

Engineering Specifications

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

**HYGOOD® INERGEN® FIRE SUPPRESSION SYSTEM WITH
AUTOPULSE 542R AGENT RELEASING CONTROL PANEL
AND HYGOOD® LITHIUM-ION RISK PREVENTION SYSTEM
ENGINEERING SPECIFICATIONS**

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Johnson Controls

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PART 1 – GENERAL

1.01 DESCRIPTION OF WORK:

- A. Design and installation of an engineered fire detection and “Total Flood” INERGEN® Clean Agent Fire Suppressions System with an AUTOPULSE 542R 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. System design is based on the use of Selector valves to direct the flow of INERGEN® agent into the protected zone where indicated on drawings. Quantity of INERGEN® cylinders is to be based on the largest zone of protection. Cylinders shall be provided to offer adequate protection of the largest zone of protection. Selector valves shall be provided to supply discharge of proper design concentration of INERGEN® agent into the protected zone.
- C. Drawings: The contract drawings indicate the general arrangements of the areas to receive detection and INERGEN® system protection. Contractor is to review all drawings so that all items affecting the operation of the fire detection/INERGEN® 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 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 864: Control Units and Accessories for Fire Alarm Systems
 - UL 1638: Visual Signaling Appliances
 - UL 1971: Signaling Devices for Hearing Impaired
 - 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 system complete shall have the following applicable listings and approvals
 - a) Underwriters Laboratories Inc.
 - b) Factory Mutual Global

1.03 REQUIREMENTS:

- A. This installation shall be made in strict accordance with the drawings, specifications and applicable NFPA Standards. All equipment and devices used shall be listed by the standardizing agencies (UL and/or FM).
- B. Design and installation of the fire detection/INERGEN® fire suppression system will be in strict accordance with the following guidelines and regulatory agencies:
 1. NFPA 2001 Clean Agent Fire Extinguishing Systems
 2. NFPA 72 National Fire Alarm Code, Latest Edition
 3. NFPA 70 National Electric Codes, Latest Edition
 4. Americans with Disabilities Act, Title 24, Latest Edition

1.04 GENERAL:

- A. Furnish all engineering design and materials for a complete fire detection/INERGEN® fire suppression system including charged INERGEN® storage cylinders, nozzles, control unit, detectors, wiring, annunciators, alarm and all other equipment necessary for a complete operational system.
- B. Major system components shall be produced by Tyco (no alternatives) and shall be installed by an authorized HYGOOD® Distributor certified for the design, installation, and service of INERGEN® 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 INERGEN® 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. Sequence of operation, electrical schematics and connection diagrams shall be provided to completely describe the operation of the INERGEN® system controls.

- F. Sequence of operation, electrical schematics and connection diagrams shall be provided to completely describe the operation of the INERGEN® system controls.
- G. Flow calculations per section 4.2

PART 2 – PRODUCTS

2.01 SYSTEM DESCRIPTION AND OPERATION:

- A. The equipment manufacturer shall be Johnson Controls sold under brands including HYGOOD® and INERGEN®, AUTOPULSE and LI-ION TAMER.
- B. The system shall be an INERGEN® total flooding, gaseous, clean agent, fire suppression system designed to provide a uniform concentration of INERGEN® agent for the protected area. Agent shall be IG-541.

The amount of INERGEN® agent to be provided shall be the amount required to obtain a uniform (minimum) concentration as required by the HYGOOD® INERGEN® Design, Installation, Operation, and Maintenance Manual for a minimum period of 30 minutes or for a time period to allow for response by trained personnel. Take into consideration such factors as non-closable openings (if any), "rundown" time of fans, time required for dampers to close (and requirements for any additional dampers), and any other feature of the facility that could affect concentration. The design concentration shall meet the requirements of the HYGOOD® INERGEN® Design, Installation, Operation, and Maintenance Manual.

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

- C. Cross-zoned Smoke Detection: The INERGEN® system shall be automatically actuated by cross-zoned detection circuits. Smoke detectors shall be photoelectric with compatibility listings for use with the control unit. Smoke detectors shall be installed at no more than 250 ft² (23.2 m²) of coverage per detector. The system shall require 2 detectors in alarm prior to automatic agent release. 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 should be observed. The system shall require two detectors in alarm prior to automatic agent release.

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

2.02 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 (INERGEN® agent release).
- C. Upon completion of the time delay the INERGEN® 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 INERGEN® cylinders releasing gaseous agent into the protected area.

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 INERGEN® 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 INERGEN® 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 IRI and FM guidelines.

2.04 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, if off gas materials cannot be dispersed by ventilation or dilution in hazard area)
 - 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 (INERGEN® agent release).
- C. Upon completion of the time-delay sequence, the INERGEN® 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 INERGEN® cylinders releasing gaseous agent into the protected area

PART 3 – MATERIAL AND EQUIPMENT

3.01 GENERAL REQUIREMENTS:

- A. Materials and equipment shall be of a single manufacturer: Johnson Controls. Alternates will not be accepted. The name of the manufacturer and the serial numbers shall appear on all major components.

3.02 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.

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- 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.

3.03 CONTROL SYSTEMS – GENERAL:

- A. All control systems shall be UL Listed or 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

3.04 CONTROL UNIT – AUTOPULSE 542R CONTROL SYSTEM:

- A. The control unit shall be an HYGOOD® 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

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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.

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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.

3.05 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 HYGOOD® 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 HYGOOD® 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.

3.06 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.

3.07 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.

3.08 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.

3.09 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.

3.10 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.

3.11 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 12-24 VDC.
- F. The controller shall use less than 10W of power and be capable of connecting to a battery source for backup power of 72 hours in the event building power is lost.
- G. The controller shall be capable of connection and expansion by connecting multiple controllers together.

3.12 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.

3.13 LITHIUM-ION MONITORING SENSOR

- A. Compact design to allow for mounting within or on the frame of lithium-ion battery racks.
- B. Shall be capable of operating in no airflow conditions or while HVAC airflow is present.
- C. Shall be capable of operation without calibration.
- D. 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)

PART 4 – SYSTEM ARRANGEMENT

4.01 INERGEN® FIRE SUPPRESSION SYSTEM:

- A. The INERGEN® fire suppression system shall be of the engineered, permanently piped, fixed nozzle type with all pertinent HYGOOD® components provided.
- B. All agent storage cylinders shall be centrally located as vertical, free-standing cylinders with wall and/or floor mounted retaining brackets. Where multiple cylinders are required for the same

hazard, a common manifold shall be employed. (Cylinders mounted horizontally shall be installed in accordance to the manufacturer's design manual.)

- C. On multiple cylinder arrangements (discharging into a common hazard), one cylinder shall be designated as the pilot cylinder and employ both the restorable electric and mechanical manual actuators. All remaining cylinders shall be pneumatically/back-pressure operated from the INERGEN® agent discharge of the pilot cylinder into the manifold.
- D. Manifoldded 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.
- E. Maximum height distance between cylinder(s) and nozzle(s) can be up to 100 ft (30.48 m) vertical. Horizontal distance is limited to hydraulic calculation.

4.02 FLOW CALCULATIONS:

- A. Computerized verification of flow calculations shall be submitted for each INERGEN® fire suppression system and include the following data as a minimum:
 - 1. Quantity of agent per nozzle
 - 2. Type of nozzle
 - 3. Pressure at nozzle (psi)
 - 4. Nozzle body nominal pipe size (inch)
 - 5. Number and size of cylinders
 - 6. Total agent
 - 7. Pipe size per pipe section
 - 8. Pipe schedule per pipe section
 - 9. Number, size and type of fitting per pipe section
 - 10. Actual length per pipe section (feet)
 - 11. Equivalent length per pipe section (feet)
 - 12. Discharge time (seconds)

PART 5 – EQUIPMENT AND MATERIAL (MECHANICAL)

5.01 PIPE MATERIAL – INERGEN® SYSTEM:

- A. System piping shall be of non-combustible materials having physical and chemical characteristics such that its integrity under stress can be predicted with reliability.
- B. As a minimum, piping materials shall be black steel pipe conforming to ASTM A-53A ERW or ASTM A-106A seamless.
- C. Under no conditions shall ordinary cast iron pipe, steel pipe conforming to ASTM A-120 or ASTM A-53/A-120 be used.
- D. Piping joints shall be suitable for the design conditions and shall be selected with consideration of joint tightness and mechanical strength.
- E. As a minimum, fittings beyond the orifice union/nipple shall be black, 300 lb class fittings conforming to ANSI B-16.3. Ordinary cast iron fittings shall not be used.

- F. The system manifold up to the orifice union nipple must be constructed of Schedule 80 piping and 2000 lb or 3000 lb forged steel fittings. Distribution piping downstream of the orifice union must be a minimum of Schedule 40 with 300 lb fittings.
- G. All piping shall comply with NFPA 2001.
- H. Piping shall be installed in accordance with good commercial practice to the appropriate codes, securely supported with UL Listed hangers and arranged with close attention to the design layout since deviations may alter the design flow performance as calculated.
- I. Piping shall be bracketed within 12 in. (0.3 m) of all discharge nozzles.
- J. All piping shall be reamed, blown clear and swabbed with appropriate solvent to remove mill varnish and cutting oils before assembly.
- K. Multi-outlet fittings other than tees shall not be permitted.
- L. Assembly of all joints shall conform to the appropriate standards. Threaded pipe joints shall utilize Teflon tape applied to the male threads only.

5.02 EXTINGUISHING AGENT:

- A. The agent shall be INERGEN® agent, a registered trademark.
- B. The agent shall be a mixture of three inerting (oxygen diluting) gases: 52% nitrogen, 40% argon, and 8% carbon dioxide.

5.03 INERGEN® STORAGE CYLINDERS:

- A. Cylinder assemblies shall be of steel construction with a standard RED enamel paint finish. Each cylinder shall be equipped with a pressure seat-type valve and gauge. The system shall utilize HYGOOD® CV-98 valve assemblies. When the system's capacity exceeds 40 cylinders, a second pilot valve shall be provided and used for cylinder activation. Each valve shall be constructed of forged brass and shall attach to the cylinder providing a leak-tight seal.
 - 1. For 150 bar cylinders, each valve shall also include a safety pressure relief device, which provides relief at 3000 to 3360 psi (206.8 to 231.7 bar) per CGA test methods. Cylinder charging pressure is 2175 psi at 70 °F (150 bar at 21 °C).
 - 2. For 200 bar cylinders, each valve shall also include a safety pressure relief device, which provides relief at 4000 to 4480 psi (276 to 309 bar) per CGA test methods. Cylinder charging pressure is 2900 psi at 70 °F (200 bar at 21 °C).
- B. First filling of the cylinder assembly shall be by a Tyco manufacturing facility.

5.04 CYLINDER BRACKET:

- A. Each cylinder assembly shall be furnished with a bracket made from welded steel. The bracket shall hold the cylinders in a saddle with a front bracket piece that secures the cylinders. The brackets shall be modular in design to allow added bracketing or stacking of cylinders depending on installation requirements.
- B. Cylinder brackets shall be UL listed and/or FM approved for use with the INERGEN® system.

5.05 VALVE ACTUATORS:

- A. Electric valve actuators shall be of brass construction and stackable design with swivel connections to allow removal of actuators for maintenance or testing.
- B. Operation of actuators shall not require replacement of components. NO ELECTRO-EXPLOSIVE DEVICES may be used to actuate the valve assembly.
- C. Electric actuators shall be the magnetic latch, continuous duty type for 12 VDC operation.
- D. Actuation devices shall be UL listed and/or FM approved for use with the INERGEN® fire suppression system.

5.06 DISCHARGE HOSE/CHECK VALVE:

- A. When manifolding, all cylinder assemblies shall include a flexible discharge hose and check valve for connection to the manifold inlet.
- B. All hose/check valves shall be UL listed and/or FM approved for use with the CV-98 INERGEN® valve as manufactured by Tyco. (Flexible Discharge Bend)

5.07 DISCHARGE NOZZLES:

A. **Standard Discharge Nozzle**

- 1. Discharge nozzles shall be of two-piece construction and sized to provide flow rates in accordance with system design flow calculations.
- 2. A nozzle inlet orifice plate shall be included. The orifice size shall be determined by a computerized UL listed flow calculation program.
- 3. Orifice(s) shall be machined in the nozzle body to provide a horizontal discharge pattern based upon the approved coverage arrangements.
- 4. Nozzles shall be permanently marked with the manufacturer's part number. The nozzles shall be threaded directly to the discharge piping without the use of special adapters.
- 5. Nozzles shall be UL listed as manufactured by Johnson Controls.

B. **Acoustic Damping Discharge Nozzle (Optional for noise sensitive Environments)**

- 1. Acoustic damping discharge nozzles shall be used in installations requiring reduced acoustic footprint, such as data centers. The reduced acoustic footprint limits sensitive electronics from being exposed to high sound levels.
- 2. For acoustic sensitive installations, an acoustic impact evaluation should be performed specific to the hazard area being protected. The report shall include the sound power generated by the suppression system, room parameters and estimated sound pressure level impact on sensitive electronic equipment such as Hard Disc Drives.
- 3. The sound pressure level impact on Hard Disc Drives shall be below 110dbZ across the 1/3 octave sound bands from 500Hz to 10K Hz.
- 4. Discharge nozzles shall be constructed to provide flow rates in accordance with system design flow calculations.
- 5. The nozzles shall be threaded to the discharge piping via an orifice pipe assembly that includes the nozzle inlet orifice plate.

6. The nozzle orifice plate drill size shall be determined by a computerized UL listed flow calculation program.
7. Agent discharge orifice(s) shall be machined in the nozzle body to provide a horizontal discharge pattern based upon the approved coverage arrangements.
8. Sound control mechanisms shall be deployed as an integral element of the Acoustic Nozzles.
9. Nozzles shall be UL listed and the acoustic performance shall be UL verified as manufactured by Johnson Controls.

5.2 ORIFICE UNION/NIPPLE ASSEMBLIES:

- A. An orifice union/nipple shall be included in the manifold to reduce pressure in the downstream pipe network.
- B. Orifice union/nipple assemblies shall be rated at 2000 lb Class minimum.
- C. Orifice union/nipple assemblies shall be permanently marked with the manufacturer's orifice code. The union orifice/nipple shall be threaded directly to the manifold piping without the use of special adapters.
- D. Union orifice/nipple assemblies shall be UL Listed and/or FM Approved for use with the INERGEN® fire suppression system.

5.3 SYSTEM CHECKOUT AND TESTING:

- 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 may also be performed if the AHJ requires one.
- B. Inspection shall be performed in the presence of the owner's representative, architect's or engineer's representative, insuring authority and/or the local AHJ.
- C. All mechanical and electrical components shall be tested according to the manufacturer's recommended procedure to verify system integrity.
- D. Inspection shall include a complete checkout of the detection/control system and certification of cylinder pressure. A written report shall be filed with the owner.
- E. As-built drawings shall be provided by the contractor (2 copies) indicating the installation details. All routing of piping, electrical conduit and accessories shall be noted.
- F. Equipment installation and maintenance manuals shall be provided in addition to the as-built drawings.
- G. Prior to final acceptance, the contractor shall provide operational training in all concepts of the system to the owner's key personnel. Training shall consist of:
 1. Control system operation
 2. Trouble procedures
 3. Abort procedures
 4. Emergency procedures
 5. Safety requirements
 6. Demonstration of the system (excluding INERGEN® agent release)

- H. The quantity of agent shall reflect the actual design quantity of INERGEN® agent.
- I. A functional test shall be completed prior to the concentration test consisting of detection, alarm, release, accessories related to the system, AUTOPULSE 542R control unit, and a review of the cylinders, piping, fittings, hangers, and cylinder pressure.
- J. 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 insuring authority.
- K. INERGEN® system test procedures shall be recommended by the equipment manufacturer and/or the INERGEN® equipment supplier.
- L. 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.
- M. The sampling point(s) shall be located at a strategic area(s) but no higher than the highest combustible contents.
- N. 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.

PART 6 – WARRANTY

6.01 WARRANTY:

- A. **Environmental:** The manufacturer (Tyco) shall offer a 20-year warranty covering regulations banning or restricting use of the INERGEN® agent due to environmental issues.
- B. **Evergreen Discharge:** Replacement cost for the INERGEN® agent shall be covered in a 20-year discharge warranty except for the system commissioning discharge test, regardless of the cause of the fire suppression system discharge.
- C. **Components/System:** Limited one year warranty shall be offered for defects in workmanship and material.

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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