconds.
4. Cross zone option shall be selectable (2 zones in alarm before release).
5. Three abort functions options shall be selectable: (1) Standard UL method; (2) IRI method; and (3) local AHJ method.
6. A second release circuit may be selected in place of a third notification circuit.
7. A supervised manual release circuit shall be provided which, when activated, shall override the Abort.
8. 7 AH to 18 AH battery options shall be available providing up to 90 hours standby.
9. A watchdog timer to supervise microprocessor shall be provided.

H. Power Supply:

1. The power supply shall be integral to the control unit and provide all control unit and peripheral devices power needs.
2. Input power shall be 120 VAC, 60 Hz. The power supply shall provide an integral battery charger for use with batteries up to 26 AH.
3. The power supply shall also provide 3.66 amperes of regulated 24 VDC power for release circuits and alarm notification devices, four-wire smoke detector power of 24 VDC up to 500 mA, non-resettable power of 24 VDC up to 500 mA.
4. The power supply shall be designed to meet UL and NFPA requirements for power-limited operation on all notification and initiating circuits.
5. Positive-temperature-coefficient thermistors, circuit breakers, fuses, or other over-current protection shall be provided on all power outputs.

I. Mechanical Design:

1. The control unit shall be housed in a cabinet designed for mounting directly to a wall or vertical surface. The back box and door shall be constructed of 0.060 steel with provisions for electrical conduit connections into the sides and top. The door shall provide a key lock and include a glass or other transparent opening for viewing of all indicators. The cabinet shall be approximately 5 in. (127 mm) deep, and 16.5 in. (419 mm) wide, and 19 in. (483 mm) high. An optional trim ring shall be used for flush mounting of the

cabinet. Space shall be provided in the cabinet for up to 18 AH batteries.

J. Batteries:

1. Batteries shall be 12 volt, Lead-Cell type providing 24 VDC (2 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.

3.09 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 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, 120 VAC or 28 VDC for remote LED alarm annunciation of the detector.

H. Photoelectric-type smoke detector shall be the light reflective type and compatible with the AUTOPULSE 542R 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. Photoelectric-type smoke detector with heat detector shall be the light reflective type and compatible with the AUTOPULSE 542R 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.

3.10 INDICATING APPLIANCES:

A. Sounder/Strobe Combination:

1. The sounder/strobe combination shall operate on 24 VDC and shall be approved for use with the listed control system.

2. The sounder/strobe combination shall be polarized and powered from the control unit.

3. The device shall be UL listed or FM approved.

4. The strobe shall be listed to UL Standard 1971 for the Hearing Impaired, approved for Fire Protective Service, and rated at either 15 cd or 75 cd.

5. The sounder shall have 8 tone options selected by means of programming clips.

B. Strobe:

1. The strobe shall operate at 24 VDC and shall be approved for use with the listed control system.

2. The strobe shall be polarized and powered from the control unit.

3. The strobe shall be UL listed or FM approved.

4. The strobe shall be listed to UL Standard 1971 for the Hearing Impaired, approved for Fire Protective Service, and rated at either 15 cd or 75 cd.

C. Sounder:

1. The sounder shall operate at 24 VDC and shall be approved for use with the listed control system.

2. The sounder shall be polarized and powered from the control unit.

3. The device shall be UL listed or FM approved.

4. The sounder shall have 8 tone options selected by means of programming clips.

3.11 MANUAL PULL STATIONS:

A. The manual pull stations shall be provided for the release (electrical) of the fire suppression system in case of an emergency.

B. The device shall be UL listed.

C. Manual stations shall be metal with clearly visible operating instructions provided on the cover. The word FIRE shall appear on the front and both sides of the stations.

D. Operation shall require 2 actions.

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 at 28 VDC @ 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 in either the "Normal" or "Lock- Out" 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 to indicate a trouble 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 @ 1.1 amp make/break or 6 amp continuous carry.

D. The terminal connections shall be of the screw type.

3.14 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.

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

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 If each inspection.

PART 5 - WARRANTY

5.01 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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