

## SECTION 28 31 10 - FIRE ALARM AND DETECTION SYSTEM MODIFICATION

## PART 1 - GENERAL

## 1.1 DESCRIPTION

- A. The provisions of the General Requirements, Supplementary Requirements, and Division 1 apply to the work specified in this Division.
- B. The requirements of this section apply to the Fire Alarm and Detection System.
- C. Provide all items, articles, materials, equipment, operations and/or methods listed, mentioned, shown and/or scheduled on the Drawings and/or in these Specifications, include all design, labor, supervision, services, permits, fees, and incidentals necessary and required to provide a complete and operable facility with a complete system required by applicable codes. Provide all labor, materials, and perform such other services necessary and reasonable incidental to the design and installation of a monitoring system, required by the Authority Having Jurisdiction.
- D. The fire alarm and detection system is a deferred submittal system, to be completed by the contractor in permit ready form. The fire alarm devices shown on the plans and described in the specification are provided to assist the contractor in their design process to provide a code compliant (at minimum) system.

## 1.2 QUALITY ASSURANCE

- A. The system shall comply with the applicable provisions of the National Fire Protection Association Standard Number 70, "National Electrical Code," Standard Number 72, "National Fire Alarm Code," and meet all requirements of the local authorities having jurisdiction.
- B. All equipment and devices shall be listed by the Underwriters Laboratories, Inc., or approved by Factory Mutual Laboratories and shall meet Federal Specification Standards.
- C. All material and equipment shall be the latest standard products of a manufacturer regularly engaged in the manufacture of the products.
- D. Equipment shall be represented by a firm with a local service organization that is factory trained and certified. The name of this organization shall be furnished to the Owner.

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- E. The contractor shall include in the basic bid all installation charges rendered by the supplier.
- F. The installing company shall employ NICET (minimum Level II Fire Alarm Technology) technicians on site to guide the final checkout and to ensure the system's integrity.
- G. The fire alarm and detection system is a deferred submittal system, to be completed by the contractor in permit ready form. The fire alarm devices shown on the plans and described in the specification are provided to assist the contractor in their design process to provide a code compliant (at minimum) system.
- H. Design Requirements
1. Comply with latest adopted edition of the NFPA 72.
  2. Design, layout, and install a system based on the occupancy type and occupant load provided by the architect.
  3. Provide all necessary design and materials for connection to:
    - a. Elevator
    - b. Sprinkler
    - c. Duct Detectors
    - d. Kitchen Hood
- I. Code required fire alarm and detection, per occupancy and occupant load, will be the minimum of the design. Items requested above and beyond code
- J. Revisions to the Contractor's design, required by the Governing Agency/Authority Having Jurisdiction, shall be at the Contractor's expense.
- K. The system and all associated operations shall be in accordance with the following:
1. National Fire Protection Association (NFPA)
  2. National Electric Code (NEC)
  3. Americans with Disabilities Act (ADA)
  4. Institute of Electrical and Electronics Engineers (IEEE)
  5. Underwriters Laboratories (UL)
  6. International Building Code (IBC)
  7. International Fire Code (IFC)
  8. Occupational Safety and Health Administration (OSHA)
  9. Authorities Having Jurisdiction (AHJ)
  10. Oregon Structural Specialty Code (OSSC)

### 1.3 SYSTEM OPERATION

- A. The fire alarm system shall be fully functional at the close of the project. The fire alarm will be checked to verify the entire system, both modified and existing, is fully operational.
- B. System operation will remain as it was prior to system modification. The new components shall operate exactly as the system was originally designed, unless otherwise requested by the AHJ.

### 1.4 SUBMITTALS

#### A. General:

- 1. Two copies of all submittals shall be submitted to the Architect/Engineer for review.
- 2. All references to manufacturer's model numbers and other pertinent information herein is intended to establish minimum standards of performance, function and quality. Equivalent compatible UL-listed equipment from other manufacturers may be substituted for the specified equipment as long as the minimum standards are met.
- 3. All substitute equipment proposed as equal to the equipment specified herein, shall meet or exceed the following standards. For equipment other than that specified, the contractor shall supply proof that such substitute equipment equals or exceeds the features, functions, performance, and quality of the specified equipment.

#### B. Shop Drawings:

- 1. Sufficient information, clearly presented, shall be included to determine compliance with drawings and specifications.
- 2. Include manufacturer's name(s), model numbers, ratings, power requirements, equipment layout, device arrangement, complete wiring point-to-point diagrams, and conduit layouts.
- 3. Show annunciator layout, configurations, and terminations.

#### C. Manuals:

- 1. Submit simultaneously with the shop drawings, complete operating and maintenance manuals listing the manufacturer's name(s), including technical data sheets.
- 2. Wiring diagrams shall indicate internal wiring for each device and the interconnections between the items of equipment.
- 3. Provide a clear and concise description of operation that gives, in detail, the information required to properly operate the equipment and system.

4. Approvals will be based on complete submissions of manuals together with shop drawings.

D. Software Modifications:

1. Provide the services of a factory trained and authorized technician to perform all system software installations, modifications, upgrades or changes. Response time of the technician to the site shall not exceed 4 hours.
2. Provide all hardware, software, programming tools and documentation necessary to modify the fire alarm system on site. Modification includes addition and deletion of devices, circuits, zones and changes to system operation and custom label changes for devices or zones. The system structure and software shall place no limit on the type or extent of software modifications on-site. Modification of software shall not require power-down of the system or loss of system fire protection while modifications are being made.

- E. Certifications: Together with the shop drawing submittal, submit a certification from the major equipment manufacturer indicating that the proposed supervisor of the installation and the proposed performer of contract maintenance is an authorized representative of the major equipment manufacturer. Include names and addresses in the certification.

- F. Fire alarm documents are to be submitted together for review.

- G. Additional requirements maybe set by Architect verify prior to submittal.

## PART 2 - PRODUCTS

### 2.1 ACCEPTABLE MANUFACTURERS

- A. Match existing.
- B. Documentation from the manufacturer shall be presented to the Architect and Engineer certifying that the persons making the final connections, system programming, check-out and providing the warranty are factory trained technicians in the employ of the factory authorized representative.

### 2.2 MAIN FIRE ALARM CONTROL PANEL:

- A. The FACP shall be modified as required for additional circuits.

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2.3 ANNUNCIATORS

## A. Alphanumeric LCD Type Annunciator:

1. The alphanumeric display annunciator shall be a supervised, remotely located backlit LCD display containing a minimum of eighty (80) characters for alarm annunciation in clear English text.
2. The LCD annunciator shall display all alarm and trouble conditions in the system.
3. An audible indication of alarm shall be integral to the alphanumeric display.
4. The display shall be UL listed for fire alarm application.
5. It shall be possible to connect up to 32 LCD displays and be capable of wiring distances up to 6,000 feet from the control panel.
6. The annunciator shall connect to a separate, dedicated "terminal mode" EIA-485 interface. This is a two-wire loop connection and shall be capable of distances to 6,000 feet. Each terminal mode LCD display shall mimic the main control panel.
7. The system shall allow a minimum of 32 terminal mode LCD annunciators. Up to 10 LCD annunciators shall be capable of the following system functions: Acknowledge, Signal Silence and Reset, which shall be protected from unauthorized use by a key switch or password.
8. The LED annunciator shall offer an interface to a graphic style annunciator and provide each of the features listed above.

## 2.4 SYSTEM COMPONENTS - ADDRESSABLE DEVICES

## A. Addressable Devices – General:

1. Addressable devices shall use simple to install and maintain decade (numbered 0 to 9) type address switches.
2. Addressable devices, which use a binary-coded address setting method, such as a DIP switch, are not an allowable substitute.
3. Detectors shall be intelligent (analog) and addressable, and shall connect with two wires to the fire alarm control panel signaling line circuits. Detectors shall be supplied with dual auxiliary contacts for connection to air handlers, elevator controls, and other systems as required.
4. Addressable smoke and thermal detectors shall provide dual alarm and power/polling LEDs. Both LEDs shall flash under normal conditions, indicating that the detector is operational and in regular communication with the control panel, and both LEDs shall be placed into steady illumination by the control panel, indicating that an alarm condition has been detected. If required, the LED flash shall have the ability to be removed from the system program. An output connection shall also be provided in the base to connect an external remote alarm LED.

5. The fire alarm control panel shall permit detector sensitivity adjustment through field programming of the system. The panel on a time-of-day basis shall automatically adjust sensitivity.
6. Using software in the FACP, detectors shall automatically compensate for dust accumulation and other slow environmental changes that may affect their performance. The detectors shall be listed by UL as meeting the calibrated sensitivity test requirements of NFPA Standard 72, Chapter 7.
7. The detectors shall be ceiling-mount and shall include a separate twist-lock base with tamper proof feature. Base shall include a sounder base with a built-in (local) sounder rated at 85 DBA minimum, a relay base and an isolator base designed for Style 7 applications.
8. The detectors shall provide a test means whereby they will simulate an alarm condition and report that condition to the control panel. Such a test may be initiated at the detector itself (by activating a magnetic switch) or initiated remotely on command from the control panel.
9. Detectors shall also store an internal identifying type code that the control panel shall use to identify the type of device (ION, PHOTO, THERMAL).
10. Detectors will operate in an analog fashion, where the detector simply measures its designed environment variable and transmits an analog value to the FACP based on real-time measured values. The FACP software, not the detector, shall make the alarm/normal decision, thereby allowing the sensitivity of each detector to be set in the FACP program and allowing the system operator to view the current analog value of each detector.
11. Detectors shall provide address-setting means using decimal switches and shall also store an internal identifying code that the control panel shall use to identify the type of device. LEDs shall be provided that shall flash under normal conditions, indicating that the device is operational and is in regular communication with the control panel.
12. Addressable devices shall provide address-setting means using decimal switches and shall also store an internal identifying code that the control panel shall use to identify the type of device. LED(s) shall be provided that shall flash under normal conditions, indicating that the device is operational and is in regular communication with the control panel.
13. A magnetic test switch shall be provided to test detectors and modules. Detectors shall report an indication of an analog value reaching 100% of the alarm threshold.

B. Addressable Pull Box (Manual Station):

1. Addressable pull boxes shall, on command from the control panel, send data to the panel representing the state of the manual switch and the addressable communication module status. They shall use a key operated test-reset lock, and shall be designed so that after actual emergency operation, they cannot be restored to normal use except by the use of a key.
2. All operated stations shall have a positive, visual indication of operation and utilize a key type reset.

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3. Manual stations shall be constructed of Lexan with clearly visible operating instructions provided on the cover. The word FIRE shall appear on the front of the stations in raised letters, 1.75 inches (44 mm) or larger.
- C. Intelligent Photoelectric Smoke Detector: The detectors shall use the photoelectric (light-scattering) principal to measure smoke density and shall, on command from the control panel, send data to the panel representing the analog level of smoke density.
- D. Intelligent Thermal Detectors: Thermal detectors shall be intelligent addressable devices rated at 135 deg. F (58 degrees C) and have a rate-of-rise element rated at 15 deg. F (9.4 degrees C) per minute. It shall connect via two wires to the fire alarm control panel signaling line circuit.
- E. Duct Smoke Sensor: The detector is to be Photoelectric type.
1. If possible the detector and housing will be a one-piece design. The housing and detector separate is allowed if a one-piece unit is not available.
    - a. The duct detector housing shall be supplied with a clear cover so the presence of smoke can be monitored.
    - b. Shall be supplied with either a magnetic test feature or an injection tube for device testing.
    - c. Designed to operate with air velocity in the range of 300-4000fpm.
    - d. Coordinate with mechanical plans for duct size and provide the appropriate length of sampling tubes.
    - e. For maintenance purposes, it shall be possible to clean the duct housing sampling tubes by accessing them through the duct housing front cover.
  2. Detectors of either design will be provided with relays to connect to the fire alarm panel and DDC panel, as well as connect to a remote status LED.
  3. Remote status LED will display the detector status exactly the same as the detector. The remote status LED is to indicate the detector is operational, in trouble mode, or in alarm.
    - a. The remote status LED is required if the duct detector is over 10' off the finished floor or is not visible because of a drop ceiling.
    - b. Verify exact location to mount the remote status LED with the local AHJ prior to installation.
- F. Addressable Dry Contact Monitor Module
1. Addressable monitor modules shall be provided to connect one supervised IDC zone of conventional alarm initiating devices (any N.O. dry contact device) to one of the fire alarm control panel SLCs.

2. The monitor module shall mount in a 4-inch square (101.6 mm square), 2-1/8 inch (54 mm) deep electrical box.
3. The IDC zone shall be suitable for Style D or Style B operation. An LED shall be provided that shall flash under normal conditions, indicating that the monitor module is operational and in regular communication with the control panel.
4. For difficult to reach areas, the monitor module shall be available in a miniature package and shall be no larger than 2-3/4 inch (70 mm) x 1-1/4 inch (31.7 mm) x 1/2 inch (12.7 mm). This version need not include Style D or an LED.

G. Two-Wire Detector Monitor Module:

1. Addressable monitor modules shall be provided to connect one supervised IDC zone of conventional 2-wire smoke detectors or alarm initiating devices (any N.O. dry contact device).
2. The two-wire monitor module shall mount in a 4-inch square (101.6 mm square), 2-1/8 inch (54 mm) deep electrical box or with an optional surface backbox.
3. The IDC zone may be wired for Class A or B (Style D or Style B) operation. An LED shall be provided that shall flash under normal conditions, indicating that the monitor module is operational and in regular communication with the control panel.

H. Addressable Control Module:

1. Addressable control modules shall be provided to supervise and control the operation of one conventional NACs of compatible, 24 VDC powered, polarized audio/visual notification appliances. For fan shutdown and other auxiliary control functions, the control module may be set to operate as a dry contact relay.
2. The control module shall mount in a standard 4-inch square, 2-1/8 inch deep electrical box, or to a surface mounted backbox.
3. The control module NAC may be wired for Style Z or Style Y (Class A/B) with up to 1 amp of inductive A/V signal, or 2 amps of resistive A/V signal operation, or as a dry contact (Form-C) relay. The relay coil shall be magnetically latched to reduce wiring connection requirements, and to insure that 100% of all auxiliary relay or NACs may be energized at the same time on the same pair of wires.
4. Audio/visual power shall be provided by a separate supervised power circuit from the main fire alarm control panel or from a supervised, UL listed remote power supply.
5. The control module shall be suitable for pilot duty applications and rated for a minimum of 0.6 amps at 30 VDC.



- I. Addressable Relay Module: Addressable Relay Modules shall be available for HVAC control and other building functions. The relay shall be form C and rated for a minimum of 2.0 Amps resistive or 1.0 Amps inductive. The relay coil shall be magnetically latched to reduce wiring connection requirements, and to insure that 100% of all auxiliary relay or NACs may be energized at the same time on the same pair of wires.

## 2.5 ALARM INDICATING DEVICES

- A. Speakers shall be of sufficient number so that an alarm shall be clearly audible to all occupants of the building and/or fire area, as required by these specifications. Wall mounted devices shall be mounted in such a way that the lens is not less than 80" and not greater than 96" above the finished floor. Locations where ceilings prevent the installation at 96" centerline, the centerline of the unit shall be 6" below the ceiling.
- B. Audible alarm signals shall produce a sound level at least 15 dBA above the average ambient sound level or 5 dBA above the maximum sound level having a duration of a least 60 seconds (whichever is greater) measured 5 feet above the floor in each occupied area. The average ambient sound level is the root mean square, a weighted sound pressure measured over a 24-hour period.
- C. Strobes shall be installed as shown on the drawings in accordance with the requirements of the UL 1971 standard and NFPA 72. Where multiple visual notification appliances can be seen from any location, circuitry shall be incorporated for the synchronization of flash rate.
  - 1. Strobes shall produce a flash rate of one (1) flash per second minimum over the listed input voltage (20VDC - 31VDC) range.
  - 2. Strobes shall incorporate a Xenon flashtube enclosed in a rugged Lexan lens or equivalent with solid-state circuitry.
  - 3. Strobe intensity shall be rated per UL 1971 for 15/75, 30/75, 60/75, 75 or 110 Candela. Dual listing strobes of 15/75 intensity for UL 1971/near-axis requirements shall be used where acceptable.
  - 4. Strobes shall be available for semi-flush or surface mounting and in conjunction with audible appliances as required.
- D. Provide manufacturer's standard wireguard where so indicated on the Drawings.

## 2.6 CONDUIT AND WIRE:

- A. Conduit:
  - 1. Conduit shall be in accordance with The National Electrical Code (NEC), local and state requirements.

2. Where required, all wiring shall be installed in conduit or raceway. Conduit fill shall not exceed 40 percent of interior cross sectional area where three or more cables are contained within a single conduit.
3. Cable must be separated from any open conductors of power, or Class 1 circuits, and shall not be placed in any conduit, junction box or raceway containing these conductors, per NEC Article 760-29.
4. Wiring for 24 volt DC control, alarm notification, emergency communication and similar power-limited auxiliary functions may be run in the same conduit as initiating and signaling line circuits. All circuits shall be provided with transient suppression devices and the system shall be designed to permit simultaneous operation of all circuits without interference or loss of signals.
5. Conduit shall not enter the fire alarm control panel, or any other remotely mounted control panel equipment or backboxes, except where conduit entry is specified by the FACP manufacturer.
6. Conduit shall be 3/4 inch (19.1 mm) minimum.

B. Wire:

1. All fire alarm system wiring shall be new.
2. Wiring shall be in accordance with local, state and national codes (e.g., NEC Article 760) and as recommended by the manufacturer of the fire alarm system. Number and size of conductors shall be as recommended by the fire alarm system manufacturer, but not less than 18 AWG (1.02 mm) for Initiating Device Circuits and Signaling Line Circuits, and 14 AWG (1.63 mm) for Notification Appliance Circuits.
3. All wire and cable shall be listed and/or approved by a recognized testing agency for use with a protective signaling system.
4. Wire and cable not installed in conduit shall have a fire resistance rating suitable for the installation as indicated in NFPA 70 (e.g., FPLR).
5. Wiring used for the multiplex communication circuit (SLC) shall be twisted and shielded and support a minimum wiring distance of 10,000 feet. In certain applications, the system shall support up to 2 SLCs with up to 1,000 feet of untwisted, unshielded wire. The design of the system shall permit use of IDC and NAC wiring in the same conduit with the SLC communication circuit.

C. Terminal Boxes, Junction Boxes and Cabinets: All boxes and cabinets shall be UL listed for their use and purpose.

## PART 3 - EXECUTION

### 3.1 OPERATION

- A. The fire alarm components (i.e. pull stations, smoke detectors, photoelectric smoke detectors, speakers, magnetic door holders, fire alarm panel, batteries, chargers, fire alarm cable, etc.) will be supplied, installed and connected by Division 16 Contract Work. Duct smoke detectors are to be installed by Division 15, supplied and wired by Division 16.
- B. The fire alarm system operation subsequent to the alarm activation of any pull station or automatic detection device shall be as follows:
  - 1. Sound the building audible alarm devices.
  - 2. Display on the control panel the English language description of the alarm and its location.
  - 3. Print on the printer the alarm type, location, time and date.
  - 4. Activate programmed output modules points.
  - 5. Report the condition to the central station.
  - 6. Log in the event buffer all system activity.
  - 7. Recall the elevator if the alarm is activated from the lobby smoke detector(s).
  - 8. Release magnetically held fire doors.
  - 9. Deactivate the 120 volt smoke damper circuits.
  - 10. Operate the elevator power module shunt trip switch to disconnect elevator power if the alarm is activated from the elevator heat detector(s).
- C. Zoning: Provide each initiating device with its own address. This includes all detectors, pull stations, sprinkler flow switches, tamper switches, low air switches and any other monitored point.

### 3.2 INSTALLATION

- A. Boxes, Enclosures and Wiring Devices:
  - 1. Boxes shall be installed plumb and firmly in position.
  - 2. Extension rings with blank covers shall be installed on junction boxes where required.
  - 3. Junction boxes served by concealed conduit shall be flush mounted.
  - 4. Upon initial installation, all wiring outlets, junction, pull and outlet boxes shall have dust covers. Dust covers shall not be removed until wiring installation when permanent dust covers or devices are installed.

5. All junction box covers shall be painted fire department red and be affixed with a decal or silk-screened label "Fire Alarm System."
6. Wet or damp locations shall require a NEMA rated enclosure suitable for the environment in which an addressable field device or module are to be installed. (i.e. monitoring of sprinkler water flow, tamper switches and OS&Y valves)
7. Termination junction boxes shall be of adequate size and room to facilitate ease of accessibility to work on wiring and to provide ample space for proper identification labeling. Enclosure design shall incorporate the use of a back plate within the enclosure to provide ease of installation. Terminal blocks shall be affixed to a secured mounting rail. Terminal enclosures shall be painted fire department red and stenciled "Interior Fire Alarm System."
8. Electrical conduits shall enter only at the side or the bottom of control cabinets, unless designed and approved for entry on the top.
9. All conduits shall be grounded to a water main by approved ground clamps with a conductor equal in size to the largest conductor used in the system; but in no case shall the ground conductor be smaller than no. 10 AWG.

B. Conductors:

1. Each conductor shall be identified as shown on the drawings at each with wire markers at terminal points. Attach permanent wire markers within 2 inches of the wire termination. Marker legends shall be visible.
2. All wiring shall be supplied and installed in compliance with the requirements of the National Electric Code, NFPA 70, Article 760, and that of the manufacturer-wiring guides.
3. Wiring in accessible locations (i.e. above removable ceiling tiles) may be open fire alarm cable. The cabling is to be supported off the ceiling grid by means of D-rings, J-Hooks, or other products manufactured for the purpose. The cable is to be supported at least every 5' and will not share a cable path with any other system. Cable shall not be attached to conduit, pipe, or ceiling stringers used by any other trade.
4. Wiring in inaccessible locations (i.e. walls, above gyp ceilings) shall be in a conduit raceway system. The contractor has the option to re-use the existing fire alarm raceway system if applicable and found to be in good condition. All conductors installed in existing raceway shall be THHN. Verify wiring with equipment supplier and increase conduit size where required.
5. Wiring for analog loop circuits, conventional detection circuits, speaker circuits and telephone circuits shall be based on the fire alarm manufacturer's wiring guidelines, but shall not be smaller than #18 AWG.
6. Splices shall be made with UL listed wire nuts of the appropriate size for the cable gauge and count.
7. Crimp-on type spade lugs shall be used for terminations of stranded conductors to binder screw or stud type terminals. Spade lugs shall have upset legs and insulation sleeves sized for the conductors.

8. A consistent color code for fire alarm system conductors throughout the installation shall be provided. The installation contractor shall submit for approval prior to installation of wire, a proposed color code for system conductors to allow rapid identification of circuit types.
9. All nominal voltage branch circuit power feeds (120/220 VAC) shall be identified "labeled" at both ends of the circuit to indicate its source and purpose.
10. Wiring within system control panels shall be arranged and routed to allow accessibility to equipment for adjustment and maintenance and to isolate nominal voltage wiring from system low voltage wiring.
11. Splices in electrical conductors in vertical risers are prohibited.
12. Initiating circuits shall be arranged to serve like categories (manual, smoke, waterflow). Mixed category circuitry shall not be permitted except on signaling line circuits connected to intelligent reporting devices.
13. Communication circuits give off RF noise. Maintain at least an eighteen-inch distance from all other communication circuits, where possible.

### 3.3 FIELD QUALITY CONTROL

- A. Certificate of Compliance: Complete and submit to the project engineer in accordance with NFPA 72, paragraph 1.7.2.
- B. Field-Testing General:
  1. Prior to any testing or programming verify numbering scheme, room names, and other means of identifying addressable devices prior to testing and labeling. The owner will be given a minimum of one week notice prior to the contractor requiring to have the numbering scheme requested by the owner.
  2. Each addressable analog smoke detector shall be individually field tested prior to installing the device at its designated location to ensure reliability after shipment and storage conditions. A dated log indicating correct address, type of device, sensitivity and initials of the technician performing test - using test equipment specifically designed for that purpose - shall be prepared and kept for final acceptance documentation. After testing, the detection devices and base shall be labeled with the system address, date and initials of installing technician. Labeling shall not be visible after installation is complete.
  3. Wiring runs shall be tested for continuity, short circuits and grounds before system is energized. Tests shall check for stray voltage not to exceed 1 volt AC/DC unless otherwise specified by the manufacturer. Resistance, current and voltage readings shall be made as work progresses.
  4. All test equipment, instruments, tools and labor required to conduct the system tests shall be made available by the installing contractor.
  5. In addition to the testing specified to be performed by the installing contractor, the installation shall be subject to test by the acceptance inspector.

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C. Final Acceptance Testing:

1. Testing shall be in accordance with NFPA72 and this specification.
2. A final As-built Function Matrix shall be prepared by the installing contractor referencing each alarm input to every output function affected as a result of an alarm, trouble or supervisory condition on that input. In the case of outputs programmed using more complex logic functions involving "any," "or," "not," "count," "time," and "timer" statements; the complete output equation shall be referenced in the matrix.
3. The installing contractor prior to testing shall prepare a complete listing of all device labels for alphanumeric annunciator displays and logging printers.
4. The acceptance inspector shall use the system record drawings during the testing procedure to verify operation as programmed. In conducting the tests, the acceptance inspector shall request demonstration of any or all input and output functions. The items tested shall include but not be limited to the following:
  - a. System wiring shall be tested to demonstrate correct system response and correct subsequent system operation in the event of:
    - 1) Open, shorted and grounded intelligent analog signaling line circuit.
    - 2) Open, shorted and grounded network signaling line circuit.
    - 3) Open, shorted and grounded conventional initiating device circuits.
    - 4) Intelligent device removal.
    - 5) Primary power or battery disconnected.
    - 6) Incorrect device address.
    - 7) Printer trouble, off line or out of paper.
    - 8) Loss of data communications between system control panels.
    - 9) Loss of data communications between system annunciators.
  - b. System evacuation alarm indicating appliances shall be demonstrated as follows:
    - 1) All alarm notification appliances actuate as programmed.
    - 2) Audibility and visibility at required levels.
  - c. System indications shall be demonstrated as follows:
    - 1) Correct message display for each alarm input, at the control panel, each remote alphanumeric LCD display.
    - 2) Correct annunciator light for each alarm input, at each annunciator and color graphic terminal.
    - 3) Correct printer logging for all system activity.
  - d. System on-site and/or off-site reporting functions shall be demonstrated as follows:
    - 1) Correct alarm custom message display, address, device type, date and time transmitted for each alarm input.

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- 2) Correct trouble custom message display, address, device type, date and time transmitted for each alarm input.
      - 3) Trouble signals received for disconnect.
    - e. Secondary power capabilities shall be demonstrated as follows:
      - 1) System primary power shall be disconnected for a period of time as specified herein. At the end of that period, an alarm condition shall be created and the system shall perform as specified for a period as specified.
      - 2) System primary power shall be restored for forty-eight hours and system-charging current shall be normal trickle charge for a fully charged battery bank.
      - 3) System battery voltages and charging currents shall be checked at the fire alarm control panel using the test codes and displayed on the LCD display.
  - 5. In the event of system failure to perform as specified and programmed at the discretion of the acceptance inspector, the test shall be terminated.
    - a. The installing contractor shall retest the system, correcting all deficiencies and providing test documentation to the acceptance inspector.
    - b. In the event that software changes are required during the testing, the system manufacturer to compare the edited program with the original shall furnish a utility program. This utility shall yield a printed list of the changes and all system functions, inputs and outputs affected by the changes. The items listed by this program shall be the minimum acceptable to be retested before calling for resumption of the testing. The printed list and the printer log of the retesting shall be submitted before scheduling of the testing.
    - c. The acceptance inspector may elect to require the complete testing to be performed again if modifications to the system hardware or software warrant complete retesting.
- D. Notify owner representative one week prior to all system testing days so they may witness tests.
- E. Documentation:
- 1. System documentation shall be furnished to the owner and shall include but not be limited to the following:
    - a. Provide cut sheets for all equipment installed during construction. If multiple items are shown on one page indicate exactly which item was installed. Provide this information in hard copy and on CD with the record drawings.
    - b. System record drawings and wiring details including one set of reproducible hard copy, as well as, drawings on CD (compact disks) in a both CAD (or compatible program) and PDF.
    - c. System operation, installation and maintenance manuals.
    - d. Written documentation for all logic modules as programmed for system operation with a matrix showing interaction of all input signals with output commands.

- e. Documentation of system voltage, current and resistance readings taken during the installation and testing.
  - f. System program "hard copy" showing system functions, controls and labeling of equipment and devices. Also provide a CD with system file.
- F. Test Equipment: The contractor shall furnish to the owner all test equipment as required to program the field analog devices, specifically an intelligent device programmer-tester or a calibrated smoke generator with power source.
- G. Warranty/Services: The contractor shall warrant the entire system against system hardware and electrical defects including programming software defects for a period described in the contract general conditions, but not less than one year. This period shall begin upon satisfactory completion and certification of final acceptance testing of the system. Contractor shall provide to owner a letter stating the start-date and end-date of warranty period. In addition, the contractor shall also provide an updated list of name(s) and phone number(s) for normal and off-hours contacts necessary to respond to warranty issues. Response to warranty notification shall require a reply within 24 hours of initial contact.

#### 3.4 MAINTENANCE INSTRUCTIONS

- A. Complete maintenance instructions for all devices including trouble-shooting procedures shall be provided to the owner. Owner's personnel shall receive a minimum of six hours of hands on system training.

#### 3.5 OPERATION AND MAINTENANCE MANUALS

- A. Provide manuals in accordance with Section 16050. Manuals are to contain as-built drawings on disk utilizing Autocad, spare parts list, operating procedures, trouble shooting guide, operating system data file print out, operating system data file on disk, a one year service proposal on the system and a copy of the completed NFPA "Record of Completion."

END OF SECTION 28 31 00