



SECTION 28 0000 – Division 28 Table of Contents

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28 3500	REFRIGERANT DETECTION AND ALARM



WMU Design Guidelines Instructions: These guidelines are to be used by the Design Professional to inform the design process and outline WMU-specific desires for all University projects. These guidelines have been edited to reflect WMU preferences, and the intent is for the Design Professional to use this information to guide their normal specifications-writing process. Straying from what is indicated in the guidelines is not prohibited, but shall be discussed with WMU during the development of the project.

SECTION 28 3100 – FIRE ALARM SYSTEMS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

- A. Drawings and general provisions of Contract, including General and Supplementary Conditions and other Division 1 Specification Sections, apply to this Section.
- B. Requirements of Section 08710 "Door Hardware" Apply to this Section.
- C. Requirements of the following Division 26 Sections apply to this Section:
 - 1. "Basic Electrical Requirements."
 - 2. "Basic Electrical Materials and Methods."
 - 3. "Raceways and Boxes For Electrical Systems."

1.2 SUMMARY

- A. This Section includes fire alarm systems. It includes requirements for system components including the following:
 - 1. Addressable Manual pull stations.
 - 2. Addressable and Adjustable Smoke Detectors.
 - 3. Addressable and Adjustable Duct Detectors.
 - 4. Addressable Interface Units
 - 5. Visual Alarm Signals.
 - 6. Combination Speaker & Strobe Devices.
 - 7. Door holders, and Detectors.
 - 8. Fire alarm control panel (FACP), with voice evacuation.
 - 9. Fire Alarm Subpanels (FSP).



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10. Remote Annunciator.
11. Emergency power supply.

B. Related Sections: The following Division 15 and 26 Sections contain requirements that relate to this Section:

1. Division 15 Section "Fire Protection System" for water flow, pressure, or tamper switches connected to fire alarm system.
2. Division 15 Section "Pneumatic Control Systems" for duct smoke detectors.
3. Division 15 Section "Electrical Control System" for duct smoke detectors.
4. Division 15 Section "Sequence of Operation" for duct smoke detectors.

1.3 DEFINITIONS

- A. Alarm Initiating Device: A manual station, smoke detector, heat detector, or sprinkler water flow switch.
- B. Alarm Signal: Signifies a state of emergency requiring immediate action. Pertains to signals such as the operation of a manual station and the operation of a sprinkler system flow switch.
- C. Class A Wiring: Circuits arranged and electrically supervised so a single break or single ground fault condition will be indicated by a trouble signal at the FACP and the circuit will continue to be capable of operation for its intended service in the faulted condition no matter where the break or ground fault condition occurs.
- D. Multiplex System: One using signaling method characterized by the simultaneous or sequential transmission, or both, and the reception of multiple signals in a communication channel, including means for positively identifying each signal.
- E. Supervisory Signal: Indicates need for action regarding fire suppression or other protective system.
- F. Trouble Signal: Indicates that a fault, such as an open circuit or ground, has occurred in the system.
- G. Zone: Initiating device or combination of devices connected to a single alarm initiating device circuit.



1.4 SYSTEM DESCRIPTION

- A. General: Zoned, noncoded, addressable, microprocessor-based type system with manual and automatic alarm initiation, analog addressable smoke detectors, and automatic alarm verification for alarms initiated by certain smoke detector zones as indicated.
- B. Signal Transmission: Multiplex signal transmission dedicated to fire alarm service only.
- C. Audible Alarm Indication: By horns and bells for alarm zones indicated and by voice alarm messages and tone signals on loudspeakers for remaining zones.
- D. System connections for alarm initiation and alarm indicating circuits: Class A wiring.
- E. Functional Description: Provide a complete fire alarm and detection system with the following functions and operating features:
 - 1. Priority of Signals: Automatic response functions shall be accomplished by the first zone initiated. Alarm functions resulting from initiation by the first zone shall not be altered by subsequent alarms. An alarm signal shall be the highest priority. Supervisory or trouble signals shall have second-and third-level priority. Signals of a higher level priority shall take precedence over signals of lower priority even though the lower priority condition occurred first. Annunciate all alarm signals regardless of priority or order received.
 - 2. Non-interfering: Provide supervised system so a signal on one does not prevent the receipt of signals from any other device. All zones shall be manually resettable from the FACP after the initiating device or devices have been restored to normal. Systems that require the use of batteries or battery backup for the programming function are not acceptable.
 - 3. Signal Initiation: The manual or automatic operation of an alarm initiating, or supervisory operating device shall cause the affected device to transmit an appropriate signal to the FACP.
 - 4. Transmission to Remote Central Station: Alarm signals shall be automatically routed in a listed and approved manner to a remote station service transmitter using listed and approved equipment. Final connections to the remote station service transmitters will be made under another Contract, and connections to the FACP shall be made under this Contract.
 - 5. Silencing at FACP: Switches shall provide capability for acknowledgment of alarm; supervisory, trouble, and other specified signals at the FACP; and capability to silence the local audible signal and light. Subsequent zone alarms shall cause the audible signal to sound again until silenced in mm by switch operation. Restoration to normal of alarm, supervisory, and trouble conditions shall extinguish the associated visual annunciation and cause the audible signal to sound again until the restoration is acknowledged by switch operation.
 - 6. Power Loss Indication: Sound trouble signal at the FACP upon loss of primary power at the FACP. Provide an indication at the FACP when the system is operating on an alternate power supply.



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7. Power Loss Indication: Sound trouble signal at the FACP upon loss of primary power at the FACP and the remote annunciator. Illuminate the emergency power light at both locations when the system is operating on an alternate power supply.
 8. Annunciation: Annunciate manual or automatic operation of any alarm or supervisory initiating device both on the FACP and on the remote annunciator indicating the location and type of device.
 9. FACP Alphanumeric Display: Alphanumeric LCD display.
 10. General Alarm: A system general alarm includes:
 - a. Indicating the general alarm condition at the FACP and the remote annunciator.
 - b. Identifying the device that is the source of the alarm and its location at the FACP and the remote annunciator.
 - c. Initiating audible and visible alarm signals throughout the building.
 - d. Closing fire and smoke doors normally held open by magnetic door holders.
 - e. Stopping supply and return fans serving zone where alarm initiated.
 - f. Initiating smoke control sequence through a signal to the building automatic temperature control system.
 - g. Unlocking designated doors.
 - h. Initiating transmission of alarm signal to remote central station.
 11. Manual station alarm operation initiates a general alarm.
 12. Water flow alarm switch operation:
 - a. Initiates a general alarm.
 13. Smoke detection initiates a general alarm.
 14. Sprinkler valve tamper switch operation:
 - a. Causes a supervisory audible and visible "valve tamper" signal indication at FACP and annunciator.
 - b. Initiates transmission of supervisory signal to remote central station.
 15. Fire pump power failure, including a dead phase or phase-reversal condition:
 - a. Causes a supervisory audible and visible "fire pump power failure" signal to be indication at FACP and annunciator.
 - b. Initiates transmission of trouble signal to remote central station.
 16. Remote Detector Sensitivity Adjustment: Manipulation of controls at the FACP causes the selection of specific addressable smoke detectors for adjustment, displays of their current status and sensitivity settings, and controls changes in those settings. Provide ability of using the same controls to program repetitive scheduled changes in sensitivity of specific detectors.
- F. Recording of Events:
1. Permissible Signal Time Elapse: The maximum permissible elapsed time between the actuation of any fire alarm or fire detection system alarm initiating device and its indication at the FACP is two seconds.
 2. Independent System Monitoring: Supervise each independent smoke detection system, duct detector, and elevator smoke detection system for both normal operation and trouble.
 3. Circuit Supervision: Indicate circuit faults with both a zone and a trouble signal at the FACP. Provide a distinctive indicating audible tone and (LED) indicating light. The maximum elapsed time between the occurrence of the trouble condition and its indication



at the FACP is 200 seconds.

1.5 SUBMITTALS

- A. General: Submit the following in accordance with Conditions of Contract and Division 1 Specification Sections.
- B. Product data for fire alarm system components including but not limited to dimensioned plans, sections, and elevations showing minimum clearances, installed features and devices, and list of materials.
- C. Wiring diagrams from manufacturer differentiating between manufacturer- installed and field-installed wiring. Include diagrams for equipment and for system with all terminals and interconnections identified. Include drawings indicating components for both field and factory panel wiring.
- D. System operation description including method of operation and supervision of each type of circuit and sequence of operations for all manually and automatically initiated system inputs. Description shall cover this specific project. Manufacturer's standard descriptions for generic systems are not acceptable.
- E. Calculations for battery capacity for both alarm and supervisory modes.
- F. Operation and maintenance data for inclusion in Operating and Maintenance Manual specified in Division 1 Section 01 4200, "Codes and Standards." Operation and maintenance data shall cover each type of product, including all features and operating sequences, both automatic and manual. Provide spare parts data.
- G. Submission to Authority Having Jurisdiction: In addition to routine submission of the above material, make a simultaneous identical submission to the authority having jurisdiction. Include copies of annotated Contract Drawings as required to depict component locations to facilitate review. Upon receipt of comments from the authority, submit a copy of the marked-up submittal for review. Make resubmission's to the authority if required to make clarifications or revisions to obtain approval.

1.6 QUALITY ASSURANCE

- A. Installer Qualifications: Engage an experienced Installer who is a factory-authorized service representative to perform the Work of this Section.



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- B. Compliance with Local Requirements: Comply with the applicable building code, local ordinances, and regulations and the requirements of the authority having jurisdiction.
- C. Electrical Component Standard: Components and installation shall comply with NFPA 70 "National Electrical Code."
- D. NFPA Compliance: Provide fire alarm and detection systems conforming to the requirements of the following publications:
 - 1. NFPA 72A, "Installation, Maintenance, and Use of Local Protective Signaling Systems for Guards Tour, Fire A/arm, and Supervisory Service."
 - 2. NFPA 72E, "Automatic Fire Detectors."
 - 3. NFPA 72F, "Installation, Maintenance, and Use of Emergency Voice/A/arm Communication Systems."
 - 4. NFPA 72G, "Guide for the Installation, Maintenance and Use of Notification Appliances for Protective Signaling Systems."
- E. UL Listing and Labeling: Provide system and components specified in this Section that are listed and labeled by UL.
- F. Single-Source Responsibility: Obtain fire alarm components from a single source who assumes responsibility for compatibility for system components furnished.

1.7 MAINTENANCE SERVICE

- A. Maintenance Service Contract: Provide maintenance of fire alarm systems and equipment for a period of 12 months commencing with Substantial Completion, using factory-authorized service representatives.
 - 1. Basic services: Systematic, routine maintenance visits on a monthly basis at times coordinated with the Owner. In addition, respond to service calls within 24 hours of notification of system trouble. Adjust and replace defective parts and components with original manufacturer's replacement parts, components, and supplies.

PART 2 - PRODUCTS

2.1 MANUFACTURERS



- A. Manufacturers: Subject to compliance with the requirements provide products by the following:
 - 1. Simplex Time Recorder Co.

2.2 MANUAL PULL STATIONS

- A. General: Double action type, fabricated of plastic and finished in red with molded raised letter operating instructions of contrasting color. The stations shall be addressable.

2.3 SMOKE DETECTORS

- A. General: Comply with UL 268, “ Smoke Detectors for Fire Protective Signaling Systems .” Provide the following features:
 - 1. Factory Nameplate: With serial number and type identification.
 - 2. Operating Voltage: 24 – V d.c., nominal.
 - 3. Self – Restoring: Provide detectors that do not require resetting or readjustment after actuation to restore them to normal operation.
 - 4. Plug – in Arrangement: Detector and associated encapsulated electronic components mounted in a module that connects to a fixed base with a twist locking plug connection. The plug connection shall require no springs for secure mounting and contract maintenance. Provide terminals in the fixed base for building wiring.
 - 5. Visual Indicator: Connected to indicate detector has operated.
 - 6. Addressability: Provide detectors with a communication transmitter and receiver having a unique identification and status reporting capability to the FACP.
 - 7. Remote Controllability: Provide detectors individually monitorable at the FACP for calibration, sensitivity, and alarm condition, and have capability of individually adjustable sensitivity from the FACP.

- B. Addressable Photoelectric Smoke Detectors: Include the following features and Characteristics:
 - 1. Detector Sensitivity: Between 0.5 and 3.7 percentage per foot smoke obscuration when tested in accordance with UL 268.
 - 2. Sensor: Infrared detector light source with matching silicon cell receiver.

- C. Addressable Duct Smoke Detector: Photoelectric – type with sampling tube of design Dimensions as recommended by the manufacturer for the specific duct size and Installation conditions where applied. Complete with housing and relay as required for Fan shut down. Provide smoke alarm indicator with LED lamp on a lexan plate with same sensitivity as the area detectors above.



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- D. Addressable Thermal Detector: Rate-compensated/fixed-temperature type with plug – In base and alarm indication lamp. Provide detectors with a communication transmitter and receiver complete having a unique identification, and status-reporting capability to the FACP. 1350F fixed temperature with rate of rise heat detectors and 200°F fixed temperature heat detectors.

2.4 ALARM INDICATING DEVICES

- A. General: Equip alarm indicating devices for mounting as indicated. Provide terminal blocks for system connections.
- B. Addressable Interface units: Unit designed to monitor system component not equipped for multiplex communication with FACP and transmit identification and status to that terminal. Provide units with a communication transmitter and receiver complete having a unique identification and status-reporting capability to the FACP.
- C. Visual Alarm Signals (Fire Alarm Strobes): Strobes shall comply with the Americans with Disabilities Act of 1990 (ADA). To reduce the risk of seizure induced by an individual viewing multiple strobes flashing asynchronously the fire alarm strobes shall be synchronized. The strobes shall flash at the same instant. This shall be accomplished in a UL listed manner.
- D. Combination speaker and strobe enunciators. Strobes shall comply with the American with Disabilities Act of 1990 (ADA). Multitap speaker assembly shall be complete with back box, grill and transformer power tap. Speaker shall have 88 dBA or greater at 10 feet and two watts when driven with a 1000 hertz signal. Speaker tap wattage for the sizing of the amplifiers are indicated on the drawings. Individual speaker taps may need to be adjusted to achieve the specified dB level. After the contractor performs the required tests, he/she shall make the tap adjustments to balance the system without added cost to the University.
- E. Ceiling mounted Fire Alarm Speaker: Speaker shall have multitap power transformer with U.L. fire alarm frequency response of 400-4000 hertz and non-fire alarm response of 125-12,000 hertz. Provide mounting brackets that span the ceiling grid and independently support the speaker assembly. Speaker shall have 88 dBA or greater at 10 feet and two watts when driven with a 1000 hertz signal. Individual speaker taps may need to be adjusted to achieve the specified dB level. After the contractor performs the required tests, he/she shall make the tap adjustments to balance the system without added cost to the University.

2.5 MAGNETIC DOOR HOLDERS

- A. Door Holder/Closer with integral detector: Provide electro-magnetically controlled door holder/closer where indicated on the drawings to restrict the spread of smoke and or fire. Upon removal of power, or when smoke is sensed the closer will automatically close the door from any angle of opening. Connect the fire alarm system so a general alarm will sound when it detects smoke. Adjust closures to owner satisfaction.



2.6 FIRE ALARM CONTROL PANEL (FACP)

A. Fire Alarm Control Panel (FACP):

1. The Main Fire Alarm Control Panel is to be a fully integrated, microprocessor-based Life Safety System. The system shall support Analog/Addressable or traditional hard wire detection methods. Integral to the system shall be an audio evacuation system and multiplex data line technology. Communications shall be possible via RS-485, fiber optic and/or 20mA data lines.
2. Comply with UL 864, 'Control Units for Fire Protective Signaling Systems.'
3. The panel shall be housed in a surface wall mount enclosure. Cabinets to have key locked front door and lexan viewing window. Two keys shall be given to the owner at the time of occupancy.
4. The normal operating mode of the system shall be with the system power supplies connected and no alarms present. In this mode, a "normal" visual display will be shown.
 - a. The normal operating mode of the system shall be with the system power supplies connected and no alarms present. In this mode, a "normal" visual display will be shown.
 - b. When the control panel goes into the alarm condition, the "fire alarm" display shall be shown, the buzzer pulsates, number of messages waiting, type of alarm, alarm zone or device number and the time that the alarm occurred. A second line shall be dedicated to the user specified message that the owner will furnish to the equipment supplier and the equipment supplier will program the system.
 - c. To acknowledge the alarm, the operator shall press the acknowledge button, and the buzzer will silence providing there isn't an additional alarm waiting, if there are additional alarms, acknowledgment of ail alarms is required. To silence audible devices, the operator shall press the alarm silence button, a new alarm shall cause the audible devices to resound. To reset the network the operator shall press the reset button.
 - d. Trouble/supervisory mode: During a trouble condition, a trouble visual indication shall be displayed, and the buzzer shall pulsate. The display shall indicate the zone or device number: the operator shall silence the buzzer by acknowledging all messages.
 - e. During the supervisory condition a supervisory display shall be indicated, and the buzzer shall pulsate. The display shall indicate the type of trouble and the device



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- or zone number. The operator shall silence the buzzer by acknowledging all messages.
- f. The unit shall contain a real time clock, keypad front panel switches for Reset, Alarm and Trouble Silence, Drill/All Call and indication for Normal, Alarm, Supervisory, Trouble and Test/Program.
 - g. Indicating Lights: In addition to the text display, provide individual LED indicating lights for each type of alarm and supervisory device. Provide an LED to indicate trouble. The actuation of any alarm or supervisory signal shall cause the illumination of a zone light, or device light. System trouble shall cause the illumination of all of these lights and also the trouble light. In addition to these LED indicators, provide normal power and emergency power indicating lights. Provide a toggle switch or push-button LED test switch. The test switch shall not require key operation.
 - h. Four recorded voice messages shall be required. The first shall be a slow whoop and will indicate a fire condition. The second is an "all clear" voice annunciation for fire. The third is a severe weather voice recording. The fourth is a severe weather "all clear" voice annunciation. The exact language will be furnished by the University.
5. Provide the following voice system operation:
- a. Provide one-way voice communication and tone generating.
 - b. A central audio control panel shall be provided for the necessary alarm message/ tone generation, main and remote microphone connections, music inputs and mixer/pre-amplifier circuits. Continuous supervision shall be provided. Audio outputs shall have individual gain control.
 - c. A hand held, push-to-talk microphone shall be provided recessed within a protective panel-mounted enclosure. The microphone shall be a dynamic communication type with a frequency range of 200 Hz to 4000 Hz and shall be equipped with a self-winding five foot coiled cable. An LED indicator shall be provided to indicate microphone push-to-talk button has been pressed and speaker circuits are ready for transmission. Microphone shall be supervised from disconnection.
 - d. An audio control switch module shall be furnished to provide manual control of audio functions. These switches and associated LED indicators shall be supervised from disarrangement or failure.
 - e. Audio power amplifiers shall be furnished with self contained filtered 24VDC power supply, transformer and amplifier monitor circuits. Amplifiers shall provide a 25 VRMS output with a frequency response of 120 Hz to 12,000 Hz. Provide a sufficient quantity of amplifiers to operate all system speakers simultaneously at the wattage indicated on the drawings plus 25 percent spare capacity.
 - f. Digitized tones for alarm or auxiliary requirements shall be provided; Tome requirements are: Slow Whoop, wail, march time beep, continuous horn, stutter, chime, coded horn, hi/ho, and steady tones of specified frequency. Tone sequence



shall be determined by the University. Steady tones shall be available in temporal code patters.

- g. A pre-recorded digitized voice message shall be provided for automatic transmission to building occupants during alarm condition.
- h. Message generation shall be software derived with no mechanical interface permitted, system shall be capable of generating custom message of up to four minutes in length.
- i. A self-contained speaker shall provide testing of the message(s) without disturbing the occupants of the facility.
- j. Voice control system shall report trouble and supervisory conditions to the system and the network control panel. These conditions shall be reported by specific type and occurrence; summary indications are not to be utilized.
- k. Equip voice evacuation control panel cabinet with unit heater designed to be activated when control panel enclosure reaches 40 degrees (F). Heater to maintain enclosure temperature at or above 40 degrees (F).

2.7 EMERGENCY POWER SUPPLY

- A. General: Components include battery, charger, and an automatic transfer switch.
- B. Battery: Sealed lead-acid or nickel cadmium type. Provide sufficient capacity to operate the complete alarm system in normal or supervisory (nonalarm) mode for a period of 24 hours. Following this period of operation on battery power, the batteries shall have sufficient capacity to operate all components of the system, including all alarm indicating devices in alarm or supervisory mode for a period of 15 minutes.
 - 1. Magnetic door holders shall not be served by emergency power. Magnetic door holders shall be released on the failure of primary power.
- C. Automatic Transfer Switch: Transfer the load to the battery without loss of signals or status indications in the event of the failure of primary power.
- D. Battery Charger: Solid-state, fully automatic, variable- charging-rate type. Provide for 150 percent of the connected system load while maintaining the batteries at full charge. In the event batteries are fully discharged, the charger shall recharge them fully within four hours. Charger output shall be supervised as part of system power supply supervision.

2.8 FIRE ALARM SUBPANELS (FSP)



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- A. Subpanels shall be of the same type and style of the FACP. They shall communicate all points and alarms individually to the FACP. Subpanels shall have LCD visual display as the FACP as well as a battery and charger system for standalone operation. Subpanels shall operate independently of the FACP, in the case of a communication problem between the units. The panels shall provide voice system operation similar to the FACP.

2.9 WIRE

- A. Line-Voltage and Low-Voltage Circuits: Stranded copper conductors with 600-V rated insulation.
- B. Provide plenum rated cabling if not in EMT conduit.
- C. Use wiring as recommended by fire alarm equipment and supplier.

PART 3 - EXECUTION

3.1 INSTALLATION, GENERAL

- A. Install system in accordance with NFPA Standards referenced in Parts 1 and 2 of this Section.
- B. Fire Alarm Power Supply Disconnect: Paint red and label "FIRE ALARM." Provide with lockable handle or cover.

3.2 EQUIPMENT INSTALLATION

- A. Manual Pull Stations: Unless otherwise indicated mount semi-flush in recessed back boxes with operating handles 48" above finished floor.
- B. Water Flow Detectors and Valve Supervisory Switches: Connect for each sprinkler valve station required to be supervised.
- C. Smoke Detectors: Install detectors indicated to be ceiling mounted not less than 4 inches from a side wall to the near edge. Install detectors located on the wall at least 4 inches but not more than 12 inches below the ceiling. For exposed solid joist construction, mount detectors on the bottoms of the joists. On smooth ceilings, install detectors not over 30 ft. apart in any direction. Install detectors no closer than 5 ft. from air registers.



- D. Audible Alarm Indicating Devices: Install not less than 90 inches above the finished floor nor less than 6 inches below the ceiling. Unless otherwise indicated, install bells and horns on flush mounted back boxes with the device operating mechanism concealed behind a grille. Combine audible and visible alarms at the same location into a single unit.
- E. Visual Alarm Indicating Devices: Install adjacent to each alarm bell or alarm horn. Install not less than 80 inches above the finished floor and at least 6 inches below the ceiling. Fire Alarm Control Panel (FACP): Surface mount with tops of cabinets not more than 6 ft. above the finished floor.

3.3 WIRING INSTALLATION

- A. Wiring Method: Install wiring in metal raceway in accordance with Division 16 Section "Raceways." Conceal raceway except in unfinished spaces and as indicated.
- B. Wiring Within Enclosures: Install conductors parallel with or at right angles to the sides and back of the enclosure. Bundle, lace, and train the conductors to terminal points with no excess. Connect conductors that are terminated, spliced, or interrupted in any enclosure associated with the fire alarm system to terminal blocks. Mark each terminal in accordance with the wiring diagrams of the system. Make all connections with approved crimp-on terminal spade lugs, pressure-type terminal blocks, or plug connectors.
- C. Cable Taps: Use numbered terminal strips in junction, pull or outlet boxes, cabinets, or equipment enclosures where any circuit tap is made.
- D. Alarm Wiring: For the low-voltage portion of the fire alarm system, shall comply with the fire alarm equipment suppliers recommendations.
- E. Color Coding: Color code all fire alarm conductors differently from the normal building power wiring. Provide red color for initiating circuits wiring and a blue color for supervisory circuits. Paint fire alarm system junction boxes and covers red.
- F. Wiring to Central Station Transmitter: Provide a 1-inch conduit between the FACP and the central station transmitter connection as indicated. Provide number of conductors and electrical supervision for connecting wiring as required to suit central-station monitoring function.

3.4 GROUNDING



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- A. Ground equipment and conductor and cable shields. For audio circuits, minimize to the greatest extent possible ground loops, common mode returns, noise pickup, cross talk, and other impairments. Provide 5-ohm ground at main equipment location. Measure, record, and report ground resistance.

3.5 FIELD QUALITY CONTROL

- A. **Manufacturer's Field Services:** Provide services of a factory-authorized service representative to supervise the field assembly and connection of components and the pretesting, testing, and adjustment of the system.
- B. **Pretesting:** Upon completing installation of the system, align, adjust, and balance the system and perform complete pretesting. Determine, through pretesting, the conformance of the system to the requirements of the Drawings and Specifications. Correct deficiencies observed in pretesting. Replace malfunctioning or damaged items with new and retest until satisfactory performance and conditions are achieved. Prepare forms for systematic recording of acceptance test results.
- C. **Final Test Notice:** Provide 10 days' minimum notice in writing when the system is ready for final acceptance testing.
- D. **Minimum System Tests:** Test the system in accordance with the procedures outlined in NFPA 72H, Chapters 2 and 4 and NFPA 72E, Chapter 8. Minimum required tests are as follows:
 - 1. Verify the absence of unwanted voltages between circuit conductors and ground.
 - 2. Megger test all conductors other than those intentionally and permanently grounded with electronic components disconnected. Test for resistance to ground. Report readings less than 1- megohm for evaluation.
 - 3. Test all conductors for short circuits utilizing an insulation testing device.
 - 4. With each circuit pair, short circuit at the far end of the circuit and measure the circuit resistance with an ohmmeter. Record the circuit resistance of each circuit on the record drawings.
 - 5. Verify the control unit is in the normal condition as detailed in the manufacturer's operating and maintenance manual.
 - 6. Test initiating and indicating circuits for proper signal transmission under open circuit conditions. One connection each should be opened at not less than 10 percent of the initiating and indicating devices. Proper signal transmission in accordance with class of wiring used shall be observed.
 - 7. Test each initiating and indicating device for alarm operating and proper response at the control unit. Test smoke detectors with actual products of combustion.
 - 8. Test the system for all specified functions in accordance with the manufacturer's operating and maintenance manual. Systematically initiate specified functional performance items at each station including making all possible alarm and monitoring initiations and using all communications options. For each item, observe related performance at all devices required to be affected by the item under all system sequences. Observe indicating lights, displays, signal tones, and annunciator indications.



Observe all voice audio for routing, clarity, quality, freedom from noise and distortion, and proper volume level.

9. Test both primary power and secondary power. Verify, by test, the secondary power system is capable of operating the system for the period and in the manner specified.

E. Alarm Notification Appliances:

1. Audible: Measure sound pressure level with sound level meter meeting ANSI S-1.4a, Sound Level Meters, Type 2 requirements. Measure and record levels throughout protected area. Submit one copy of the test results to engineer and one to the owner. Verify voice clarity.
2. Visible: Test in accordance with the manufacturer's instructions. Verify device locations are per approved layout and confirm that no floor plan changes affect the approved layout.

F. Multiplex Systems:

1. Verify communication between sending and receiving units under both normal and standby power.
2. Verify communication between sending and receiving units under open circuit and short-circuit trouble conditions.
3. Verify communications between sending and receiving units in all directions when multiple communication pathways are provided.
4. Verify all system functions and features in accordance with manufacturer's instructions.
5. Provide two EPROM system reprogrammings after shop drawing approval without added charge to the owner.
6. Retesting: Rectify deficiencies indicated by tests and completely retest work affected by such deficiencies at Contractor's expense. Verify by the system test that the total system meets the Specifications and complies with applicable standards.
7. Report of Tests and Inspections: Provide a written record of inspections, tests, and detailed test results in the form of a test log. Submit log upon the satisfactory completion of tests to Owner and Architect/Engineer.

3.6 COMMISSIONING

- A. Provide the services of a factory-authorized service representative to demonstrate and train Owner's maintenance personnel as specified below.



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1. Train Owner's maintenance personnel in the procedures and schedules involved in operating, troubleshooting, servicing, and preventive maintaining of the system. Provide a minimum of 8 hours training.
2. Schedule training with the Owner at least seven days in advance.
3. Occupancy Adjustments: When requested within one year of date of Substantial Completion, provide on-site assistance in adjusting sound levels and adjusting controls to suit actual occupied conditions. Provide up to three visits to the site for this purpose.

END OF SECTION 28 3100



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SECTION 28 3500 - REFRIGERANT DETECTION AND ALARM

PART 1 - GENERAL

1.1 SUMMARY

- A. This Section includes refrigerant monitors and notification appliances.
- B. This Section includes refrigerant monitors, **[and]**notification appliances**[, and SCBA]**.

1.2 DEFINITIONS

- A. CMOS: Complementary metal-oxide semiconductor.
- B. LCD: Liquid-crystal display.
- C. LED: Light-emitting diode.
- D. MOS: Metal-oxide semiconductor.
- E. NDIR: Non-dispersive infrared.
- F. PIR: Photoacoustic infrared.
- G. **[SCBA]**: Self-contained breathing apparatus.

1.3 ACTION SUBMITTALS

- A. Product Data:
 - 1. For each type of refrigerant monitor, include refrigerant sensing range in ppm, temperature and humidity range, alarm outputs, display range, furnished specialties, installation requirements, and electric power requirement.
 - 2. For **[SCBA]**, include mounting details, service requirements, and compliance with authorized Federal agency.
- B. Shop Drawings:
 - 1. Air-Sampling Tubing: Size, routing, and termination including elevation above finished floor.
 - 2. Wiring Diagrams: Power, signal, and control wiring.



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1.4 INFORMATIONAL SUBMITTALS

- A. Coordination Drawings: Include machinery-room layout showing location of monitoring devices and air-sampling tubing with filter/inlet locations in relation to refrigerant equipment.
- B. Product Certificates: For monitoring devices and **[SCBA]**, signed by product manufacturer.
- C. Field quality-control test reports.

1.5 CLOSEOUT SUBMITTALS

- A. Operation and maintenance data.

1.6 MAINTENANCE MATERIAL SUBMITTALS

- A. Furnish extra materials described below that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.
 - 1. One calibration kit including clean air calibration gas bottle for zero calibration and specific refrigerant calibration gas for span calibration, minimum 58-L capacity, pressure regulator, and tubing.

1.7 COORDINATION

- A. Coordinate refrigerant detection and alarm system with refrigeration equipment supplier for compatibility.

PART 2 - PRODUCTS

DESIGNER NOTE: The Consultant shall coordinate the specific detection technology with the refrigerants being monitored.

2.1 **[CMOS] [MOS]** REFRIGERANT MONITOR

- A. Available Manufacturers: Subject to compliance with requirements, manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
 - 1. Chillgard Refrigerant Monitors; MSA; Instrument Division.
 - 2. Genesis International Inc.
 - 3. Toxalert, Inc.
- B. Description: Sensor shall be factory tested, calibrated, and certified to continuously measure and display the specific gas concentration and shall be capable of indicating, alarming, **[shutting down fuel-fired equipment,**]and automatically activating ventilation system.
- C. ASHRAE: Monitoring system shall comply with ASHRAE 15.



D. Performance:

1. Refrigerant to Be Monitored: **[R-22] [R-134a] [R-407C] [R-410A]**.
2. Range: 0 to 1000 ppm.
3. Minimum Detectability: 50 ppm.
4. Accuracy: Maximum 10 percent of full scale.
5. Repeatability: Maximum plus or minus 2 percent of full scale.
6. Response: Maximum 150 seconds for 90 percent of full scale, and 20-second step change.
7. Detection Level Set Points:
 - a. Detection Level 1: **[50] <Insert value>** ppm.
 - b. Detection Level 2: **[250] <Insert value>** ppm.
8. Operating Temperature: 32 to 104 deg F.
9. Relative Humidity: 20 to 95 percent, noncondensing over the operating temperature range.
10. Site Elevation: Maximum **[6560 feet]** <Insert elevation>.

E. Input/Output Features:

1. Maximum Power Input: 120-V ac, 60 Hz, 75 W.
2. Number of Sensor/Transmitter Points: **[One] [Four] <Insert number>**.
3. Alarm Relays: Minimum 3 relays at a minimum of 5-A resistive load each.
4. Alarm Set Points: Displayed and adjustable through keypad on front of meter.
5. Alarm Silence Switch: Mount in the front panel of the monitor to stop audible and visual notification appliances, but alarm LED remains illuminated.
6. Alarm Manual Reset: Momentary-contact push button in the front panel of the monitor stops audible and visual notification appliances, extinguishes alarm LED, and returns monitor to detection mode at current detection levels.
7. Display: Alphanumeric LCD, LED indicating lights for each detection level; acknowledge switch and test switch mounted on front panel; alarm status LEDs and service fault/trouble LEDs.
8. Audible Output: Minimum 75 dB at 10 feet.
9. Visible Output: Strobe light.
10. Analog Output: 0- to 10-V dc into 2k ohms, or 4- to 20-mA into 1k ohms.
11. Serial Output: RS-232 or RS-485[**compatible with HVAC controls**].
12. Enclosure: NEMA 250, **[Type 1] [Type 12] <Insert type>**, with locking quarter-turn latch and key.

2.2 NDIR REFRIGERANT MONITOR

- A. Available Manufacturers: Subject to compliance with requirements, manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
1. Bacharach, Inc.
 2. Genesis International Inc.
- B. Description: Sensor shall be factory tested, calibrated, and certified to continuously measure and display the specific gas concentration and shall be capable of indicating, alarming, shutting down fuel-fired equipment, and automatically activating ventilation system.



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- C. ASHRAE: Monitoring system shall comply with ASHRAE 15.
- D. Performance:
1. Refrigerant to Be Monitored: **[R-22] [R-123] [R-134a] [R-407C] [R-410A]**.
 2. Refrigerant to Be Monitored: As required by furnished chiller.
 3. Range: 0 to 1000 ppm.
 4. Sensitivity:
 - a. Minimum Detectability: 10 ppm.
 - b. Accuracy: 0 to 100 ppm; plus or minus 10 ppm. 100 to 1000 ppm; plus or minus 10 percent of reading.
 - c. Repeatability: Plus or minus 1 percent of full scale.
 - d. Response: Maximum 10 seconds per sample.
 - e. Detection Level Set Points:
 - 1) Detection Level 1: 10 ppm.
 - 2) Detection Level 2: 50 ppm.
 - 3) Detection Level 1: **[1] <Insert value>** ppm.
 - 4) Detection **[Level 2] [Level 1]: [10] [50] <Insert value>** ppm.
 - 5) Detection **[Level 3] [Level 2]: [50] [250] <Insert value>** ppm.
 5. Sensitivity:
 - a. Minimum Detectability: 20 ppm.
 - b. Minimum Detectability: **[20] <Insert value>** ppm.
 - c. Accuracy: 0 to 100 ppm; plus or minus 20 ppm, 100 to 1000 ppm; plus or minus 5 percent of reading.
 - d. Repeatability: Plus or minus 1 percent of full scale.
 - e. Response: 50 percent of a step change in 60 seconds.
 - f. Detection Level Set Points:
 - 1) Detection Level 1: 50 ppm.
 - 2) Detection Level 2: 250 ppm.
 - 3) Detection Level 1: **[20] <Insert value>** ppm.
 - 4) Detection **[Level 2] [Level 1]: [50] <Insert value>** ppm.
 - 5) Detection **[Level 3] [Level 2]: [250] <Insert value>** ppm.
 6. Operating Temperature: 32 to 104 deg F.
 7. Relative Humidity: 20 to 95 percent, noncondensing over the operating temperature range. Compensate sensor for relative humidity.
 8. Site Elevation: Maximum **[6560 feet] <Insert elevation>**.
- E. Input/Output Features:
1. Maximum Power Input: 120-V ac, 60 Hz, 75 W.
 2. Number of Air-Sampling Points: As required.
 3. Number of Air-Sampling Points: **[One] [Four] [Eight] [16] <Insert number>**.
 4. Air-Sampling Point Inlet Filter: 0.10-micron filter element for each sampling point.
 5. Air-Sampling Point Analog Output: 0- to 10-V dc into 2k ohms, or 4- to 20-mA into 1k ohms matched to sensor output.
 1. Alarm Relays: Minimum 3 relays at a minimum of 5-A resistive load each.
 2. Alarm Relays: Minimum **[3] [4]** relays at a minimum of 5-A resistive load each.



3. Alarm Set Points: Displayed on front of meter and adjustable through keypad on front of meter.
4. Alarm Acknowledge Switch: Mount in the front panel of the monitor to stop audible and visual notification appliances, but alarm LED remains illuminated.
5. Alarm Manual Reset: Momentary-contact push button in the front panel of the monitor stops audible and visual notification appliances, extinguishes alarm LED, and returns monitor to detection mode at current detection levels.
6. Display: Alphanumeric LCD, LED indicating lights for each detection level; acknowledge switch and test switch mounted on front panel; alarm status LEDs and service fault LEDs.
7. Audible Output: Minimum 75 dB at 10 feet.
8. Visible Output: Strobe light.
9. Sensor Analog Output: 0- to 10-V dc into 2k ohms, or 4- to 20-mA into 1k ohms.
10. Serial Output: RS-232 or RS-485 compatible with HVAC controls.
1. Enclosure: NEMA 250, Type 1, with locking quarter-turn latch and key.
2. Enclosure: NEMA 250, [Type 1] [Type 12] <Insert type>, with locking quarter-turn latch and key.

2.3 PIR REFRIGERANT MONITOR

2.4 MONITOR ALARM SEQUENCE

- A. Detection Level 1: Notify HVAC control workstation of detection in the refrigeration equipment room on a rise or fall of refrigerant concentration to this level. Start ventilation system at low speed to allow occupancy by maintenance technicians to identify leaks. Cycle blue strobe lights.
- B. Detection Level 1: Notify the HVAC control workstation of the detection in the refrigeration equipment room on a rise or fall of refrigerant concentration to this level. Run ventilation system on high speed due to a rise in concentration to this level, and return ventilation system to low speed on a reduction in concentration below this level. Operate the ventilation system for a minimum of five minutes. Cycle amber strobe lights.
- C. Detection Level 1: Notify the HVAC control workstation of the detection in the refrigeration equipment room on a rise or fall of refrigerant concentration to this level. Run ventilation system at high speed on a rise in concentration to this level, and change to low speed on a reduction in concentration below this level. Operate the ventilation system at high speed for a minimum of five minutes. Cycle amber strobe lights.
- D. Detection Level 2: Notify the HVAC control workstation of the detection in the refrigeration equipment room on a rise or fall of refrigerant concentration to this level. Sound alarm horns and cycle red strobe lights inside and outside refrigeration equipment room. Terminate operation of any combustion-process equipment located in the refrigeration equipment room. Provide manual reset for this detection level.
- E. Detection Level 2: Notify the HVAC control workstation of the detection in the refrigeration equipment room on a rise or fall of refrigerant concentration to this level. Sound alarm horns and cycle red strobe lights inside and outside refrigeration equipment room. Terminate operation of any combustion-process equipment located in the refrigeration equipment room. Provide manual reset for this detection level.



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- F. Sensor Fault/Trouble: Notify HVAC control workstation of fault/trouble detection in monitor.

2.5 NOTIFICATION APPLIANCES

- A. Horns: Comply with UL 464; electric-vibrating-polarized type, listed by a qualified testing agency with provision for housing the operating mechanism behind a grille. Horns shall produce a sound-pressure level of 90 dBA, measured 10 feet from the horn.
- B. Visible Alarm Devices: Comply with UL 1971; three color xenon strobe lights, with clear or nominal white polycarbonate lens mounted on an aluminum faceplate. The words "REFRIGERANT DETECTION" printed in minimum 1/2-inch- high letters on the lens.
- C. Visible Alarm Devices: Comply with UL 1971; three color xenon strobe lights, with clear or nominal white polycarbonate lens mounted on an aluminum faceplate. The words "REFRIGERANT DETECTION" printed in minimum 1/2-inch- high letters on the lens. Rated light output is [75] [110] <Insert number> candela.

2.6 AIR-SAMPLING TUBING

- A. Annealed-Temper Copper Tubing: ASTM B 88, Type L.
- B. Polyethylene Tubing: ASTM D 2737, flame-retardant, nonmetallic tubing rated for ambient temperature range of 10 to 150 deg F.

2.7 SCBA

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - 1. MSA; Safety Products Division.
 - 2. Scott Health & Safety; a division of Tyco Safety Products.
 - 3. Survivair
- B. Description: Open-circuit, pressure-demand, compressed-air SCBA; includes completely assembled, portable, self-contained devices designed for application in hazardous breathing environment. Tested and certified by the National Institute for Occupational Safety and Health and the Mine Safety and Health Administration according to 42 CFR 84, Subpart H.
- C. Face Piece: Silicon, EPDM, or nitrile rubber, one-size-fits-all with double-sealing edge, stainless-steel speaking diaphragm and lens retainer, five adjustable straps to hold face piece to head (two straps on each side and one on top), exhalation valve in mask, close-fitting nose piece to ensure no CO₂ buildup, and perspiration drain to avoid skin irritation and prevent lens fogging.
- D. Backplate: Ergonomically designed of glass fiber, aluminum, or thermoset plastic.
- E. Harness and Carrier Assembly: Large triangular back pad, with backplate and adjustable waist and shoulders straps. Modular design, detachable components, easy to clean and maintain.



Shoulder straps are padded with flame-resistant material, reinforced with stainless-steel cable, and attached with T-nuts, washers, and screws.

- F. Air Cylinder, Regulator, and Pressure Gages: [30] [45] [60]-minute, low-pressure 2216-psig, carbon-fiber composite, fiberglass composite, or all- aluminum cylinders fitted with quick-fill assembly for refilling and air transfer. Two-stage regulator, and gage with end of service time whistle signal.
- G. Wall-Mounted Case: Watertight, high visibility orange or yellow, corrosion-resistant, tough, lockable plastic case.

PART 3 - EXECUTION

3.1 INSTALLATION

- A. Comply with ASHRAE 15.
- B. Comply with ASHRAE 15[**and ASHRAE 147**].
- C. Install air-sampling inlets, or diffusion type monitors in pits, tunnels, or trenches in machinery room that are accessible to personnel.
- D. Floor mount diffusion-type monitor, sensor/transmitters, or air-sampling inlets on slotted channel frame 12 to 18 inches above the floor in a location near the refrigerant source or between the refrigerant source and the ventilation duct inlet.
- E. Wall mount air-sampling multiple-point monitors with top of unit 60 inches above finished floor.
- F. Run air-sampling tubing from monitor to air-sampling points, in size as required by monitor manufacturer. Install tubing with maximum unsupported length of 36 inches, for tubing exposed to view. Terminate air-sampling tubing at sampling points with filter recommended by monitor manufacturer.
- G. Install air-sampling tubing with sufficient slack and flexible connections to allow for vibration of tubing and movement of equipment.
- H. Purge air-sampling tubing with dry, oil-free compressed air before connecting to monitor.
- I. Number-code or color-code air-sampling tubing for future identification and service of air-sampling multiple-point monitors.
- J. Extend air-sampling tubing from exhaust part of multiple-point monitors to outside.
- K. Extend air-sampling tubing from outdoors to outdoor inlet connection of NDIR monitors. Terminate air-sampling tubing at outdoor inlet location with filter recommended by monitor manufacturer.
- L. Install warning signs, labels, and nameplates to identify detection devices according to Division 23 Section "Identification for HVAC Piping and Equipment."



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- M. Install warning signs, labels, and nameplates to identify detection devices **[and SCBA]** according to Division 23 Section "Identification for HVAC Piping and Equipment."
- N. Place warning signs inside and outside each door to the refrigeration equipment room. Sample wording: "AUDIBLE AND VISUAL ALARM SOUNDING INDICATES REFRIGERANT DETECTION - ENTRY REQUIRES SCBA."
- O. Audible Alarm-Indicating Devices: Install at each entry door to refrigeration equipment room, and position not less than 6 inches below the ceiling. Install horns on flush-mounted back boxes with the device-operating mechanism concealed behind a grille.
- P. Visible Alarm-Indicating Devices: Install adjacent to each alarm horn at each entry door to refrigeration equipment room, and position at least 6 inches below the ceiling.
- Q. Mount primary**[and secondary backup]** **[SCBA]** on wall outside **[each]** interior door to refrigeration equipment room.

3.2 FIELD QUALITY CONTROL

- A. Testing Agency: **[Owner will engage]** **[Engage]** a qualified testing agency to perform tests and inspections and prepare test reports.
- B. Manufacturer's Field Service: Engage a factory-authorized service representative to inspect, test, and adjust components, assemblies, and equipment installations, including connections. Report results in writing.
- C. Perform tests and inspections and prepare test reports.
 - 1. Manufacturer's Field Service: Engage a factory-authorized service representative to inspect components, assemblies, and equipment installations, including connections, and to assist in testing.
- D. Tests and Inspections:
 - 1. Inspect field-assembled components, equipment installation, and electrical connections for compliance with requirements.
 - 2. Test and adjust controls and safeties.
 - 3. Test Reports: Prepare a written report to record the following:
 - a. Test procedures used.
 - b. Test results that comply with requirements.
 - c. Test results that do not comply with requirements and corrective action taken to achieve compliance with requirements.
- E. Repair or replace malfunctioning units and retest as specified above.



3.3 DEMONSTRATION

- A. Engage a factory-authorized service representative to train Owner's maintenance personnel to adjust, operate, and maintain refrigerant detection devices. Refer to requirements in Division 01 Section "Demonstration and Training."
- B. Engage a factory-authorized service representative to train Owner's maintenance personnel to adjust, operate, and maintain refrigerant detection devices [and SCBA]equipment. Refer to requirements in Division 01 Section "Demonstration and Training."
- C. SCBA Training: Provide an instructional video that details operating procedures of equipment.

END OF SECTION **28 3500**