



Engineering Specifications

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

**GEM® SAPPHIRE® PLUS FIRE SUPPRESSION SYSTEM WITH
AUTOPULSE 542R AGENT RELEASING CONTROL PANEL
AND LITHIUM-ION RISK PREVENTION SYSTEM
ENGINEERING SPECIFICATION**

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PART 1 – GENERAL

1.1 DESCRIPTION OF WORK

- A. This specification outlines the requirements for a "Total Flood" SAPPHIRE PLUS 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. In areas where multiple hazard zones are protected with a common bank of containers, the use of selector valves shall be used to direct flow of SAPPHIRE agent to the protected zone(s). Quantity of SAPPHIRE PLUS containers shall be based upon the largest zone of protection. Selector valves shall be provided to deliver the proper design concentration for each specific protected zone.
- C. The contract drawings indicate the general requirements of the areas to receive detection and SAPPHIRE PLUS system protection. Contractor shall review all drawings so that all items affecting the operation of the fire detection/SAPPHIRE PLUS fire suppression system (such as equipment location, air diffusers, damper closures, and door openings) are considered in the design of the engineered system.
- D. 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.

1.2 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

1.3 APPROVALS

- A. The fire detection and suppression systems 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.

1.4 QUALITY ASSURANCE

- A. Manufacturer:
 1. The manufacturer of the suppression system hardware components shall be ISO 9001 registered.
 2. The manufacturer's identification mark as applicable shall appear on all major components.
 3. All devices, components and equipment shall be supplied by the same manufacturer.
 4. All devices, components and equipment shall be new, standard products of the manufacturer's latest design and suitable to perform the functions intended.
- B. Installer:

1. The installing contractor shall be an authorized GEM® distributor certified for the design, installation, testing, and maintenance of the SAPPHIRE PLUS Clean Agent Fire Suppression Systems.
2. The installing contractor shall install the SAPPHIRE PLUS Clean Agent Fire Suppression System in strict accordance with the drawings, specifications, and applicable NFPA Standards and code requirements.
3. The installing contractor shall maintain, or have access to, a Clean Agent refill station. The installing contractor shall provide proof of ability to recharge the largest SAPPHIRE PLUS Clean Agent Fire Suppression System within the period of time specified in the contract after a discharge including holding an appropriate quantity of Clean Agent.
4. The installing contractor shall be an authorized GEM® distributor of the SAPPHIRE PLUS Clean Agent Fire Suppression System equipment so that immediate replacement parts are available from inventory.
5. The installing contractor shall show proof of emergency service available 24 hours a day, 7 days a week. Contractor 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 in liability insurance.

1.5 DESIGN DOCUMENTATION

- A. Design and installation of the fire detection/SAPPHIRE PLUS fire suppression system will be in strict accordance with the following guidelines and regulatory agencies:
- NFPA 2001: Standard on Clean Agent Fire Extinguishing Systems
 - NFPA 72: National Fire Alarm and Signaling Code, Latest Edition
 - NFPA 70: National Electrical Code, Latest Edition
 - Americans with Disabilities Act, Title 24, Latest Edition
- B. SAPPHIRE PLUS Suppression System
1. SAPPHIRE PLUS fire suppression system shall be of the engineered, permanently piped, fixed nozzle type with all pertinent components.
 2. All agent storage tank(s) shall be centrally located as vertical, free-standing with wall mounted retaining brackets. Where multiple cylinders are required for the same hazard, a common manifold shall be employed.
 3. On multiple cylinder arrangements (discharging into a common hazard), one cylinder shall be designated as the master cylinder employing the resettable electric actuator, mechanical manual actuator, or both. All remaining cylinders shall be pneumatically operated from the SAPPHIRE agent through the actuation line.
 4. Manifolder cylinders shall employ a flexible discharge hose to facilitate installation and system maintenance. Each cylinder on a manifold shall also include an agent check valve installed to the manifold inlet. An adjustable adapter should also be used to connect the discharge hose to the manifold.
- C. The installing contractor shall submit the following design information and drawings for approval prior to starting installation work on this project:
1. Installation layout drawings having an appropriate scale detailing the location of all agent storage containers, nozzles, pipe runs (including pipe sizes and lengths), electrical control panel(s), and associated devices.
 2. Separate drawing layouts, shall be provided for the mechanical and electrical work in the room, floor and ceiling voids.
 3. Drawing to provide legend identifying all symbols used.
 4. Complete computerized hydraulic flow calculations, from the UL/FM approved software, shall be provided for all SAPPHIRE PLUS Clean Agent Fire Suppression System, and shall include the following as a minimum:

*GEM® SAPPHIRE® PLUS Clean Agent Fire Suppression System with
AUTOPULSE 542R Agent-Releasing Control Panel and
Lithium-Ion Risk Prevention System*

- a) Quantity of agent per nozzle
- b) Nozzle orifice diameters
- c) Pressure at nozzle (psi)
- d) Nozzle body nominal pipe size (inch)
- e) Number and size of cylinders
- f) Total agent
- g) Pipe size per pipe section
- h) Pipe schedule per pipe section
- i) Number, size and type of fitting per pipe section
- j) Actual length per pipe section (feet)
- k) Equivalent length per pipe section (feet)
- l) Discharge time (seconds)

D. 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 panel
 - d) Release devices
 - e) Alarm devices
 - f) Lithium-ion off-gas control modules
 - g) Lithium-ion off-gas monitoring and reference sensors
 - h) Agent storage cylinders
 - i) Mounting brackets
 - j) Discharge nozzles
 - k) Abort stations
 - l) Piping isometrics
 - m) Flow calculations
2. Contractor shall provide warranty information of each component and device used in the system.
3. Contractor shall provide the operation and maintenance procedures 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.
4. Drawings shall indicate locations, installation details, and operational details of all equipment associated with the SAPPHIRE PLUS 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.

5. Contractor shall provide a complete riser diagram with specific detail regarding connections to all monitor and control functions.
6. Contractor shall provide a testing plan that includes means, methods and schedules for interface testing with systems that will be connected via monitor or control modules.
7. Sequence of operation, electrical schematics and connection diagrams shall be provided to completely describe the operation of the SAPPHIRE PLUS system controls.
8. Contractor shall provide flow Calculations per Section 1.5C.4

PART 2 – SYSTEM REQUIREMENTS

2.1 SYSTEM DESCRIPTION AND OPERATION

- A. The system shall be a Total Flood SAPPHIRE PLUS Clean Agent Fire Suppression System supplied by Johnson Controls sold under brands including GEM®, SAPPHIRE, and AUTOPULSE.
- 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, and shall include mechanical and electrical installation, all detection and control equipment, agent storage containers, SAPPHIRE agent, discharge nozzles, pipe and fittings, manual release, delay or abort devices, audible and visual alarms, auxiliary devices and controls, shutdowns, alarm interface, advisory signs, functional checkout and testing, training and all other operations and equipment necessary for a SAPPHIRE PLUS Clean Agent Fire Suppression System.
- D. Contractor shall provide two inspections during the first year of service: Inspections shall be made at 6-month intervals thereafter. It is the joint responsibility of the contractor and system owner to ensure that 6-month inspections are being conducted.
- E. The general contractor shall be responsible for sealing and securing the hazard areas against agent loss and / or leakage during the “hold” period, which is a minimum period of 30 minutes or a time period sufficient to allow for cooling of the lithium-ion batteries and response by trained personnel.
- F. Smoke Detection: The SAPPHIRE PLUS system shall be automatically actuated by either counting zone detection or cross-zoned detection methodology. Smoke sensors / detectors shall utilize photoelectric technology and/or Aspiration Smoke Detectors (ASD) for very early warning smoke detection. Smoke detectors and ASD sample points shall be installed at no more than 250 ft² (23.2 m²) of coverage per detector. When using analog addressable sensors or ASD detectors offering pre-alarm thresholds, further system design consideration is suggested for providing very early warning detection which can offer extended investigation time prior to suppression agent release. In all cases, the compatibility listings of the detectors for use with the control unit shall be observed. The system shall require two detectors in alarm prior to automatic agent release.
- G. Both Photoelectric and ASD type smoke detectors can be combined in the releasing process, using one of following methods:
 1. 1st alarm ASD / 2nd alarm ASD
 2. 1st alarm ASD / 2nd alarm Photoelectric Detector
 3. 1st alarm Photoelectric Detector / 2nd alarm Photoelectric Detector

2.2 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.

2.3 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 when operated shall interrupt the pre-discharge countdown timer for 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 AHJ and FM guidelines.

2.4 LITHIUM-ION OFF-GAS MONITOR INDICATION SEQUENCE OF OPERATION

- A. Notification from monitoring sensor within the Lithium-Ion Risk Prevention system 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 battery 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-gasses 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 air conditioning shutdowns and automatic dampers.
3. Initiate a programmable time delay (SAPPHIRE agent release).

- C. Upon completion of the time-delay sequence, the SAPPHIRE PLUS Clean Agent Fire Suppression 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

Part 3 - MATERIAL AND EQUIPMENT

3.1 GENERAL REQUIREMENTS:

- A. The SAPPHIRE PLUS Clean Agent Fire Suppression System materials and equipment shall be of standard products of a single manufacturer (Johnson Controls) latest design and suitable to perform all intended functions. The name of the manufacturer and serial numbers shall appear on all major components.
- B. All relevant devices and equipment shall be listed by the standardizing agencies (UL and/or FM)
- C. The system design can be modular, central storage, or a combination of both design criteria.
- D. Systems shall be designed in accordance with the manufacturer's guidelines.

3.2 AGENT CONTAINER

- A. The Clean Agent shall be stored in SAPPHIRE PLUS Clean Agent Fire Suppression System storage containers. Containers shall be super-pressurized with dry nitrogen to an operating pressure of 70 bar at 68°F (20°C). Containers shall be of seamless high-strength low alloy steel construction and meeting the requirements of the DOT/ISO.
- B. Containers (master) shall be actuated by either an electrical actuator fitted with an integrated placement indicator switch to show correct fitment of the actuator or by pneumatic means from a nitrogen pilot container. The nitrogen pilot container electrical actuator shall be fitted with a placement indicator switch. Explosive actuation devices shall not be permitted.
- C. All containers shall be centrally located as vertical, free-standing with wall mounted retaining brackets. Where multiple containers are required for the same hazard, a common manifold should be considered.
- D. For systems protecting multi hazards using a central container bank and selector valves, the appropriate full bore selector valve shall be fully opened before the system containers are operated. Selector valves shall be UL Listed and FM Approved, as manufactured by Johnson Controls.
- E. Manifoldded containers shall employ a flexible discharge hose to facilitate installation and system maintenance. Each container on a manifold shall also include an agent check valve installed to the manifold inlet.
- F. Each container shall have a pressure gauge or contacted pressure gauge (optional) to provide visual and electrical supervision of the container pressure. The contacted pressure gauge shall be wired to the control panel to provide audible and visual alarms in the event the container pressure drops below 63 bar for a temperature range of -20 to 122 °F (-20 to 50 °C) or 65 bar for a temperature range of 32 to 149 °F (0 to 65 °C). The pressure gauge shall be color coded to provide an easy, visual indication of container pressure.
- G. Containers shall have a pressure relief device that automatically operates before the internal nominal pressure exceeds 180 bar.

3.3 NOZZLE AND PIPE NETWORK

- A. Discharge nozzles shall be provided within the manufacturer's guidelines to distribute the 3M™ NOVEC™ 1230 agent throughout the protected spaces.
 1. The nozzles shall be designed to provide proper agent quantity and distribution.
 2. Nozzles shall be available in 1/2 in. (15 mm) through 2 in. (50 mm) pipe sizes.
 3. Each size shall be available in 180° and 360° distribution patterns.
 4. Nozzles shall be permanently piped, fixed nozzle type with all pertinent components.

- B. Distribution piping and fittings shall be installed in accordance with the manufacturer's requirements, NFPA 2001/EN 15004 / ISO 14520/ FSSA, and approved piping standards and guidelines. All distribution piping shall be installed by qualified individuals using industry accepted practices and quality procedures. All piping shall be adequately supported and anchored at all directional changes and nozzle locations.
- C. All piping shall be reamed, blown clear and swabbed with suitable solvents to remove burrs, mill varnish, and cutting oils before assembly.
- D. All pipe threads shall be sealed with a suitable pipe sealant applied to the male thread only.

3.4 AGENT:

- A. The fire suppression agent shall be 3M™ NOVEC™ 1230 Fire Protection Fluid, supplied by a 3M™ approved OEM partner.
- B. Agent shall not contain any Hydrofluorocarbons (HFC).

3.5 CAUTION SIGNS:

- A. Entrance signs are required at each entrance to a protected space.
- B. Manual discharge signs are required at each manual release station.

3.6 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.

3.7 LITHIUM-ION REFERENCE 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.

3.8 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)

3.9 ELECTRICAL

- A. All electrical enclosures, raceways and conduits shall be employed in accordance with applicable codes and intended use, 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, 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. All 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.

3.10 CONTROL SYSTEM

- 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 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

3.11 CONTROL UNIT – AUTOPULSE 542R

- A. The control unit shall be an GEM® 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

3.12 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 GEM® 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 GEM® 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.

3.13 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

3.14 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.

3.15 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.

3.16 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.

3.17 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

4.1 SYSTEM INSPECTION AND CHECKOUT

- A. The completed installation shall be inspected by factory authorized and trained personnel. The inspection shall include a full operational test of all components per the equipment manufacturer's recommendations. A system discharge concentration test may also be performed if the required.
- B. Inspection shall be performed in the presence of the owner's representative, architect, or engineer's representative, insuring authority and/or the local AHJ.
- C. All functions, including system and equipment interlocks, must be operational during the acceptance tests.
- D. All containers and distribution piping shall be checked for proper mounting and installation.
- E. All electrical wiring shall be tested for proper connection, continuity and resistance to earth.
- F. All mechanical and electrical components shall be tested according to the manufacturer's recommended procedure to verify system integrity.

- G. Inspection shall include a complete examination of the detection / control system and certification of container pressure. A written report shall be filed with the owner.
- H. As-built drawings (two-copies) shall be provided by the contractor indicating the installation details. All routing of piping, electrical conduit, and accessories shall be noted.
- I. Equipment installation and maintenance manuals shall be provided in addition to the as-built drawings.
- J. Prior to final acceptance, the contractor shall provide operational training in all aspects of the system to the owner's key personnel. Training shall consist of:
 - 1. Control system operations
 - 2. Trouble procedures
 - 3. Abort switches procedures
 - 4. Emergency procedures
 - 5. Safety requirements
 - 6. Demonstration of the system (excluding SAPPHIRE agent release)
- K. The quantity of agent shall reflect the actual design quantity of SAPPHIRE agent.
- L. If a discharge concentration test is required, a prior functional test shall be completed consisting of detection, alarm, release, accessories related to the system, control unit, and a review of the containers, piping, fittings, hangers, and container pressure.
- M. Discharge concentration testing shall be performed under the supervision of the contractor's authorized personnel in the presence of the owner's representative, local authorities, and any other authority.
- N. The contractor shall provide a gas analyzer capable of automatically recording sampling points. Concentration recording shall continue until authorities are satisfied with hazard integrity or until 30 minutes have elapsed.
- O. The sampling point(s) shall be located at a strategic area(s) but no higher than the highest combustible contents.
- P. If the test results indicate that the design concentration was not achieved and/or held, the contractor shall determine the cause of the failure. After determination of the cause, the system shall be recharged and again placed in operation. The contractor shall only be responsible for retest based on equipment design failure.

4.2 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 release and (optional) hold or abort functions, supervisory and emergency procedures.

4.3 OPERATION AND MAINTENANCE

- A. Prior to final acceptance, the installing contractor shall provide 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 and maintenance shall be included in the manual.

4.4 AS-BUILT DRAWINGS

- A. Upon completion of each system, the installing contractor shall provide 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 release unit(s), and abort / hold switch(s), etc.), as well as piping and conduit routing details. Show all room or facility modifications, including door and / or damper installations. One copy of reproducible engineering drawings shall be provided reflecting all actual installation details.

4.5 ACCEPTANCE TEST

- A. 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 a Door Fan Pressurization Equipment System, or equivalent, with integrated computer program. All testing shall be in accordance with EN 15004 / ISO 14520 or NFPA 2001 as applicable.
- B. If room pressurization testing indicates that openings exist which would result in leaks and / or loss of the Clean Agent, the installing contractor shall be responsible for coordinating the proper sealing of the protected space(s) by the general contractor or their 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. If the first door fan pressurization test is not successful 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, until a successful test result is obtained. Copies of successful test results shall be submitted to the owner for their record. Upon acceptance by the owner, the completed system(s) shall be placed into service.

4.6 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 EN 15004 / ISO 14520 or NFPA 2001.
- B. Documents certifying satisfactory system(s) inspection shall be submitted to the owner upon completion of each inspection.

4.7 WARRANTY

- A. Environmental: The manufacturer (Johnson Controls) shall offer a 20-year environmental warranty covering regulations banning or restricting use of the SAPPHIRE PLUS Clean Agent Fire Suppression System due to environmental issues.
- B. Components / System: Limited one year warranty shall be offered for defects in workmanship and material.

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

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