

SECTION 21 22 00

CLEAN AGENT FIRE EXTINGUISHING SYSTEM

PART 1 - GENERAL

1.01 SECTION INCLUDES

- A. Alarm operation description.
- B. Trouble operation description.
- C. Control and supervisory systems.
- D. Fire suppression agent.
- E. Agent storage and distribution components.
- F. Signs and identification.
- G. Pipe fittings, wire, and conduit.

1.02 RELATED SECTIONS

- A. The fire alarm and detection system is specified in Section 28 31 00 - Fire Detection and Alarm System.

1.03 DESCRIPTION

- A. Each room to be protected shall be considered a single zone for fire suppression protection.
- B. The quantity of the agent shall be that necessary to maintain seven percent minimum concentration for at least ten minutes. Such factors as unclosable openings (if any), "rundown" time for fans, time required for dampers to close, and all other features of the facility that could affect concentration shall be considered.
- C. The design discharge time shall be one minute.
- D. Design and operation of the system shall comply at a minimum with the appropriate requirements of NFPA 2001 and the requirements of the nationally recognized testing authorities for which listings or approvals have been obtained.
- E. Fire Protection System: Total flooding of hazard area with fire extinguishing agent, to extinguishing fire.
- F. Locate extinguishing agent supply and back-up supply in each hazard area.
- G. System is fixed installation with equipment designed and installed to provide fire-extinguishing capability for the area as indicated.

1.04 MEASUREMENT AND PAYMENT

- A. General: Clean agent fire suppression system will not be measured separately for payment but will be paid for as part of the Contract lump-sum price for Mechanical Work.

1.05 REFERENCES

- A. California Code of Regulations, Title 24, Part 3, California Electrical Code
- B. California State Fire Marshal (CSFM):
 - 1. Building Materials Listing Program
- C. American Society of Mechanical Engineers (ASME):
 - 1. ASME B16.3 Malleable Iron Threaded Fittings
 - 2. ASME B16.18 Cast Copper Alloy Solder Joint Pressure Fittings
 - 3. ASME B16.22 Wrought Copper and Copper Alloy Solder Joint Pressure Fittings
 - 4. ASME B31.1 Power Piping
 - 5. ASME B40.1 Gages – Pressure Indicating Dial Type – Elastic Element
 - 6. ASME Boiler and Pressure Vessel Code, Section VIII, Division 1 – Rules for Construction of Pressure Vessels.
 - 7. ASME Boiler and Pressure Vessel Code, Section IX – Welding and Brazing Qualifications.
- D. American Society for Testing and Materials (ASTM):
 - 1. ASTM A53 Standard Specification for Pipe, Steel, Black and Hot-Dipped, Zinc Coated, Welded and Seamless
 - 2. ASTM A106 Standard Specification for Seamless Carbon Steel Pipe for High-Temperature Service
 - 3. ASTM A135 Standard Specification for Electric-Resistance-Welded Steel Pipe
 - 4. ASTM A234/A234M Standard Specification for Pipe Fittings of Wrought Carbon Steel and Alloy Steel for Moderate and Elevated Temperatures
 - 5. ASTM B32 Standard Specification for Solder Metal

- 6. ASTM B88 Standard Specification for Seamless Copper Water Tube (ASTM B88M – Standard Specifications for Seamless Copper Water Tube (Metric).

E. American Welding Society (AWS):

- 1. AWS A5.8 Specifications for Filler Metal for Brazing and Braze Welding
- 2. AWS D1.1 Structural Welding Code - Steel

F. National Electrical Manufacturers Association (NEMA):

- 1. NEMA ICS 6 Industrial Control and Systems: Enclosures

G. National Fire Protection Association (NFPA):

- 1. NFPA 70 National Electrical Code
- 2. NFPA 72 National Fire Alarm Code
- 3. NFPA 75 Electronic Computer Rooms
- 4. NFPA 2001 Clean Agent Fire Extinguishing Systems

H. Underwriters Laboratories Inc. (UL):

- 1. UL 393 Indicating Pressure Gages for Fire-Protection Service
- 2. UL 404 Gages, Indicating Pressure, for Compressed Gas Service

1.06 SUBMITTALS

A. General: Refer to Section 01 33 00 - Submittal Procedures, and Section 01 33 23 - Shop Drawings, Product Data, and Samples, for submittal requirements and procedures.

B. Shop Drawings and Data:

- 1. All drawings and calculations shall be prepared in accordance with NFPA 2001. Refer to Article entitled “Quality Assurance” herein for requirement that drawings and calculations be signed and stamped by professional engineer.
- 2. Drawings shall bear stamp of approval of authority having jurisdiction and shall indicate locations, installation details, and operation details of all equipment and piping, control diagram, wiring diagram and sequence of operation associated with the fire suppression system.
- 3. Piping plan view and detail drawings shall be drawn to scale and isometrics dimensioned to show the entire storage and distribution system, the nozzle and detector location, and layout of annunciator final graphics. The detector and nozzle locations shall be coordinated with lighting fixtures, diffusers, ductwork, and other equipment installed in

the protected room. Indicate manual pull station, control panel, and accessory locations and details.

4. Electrical drawings shall indicate the complete sequence of operations of the system, termination diagrams and locations of interfaces with other systems.
 5. Calculations shall be submitted demonstrating that the proposed system can provide the design concentration within the design discharge time. Submit design calculations bearing stamp of approval of authority having jurisdiction.
 6. Calculations shall be submitted showing required battery capacity, verify system pressure, nozzle flow rate, orifice code numbers, piping pressure losses, component flow data and pipe sizes.
 7. Indicate any required construction phasing.
- C. California State Fire Marshal: Shop Drawings of the clean agent fire suppression system shall be submitted to the Engineer for submission to the State Fire Marshal for approval. Include State Fire Marshal listing numbers, as listed in the State Fire Marshal's Building Materials Listing Program, for all components. Shop Drawings require approval of the State Fire Marshal before any installation work may begin.
- D. Certificates of Compliance: Submit such certified test reports for materials and equipment to demonstrate compliance with specification requirements.
- E. Product Data: Material and equipment information shall include manufacturer's catalog cuts and technical data for each of the following components or devices used in the system and shall bear stamp of authority having jurisdiction:
1. Smoke sensors;
 2. Manual discharge switches (pull stations);
 3. Control panel;
 4. Release devices;
 5. Alarm devices;
 6. Storage containers;
 7. Mounting brackets;
 8. Nozzles;
 9. Abort stations; and
 10. Contact monitor modules.
- F. Operation and Maintenance Data: Submit operation and maintenance data for the equipment and system provided in accordance with Section 01 78 23 - Operation and Maintenance Data. Include recommended spare parts list.
- G. Certified Test Reports: Submit certified test reports that indicate successful completion of all tests performed as required by Article 3.04 herein.
- H. Manufacturer: Certify that system meets or exceeds specified requirements and NFPA 2001.

1.07 QUALITY ASSURANCE

A. Qualifications of the System Designer and Installer:

1. The system installer or subcontractor for this work shall possess a valid C-16 California Contractor's License. The fire suppression system shall be designed by an experienced and qualified individual or firm regularly engaged in the design of clean agent fire extinguishing systems. Drawings and calculations shall be signed and sealed by a registered California Professional Engineer.
2. The installer shall maintain a 24-hour, seven-day-a-week telephone number for emergencies. Factory-trained personnel shall be kept on call for emergency service at all times.

B. Identification of Materials and Equipment: Materials and equipment shall be clearly marked or stamped with the manufacturer's name, nameplate data or stamp, rating, and conformance with corresponding standard number, as applicable.

C. Perform work in accordance with NFPA 70 and NFPA 72, applicable UL standards and requirements of applicable codes and ordinance.

D. Indicate manufacturer's name and pressure rating on valve body. Indicate manufacturer, type and size, part number, orifice code or orifice diameter on discharge nozzles. Markings shall be standard and visible after installation.

E. Certified Tests and Listings: Fire protection material and equipment shall be approved or listed by a nationally recognized testing laboratory of fire protection equipment for this application.

F. Equipment and devices of the system shall be of identical type, model and manufacturer as submitted and shall be approved by the California State Fire Marshal.

G. Components of the system, as listed in Article 1.06.E herein, shall be the products of one manufacturer.

H. Equipment shall be new and shall be of the most current design available from the manufacturer.

I. Welding Materials and Procedures: Conform to ASME Section IX.

1.08 DESIGN REQUIREMENTS

A. Provide sufficient amount of fire extinguishing agent liquid to convert into fire extinguishing agent vapor. Consider the following when computing volume:

1. Volume of hazard area.
2. Specific volume of fire extinguishing agent vapor.
3. Additional quantities of fire extinguishing agent required to compensate for openings, pipe losses, and nitrogen dilution.
4. Forced ventilation, fan coast-down time, and damper actuation time.
5. Mechanical smoke control system.

6. Other special conditions affecting extinguishing efficiency.

- B. Interface system with building fire alarm system.
- C. Manufacturer Qualification: Company specializing in manufacturing the products specified in this Section with minimum three years documented experience.
- D. Design system under direct supervision of a California licensed professional engineer experienced in design of this work.

1.09 REGULATORY REQUIREMENTS

- A. Conform to applicable code for system design, fabrication, and installation.
- B. Conform to NFPA 70 and NFPA 72 code for electrical wiring and wiring devices.
- C. Provide certification of inspection approval of fire protection system by authority having jurisdiction.
- D. Products Requiring Electrical Connection: Listed and classified by Underwriters Laboratories Inc., and acceptable to the authority having jurisdiction as suitable for the purpose specified and indicated.

1.10 DELIVERY, STORAGE, AND PROTECTION

- A. Refer to Section 01 60 00 - Product Requirements, for requirements. Transport, handle, store, and protect products.
- B. Accept materials and components on site in shipping containers. Inspect for damage.
- C. Delivery and store equipment in shipping containers with labeling in place. Deliver fire-extinguishing agent in approved containers.

1.11 MAINTENANCE SERVICE

- A. Refer to Section 01 77 00 - Closeout Procedures, for requirements.
- B. Conduct inspections 6 months and 12 months from date of Substantial Completion to verify proper operation of system and to check agent container weight and pressure. Include a thorough check of controls, detection and alarm systems.
- C. Submit documents, certifying satisfactory system conditions. Include manufacturer's certificate of acceptance of Inspector's qualifications.

1.12 SITE CONDITIONS

- A. Inspect surfaces and structures where the system components will be anchored or fastened before the work of this Section begins. Determine that surfaces and structures are capable of supporting the system components and their weight.

- B. Coordinate the installation of the system with the station alarm and detection system and other systems and components, pipes, and conduits, so as to avoid conflicts of space and installation.

PART 2 - PRODUCTS

2.01 ALARM OPERATION DESCRIPTION

- A. Alarm Phase I: One hundred percent smoke density at any sensor shall trigger or activate equipment functions as follows:
 - 1. Annunciate the device status and its location at the system control panel;
 - 2. Cause a pre-alarm audio-visual (horn) to slow modulate within the protected zone;
 - 3. Send an alarm signal via dry contact closure to the station fire alarm control panel provided under Section 28 31 00 - Fire Detection and Alarm System; and
 - 4. Record the event in the system control panel's nonvolatile RAM memory buffer for post event recall and analysis.
 - 5. Shut down air conditioning system and close dampers.

- B. Alarm Phase II: One hundred percent smoke density at any second sensor within the same protected area shall trigger or activate equipment functions as follows:
 - 1. Annunciate the device status and its location at the system control panel;
 - 2. Cause a pre-discharge audio/visual alarm (horn) to fast modulate within the protected zone;
 - 3. Send a pre-discharge signal via dry contact closure to the station fire alarm control panel provided under Section 28 31 00 - Fire Detection and Alarm System;
 - 4. Record the event in the system control panel's nonvolatile RAM memory buffer for post event recall and analysis; and
 - 5. Activate a thirty-second time delay.

- C. Alarm Phase III: Agent Discharge:
 - 1. After the 30-second time delay has expired the initiator shall be activated to release the fire-extinguishing agent.
 - 2. Upon discharge, warning horn/lights shall activate continuously at all entrances to the protected area.
 - 3. Record the event in the system control panel's nonvolatile RAM memory buffer for post event recall and analysis.

- D. Manual Station Operation:

1. Requirements: The system shall be capable of being actuated by manual discharge switches for the protected area. Operation of a manual discharge switch shall cause alarm devices and shutdown functions to operate immediately. Manual stations used to release agents shall require two separate and distinct operations. The manual discharge switch shall override the time delay and abort capabilities of the system. Manual discharge switches shall be provided in the protected area at all of the exits. Each manual station shall be addressable and activation of these devices shall provide custom information at the station fire alarm control panel.
2. Pull Stations: Surface housing fitted with double action control fitted with “push-in” tab and “pull-down” lever that locks in position after releasing spring-loaded contact, for mounting on electrical outlet box.
3. Labeling: Locate engraved label adjacent to each manual pull station indicating area protected, and that actuation will cause discharge of fire extinguishing agent.

2.02 TROUBLE OPERATION DESCRIPTION

- A. Trouble Conditions: The system fire detection system shall provide the following sequence of operation for any trouble condition:
 1. Display a custom message identifying the device in trouble.
 2. Record the event in the system control panel’s nonvolatile RAM memory buffer for post event recall and analysis.
 3. Send a trouble signal via dry contact closure to the station fire alarm control panel provided under Section 28 31 00 - Fire Detection and Alarm System.

2.03 MATERIALS AND EQUIPMENT

- A. General Requirements:
 1. Equipment and accessories furnished hereunder shall be standard components of a specified manufacturer. Catalog numbers and model designations shall indicate design, quality, and type of material as well as required operating characteristics.
 2. Field fabricated equipment not supplied by the manufacturer will not be acceptable unless first approved by the Engineer.
 3. Locks for all cabinets shall be keyed alike.
- B. Control and Supervisory Systems:
 1. System Control Panel: (Red in color)
 - a. The system control panel shall be red in color, and shall process all input signals, sequence the levels of alarms, and provide outputs to the extinguishing agent storage containers. Auxiliary outputs and dry contacts shall be available to shut down fans, activate dampers, contact other agencies, or annunciate to remote devices. The system shall have standby batteries and charger for continuous operation of

detection, alarm, actuation and supervision function to provide a minimum of 24 hours of emergency power. The system control panel shall provide for either a Style "D" or a Style "B" (allowing T-Tapping) as defined in NFPA 72, type wiring and shall utilize initiating devices connected in parallel to provide automatic battery switch-over upon failure of primary power supply.

- b. The system control panel shall utilize parallel agent release modules as a method of discharging the agent. The operation of a discharge signal shall immediately cause the appropriate agent release modules to activate and release agent. The initiator circuit shall be a parallel Style "D" circuit. Any system utilizing series initiators, series solenoids or mechanically activated solenoids is unacceptable. All initiator wiring shall be fully supervised.
2. Central Control Module (CCM): This module shall control, supervise, and continuously monitor the entire system through the use of an industrial grade 16-bit micro controller. This module shall include a backlit liquid crystal display (LCD) with up to 40 alphanumeric characters that provide individual custom messages associated with every addressable device in the system. The CCM shall include touch membrane switches for each of the following:
- a. Location: Display a 40 character custom message associated with the individually addressable devices reporting to the CCM or a manufacturer-specified message for devices (i.e. door holders, air conditioning units) supervised and controlled by the CCM.
 - b. Next Trouble: Displays the chronological sequence of individual addressable devices in trouble reporting to the CCM or a manufacturer-specified message for devices supervised and controlled by the CCM.
 - c. Next Alarm: Displays the chronological sequence of individual addressable devices in alarm reporting to the CCM.
 - d. History Buffer: The CCM shall contain a 256-event nonvolatile history buffer. This history shall be retrieved by downloading the information through an internal RS232 port, and USB port to a personal computer and printer without having to purchase additional software.
 - e. Field Programming: This system shall be fully field programmable and shall not require factory assistance for reconfiguration of any kind.
 - f. Expansion Capability: To allow for future expansions, the central control module shall be capable of connecting a minimum of 1016 individual addresses.
 - g. Approved as alarm and releasing device, with solid-state internal circuitry enclosed in NEMA ICS 6, Type 1 cabinet.
 - h. Provide supervision to NFPA 72, Class A of following circuits for wire break or ground faults:
 - 1) Zone detection loops.

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- 2) Remote manual discharge stations.
- 3) Suppression system solenoid valves.
- 4) Power supply and circuit wiring and fuse.
- 5) Battery interconnecting wires and fuse.
- 6) Alarm in abort mode.
- i. Equip panel with following standard feature:
 - 1) Visual and audible annunciation of trouble or alarm signals.
 - 2) Panel reset switch.
 - 3) Trouble alarm silence switch with ring back feature.
 - 4) Single Zone Detection: Cross zone (optional).
 - 5) Battery test meter and switch.
 - 6) Manual discharge switch.
 - 7) Deadman abort switch.
 - 8) Programmable timers for pre-discharge and discharge, 0-60 second cycle.
 - 9) Isolated relay contactors for external alarm or equipment and ventilation shutdown.
 - 10) Relay contactors for general trouble signal.
 - 11) Relay contactor activated by detector zone board in alarm or trouble mode.
3. Operating Sequence:
 - a. Actuation of one detector in either zone circuit:
 - 1) Illuminate zone indicator.
 - 2) Energize alarm bell.
 - 3) Shut down air-conditioning system and close dampers.
 - 4) Close doors to area.
 - 5) Signal building fire alarm system via dry contact.
 - b. Actuation of second detector on second zone circuit:

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- 1) Illuminate zone indicator.
 - 2) Energize alarm horn.
 - 3) Shut down power to protected equipment
 - 4) Actuate time delay for up to (30) (60) seconds.
 - 5) Release extinguishing agent into protected area.
 - 6) If abort switch is engaged, delay release.
 - 7) Upon abort switch disengagement release extinguishing agent unless system cleared and reset.
 - 8) Signal building fire alarm system via dry contact closure.
- c. Discharge of Extinguishing Agent:
- 1) Sounds alarm bells and horns.
 - 2) Operates strobes.
- d. Temperature Detection:
- 1) Lower Temperature: Illuminate indicator and energize (bell) (horn).
 - 2) Higher Temperature: Shut down power to protected equipment.
4. Manual Discharge Station: Manual discharge stations shall have a dual action release configuration to prevent accidental system discharge. The legend on the front of the station shall read "Agent-Release". These stations shall be located at both emergency fire exits. A contact monitor module will be included with each station to give it a specific address (location) through the CCM.
5. System Abort Switch: The switch shall be a momentary deadman-type, that when depressed, interrupts the automatic sequence of the control system and prevents agent discharge. Each switch shall be permanently labeled "System Abort". These stations shall be located at both emergency fire exits. A contact monitor module shall be included with each switch to give it a specific address (location) through the CCM.
6. Verified Detection Sensors:
- a. The photoelectric sensors shall be spaced and located, in accordance with the manufacturer's specifications and with the guidelines of NFPA 72. In no case shall detector coverage be greater than 250 square feet per detector.
 - b. The system control panel shall provide the command and interrogation signals that confirm an alarm by comparing (with consecutive multiple passes of the "interrogation window") sensor information with stored data on fire conditions. The analog/addressable photoelectric sensor shall provide true linear analog data to the

CCM in order for the CCM to differentiate between higher and lower values of smoke density and to establish a working range of sensitivity levels unique to the particular environment. All adjustments needed for sensor sensitivity to meet ambient conditions must have a minimum of 12 levels of adjustment.

- c. The system shall have the capacity to automatically conduct a weekly functional test of each sensor, that is accomplished by means of a test LED fitted within each sensor. When automatically activated by the control panel this test LED shall produce an infrared signal level directly equivalent to that reflected by a given percentage of smoke entering the chamber. Any sensor not responding to its preset limits shall be automatically readjusted to a programmed level of sensitivity.

7. Alarm Signal Outputs:

- a. Outputs shall be provided from the system control panel for interface with station fire alarm control panel.
- b. Audible/visual alarm horn/strobes: The alarms shall operate on 24-volt polarized DC power and allow for supervision. The alarm unit shall have a minimum sound level of 97 decibels at 10 feet. All strobes including both in the protected room and outside room, shall be capable of 100 candelas.

C. Fire Suppression Agent:

- 1. The agent shall be heptafluoropropane, HFC-227ea. The physical and chemical properties shall conform with the requirements of NFPA 2001.
- 2. The agent shall be stored in containers, super-pressurized with nitrogen to a maximum total pressure level at 70 degrees F of 360 psig. Higher-pressure agents will not be acceptable.
- 3. The agent shall have the following characteristics:
 - a. Ozone depletion potential of zero;
 - b. Atmospheric lifetime less than 50 years; and
 - c. 4-hour LC₅₀ > 788,696 ppm

D. Agent Storage and Distribution Components:

- 1. Agent Storage Containers:
 - a. Standard model and size for ease of replacement and addition. Design, fabricate, certify, and stamp cylinders in accordance with ASME Section VIII.
 - b. The supply area of agent shall be central storage by design. The storage vessels shall be capable of being refilled in the field and checked for liquid level without the aid of scales or other special tools.

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- c. The supply shall be located as indicated, so that proper hydraulic agent distribution is achieved. Agent storage containers shall be floor mounted and shall include bracket assemblies designed to withstand 1000 pounds thrust for 10 seconds. Floor space is limited, therefore, alternatives requiring more floor space will not be considered.
 - d. The storage containers shall be actuated by means of an electronic initiator. Each container shall be actuated individually. Master/slave solenoid configurations will not be considered.
 - e. Identification: Permanent plate, specifying agent, tare and gross weight, pound of fire extinguishing agent, and pressurization level, installed so plate is visible and readable.
 - f. Cylinder valves: Heavy duty forged brass, incorporating safety release pressure operated manual control, solenoid discharge valve, and pressure gage. Provide solenoid pilot valves for each cylinder or bank of cylinders.
 - g. Manifold: Provide for systems with more than one cylinder with rack to secure each cylinder and check valves between each cylinder discharge and manifold.
 - h. The container and valve shall be capable of releasing the agent as fast as possible and shall in no case exceed 10 seconds.
 - i. A nameplate indicating the manufacturer's name and part number, agent fill weight, and total charged weight shall be permanently bonded to each container.
 - j. Safety Release: Equip cylinder with frangible disk safety device.
 - k. The release valve shall accommodate a "straight through" vertical discharge with no directional changes for maximum discharge efficiency and safety. The releasing valve shall contain a "fast-acting" scored, non-fragmenting rupture membrane, which will burst when the pyrotechnic initiator is activated via an electric signal from the control panel.
2. Actuator: Release of the agent shall be accomplished by an electrical signal from the system control panel in conjunction with a specifically designed agent release module. Systems that employ more than one cylinder shall have all electric initiators connected in parallel.
3. Low Pressure Switch:
- a. The agent storage container shall be equipped with a low-pressure switch to indicate a loss of container pressure. A decrease in pressure from 360 psi to 275/272 psi will cause the normally closed contact to open, thereby indicating a trouble condition.
 - b. Low pressure switch shall be monitored by the system control panel and shall provide a specific indication of cylinder low pressure.

4. Liquid Level Indicator: Tanks holding in excess of 60 pounds of agent shall contain a liquid level indicator to monitor vessel contents, in addition to the low-pressure switch.
5. Discharge Nozzles:
 - a. Nozzles shall distribute the agent throughout the protected area. Single nozzle shall not discharge more than 250 pounds of agent.
 - b. The nozzles shall utilize a 180 or 360-degree pattern and shall be designed to direct the discharge of agent parallel to the ceiling, thus minimizing the possibility of disturbance to objects within the room.
 - c. Construction: One-piece chrome plated brass or aluminum nozzle with textured finish with female pipe thread integral on body. Direct discharge parallel to ceiling.
 - d. Identification: Permanently mark nozzles to show equivalent single orifices diameter.

2.04 SIGNS AND IDENTIFICATION

- A. Provide signs and identification as specified in Section 20 40 13 - Identification for Facility Services, and in conformance with NFPA 2001.
- B. Provide signs and identification to each valve required to be identified.
- C. Provide engraved nameplates for all manual discharge stations and abort switch locations to indicate their function. All alarm devices shall have similar identification plates.
- D. Each entrance door shall include a caution placard indicating that the area is being protected by a clean agent fire suppression system.

2.05 PIPE, FITTINGS, WIRE, AND CONDUIT

- A. Pipe and Pipe Fittings:
 1. Pipe and pipefittings shall conform with the requirements of NFPA 2001. Provide pipe with no burst pressure less than 600 psig operating pressure.
 2. The method of joining pipe shall conform with applicable requirements of NFPA 2001.
 3. Hangers and bracketing shall conform with seismic zone 4 requirements.
- B. Wire and Conduit:
 1. Wire: No. 14 awg copper wire conforming with the requirements of Section 26 05 24 - Low and Medium Voltage Wires and Cables, with insulation rating of 300 volts and temperature rating of 105 degrees C. Provide power limited fire protective signaling cables conforming with the California Electrical Code, Articles 725 and 760, Type FPLR.

- a. Unavoidable splices shall be crimp-connected. Wire nuts are not acceptable.
- 2. Conduit: Galvanized rigid steel conduit, fittings, and accessories conforming to the requirements of Section 20 50 13 - Raceways for Facility Services.

PART 3 - EXECUTION

3.01 INSTALLATION

- A. Installation Standards: Comply with applicable requirements of the NFPA 2001 and the California Electrical Code.
- B. System Installation Requirements: The fire suppression system shall be installed by the manufacturer or its authorized representative as indicated and in accordance with the approved Shop Drawings and the manufacturer's installation instructions and recommendations.
- C. Electrical Wiring:
 - 1. Wiring shall be installed in galvanized rigid steel conduit, except that galvanized steel flexible conduit may be used for short runs where necessary for movement of devices.
 - 2. Wiring shall be installed to conform with the requirements of the California Electrical Code, Article 725B for Class 1 Signal Systems, except as otherwise permitted for limited energy circuits, as specified in NFPA 72.
- D. Securely support piping (in accordance with ASME B31.1) with allowance for fire-extinguishing agent thrust forces, and thermal expansion and contraction.
- E. Use grooved mechanical couplings and fasteners only in accessible locations. Roll groove piping only.
- F. Install unions downstream of valves and at equipment or apparatus connections.
- G. Prepare pipe, fittings, supports, and accessories for finish painting, in accordance with Section 09 91 00 - Painting.
- H. Identify in accordance with NFPA 2001 requirements. Refer to Section 20 40 13 - Identification for Facility Services. Place directional arrows and system labels wherever piping changes direction and minimum 20 feet (6 m) on straight runs.
- I. Secure cylinders as indicated on Drawings. (Where manifolded, mount and support by rack as indicated. For each system provide same size cylinders containing equal amounts of liquid).
- J. In rooms with suspended ceiling tiles, clip or retain tiles within 4-foot (1.2 m) radius of the nozzles to prevent lifting during discharge.
- K. Install wiring in accordance with Section 26 05 24 - Low and Medium Voltage Wire and Cables, requirements.
- L. Make final connections between equipment and system wiring under direct supervision of factory trained representative of manufacturer.

- M. Install engraved plastic instruction plate, detailing emergency procedures, at control panel and at each manual discharge and abort switch location. At control panel identify control logic units, contacts, and major circuits with permanent nameplates.
- N. At hazard area walls pack space between pipe, pipe sleeve or surface penetration with mineral fiber with elastomer caulk to depth 1/2 inch (13 mm). Provide escutcheons where exposed piping passes through walls, floors, and ceilings. Seal pipe penetrations of fire separations. Refer to Section 07 90 00 - Joint Protection.
- O. Locate discharge nozzle approximately 6 inches (150 mm) above or below ceiling and 6 inches (150 mm) below raised floors. Avoid interference with other piping and equipment.
- P. Locate remote manual releases at one or more doors to protect area where indicated. Locate deadman abort switch adjacent.
- Q. Locate strobe units at all points of entrance to protected area.
- R. Locate abort station at all points of exit from protected area.
- S. Ream pipe and tube ends. Remove burrs. (Bevel plain end ferrous pipe.) Remove scale and dirt on inside and outside before assembly. Blow out pipe before nozzles or discharge devices are installed.
- T. Route piping in orderly manner, concealed, plumb and parallel to building structure, and maintain gradient. Install piping to conserve building space, and not interfere with use of space and other work.

3.02 PAINTING

- A. Except where indicated otherwise, piping systems shall not be painted. Where pipes are indicated to be painted, prepare pipe in accordance with Section 09 91 00 - Painting. Provide protective covering to keep paint away from the discharge nozzles. Protective covering shall be removed at completion under Section 09 91 00 - Painting.

3.03 IDENTIFICATION

- A. Apply or install signs and identification in accordance with the requirements of Section 20 40 13 - Identification for Facility Services.

3.04 TESTS

- A. System Tests: Tests shall demonstrate that the operation and installation requirements of this specification have been met. Submit certified copies of tests as specified in Article 1.06.G herein.
- B. Functional Tests: Tests shall demonstrate that the entire control system functions as designed. All circuits shall be tested including automatic discharge, manual discharge, and equipment shutdown and alarm devices. In addition, supervision of each circuit shall be tested.

- C. Design Review Test: Take field measurements of the room, and field calculate the amount of clean agent required to reach the design criteria, and match against the contents of the clean agent storage containers.
- D. Pressurization Test: Conduct a door fan test to determine the overall containment capacity of the clean agent protected area, and equivalent leakage area of the room. The calibrated fan unit shall be used to pressurize or depressurize the area with all air conditioning shutdown and dampers closed, and monitor airflow versus pressure data. The results shall be used to calculate a pass or non-pass conclusion. A manufacturer-approved testing unit and program shall be used for this test.
- E. Piping Test Review: Make a field verification of the piping network and match against the drawing flow calculations. All significant variations will require recalculation of the piping system.
 - 1. A distribution piping and valve, prior to nozzle installation pressurization test shall be conducted that requires 150 psi to be held for 10 minutes with no more than 10 percent pressure drop. Inspect joints using soap water solution or halide torch or lamp, replace and retest.
 - 2. A "puff" test using dry nitrogen shall be conducted. Caps shall be placed over all discharge nozzles and adequate pressure shall be supplied to demonstrate that all of the caps will blow off indicating that the pipes are free of obstructions.
 - 3. Upon completion of installation provide final checkout inspection by factory-trained representative of manufacturer to ascertain proper system operation. Leave system in a fully commissioned and automatic readiness state with circuitry energized and supervised.
 - 4. Submit original copies of tests, indicating that factory trained technical representatives of the manufacturer have inspected and tested systems and are satisfied with methods of installation, connections and operations.

3.05 TRAINING AND INSPECTIONS

- A. Training Requirements: Provide complete system operation training of at least four hours for six of the District's maintenance personnel in accordance with Section 01 79 00 - Demonstration and Training.
- B. Fire Suppression System Inspections:
 - 1. Provide two inspections of the system during the one-year warranty period. The first inspection shall be six months after system acceptance and the second after 12 months. Inspections shall include the determination of agent container weight and pressure and that the mechanical systems are in proper working order.
 - 2. Inspections shall also include a complete checkout of the control and alarm system and test, if possible that all interlocking systems are functioning properly.
 - 3. Documents certifying satisfactory system conditions shall be submitted upon completion of each inspection.

END OF SECTION 21 22 00