SECTION 28 31 00 - FIRE ALARM SYSTEMS FOR BUILDINGS

1.01 SUMMARY:

A. **Basic Function**: The fire alarm systems shall prevent life and property loss and minimize injury to personnel and property damage in the event of a fire at any one building of a locks complex, by providing smoke detection at selected buildings and other locations of the locks complex, audiovisual alarm for prompt evacuation of persons inside the buildings, and remote notification for rapid fire truck and ambulance dispatch.

B. **Scope**: This Section contains the performance specifications for smoke detection and fire alarm systems that shall be required in certain rooms, buildings and other locations of each locks complex. [A16]The rooms and buildings and other locations are described in Sections 01 81 36 (*O&M Buildings and Facilities – Program*) and 01 81 36.13 (*O&M Buildings and Facilities – Space Programming*).[A16] The fire alarm system, upon verification of detection by any alarm initiating device, shall activate the alarm indicating devices, send remote alarm and information to locks control operator, the security monitor system in the guard house [GH], and Employer's emergency response center, and proceed to shut down mechanical or artificial ventilation equipment and elevator recall.

1. [A16]**Design**: The Contractor shall design and specify a complete Fire alarm System for each Building listed in Subparagraph 1.04 B.

2. **Construction**: The Contractor shall furnish and install a complete Fire Alarm System for the Main Control Building {CB} only. The Fire Alarm Systems for all other buildings will be furnished and installed by the Employer. The Contractor shall provide all the necessary ducts, conduits, and cable trays installation or spaces for the future installation of the Fire Alarm System cables by others.

[A17]3. **Field testing**: The Contractor shall perform testing of system components and subsystems as part of the Quality Control Function that is under the responsibility of the Contractor. Such testing shall be part of the Pre-commissioning Tests required by Section 01 91 00 (*Tests on Completion and Tests after Completion*). This Section includes the minimum requirements for field testing and shall be complemented by the manufacturer's recommended field testing procedures. [A17]

1.02 REFERENCES: [A16]

A. **American National Standards Institute (ANSI) Publication**:

A117.1-03	Accessible and Useable Buildings and Facilities

B. **National Electrical Manufacturers Association (NEMA) Publication**:

	Training Manual on Fire Alarm Systems (2003; replaces SB4-85)

C. **National Fire Protection Association (NFPA) Publications**:

1-06	Uniform Fire Code
70 08	National Electrical Code
72-07	National Fire Alarm Code

75-03	Standard for the Protection of Electronic Computer/Data Processing Equipment
76-05	Recommended Practice for the Fire Protection of Telecommunications Facilities
90A-05	Installation of Air-Conditioning and Ventilating Systems
101-06	Code for Safety to Life from Fire in Buildings and Structures

D. **Underwriters Laboratories, Inc. (UL) Standards for Safety**:

13-05	Power Limited Circuit Cables
38- 05	Manual Signaling Boxes for Fire Alarm Systems
94-06	Tests for Flammability of Plastic Materials for Parts in Devices and Appliances
217-07	Single and Multiple Station Smoke Alarms
268-06	Smoke Detectors for Fire Alarm Signaling Systems
268A-06	Smoke Detectors for Duct Application
464-03	Audible Signal Appliances
521-05	Heat Detectors for Fire Protective Signaling Systems
864-06	Control Units and Accessories for Fire Alarm Systems
924-06	Emergency Lighting and Power Equipment
1480-06	Speakers for Fire Alarm, Emergency, and Commercial and Professional Use
1481-06	Power Supplies for Fire-Protective Signal Systems
1635-05	Digital Alarm Communicator System Units
1638-03	Visual Signaling Appliances - Private Mode Emergency and General Utility Signaling
1666-07	Test for Flame Propagation Height of Electrical and Optical-Fiber Cable Installed Vertically in Shafts
1971-06	Signaling Devices for the Hearing Impaired

1.03 REQUIREMENTS:

A. **Environmental Performance**:

1. **Weather Resistance**: All fire alarm system components shall be suitable for continuous operation in the exterior environment at each locks complex. Alarm initiating devices and indicating devices shall be weatherproof for indoor/outdoor use, shall prevent the entrance of water and shall not be affected by temperature and humidity. Fire alarm components installed in outdoor locations shall be UV resistant.

2. **Ambient**: Fire alarm systems control panels, components, accessories, and wiring shall be located to minimize malfunction or failure due to adverse environmental conditions, flooding, fire, and vandalism.

3. **Protection**: Alarm initiating devices and indicating devices shall be protected against possible entry of dust and insects.

B. **Safety Performance**:

1. **Radioactivity**. No components in the system shall contain radioactive materials.

2. **Grounding and Bonding**: Shall be in accordance with Section 26 05 26 (*Grounding and Bonding for Electrical Systems*).

3. **Strobe Lamp Synchronization**: When two or more lights are in an individual's field of view at any time, strobes shall be synchronized so that the composite flashing rate does not exceed two flashes per second.

C. **Interference Radio Frequency Immunity**: The system shall be immune to radio frequency emissions from cellular telephones as well as portable VHF/UHF radios.

D. **Durability Performance**:

1. **Construction**: Alarm initiating devices and alarm indicating devices shall be heavy duty or industrial duty.

2. **Corrosion Resistance**: Alarm initiating devices and indicating devices, and other components of the fire alarm system shall be constructed of corrosion resistant materials and shall be further protected against the effects of corrosion.

3. **Tamper Resistance**. Fire alarm components in public spaces shall be tamper resistant.

E. **Reliability Requirements**:

1. **Loss of Power**: Upon loss of primary operating power, the system shall automatically transfer to emergency backup battery power and shall provide audible and visible trouble indication.

2. **Maintainability**: When the backup batteries are disconnected for any reason, or have low voltage, the system shall automatically operate on facility power and shall provide trouble indication.

3. **Surge Protectors**: Fire alarm power circuits and remote signaling telephone circuits shall be protected against voltage surges in accordance with Section 26 43 13 (*Transient Voltage Surge Suppressors*).

F. **Operations and Maintenance Requirements**:

1. **Equipment**: The equipment and design used at both locks complexes shall be identical.

2. **Maintainability**: Fire alarm equipment and devices shall be from the same manufacturer.

3. **Keys**: Wherever possible, locks for the same type of equipment or components shall use the same key.

4. **Identification**:

   a. Identification of equipment, cable and conduit runs shall be in accordance with Section 26 05 53 (*Identification for Electrical Systems*).

   b. **Nameplates**: Major components of equipment shall have manufacturer's name, address, catalog number, model, style, voltage or current rating, and/or type identified on a corrosion resistant metal nameplate securely and conspicuously engraved, attached to each item of equipment.

   c. **Labels**: All addressable devices shall be clearly labeled.

   d. Tags with stamped identification number shall be furnished for keys and locks.

G. [A16]**Reserved**[A16]

H. **Appearance Requirements**. In the building lighting panelboard, the dedicated circuit breakers for fire alarm system circuits shall be color red. Fire alarm control panel, battery enclosure, alarm indicating devices and manual pull stations shall be color red.

1.04 DESIGN CRITERIA/SYSTEM DESCRIPTION AND PERFORMANCE:

A. **System Description**:

1. **General**: The fire alarm system at one locks complex shall be independent from the fire alarm system at the other locks complex. The fire alarm system in a building shall be independent from the fire alarm system in another building.

2. **Safety**: The fire alarm system shall provide an audiovisual alarm to building occupants, interact with other life safety systems and increase survivability in the event of a fire.

3. **Alarm signals**: Shall be consistent throughout the Site. The system(s) shall be capable of producing at least three distinctive audible evacuation signals based on the type of initiating device: one for fire alarm, one for fire drills, and one for bomb threat.

4. **Threat Activation**: Bomb threat switches shall be installed at the locks control operator station [CB] and at the security central monitoring station in the guard house [GH]. Upon activation of a bomb threat switch, the alarm signal of all fire alarm systems installed in the locks complex shall be activated.

5. **Standards and Code Compliance**: The fire alarm system shall conform to the applicable requirements of NFPA 70, NFPA 72, NFPA 90A, and NFPA 101. All equipment and materials shall be new and listed by the Underwriters Laboratories, Inc. for the intended use.

B. **Buildings and Rooms Included**: At each set of locks, the following buildings and rooms shall be individually protected by a smoke detection and fire alarm system.

1. Main control room building [CB]

2. Personnel building [PB]

3. Maintenance building [MB]

[A4] (Deleted text)

[A4]4[A4]. Generator room [GR]

5. Fire-fighting equipment rooms [FERs]
6. Crossunders and Crossunder elevator rooms [CERs]
7. Machinery rooms — gates [MRs-G]
8. Machinery rooms — valves [MRs-V]
9. Machinery rooms — Water-Saving Basins [MRs-WSB]
10. Electrical rooms [ELRs]

C. **Design**:

1. **Zones**: The fire alarm smoke detection circuits in each building shall have a separate zone for each clearly identifiable area. In buildings with more than one floor, the detectors of each floor shall be in a separate zone. In buildings with separate rooms, each major type of room shall be in a separate zone. A zone shall be dedicated to the smoke detectors located under access floors and inside roof attics, where available.
2. **Alarm Signal**: Upon activation of any alarm initiating device, continuous fire alarm signal shall be transmitted to all interior and exterior alarm indicating devices in the building, for a predetermined period of time before the alarm indicating devices may be manually or automatically restored to normal.
3. **Signaling**: Local signaling shall identify the zone and the alarm initiating device that activated the alarm, and its location. Remote signaling shall identify the building and indicate the zone that activated the alarm.
3. **Loss of Communications**: In the event of subsystem damage in a particular zone causing loss of communications to this zone, the system shall not lose communications to any other zone.
4. **Air Control System**: Upon a general alarm, the control panel shall provide a relay contact closure to locally shut down the air conditioning system. See Section 01 86 13 (*Plant – Mechanical Systems and Equipment*).
5. **Elevator Capture/Recall**: Upon a general alarm, the control panel shall provide a relay contact closure to capture and recall elevators so that these are parked in a designated floor (ground floor unless otherwise specified), and so that occupants cannot accidentally enter the fire area. See Section 01 86 13 (*Plant – Mechanical Systems and Equipment*). [A16]This requirement does not apply for the Crossunder elevators. [A16]

D. **Alarm Initiating Devices**:

1. **General**: Alarm initiating devices shall be addressable, non-coded, low profile units, capable of initiating alarm and trouble signals. Detectors shall be manually and automatically reset to restore to normal operation after an alarm has been given.
2. **Smoke Detectors**: Shall be photoelectric type, conforming to UL 217 and UL 268. Sensitivity shall be automatic to compensate for dirt level, and shall be field adjustable to compensate for aging and ambient operating conditions.

3. **Duct Smoke Detector**: Duct type smoke detectors shall be photoelectric type shall meet the requirements of NFPA 90A and UL 268A. Duct detector sampling tube(s) shall be coordinated with the width of the return air duct and the duct air speed.

4. **Heat Detectors**: Shall be fixed temperature and rate of rise type, shall comply with NFPA 72 and UL 521, and shall be suitable for ambient temperatures up to 50 °C.

5. **Manual Pull Stations**: Shall be double-action, general alarm, conforming to UL 38. Shall be key operated to reset or sound the general alarm for fire drill or test.

E. **Alarm Indicating Devices**:

1. **General**: Alarm indicating devices shall be supervised and shall conform to the applicable requirements of NFPA 72.

2. **Audible Devices**: Horns shall be continuous vibrating type, double-projector type, and shall have a minimum sound rating of 90 dB at 3 m and shall conform to the applicable requirements of UL 464.

3. **Visible Devices**: Strobe lights shall meet the applicable requirements of ANSI A117.1, UL 1480, UL 1638 (private mode), and UL 1971 (public mode).

F. **Fire Alarm Control Panels (FACP)**:

1. **Standards**: Each fire alarm control panel shall meet the requirements of NFPA 72 and UL 864, and shall be UL approved for use under NFPA 72 and for interaction with other systems such as the emergency evacuation system, security access control system, and central station monitoring system.

2 **Type & Capability**: FACP shall be solid-state; microprocessor based, modular, with expansion capability of minimum 30%, and shall be able to operate a remote annunciator. The system shall include all modules required for interacting with other systems such as the emergency evacuation system, security access control system, and central station monitoring system, and with wet pipe fire suppression system and air conditioning duct emergency closers, where required.

3. **Features**: FACP shall contain supervised, low voltage general alarm signal circuits, general alarm circuit, a reset switch, a general alarm silence switch, a buzzer with silence switch for trouble indication, and all necessary relays and devices to provide the functions described herein.

4. **Software**:

a. The Contractor shall furnish dedicated software for interrogation of FACP from IBM PC compatible portable computer, and shall make available all applicable site specific programming of control equipment.

b. The system shall require passwords for diagnostics, testing, troubleshooting, and to prevent unauthorized people to access information or make any changes. The basic input/output system (BIOS) shall not be accessible to the end user in the field.

5. **Field Programming**:

   a. The system shall be programmable in the field, through a common control, front panel keyboard and/or through the use of a portable computer with a special software package.

   b. The system shall allow field programming after log-in to conform with NFPA standards. The software shall determine valid passwords required for log-in, automatic programming of its operation, and changing manufacturer provided passwords or other valid passwords at any time.

   c. The system shall allow field programming by trained Employer's Personnel, to make all adjustments required when adding or removing alarm initiating or annunciating devices, or modules, components, devices, and accessories in the FACPs, the digital alarm communicator transmitters (DACTs), and other fire alarm system equipment without the need to contact the factory, factory representative, or Contractor, without the need of any special tool or equipment, other than that specified in Paragraph 1.04 F.5.a., and without incurring in additional costs.

6. **Features**: FACPs shall be capable of supporting addressable and non-addressable alarm initiating devices, and shall provide ground fault detection for all alarm indicating and initiating circuits.

7. **Display and Printed Reports**. Upon alarm, displays and printed reports shall show Employer's approved specific but generic location information, i.e., room identification number and name, to facilitate immediate identification of alarm activation area(s).

8. **Alarm Initiating Input Subsystem**: Shall have the number of active zones required to perform the required functions and shall provide means for adjusting the level of sensitivity for each applicable non-addressable zone, indicating sensitivity of each automatic compensation detector, and indicating when automatic compensation detectors need cleaning.

9. **Audible Devices**: Buzzer shall be capable of producing a tone with sound pressure level of 75 dB with no attenuation.

10. **Data Interfaces**: Each FACP shall have the input/output port suitable for uploading/downloading to/from a portable personal computer, and suitable for 80 column printers and video display terminals. This port shall be capable of communicating standard ASCII code at 1,200 bps or faster.

11. **Enclosures**: FACP shall be supplied with wall mounted, steel cabinet(s), hinged doors, latch, lock and keys. Batteries shall be in separate enclosure(s), meeting the above requirements, except ventilated as required.

12. **Metering Subsystem**: Shall be capable of simultaneous measurement of battery voltage and charging current, response time, sensitivity, and status of addressable detectors.

13. **Power Supplies**: Shall comply with NFPA 72 and UL 1481, and shall include the following:

    a. **Primary (Main) Power Supply**: Shall operate the system on 120 VAC, 60 Hertz, single phase.

b. **Secondary (Standby) Power Supply**: Shall consist of DC power supplied by batteries and equalize/float charger.

14. **Real Time Clock**: The system shall have a real-time clock suitable for monitoring all real-time programming and time control functions. The clock shall have means for making entries and corrections to date and time.

15. **Visual Indicators**:

a. FACP shall contain visual indicators for AC power failure, alarm silence switch activation, DC operation, fire alarm, low battery condition, power on (normal AC power operation, preferably green), and trouble (preferably amber).

b. Visual indicators shall be plainly visible when the cabinet door of the control unit is closed.

16. **Switches**:

a. FACP shall contain an alarm silence switch, trouble silence switch, power on off switch, and alarm/trouble reset switch, and shall be accessible only by unlocking and opening the unit.

b. Alarm/trouble reset switch shall reset the detection subsystem in alarm or trouble. Trouble signals shall not be self restoring without activating the reset switch.

17. **Bypass**: FACP shall provide means to bypass control functions during testing.

G. **Digital Alarm Communicator Transmitters (DACTs)**:

1. Each FACP shall have built-in, programmable, digital communicators complying with UL 1635.

2. The DACT units shall transmit coded messages over two each, 7-digit dial-up telephone lines to a digital alarm communicator receiver (DACR) at the locks control operator station [CB], at the security central monitoring station [GH] and at the Employer's emergency response center.

H. **General Alarm Processing**: Whenever one or more alarm initiating device is placed into an alarm mode, the fire alarm system shall automatically do the following:

1. Initiate audible and visual fire alarm signals throughout the protected area to alert and notify the occupants. Visually indicate the address(es) or zone(s) at the FACP and, where required, the remote indicator.

a. The general alarm shall operate until reset at the corresponding control equipment.

b. Upon activation of alarm silence switch(es), indicating devices shall stop indicating alarm condition without affecting address and/or zone indicators.

c. The switch(es) shall be overridden upon activation of a subsequent alarm from an unalarmed address or zone.

2. Send the appropriate alarm signal via a DACR at the locks control operator station [CB], at the security central monitoring station at the guard house [GH],

and at the Employer's emergency response center. Remote notification shall communicate the zone and exact location of the alarm initiating device.

I. **Signal Wiring**:

1. All fire alarm wiring shall be power limited, UL listed, color coded, in accordance with NFPA 70 and UL 13, with individually insulated copper conductors, rated minimum 300 volts.

2. All fire alarm cables shall be fire retardant and shall pass the NFPA 1 flame test, and UL 94 and UL 1666 where applicable.

   a. **Cables for Alarm Indicating Devices**: Shall be Class "B" wiring.

   b. **Cables for Alarm Initiating Devices**: Shall be Class "A" wiring.

J. **Operations and Maintenance**:

1. **Alarm Verification**:

   a. In order to prevent or minimize false alarms, a smoke alarm shall not be activated unless it is verified by the corresponding detector.

   b. The control equipment shall only indicate a smoke alarm when one or more of the following conditions occur:
      1) Another alarm occurs on the same address or zone within 90 seconds.
      2) The detector cannot be reset because the initial conditions that triggered it remain.

2. **Supervision**: The FACP shall supervise power and signal wiring to all monitoring and control circuits, and shall monitor the status of the following:

   a. All alarm initiating devices. Addressable devices shall report to the control equipment their identification, location, and status.

   b. The flow switch of the wet sprinkler system where required.

   c. The control equipment shall report the removal or failure of any device transmitting components, open or shorted, on addressable initiating circuit(s), identified by its specific device number and its location within the circuit. Other devices on the circuit shall continue to function properly even though one or more circuit components may have failed.

   d. The control equipment shall provide means to enable/disable points, list points, and view status of points.

3. **Silencing**:

   a. Alarm and trouble silence switches shall silence the alarm and trouble audible devices temporarily. Either switch placed in other than the normal position shall provide audiovisual alarm/trouble indication and re ring the trouble audible when the problem has been cleared but the switch has been left in the silence position.

   b. When the alarm silencing switch is in the silence position, subsequent alarms in other addresses and/or zones shall operate the alarm indicating devices.

c. Upon trouble detection, the silence switch shall mute the buzzer, and the corresponding light shall stay on until trouble is corrected. When light is extinguished upon the trouble correction, the audible signal shall sound again until the switch is reset to normal standby supervisory position.

4. **Ground Fault Detection**:

a. The control equipment shall detect positive and/or negative ground faults for all communications, indicating, initiating, and power circuits.

b. In case of ground fault detection, the FACP shall provide visual indication, but general alarm shall not be activated.

c. The system shall be capable of operating with a single break or single ground fault condition in the signal initiating and/or alarm indicating circuits.

5. **Testing of Smoke Detectors**:

a. System software shall automatically test the function of each smoke sensor a minimum of three times each day.

b. Failure of a smoke sensor shall activate the system trouble circuitry, display a "Test Failed" or approved equivalent indication, and identify the individual zone and addressable alarm activating device.

6. **Trouble Processing**:

a. The FACP shall detect and report the following conditions as trouble: Activation of the alarm silence switch, ground fault, low battery voltage, loss of battery voltage, loss of primary power, open circuits, power supply anomalies, short circuits, and smoke detector overcompensation.

b. Upon detection of a trouble condition, the FACP shall provide audiovisual indication, indicate the type of trouble detected and the location of the trouble in terms of address or zone, and send a trouble signal to the security central monitoring station at the guard house [GH], and to the remote annunciator where required.

c. The system shall keep operating even under trouble conditions.

7. **Walk Test**:

a. The FACP shall include a dual-mode walk test feature to allow a single person to test all alarm initiating devices and alarm indicating devices without returning to the corresponding control equipment to reset the system.

b. The walk test feature shall allow pre selection of the alarm initiating and indicating circuits that are to be included in walk test. The walk test shall include a special audible indication of zone change.

c. The walk test shall include a special audible indication that trouble has been detected on an alarm initiating or indicating circuit.

K. **Accessories**:

1. **Batteries**: Shall be continuously charged, sealed, maintenance-free, low self-discharging storage batteries that do not generate explosive or dangerous gases.

Where required, pressure relief valves shall meet the applicable requirements of UL 924.

2. **End-of-Line Resistors (EOLR)**: Shall be provided at the end of each alarm initiating circuit, with the resistance value recommended by the fire alarm system manufacturer.

3. **Monitor Modules**: Shall be furnished and installed for connecting the flow switch from the sprinkler system where available in the same building.

4. **Relays**:

   a. Relays shall be plug-in type, heavy duty, UL approved for fire alarm system use, and be rated at a minimum of 5,000,000 mechanical operations.

   b. Relays shall have self cleaning contacts of silver or an alloy of equivalent performance. Relays shall have at least one set of spare contacts.

L. **Installation**: All equipment and materials shall be installed as required by NFPA 70, NFPA 72, NFPA 75, NFPA 76, and as recommended by the manufacturer and NEMA Training Manual of Fire Alarm Systems.

1.05 SUBMITTALS: Shall be in accordance with Section 01 33 00 (*Submittal Procedures*).

A. **Before Installation**:

1. **Calculations**: Submit the following calculations:

   a. AC branch circuit capacity

   b. Wiring size

   c. Size of power supply

2. **Data**: Submit the following data and documents.

   a. Address and/or zone assignments and other coordination data.

   b. Certification of listings and approvals

   c. Descriptive data of the following items:

      1) Fire alarm control panels (FACP)

      2) Accessories

      3) Alarm indicating devices

      4) Alarm initiating devices

      5) Miscellaneous items

3. **Drawings**: Submit the following drawings in accordance with Section 01 33 00 (*Submittal Procedures*):

a. **Pictorial Maps**: For each locks complex, submit seven sets of pictorial maps, color-coded, to scale, indicating the entire plan layout of the protected areas, and clearly identifying all zones.

b. **Final Design/Shop Drawings**: Submit complete sets of printout copies of the design/shop drawings.

1) Drawings shall include installation details, outline and dimensional data, and one line, schematic, elementary diagrams to indicate functions of equipment components, equipment layout, point to point wiring diagrams, and riser diagrams.

2) Drawings shall show the exact number of devices per circuit, control equipment components, operation sequences, control unit configuration, and any other details required to demonstrate that the system has been coordinated and will properly function as a whole.

3) Diagrams for wiring external to panels shall include the corresponding cable markings, color coding, and identifiers. Wiring connections and interconnection drawings shall show the function and designation of each terminal or group of terminals, each referenced to its corresponding terminal on other drawings.

4. **Messages**: A complete list of all custom information such as messages used for display, printing, and programming.

5. **Technical Information**: The technical information shall have complete information regarding the system, software, FACP and DACT, devices, components and accessories, confirming the capability of system to allow operation, field programming, and maintenance of the equipment, including making all adjustments required when adding or removing alarm initiating or annunciating devices, or modules, components, devices, and accessories in the FACPs, the DACTs, and other fire alarm system equipment, and perform any required field programming, without the need to contact the factory, factory representative, or Contractor, without the need of any special tool or equipment, other than that specified in Paragraph 1.04 F.5.a., and without incurring in additional costs.

B. **Taking-Over Submittals**: After field tests and commissioning have been completed satisfactorily, the Contractor shall furnish and deliver to the Employer's Representative the following, in accordance with Sections 01 33 00 (*Submittal Procedures*) and 01 77 00 (*Taking-Over Procedures*):

1. **Reports**: Copies of field test reports.

2. **Reproducible**: One set of reproducible tracings showing "as-built" conditions, including all modifications.

3. **Drawings**: Sets of printout copies of the "as-built" drawings.

4. **Electronic Format**: "As-Built" drawings in electronic format.

5. **Manuals**: [A16]Operation and maintenance manuals, including complete system description.[A16] The manuals shall include maintenance instructions, listing

routine maintenance procedures, wiring diagrams, possible breakdowns and repairs, and troubleshooting guides. Instructions shall outline the step by step procedures required for system start up, operation and shutdown of the system. The instructions shall include the service manual parts list, and brief description of all equipment and their basic operating features. The troubleshooting guide shall list common causes for breakdowns and malfunctions and recommended repairs. Updating shall include recommendations provided during the training sessions.

6. **Keys**: Two keys for each control panel, manual pull station, and other lockable system components. or other lockable electrical equipment enclosure.

7. **Software**. Submit the following items:

   a. [A16]Software, site specific program listing, installation CDs, and software license.[A16]

   b. Software instruction manuals, with detailed instructions for field programming by trained Employer's Personnel, without the need to consult the factory.

   d. Manufacturer supplied passwords for testing, diagnostic, and troubleshooting.

   e. Manufacturer supplied passwords for field programming.

   f. Contractor shall submit a copy of all software required and used by the Contractor for the setting up, programming and starting up of the fire alarm system, with proper license for use, and password information to the Employer's Representative.

8. **Special Tools**: For each locks complex, all necessary special tools, as recommended by the system manufacturer. Contractor shall submit all hardware and tools required and used by the Contractor for the setting up, programming and starting up of the fire alarm system to the Employer's Representative.

9. [A16]**Reserved**[A16]

1.06 QUALITY ASSURANCE: Shall comply with Section 01 44 00 (*Quality Requirements*).

A. **Testing and Commissioning**: The Contractor shall conduct testing and commissioning work. The equipment shall operate in accordance with the specifications. Testing shall be in accordance with Section 26 90 00 (*Field Testing of Electrical Systems*), manufacturers recommended testing and testing as described in Paragraph 1.06. [A17]Commissioning shall be in accordance with Section 01 91 00 (*Tests on Completion and Tests after Completion*).[A17] The Contractor shall furnish all instruments and personnel required for the tests.

B. **General**:

1. The Contractor shall furnish the services of certified factory engineer(s), as recommended by the equipment manufacturer, to perform the start-up sequence of each system and the required adjusting, calibrating, testing, and other services necessary to ready the equipment for operation and final acceptance.

2. The Contractor shall perform preliminary and final testing of every building fire alarm device to ensure proper operation and correct annunciation.

3. The Contractor shall furnish materials and instruments required for adjusting, calibrating, and testing the equipment. Fourteen days before the tests, the Contractor shall submit a list of all the instruments recommended by the equipment manufacturer or the standards, and additional equipment to be used during the tests.

C. **Preliminary Field Tests**:

1. **Tests before Connection to Control Equipment**: [A17]These tests shall be part of the pre-commissioning requirements detailed in Section 26 90 00 (*Field Testing Electrical Systems*) [A17]

a. **Indicating Circuit Tests**: Measured resistance of supervised alarm indicating circuit wiring shall not exceed 10% of the value of the end of line resistor.

b. **Initiating Circuit Tests**: Measured resistance of supervised alarm indicating circuit wiring shall not exceed 10% of the value of the end of line resistor.

2. **Tests after Connection to Control Equipment**:

a. **Alarm Tests**:

1) Verify alarm over trouble capability.

2) Deactivate all devices in alarm status, if any. Reset system by depressing reset button on control panel. Verify alarm indicators are off and absence of alarm signal.

3) Activate each alarm initiating device type to demonstrate proper operation.

4) Each alarm initiating circuit shall be demonstrated to operate its associated alarm control unit. For each of the alarm initiating devices, verify the following:

a) All audible fire alarm devices sound. Depress push to silence alarm signals or equivalent button.

b) Address indication or zone alarm lamp is on.

c) Alarm signal at remote reporting devices.

d) Air conditioning system shut down.

e) Elevator capture/recall.

f) Verify alarm signal over trouble condition for each loop and ground.

b. **Ground Detection Tests**:

1) Connect temporary jumper from ground to each initiating and signal circuit, at a terminal in either the control equipment or at a device.

2) Verify trouble buzzer and trouble lamp are on and verify remote recording or indication.

3) Remove the temporary jumper and verify trouble buzzer is off. Verify lamps off, except "Power On" lamp.

c. **Heat Detector Tests**:

1) Rate of rise function on each heat detector shall be tested by application of heat from an approved hair dryer or heat lamp.

2) Heat detectors shall alarm the system and shall sustain repeated tests of the rate of rise function without damage or destruction of the fixed temperature element.

d. **Lamp Test**: Depress lamp test button and verify all alarm and trouble lamps on. Trouble signal will sound during lamp test.

e. **Power on Test**: Apply power to fire alarm control equipment and verify that "Power On" lamp illuminates. All switches should be in normal position. All other lamps should be off. Otherwise, depress reset button for approximately 3 seconds and verify lights.

f. **Standby Power Tests**:

1) Place system on standby power by turning off primary power. Verify trouble indication is on.

2) Initiate an alarm. Verify local and remote fire alarm indicating devices and appropriate control functions.

3) Reset system.

4) Reapply primary power and verify "Power On" lamp is on.

5) With batteries fully charged, turn off primary power. Upon completion of 24 hours of operation on battery, place the system in alarm and verify operation of all alarm devices for 15 minutes. Record and report battery voltage under no load conditions.

g. **Trouble Tests**:

1) Remove one lead at a time from each alarm initiating and signaling device type to simulate trouble condition.

2) Verify trouble lamp comes on for each address and zone, trouble buzzer, remote report signal at remote reporting device, trouble silence, trouble ring-back, and reset.

h. **Other Tests**: The Contractor shall demonstrate the operation of the following in all possible operating modes:

1) Each alarm control unit (FACP).

2) Each local and remote reporting device.

D. **Final Field Inspection Tests (FFIT)**:

1. **General**:

a. After preliminary testing, the Contractor shall perform final field inspection tests. Testing shall include preliminary functional test, recommendations of NEMA Training Manual on Fire Alarm Systems. Testing shall further demonstrate all device and equipment functions.

b. Field tests shall be made in accordance with NFPA 72, to verify that the system is complete, fully functional, stable, and ready for normal operation.

2. The system shall be demonstrated to operate in accordance with the requirements of this specification and the manufacturer's specifications. The tests shall include all applicable alarm indicating devices, alarm initiating devices, and control equipment.

3. The Contractor shall furnish service personnel qualified and experienced in the installation, inspection, testing, and maintenance of fire alarm systems. Such personnel shall conduct and perform final field inspection tests in the presence of the Employer's Representative.

E. **Training Services**:

1. **General**:

a. The Contractor shall furnish the services of a certified factory engineer, as recommended by the equipment manufacturer, to instruct, train, and certify Employer's Personnel in the operation, field programming, and maintenance of the equipment, including making all adjustments required when adding or removing alarm initiating or annunciating devices, or modules, components, devices, and accessories in the FACPs, the DACTs, and other fire alarm system equipment, and perform any required field programming, without the need to contact the factory, factory representative, or Contractor, without the need of any special tool or equipment, other than that specified in Paragraph 1.04 F.5.a., and without incurring in additional costs.

b. **Instructor Qualifications**: The instructor shall be a competent, manufacturer certified engineer or technician, trained and experienced in the specified training services, and be fluent in spoken and written English. Working experience resume of the qualified technical personnel shall be submitted.

c. Instruction and Training shall be in accordance with Section 01 79 00 (*Demonstration and Training*).

2. **Period of Training Services**:

a. The Contractor shall conduct the course for up to five users, as directed by the Employer's Representative, for a minimum of three hours per system. Unless otherwise specified, the sessions shall start prior to final field inspection tests.

b. The course shall start at a suitable time prior to the initial operation of the system, and shall be completed prior to final field inspection tests.

END OF SECTION

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