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ENGINEERING

## FIRE DETECTION AND ALARM SYSTEMS

### -- INTRODUCTION --

#### Purpose:

This consensus document is to help assure fire detection and alarm systems are reliable, maintainable, and have a long service life. It was developed with the assistance of alarm system designers, manufacturers, and contractors, the National Electrical Manufacturers Association (NEMA), Professional Engineers of North Carolina (PENC), the Automatic Fire Alarm Association (AFAA), the American Council of Engineering Companies (ACEC-NC), and key operations personnel at State agencies and universities. We use various means to obtain stakeholders input for each revision of these cost-effective fire alarm design criteria.

#### Applicability:

**This document is offered for OPTIONAL use by State agencies and others, in the public interest.** Once the owner or the design professional elects to use it, the relevant criteria it contains are invoked by being referenced or incorporated into the specification written by the engineer for that project, and are no longer optional. Although originally developed for use on State of NC construction projects, previous editions have been very widely used by designers in private sector work, and have also been adapted by jurisdictions outside NC. State agencies and university campuses have elected to use it for all of their projects. **This document, by itself, does not require a fire alarm system in any building. It just provides a set of criteria that may optionally be used, when a system is to be provided. Also, it does not constitute a complete design specification and must be supplemented with project-specific requirements written by the design professional. See pages 20, 32.**

#### Revisions and Circulation:

The North Carolina Department of Insurance (NCDol), Office of State Fire Marshal (OSFM), Engineering Division -- State Property Plan Review Section, issues this consensus-based document for optional use by designers in writing their specification. Electronic copies are available via e-mail. We always appreciate your comments, questions, or suggestions for improvement in its content. Call us at 919-661-5880 x271 or e-mail: [daustin@ncdoi.net](mailto:daustin@ncdoi.net)

This document is revised periodically, based on field reports and recommendations from stakeholders in the interest groups listed above. Refer to the Revision Record on page 19 for information on the significant changes made in this issue.

NOTE: Fine print paragraphs introduced by "NOTE:" (like this one) contain helpful explanatory material pertaining to a preceding paragraph. They often provide information to help users of this document to understand its technical content or underlying rationale. Some of them reference important requirements of other applicable standards. All of these fine print paragraphs are included for **information only**.

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ATTACHMENTS: (SEE PAGES 20, 21, AND 32 FOR INFORMATION ON THEIR CONTENT):

>>> **CHECKLIST** FOR USE BY THE DESIGN PROFESSIONAL OR OWNER'S REPRESENTATIVE, TO DO A SAMPLING-TYPE QUALITY CONTROL INSPECTION OF THE FIRE ALARM SYSTEM AFTER CONTRACTOR'S CODE-REQUIRED 100% TEST AND CERTIFICATION PER NFPA-72. IT IS ALSO HELPFUL TO THE CONTRACTOR FOR VERIFICATION OF INSTALLATION COMPLIANCE.

>>> **UNFORMATTED DOCUMENT TEXT** FOR USE WHEN OPTION 3 ON PAGE 32 IS SELECTED. THIS DOCUMENT SECTION IS DESIGNED FOR CONVENIENT ELECTRONIC PASTING OF TEXT AS JUST PART OF THE FIRE ALARM SECTION IN THE ENGINEER'S WRITTEN SPECIFICATION.

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This document contains prudent, cost-effective, consensus-based criteria for design and installation of fire detection and alarm systems and is based on lessons learned during more than 1000 such projects, as well as information gathered during open meetings with stakeholders. The criteria herein are not intended to conflict with any Code or NFPA Standard. If such conflict is observed, obtain a ruling from the AHJ who reviewed and approved the plans before proceeding with the purchase of materials or system installation.

**1.0 General Criteria for Addressable Fire Alarm Systems:**

**1.1 Authority Having Jurisdiction (AHJ) Defined, Building Permits:**

**For State-owned facilities in North Carolina** the AHJ for Code compliance is the NC Department of Insurance -- Office of State Fire Marshal. The AHJ for construction administration and inspection purposes is the entity that contracted for the design services, either the State Construction Office or the owning Agency, as applicable. NOTE: Fire alarm system inspection or acceptance testing may be delegated to the design engineer by contract.

No building permit is required for construction or renovation of facilities that are funded by the State of North Carolina and located on State-owned land. However, privately-funded projects on land leased from the State (e.g., student housing) must still be submitted to local building officials for approval, permits, and inspections.. (See below.) Written NCDol approval of the plans and specifications submitted for review is considered the equivalent of a building permit for State projects but that alone does not give authorization to proceed with construction. Such authorization requires written clearance from the entity that administers the contract.

**For private sector or local government projects** the AHJ is the local government entity that approves project plans, issues building permits, and inspects construction.

**1.2 Contractor's Shop Drawings, Review, Code Compliance, Completeness of System**

The fire alarm contractor shall submit complete Shop Drawings to the engineer for review, prior to performing any work. These shall clearly demonstrate compliance with the engineer's plans and specifications, which have a System Response Matrix showing the fire alarm system's actions (outputs) required for each type of alarm, supervisory, and trouble signal. NOTE: Any non-compliant features must be fully described. Engineer's approval (with or without corrections) of contractor's Shop Drawings, samples, cut sheets, etc., is for general conformance with the contract documents and design concept. It shall not relieve the contractor of responsibility for full compliance with the project plans and specifications, EXCEPT for any specific non-compliant features for which the engineer gives written authorization.

The fire alarm system shall comply with applicable provisions of the NC Building Code (available for sale at NCDol), and the National Fire Alarm Code (NFPA 72). The Contractor shall furnish all parts, materials, and labor customarily required or provided for a complete and operating system, in accordance with all requirements applicable, even if each needed item is not specifically shown or described in the project plans or specifications.

**1.3** The system is to be the addressable type, with a 24vdc nominal operating voltage. All equipment supplied must be specifically listed for its intended use and shall be installed in accordance with any instructions included in its listing. NOTE: The most common non-compliance with listings is exceeding environmental limits.

**1.4** The system is to have multiple access levels so owner's authorized personnel can disable individual alarm inputs or normal system responses (outputs) for alarms, without changing the system's executive programming or affecting operation of the rest of the system. How to do this must be included in the training required to be given to the owner's designated personnel (see 8.6), and must also be part of the written documentation provided by the fire alarm equipment supplier.

- 1.5 The Fire Alarm Control Unit (FACU) shall be located for convenient, rapid access. When not located in a public or normally occupied area, a Remote Annunciator (RA) with audible-visible trouble indication is required. Consult with facility manager and the local fire official, prior to locating the FACU and any RA or printer. (See 1.6)

NOTE: If there is no constantly attended station, the FACU or RA should be located in a lobby or a corridor adjacent to the entrance most likely to be used by responding personnel. Avoid placing the FACU in a locked room, since this could delay access during an emergency. Avoid M/E rooms for the same reason, and because the environment there is often inhospitable to electronics. Proper location can make an RA unneeded (save \$).

- 1.6 The FACU and all other control equipment locations, including any transponders, sub-panels, and booster power supplies, must be protected by a spot type smoke detector located within 15 feet of the equipment (measured horizontally).
- 1.7 A supervised "AHU Shutdown Defeat" switch must be provided in/adjacent to the FACU or as a key-operated function in the Remote Annunciator (if provided). If the RA option is utilized, provide an informative engraved label at the FACU about this function. The switch must cause a system "trouble" indication when it's placed in the off-normal ("Shutdown Defeated") position.

NOTE: This is to provide the owner with a convenient means to temporarily resume HVAC operation in the event an unwanted alarm will not clear, prior to arrival of the fire alarm service technician.

- 1.8 If the building has smoke control system fans (pressurization or exhaust), or smoke purge fans, provide Hand-Auto-Off switch(es) in or adjacent to FACU. They must be clearly labeled, and FACU-monitored **or** provided with status indicator lights.

NOTE: This is often provided by the controls contractor, rather than the fire alarm contractor, and does not need to be part of the fire alarm system. Responsibility should be clearly indicated in the project specification. For three-position toggle switches we recommend this intuitive arrangement: **Hand (Manual Run)** to be "up" and have an amber LED; **Auto** to be center position with a green LED; **Off** to be down and have a red LED.

- 1.9 An event printer is required for all systems exceeding 100 addressable points, **or** if the building exceeds 3 occupied floors or 60,000 SF. Provide a 120vac printer that uses ordinary (non-thermal) paper. Install in location selected by the owner. For high rise buildings only, the printer is required to be FACU-monitored and powered from a 120vac circuit supported by the generator.
- 1.10 Each addressable fire alarm system must include an LED-type "zone" annunciator at (or in) the FACU, or in another location if acceptable to the AHJ. As a minimum, this annunciator is to indicate the specific type of alarm or supervisory signal (smoke detector, waterflow, sprinkler valve closed, etc.), for groups of addressable devices. The area ("zone") that is represented by each LED shall not exceed 1 floor or 22,500 square feet, and must not cross building fire walls or smoke compartments.

EXCEPTION #1: Systems in 1 or 2-story buildings, which have 30 or fewer initiating devices, are permitted to omit the LED-type "zone" annunciator.

EXCEPTION #2: Systems with a Graphic Annunciator (GA) are permitted to omit the LED-type "zone" annunciator.

(Exceptions Continued)

1.10 (Continued)

EXCEPTION #3: The LED annunciator is permitted to be omitted if the FACU has a multi-line display that automatically defaults to displaying the first alarm, plus the first 3 (minimum) waterflow alarms and the last alarm. This is permitted to be done using 2 automatically alternating screens. If there is no sprinkler system, program the FACU to show the first 4 alarms plus the last alarm received.

EXCEPTION #4: Addressable systems that are not required to have an event printer by 1.9 are permitted to substitute a printer for the above LED annunciator. Locate for convenient access by responding emergency personnel, as directed by owner.

1.11 Alarm notification appliances (audible and visible) are to comply with NFPA 72, the North Carolina Building Code, and North Carolina Accessibility Code criteria for intensity and placement. The standard audible evacuation signal is the ANSI S3.41 three-pulse temporal pattern **except** it shall not be used if the planned action during fire emergency is to relocate occupants or protect in place, instead of immediate evacuation (e.g., some health care facilities, prisons). All strobe lights installed in a single space must be synchronized. See additional alarm notification appliance requirements in 2.4, including alternatives discussed in fine print NOTE for special situations. Contact the AHJ for additional information or to seek approval of any alternative design. CAUTION: For Group R-2 occupancies see special requirement for strobe circuits in NCBC 907.9.1.4., and for Group I-1 or R-1 see NCBC 907.9.1.3

1.12 Alarm notification appliance (NAC) circuits shall be NFPA 72 Style Y (Class B). The load connected to each circuit must not exceed 80% of rated module output and the coverage of each circuit shall not exceed 3 floors (to limit the effect of faults, and to facilitate trouble-shooting). The NAC voltage drop during alarm must not exceed 14% of the voltage measured across the batteries at that time. To achieve this, the design must consider wire size, length of circuit, device load, inherent voltage loss within the FACU's power supply, etc. The contractor shall use power outage testing to verify that the NAC circuit was designed and installed properly. (See 1.14)

NOTE: Incorrect Notification Appliance Circuit performance is a frequent cause of expensive, time-consuming rework being required on fire alarm systems to obtain AHJ acceptance.

1.13 The following protection against voltage transients and surges must be provided by the fire alarm equipment supplier, and installed by the electrical contractor:

On AC Input: A feed-through (not shunt-type) branch circuit transient suppressor such as the EFI E100HW120, Leviton 51020-OWM, Emerson/Northern Technologies TCS-HWR, Transtector ACP100BW series, or any equivalent UL 1449 - 2nd Edition Listed device submitted to and approved by the electrical design engineer. Install suppressor in a listed enclosure near the electrical panelboard, and trim excess lead lengths. Wind small coil in the branch circuit conductor just downstream of the suppressor connection. Coil to be 5 to 10 turns, about 1" diameter, and securely tie-wrapped. This series impedance will improve the effectiveness of the suppressor in clipping fast rise time voltage transients.

On DC Circuits Extending Outside Building: Adjacent to the FACU, and also near point of entry to outlying building, provide "pi"-type filter on each leg, consisting of a primary arrester, series impedance, and a fast acting secondary arrester that clamps at 30v-40v. Some acceptable models: Innovative Technology D2S33-2ML, Simplex 2081-9027/-9028, Transtector TSP8601, Ditek DTKxLVL series, Citel America B280-24V, Leviton 3824-OWM, Northern Technologies DLP-42. Submit data on others to the engineer for approval. UL 497B listing is normally a prerequisite for their consideration. Devices using only MOV active elements are not acceptable.

- 1.14 Systems are to be provided with a separate and independent source of secondary power. The State doesn't contract for full Central Station Service (with runners), so all systems that report to a Central or Remote Supervising Station shall have a minimum of 60 hours secondary power capacity, plus 5 minutes of full alarm load. Proprietary and other systems require 24 hours capacity plus 5 minutes alarm load.

EXCEPTION #1: For emergency voice/alarm systems, use 15 minutes for alarm load.

EXCEPTION #2: If single, automatic starting generator is provided, use 24 hours for battery endurance, plus the appropriate (5 or 15 minutes) alarm load. See NFPA 72.

NOTE: Most campus alarm supervising stations are normally classified as "Proprietary" systems.

**Include a copy of system battery sizing calculations with the shop drawing submittal to the engineer. Use manufacturer's battery discharge curve to determine expected battery voltage after 60/24 hours of providing standby power. Then use calculated Notification Appliance Circuit current draw in the alarm mode to determine expected voltage drop at EOL, based on conductor resistance per manufacturer's data sheet or NEC 2000, Table 8. Remember to double the ohms per foot since two conductors are required to power the circuit. Also, add any inherent voltage drop caused by the system's power supply.**

**The voltage drop at EOL must not exceed 14% of the expected battery voltage, after the required standby time plus alarm time. (Typically, for a 24 volt system, this limits the voltage drop from the battery to the EOL to 3 volts). Determine "worst case" voltage at far end of each NAC, by subtracting its calculated V-drop from the expected battery voltage. The result must be no less than the minimum listed operating voltage for the alarm notification appliances used.**

**All of these calculations must be placed on a dedicated sheet of as-built drawings, for future reference by fire alarm service technicians. NAC voltage drop is to be verified during system tests.**

NOTE: Free software for the above calculations is available at: <http://www.alarmsaf.com/powercad.html>

- 1.15 Automatic fire/smoke detectors used shall be selected in accordance with Table I, **Applications Matrix for Selecting Detection Devices**, which follows this Section.

NOTE: The Table does not require detection devices in any location or application, but simply states how they are to be selected when automatic detection is planned for the areas or occupancies listed. Where ionization or photoelectric is specified, multi-sensor smoke detectors including these technologies are permitted to be used.

NOTE: Multisensor detectors (not to be confused with "combination" detectors) are recommended for difficult environments such as college dormitories, health care facilities, jails and prisons. They employ two or more integrated operating principles in a single housing. The outputs of their analog sensors are transformed into digital signals that are combined and then processed by special algorithms. These computations enable multi-sensor smoke detectors, as a class, to respond faster when fire occurs and they also improve their ability to discriminate between the normal ambient changes in a building and those produced by fire. As a result, they have extremely low rates of nuisance ("false") alarms, an attribute that is critical in some applications.

NOTE: This document covers only addressable fire alarm systems. Non-addressable, non-analog initiating devices have commonly been called "conventional" detectors. However, since most new systems now utilize analog-addressable smoke detectors, they are the norm (or the "convention" per Webster's). Therefore, the preferred term for those older technology devices is now "non-addressable".

NOTE: Except where required by ANSI A17.1 for sprinkler installations in elevator shafts or machine rooms, heat detectors are not required in areas protected by an NFPA 13 sprinkler system, as each sprinkler head also serves as a heat detector.

**TABLE I -- APPLICATIONS MATRIX FOR SELECTING DETECTION DEVICES**

SMOKE/FIRE DETECTOR APPLICATION	ACCEPTABLE DETECTOR TYPES*			
	ION	PHOTO	IR/UV FLAME	HEAT
Atriums/Auditoriums		<b>B**</b>		
Corridors - Any Occupancy		X		
Office Areas	X	X		
Cable Rooms (PVC)		X		
Elevator Equipment Rooms	X			
Furnace/Boiler Rooms				X
Gymnasiums		<b>B**</b>		
Laboratories (Chemical)			X	X
Linen Rooms		X		
Mech/Elect. Equipment Rooms	X	X		X
Motor-Generator Rooms			X	X
Attics (Non-Conditioned Environment)				X
Loading Docks			X	X
Non-Conditioned or Hostile Environment			X	X
Storage (Conditioned Environment Only)	X	X		
Duct Smoke Detectors		X		

\* Multi-sensor or multi-criteria detectors employing the indicated technology are an acceptable alternative to the type of detector(s) indicated for any application.

\*\* "B" symbol indicates Projected Beam (Linear Beam) type smoke detector with separate transmitter and receiver, or with transceiver and prism reflector. Typical operating range limits are 30-300 feet but best service is obtained when the IR light beam spans 50-200 feet. Consider potential obstructions (banners, etc.) and accessibility for required maintenance.

CAUTION: Spaces which may be exposed to vehicle exhaust, fumes from nearby cooking, fireplaces, etc., high/low temperatures or high humidity (including dishwashing, laundry) are generally unsuitable for the use of smoke detectors. Heat detectors should include the rate-of-rise feature unless installed where temperatures may rise more than 15°F/minute from space heaters, vehicle exhaust stacks, furnaces, or following outside door closure.  
*Always consider detection device ratings vs. the environment of planned installations!*

**2.0 Emergency Voice/Alarm Communications Option:**

2.1 Where specified by the design engineer, or required by Code, the system shall have Emergency Voice/Alarm Communications capability. This may include just item (1), or both items (1) and (2), as follows:

- (1) One-way Emergency Voice-Alarm (PA Type) System
- (2) Two-way (Firemen's Telephone) Communications System

NOTE: Firemen's Telephone Systems are provided in high rise buildings, unless the local Fire Chief and AHJ agree to their omission. One-way Voice-Alarm (PA) systems are required for Assembly occupancies exceeding 1000 persons and may optionally be installed in large, low-rise buildings. The PA feature is useful for non-fire emergencies (e.g., bomb threat or severe weather) but is not for general building paging. Please call if your "A" occupancy calculates to hold more than 1000 persons but no room or space exceeds 300 and there is no location constantly attended. More benefit might be obtained from additional detection instead of a voice-alarm system.

2.2 Emergency Voice/Alarm Communications Systems installed in high rise buildings shall be designed for survivability in accordance with NFPA 72. An acceptable way to meet this is to have widely separated dual risers and to feed approximately half the speakers on each floor from each riser.

NOTE: This requirement is based on the fact that total evacuation may be impractical in high rise building fires, so the occupants of some zones may need to be relocated to areas of refuge and given further instructions until the situation is under control and their safety is assured. For most other buildings, where total and rapid evacuation is both practical and intended, alarm notification only needs to function for a few minutes to be effective and, therefore, survivability of the fire alarm system is not a major consideration in those cases.

2.3 One-way Voice/Alarm (PA) installations in buildings classified as high rise shall be dual-channel, permitting the transmission of an evacuation signal to one or more zones and simultaneous manual voice paging to other zones, selectively and in any combination. For all buildings, the One-way Voice/Alarm (PA) Communications System, where provided, must meet the requirements of 2.4 through 2.8, below.

2.4 Each floor, stairway, elevator **bank**, and Assembly space (>300) is to be a separate communication zone. Speakers are to be spaced to provide required sound levels. Check audio levels in all areas; adjust taps or install additional speakers, if needed. Strobe lights are not to be installed in elevator cars, stairways, or photo darkrooms.

NOTE: Speakers in stairways should normally be installed at every third floor landing, to avoid excessive audio levels and reverberation. Speakers in elevator cars, restrooms, and other very small, confined spaces should be tapped on very low power levels or, where permitted by the AHJ, muted to reduce sound output. Intelligibility is improved in most building areas by installing speakers closer together and using lower wattage, as opposed to the opposite. Some mechanical spaces (especially chiller rooms) and factory-industrial occupancies may have sound levels that are too high to permit effective audible alarm notification. In those situations, provide visible alarm notification appliances with ratings and spacing selected for compliance with NFPA 72. Large Assembly occupancies generally require special system design and procedural considerations to assure safe and effective egress of large crowds in a fire (or other) emergency, without causing panic. Some medical facility areas such as OR, ICU, CCU, PICU, Sleep Labs, and animal research areas also need special designs, subject to AHJ approval.

2.5 Normal audio amplifier power shall be a minimum of 120% of the system design load, per channel. For purposes of this calculation, use the amplifier's continuous two-tone output rating and the designed power setting of each individual speaker. **Provide a copy of this calculation with the shop drawing submittal to the engineer. Also include on the "calculations" sheet included as part of the as-built drawings.**

2.6 At least one backup amplifier shall be provided for each channel, equal in power to the largest primary amplifier. For systems with distributed amplifiers, provide one backup at each transponder location. Failure of any amplifier shall automatically result in the defective unit being switched off-line and replaced with the backup.

- 2.7 The audible emergency evacuation signal shall comply with 1.11. This does not preclude the system from providing additional (non-evacuation) notification signals, including recorded voice messages, for specific emergency situations. Visible alarm notification appliances must also be provided per NC Code and ADA requirements.
- 2.8 One-way Voice/Alarm and Two-way (Fireman's Telephone) digital audio circuits are to be wired with twisted pair copper conductors (AWG 18 minimum) in jacketed cable, or with fiber optic cable. Analog audio circuits are to be wired with AWG 18 minimum twisted pair copper conductors in shielded cable, Belden 8790, West Penn 293, or equal. Cable jacket color is to be gray, with red (+) and black (-) conductor insulation. For shielded cables, the shield must be continuously connected from the amplifiers to the end of line. Tape the shield splice at each speaker and handset, to insulate from ground. Single point ground the shield at the amplifier or control unit unless prohibited by system manufacturer. (See 6.7 and 6.9 for other wiring reqmts.)
- 2.9 The Fireman's Telephone system, if provided, shall indicate the location of each phone station in use and shall permit selective calling and party line operation. Provide stations per Code and also in each elevator machine room, at the fire pump, and in the room(s) containing the main switchgear and emergency generator.

**3.0 Monitoring of Signals by Supervising Station:**

3.1 Each system with automatic fire detection, or which monitors a sprinkler system, shall be equipped with a 4-channel (minimum) Digital Alarm Communicator Transmitter (DACT) for transmission of fire alarm, supervisory, and trouble signals to a Central Station, Remote Supervising Station, or Proprietary Supervising Station. The following signals shall be reported as applicable, in accordance with 3.4.

- **Fire Alarm**
- Sprinkler Waterflow Alarm
- Fire Pump Running Alarm (if pump provided)
- Fire Pump Abnormal Status Supervisory Signal (See 3.2)
- Sprinkler Valve Tamper (Closed) Supervisory Signal (See 3.2)
- Sprinkler Low Temperature / Air Pressure Supervisory Signal (See 3.2)
- Burglary / Intrusion / Duress / Other Security or Emergency Alarm (See 3.3)
- **Fire Alarm System AC Power Trouble (only if 120vac interrupted for 1-3 hours)**

EXCEPTION #1: In lieu of a DACT, the use of an addressable network is acceptable. Other appropriate means of transmitting fire alarm system signals off-premises may be permitted to be used, at the discretion of the AHJ who approves the plans.

EXCEPTION #2: With AHJ permission, the alternative described in 3.6 is permitted.

EXCEPTION #3: With AHJ permission, the transmission of signals to a supervising station may be omitted. This is typically done only for very small facilities or those so isolated that the probability of successful fire response is minimal.

- 3.2 With AHJ permission, sprinkler and fire pump *supervisory* signals are permitted to be combined by the DACT, for transmission. Contact the AHJ for more information.
- 3.3 When specified by the engineer, the DACT shall transmit a separate Computer Room Environmental Monitoring Supervisory Signal, to warn of dedicated cooling system failure and/or water under the raised sub-floor.

3.4 The precedence of signals transmitted to the Supervising Station shall be as follows:

1. Fire Alarm
2. Security Alarm
3. Supervisory Signal
4. Trouble Signal\*

\*Loss of AC power to FACU must not be sent transmitted until it has continued for **at least 1 hour but no more than 3 hours**. This avoids nuisance transmissions to the supervising station for brief power outages (switching transients, thunderstorms).

NOTE: Do not confuse fire suppression system "supervisory" signals with fire alarm system "trouble" signals. These are completely different types of signals, annunciated and transmitted as separate and distinct events.

3.5 The Contractor must provide a type of DACT that is compatible with the owner's alarm receiving equipment, or the Supervising Station selected by the owner, as applicable. He must also program the PROM, connect each DACT to the telephone line(s) provided to him, and verify proper signal receipt by the Supervising Station. The transmission means shall comply with NFPA 72 (which does not permit VOIP).

NOTE: See NFPA 72 for means of transmission requirements. It permits the phone line(s) to be shared, since the DACT can capture a line that's busy if needed. However, PBX station circuits are not permitted to be used. Contact the AHJ if VOIP, cellular, derived local channel, or RF technology is intended for the reporting means.

3.6 For buildings where full-time on-site staffing assures response (prison camps), an outside bell and high power strobe light could be an effective means of signaling alarm. Where specifically permitted by the AHJ, the following shall be provided:

- Fire Alarm Bell, 10" diameter, weatherproof
- Strobe Light, 100 cd minimum, **double** flash, clear lens, weatherproof (vehicular) (Austin 2020, Federal Signal 131DSTxxxC, Wheelock MAX-24, **or approved equal**)

#### **4.0 Smoke Detector Application and Installation:**

4.1 All addressable spot type and duct smoke detectors shall be the analog type and the alarm system shall automatically compensate for detector sensitivity changes due to ambient conditions and dust build-up within detectors. This feature must be armed and sensitivities set prior to acceptance of the system. (See 7.2, 7.3, and 7.4)

4.2 Dormitory and student apartment sleeping rooms and suite areas shall have smoke detectors with "sounder" bases controlled by the FACU, to assure audibility, unless the AHJ approves otherwise. Program the detectors so that sleeping room smoke initiates local alarm in the room, pre-signal indication at the FACU, and notification at the Supervising Station. Any common area alarm must cause immediate general alarm throughout the building, including all sounder bases in the sleeping rooms.

4.3 Spot-type detectors must be the plug-in type, with a separate base (not a mounting ring), to facilitate their replacement and maintenance. The base shall have integral terminal strips for circuit connections, rather than wire pigtails (see 6.5 for details). Each detector or detector base shall incorporate an LED to indicate alarm.

4.4 Spot-type smoke detectors shall have a built-in locking device to secure the head to the base, for tamper resistance. For detectors mounted within 12 feet of the floor, activate this lock **after** the system has been inspected and given final acceptance.

- 4.5 Spot-type smoke detectors shall not be used where ceiling height exceeds 25 feet because it makes access for maintenance very difficult and could impede response.

NOTE: Projected beam smoke detectors are recommended for these applications because they can be mounted on wall surfaces, where access is convenient (or at least where they can be reached with an extension ladder). These integrating devices can be located to compensate for possible smoke stratification. Refer to NFPA 72.

- 4.6 Unless suitably protected against dust, paint, etc., spot type smoke detectors shall not be installed until the final construction clean-up has been completed. In the event of contamination during construction, the detectors must be **replaced**.

CAUTION: Covers supplied with smoke detector heads do **not** provide protection against heavy construction dust, spray painting, etc., and must not be used for that purpose. They are suitable only during final, minor cleanup or touchup operations.

- 4.7 A detector installed where accidental damage or deliberate abuse is expected shall be provided with a guard that is listed for use with it and is acceptable to the AHJ.

NOTE: Mechanical guards always make access for regular testing and maintenance more difficult. Therefore the preferred approach, where practical, is to relocate the detectors out of harm's way, consistent with proper device response. For prison cells, one alternative is to arrange the ventilation so that a spot type detector can be installed adjacent to each cell, in the low velocity HVAC return air stream, but not necessarily in a duct. This detector is usually in the adjacent mechanical chase, beyond a baffle to protect it from abuse, accessible for maintenance. Caution: Duct type smoke detectors are not permitted to substitute for area detection.

NOTE: Air sampling type smoke detectors should be considered to protect prison cells, mental patient rooms, and other locations of relatively limited area which have a high potential for severe abuse. They're also very suited for use in semiconductor clean rooms and other very high value facilities where the **capability** for high sensitivity and multiple alarm levels is useful. Contact the NCDol for more information on this technology.

- 4.8 Identification of individual detectors is required. Assign each a unique number as follows, in sequence starting at the FACU: **(Addressable Loop # -- Device #)** Show on the as-built plans, and also permanently mount on each detector's base so that it's readable standing on the floor below without having to remove the smoke detector. Exception: For detectors with housings (i.e., air duct, projected beam, air sampling, flame), apply the identification to a suitable location on exterior of their housing.

- 4.9 All air duct/plenum detectors must have a Remote Alarm Indicator Lamp (RAIL) installed in the nearest corridor or public area and identified by an engraved label affixed to the wall or ceiling. Duct smoke detectors are permitted to be installed only inside an air duct. It is not appropriate to mount them in front of a return air opening. Duct detectors shall also be installed in a manner that provides suitable, convenient access for required periodic cleaning and calibration (see 4.11).

- 4.10 Duct detector sampling tubes shall extend the full width of the duct. Those over 36 inches long must be provided with far end support for stability.

NOTE: The preferred method for providing support is to extend the intake tube through the far side of the duct, seal around the tube where it penetrates the duct wall, and plug the end with a rubber stopper. This facilitates visual inspection, intake tube cleaning, and injection of smoke or equivalent aerosol for testing the detector.

- 4.11 Each duct detector installation shall have a hinged or latched duct access panel, 12x12 inches minimum, for sampling tube inspection and cleaning. Indicate airflow direction on the duct, adjacent to the detector, using stencil or permanent decal.

- 4.12 **Recommended** design for most occupancies: Install smoke detectors in interior exit access corridors, M/E rooms, computer rooms, and unsprinklered storage rooms.

**5.0 Fire and Life Safety Criteria for Doors Controlled by Fire Alarm System:**

5.1 For life safety reasons, any exit or exit access doors that are locked to delay egress, in accordance with 1008.1.8.6 of the NC Building Code (2006 edition), must utilize one of the following types of locking hardware:

- Magnetic Lock (fail-safe) utilizing a 24vdc magnet and contact plate
- Electro-Mechanical Lock (fail-safe) with reverse bevel type dead bolt.

These doors must **immediately** unlock upon any fire alarm signal, loss of building AC power, **disablement of the fire alarm system** (defined as loss of its 24vdc power), or upon manual operation of an unlock switch at a constantly attended location.

Where installed on smoke or fire doors, power failure shall cause these mechanisms to default to the egress mode with normal mechanical latching.

NOTE: This is to assure the smoke or fire doors continue to perform their vital function in a power failure situation, instead of swinging open and allowing the passage of smoke and fire between compartments.

5.2 Smoke doors are permitted to be held open by 24vdc wall/floor-mounted magnets powered by the FACU, and released upon alarm. The resulting current drain shall be included in the standby battery calculations **or** the system must be programmed to drop the door hold-open magnet load 60 seconds after the loss of 120vac power.

NOTE: Wall-mounted magnetic door holders and separate heavy-duty closers are recommended for control of smoke doors, instead of combination frame-mounted units that include an integral smoke detector and control mechanism, due to long-term reliability problems with the latter. Although ac-powered electromagnets are available, they have several disadvantages including the need for many additional addressable control relays, the Code requirement to separate power limited and non-power limited circuits, safety considerations for fire alarm maintenance personnel (some magnets are 120vac), and noticeable door hum caused by the magnets operating on self-rectified voltage ("raw", unfiltered dc from integral bridge rectifier).

NOTE: Relevant NFPA Standards require that smoke door to floor clearance not exceed 3/4 inch and that the gap between door pairs not exceed 1/8 inch.

5.3 For life safety reasons, all rolling steel fire doors must descend at a constant rate of 1 foot/second maximum, whether released by their thermal link or closed by FACU command. Also, in response to strong requests from many facility managers, these fire doors must either: (1) Automatically reset when raised to their normal position, **or** (2) Have a motor down - motor up mechanism controlled by the FACU.

NOTE: Doors that drop faster are a serious safety hazard to anyone who may be under them when they're released by the FACU. Those that require a mechanic to raise and reset their mechanism impose substantial recurring cost and inconvenience to the owner. Listed retrofit kits are available to correct problems with the drop rate or reset of any manufacturer's rolling steel fire door. Contact the NCDol for additional information.

NOTE: Contact the AHJ for guidance on programming the fire alarm system to determine which fire alarm initiation devices should cause release of these doors. The customary setup is to have this done for selected smoke detector and/or waterflow alarm in adjacent spaces, rather than upon general alarm, to minimize the potential disruption of possible nuisance alarms in remote parts of the building. We do not recommend that these doors drop for a single smoke alarm. Also, the FACU should have an appropriate information placard regarding this function, to avoid nuisance drops during routine system maintenance operations.

**6.0 System Configuration and Installation:**

- 6.1 Signaling Line Circuits (SLC's, also called addressable loops) must be NFPA Style 6 (Class A) with no "T" taps. Each must have a minimum of 20% spare addresses, for future use. Individual loops are permitted to cover more than 1 floor of a building.
- 6.2 To minimize wiring fault impact, isolation modules shall be provided in all of the locations listed below. If ceiling height  $\leq 10$  feet, isolator base type initiating devices are permitted to be used to satisfy any or all of the following:
1. In or immediately adjacent to the FACU, at each end of the addressable loop. These two isolators must be in the same room as the FACU and within 15 feet.
  2. After each 25 initiating devices and control points on the addressable loop, or a lesser number where recommended by the manufacturer. (Check instructions.)
  3. For loops with less than 25 devices and control points, install an isolator at the approximate middle of the loop (in addition to those at the FACU).
  4. Near the point any addressable circuit extends outside the building, except for those attached to the building exterior walls and well sheltered by walkways.
  5. For loops covering more than one floor, install isolator at terminal cabinet on each floor (with additional isolator[s] on any floor with over 25 addresses).

Each isolation module must be clearly labeled, readily accessible for convenient inspection (not above a lay-in ceiling), and shown on as-built drawings

- 6.3 All fire alarm system wiring shall be in metal conduit, surface metal raceway, or (in finished areas only, for improved appearance) surface non-metallic raceway.

EXCEPTION #1: PVC conduit is permitted to be used underground, in concrete, and in locations subject to severe corrosion (such as coastal facilities or lab/process areas).

EXCEPTION #2: Buildings on the historic register, when permitted by the AHJ.

- 6.4 All conduits that penetrate outside walls from air conditioned space must have internal sealing (duct-seal), to prevent condensation from infiltrating humid air.
- 6.5 There shall be **no** splices in the system other than at device terminal blocks, or on terminal blocks in cabinets. "Wire nuts" and crimp splices will **not** be permitted. Permanent wire markers shall be used to identify all connections at the FACU and other control equipment, at power supplies, and in terminal cabinets (see 6.6).
- 6.6 In multistory buildings, all circuits leaving the riser on each floor shall feed through a labeled terminal block in a hinged enclosure accessible from the floor. If building layout requires the terminal cabinet to be above a drop ceiling, its location must be clearly and permanently identified with a placard readable from floor. Terminal block screws shall have pressure wire connectors of the self-lifting or box lug type.
- 6.7 Addressable loop (signaling line) circuits shall be wired with type FPL/FPLR/FPLP fire alarm cable, AWG 18 minimum, low capacitance, twisted shielded copper pair. Cable shield drain wires are to be connected at each device on the loop to maintain continuity, taped to insulate from ground, and terminated at the FACU. Acceptable cables include Atlas 228-18-1-1STP, BSCC S1802s19 (same as EEC 7806LC), West Penn D975, D991 (AWG 16), D995 (AWG 14), or equal wire having capacitance of 30pf/ft. maximum between conductors. Belden 5320FJ acceptable if only FPL rating needed. The cable jacket color shall be red, with red (+) and black (-) conductor insulation. (See 6.9 for other wiring.)

6.7 (Continued)

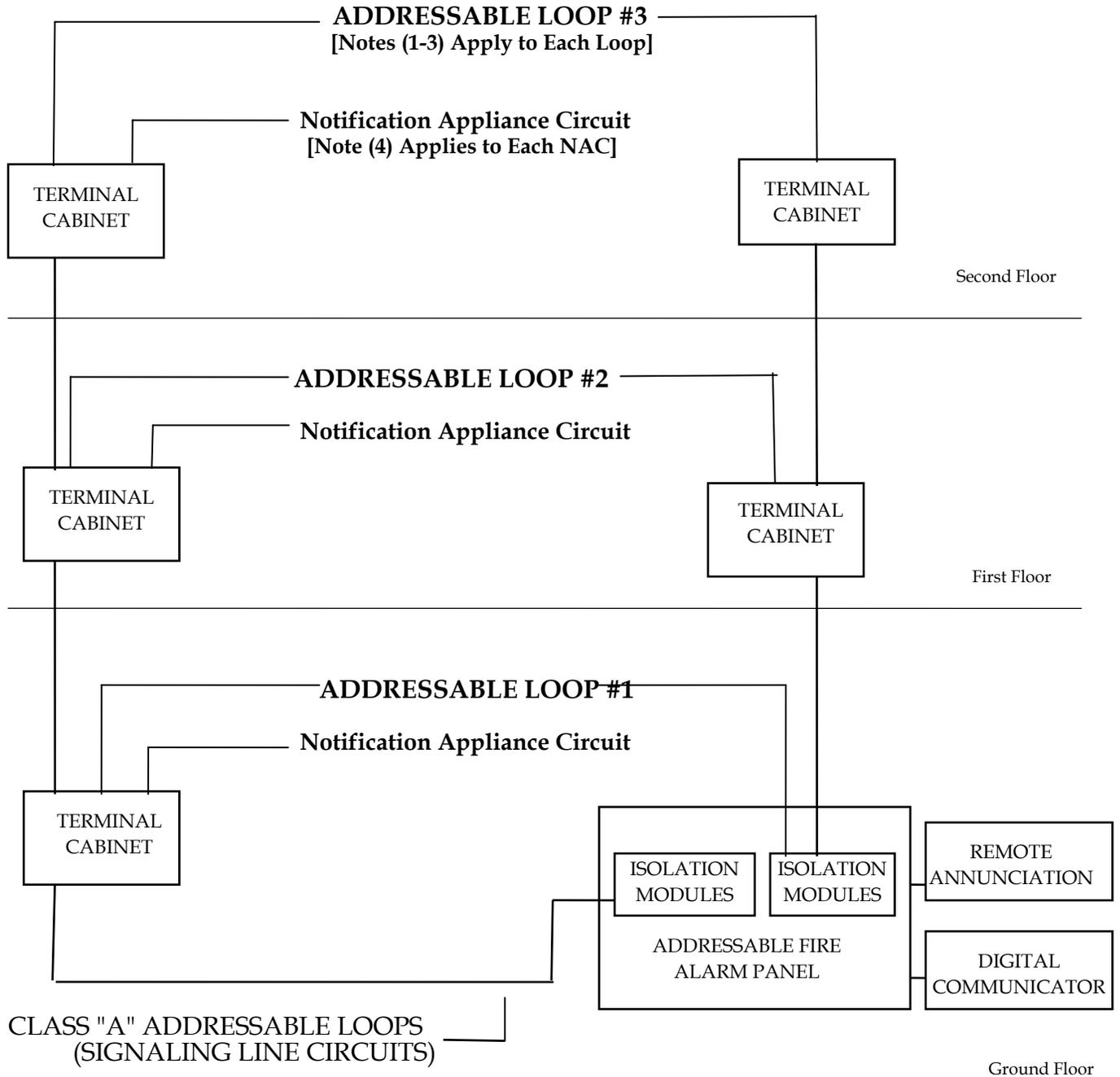
EXCEPTION #1: Unshielded cable, otherwise equal to the above, is permitted to be used if the manufacturer's installation manual requires, or states preference for, unshielded cable.

EXCEPTION #2: In underground conduit, use Type TC or PLTC cable (PE insulated) to avoid problems from moisture.

CAUTION: The previous requirement for 3/4" conduit no longer exists but cable size and the requirement to maintain a Class "A" loop on all Signaling Line Circuits frequently cause conduit fill to exceed specified maximums if the 1/2" size is used. Therefore, 3/4" raceway is still strongly recommended.

- 6.8 Addressable interface modules (used to monitor all contact type initiating devices) must be located in conditioned space, unless they are tested, listed, and marked for continuous duty across the range of temperatures and humidity expected at their installed location. With AHJ approval they may be permitted to serve as many as 3 sprinkler system valve supervisory switches, or 6 heat detectors, in a single space.
- 6.9 Except as required by 2.8 and 6.7, all other circuits in the system shall be wired with AWG 14, stranded copper, THHN/THWN conductors, installed in conduit. Color code as shown below throughout the system, without color change in any wire run:
  - Alarm notification Appliance Circuits (horns/strobes).....Blue (+)/Black (-)
  - Separate 24vdc Operating Power (for equipment).....Yellow (+)/Brown (-)
  - Door Control Circuits (magnet power, if from system).....Orange
  - Circuits from ZAM's to Monitored Devices (AWG 14/16)...Violet(+)/Grey (-)
- 6.10 Notification Appliance Circuit booster ("ADA") power supplies must be individually monitored by the FACU and protected by a smoke detector per NFPA 72. They shall not be located above a ceiling, or in non-conditioned space. NOTE: A 24vdc power circuit serving addressable control relays must also be monitored for integrity.
- 6.11 All junction boxes shall be painted red **prior** to pulling the wire. Those installed in finished areas are permitted to be painted outside to match the finish color.
- 6.12 The branch circuit breaker(s) supplying the system must be physically protected by panelboard lock or handle lock and each must be identified with a 1/4" permanent red dot applied to handle or exposed body area.
- 6.13 Provide an engraved label at each fire alarm system control unit, system sub-panel or data gathering panel, supplementary notification appliance (SNAC) panel, digital alarm communicator, etc., identifying its 120vac power source, as follows:  
**Panelboard location, panelboard identification, and branch circuit number.**
- 6.14 The fire alarm system shall monitor 120vac power to shunt trip breakers used in conjunction with fire suppression systems. Examples include a shunt trip used for cooking appliance power shut-off when the kitchen hood fire suppression system shoots, or primary elevator power shut-down upon sprinkler flow in any elevator equipment space or shaft. Use an addressable monitor module to accomplish this **supervisory** function.
- 6.15 Unless the AHJ requires otherwise, all duct smoke detectors shall be programmed for fire alarm (not for supervisory annunciation).

FIGURE A: TYPICAL RISER DIAGRAM FOR ADDRESSABLE SYSTEMS (SEE NOTES)



- NOTES: (1) This shows 1 loop per floor, a common design for larger multi-story buildings. It also has the outgoing and return loops run in 2 separate vertical risers, to promote survivability during fire (critical for high-rise).  
 (2) Unless the specification requires otherwise, a single loop is permitted to serve a maximum of 3 floors and, except for High Rise buildings, the outgoing and return loops may share a common vertical chase. However, if any loop serves more than 1 floor, include an isolation module at each terminal cabinet it uses.  
 (3) Provide isolation modules (or isolator bases) along each SLC (addressable loop), in accordance with 6.2.  
 (4) Notification Appliance Circuits (NAC's) are permitted to be Class "B" and, unless specifically permitted by the specification (e.g., for very small footprint buildings), each shall serve a maximum of 3 floors.

**7.0 Programming, Testing, and Certification:**

- 7.1 All connections to the FACU and the system's programming shall be done only by the manufacturer, or by an authorized distributor that stocks a full compliment of spare parts for the system. The technicians who do this are required to be trained and individually certified by the manufacturer, for the FACU model/series being installed. This training and certification must have occurred within the most recent 24 months, except that a NICET Level III certification will extend this to 36 months. **Copies of the certifications must be part of the Shop Drawing submittal to the engineer, prior to installation. The submittal cannot be approved without this info.**

The technician who makes final connections and programs the FACU is legally the "installer" even though most field connections to system devices and appliances are normally made by electrical contractor personnel. The responsibility for assuring a proper installation overall rests with this individual. In addition to doing the final hookups and activating the system, this individual is expected to check enough field connections to assure a proper job was done there. The absence of system "trouble" signals is not a sufficient measure of the field wiring, which could have "T" taps, the wrong type of wire, improper terminations, ground (drain wire) issues, etc.

NOTE: This means the electrical contractor is not permitted to apply power to the FACU or any system power supplies, or to make any connections to them. However, the electrical contractor is responsible for installing and making field connections to initiating devices, notification appliances, control relays, and other components.

- 7.2 When programming the system, activate the automatic drift compensation feature for all spot-type smoke detectors. Systems with alarm verification are **not** to have this feature activated without written direction from the owner's representative or the AHJ. Alarm verification must **not** be used with multi-sensor/multi-criteria detectors under any circumstances, as inadequate system response may result.

NOTE: Most applications of analog addressable smoke detectors do not require alarm verification to reduce nuisance alarms, as they are better able to discriminate between fire and common non-fire ambient events. A short operational test with normal occupancy can determine if transient ambient events are a problem.

- 7.3 Set spot-type smoke detector sensitivities to normal/medium, unless directed otherwise by the design engineer/owner's rep.

NOTE: High sensitivity may be appropriate in relatively benign, clean environments such as art museums and libraries, to improve system response time without causing nuisance alarms.

- 7.4 Print a complete **System Status and Programming Report**, after the above steps have been done. This must include the program settings for each alarm initiating device and the current sensitivity of each analog addressable smoke detector. See 7.5.

- 7.5 The manufacturer or authorized distributor (by definition, "installer") must 100% test all site-specific software functions for the system and then provide a detailed report or check list showing the system's operational matrix. This documentation must be part of the "**System Status and Programming Report**" described in 7.4.

NOTE: If AHU shutdown occurs for any alarm, then the matrix would indicate the specific control relay(s) for that function being commanded to operate for alarm from any initiating device. If a rolling steel fire door is to drop only upon waterflow alarm from its sprinkler zone, or upon any two spot smoke detectors in adjacent spaces being simultaneously in alarm, the matrix would show the door's control relay activating upon alarm from the applicable waterflow switch(es), or from any two smoke detectors in the selected spaces (AND gate).

7.6 Upon completion of the installation and its programming, the installer's technician shall test every alarm initiating device for proper response and indication, and all alarm notification appliances for effectiveness. Also, in coordination with the other building system contractors, all other system functions shall be verified, including (where applicable) elevator capture and the control of HVAC systems, door locks, pressurization fans, fire or smoke doors/dampers/shutters, etc. The engineer must be notified in advance of these 100% tests, to permit witnessing them if desired.

7.7 **The installer must fill out and submit the following documentation to the owner, through the engineer, prior to the AHJ's system acceptance inspection:**

1. The NFPA 72-1999, Figure 1-6.2.1, "**Record of Completion**" Form. Use this form (no substitutes) to detail the system installation and also to certify that: (a.) It was done per Code, and (b.) The Code-required 100% test was performed. The fire alarm installer (manufacturer or authorized distributor's technician) must sign this form. If a representative of the AHJ, owner, or engineer witnesses the tests, in whole or in part, they must also sign the form to signify that fact only (annotating the form as needed to clarify their limited role).
2. For buildings with a smoke control or smoke purge system, an HVAC balance report, in the smoke control/ smoke purge mode.
3. The System Status and Programming Report described in 7.4. This must be generated on the day of the system acceptance inspection.

NOTE: The purpose of doing Item (3) on the day of the inspection is to assure detector sensitivity has not been affected by construction dust. Prudent contractors will have taken measures to prevent detector contamination during construction, and will also have had the system do a detector sensitivity test and printout prior to the day of the inspection, to make certain all devices are properly programmed and operating within their limits.

7.8 **After** completion of the 100% system test per 7.6 and submission of documentation per 7.7, the installer is to request the **engineer** to set up an inspection. The system must operate for at least two days prior to this inspection.

NOTE: We recommend that the responding Fire Department be notified of this, for pre-fire planning purposes. On private sector projects, local fire authorities may also want to participate in system acceptance inspections. However, for State-owned property they have no inspection jurisdiction and, if present, are only to observe.

7.9 The fire alarm system will be inspected, with portions of it functionally tested. This will normally include the use of appropriate means to simulate smoke for testing detectors, as well as functionally testing the system interface with building controls, fire extinguishing systems and any off-premises supervising station. Operation of any smoke removal system will be checked as instructed by the AHJ. This statistical (sampling) inspection is intended to assure that the contractor has properly installed the system and performed the 100% operational test as required by NFPA 72. The electrical contractor shall provide two-way radios, ladders, and any other materials needed for testing the system, including a suitable smoke source.

NOTE: Smoke control and smoke management systems are normally tested by measuring air flow rates and pressure differentials, plus observing any effect the system has on the operation of exit, elevator, and stairway doors. Testing with smoke "bombs" (smoke candles) is NOT appropriate because they produce cold chemical smoke that lacks buoyancy and, therefore, does not rise like the smoke from a fire.

**8.0 System Documentation, Owner Training, and Spare Parts:**

- 8.1 In addition to the Shop Drawing submittal described in 1.1, the fire alarm system contractor shall provide the engineer two bound copies of the following technical information, for transmittal to the owner: (1) As-Built wiring diagram showing all loop numbers and device addresses, plus terminal numbers where they connect to control equipment, (2) Manufacturer's detailed maintenance requirements, (3) Technical literature on all control equipment, isolation modules, power supplies, alarm/supervisory signal initiating devices, alarm notification appliances, relays, etc, (4) The as-built "calculations" sheet referenced in paragraphs 1.14 and 2.5.
- 8.2 Complete configuration data (site-specific programming) for the system must be stored on electronic media and archived by the fire alarm system manufacturer or authorized distributor. A diskette or CD copy of this data shall be submitted to the engineer for transmission to the owner on the day the system is commissioned.
- 8.3 The manufacturer, or authorized distributor, must maintain software version (VER) records on the system installed. The system software shall be upgraded free of any charge if a new VER is released during the warranty period. For new VER to correct operating problems, free upgrade shall apply during the entire life of the system.
- 8.4 Basic operating instructions shall be framed and permanently mounted at the FACU. (If the owner concurs, they may instead be affixed to the inside of the FACU's door.) In addition, the NFPA 72 "Record of Completion" (see 7.7) must either be kept at/in the FACU, or its location shall be permanently indicated there by engraved label.
- 8.5 Provide an engraved label inside the FACU identifying its 120vac power source, as follows: **Panelboard location, panelboard identification, and branch circuit number.**
- 8.6 The **manufacturer's authorized representative** must instruct the owner's designated employees in operation of the system, and in all required periodic maintenance. A minimum of 2 hours on-site time will be allocated for this purpose and, for those facilities operating on a 24-hour basis (prisons, hospitals, etc.), one additional hour of instruction will be individually provided for the 2nd and 3rd shift. Two copies of a written, bound summary will be provided, for future reference.

NOTE: Some facilities maintain their own systems and require more in-depth training. Check to verify needs.

- 8.7 The following spare parts shall be provided with the system. For multi-building projects, calculate quantities separately for each building that contains a dedicated fire alarm control panel. If FACU also serves auxiliary buildings (e.g., storage, boiler/chiller), calculate as if one building. Increase decimal quantities to the next higher whole number:

- Fuses (If Used).....2 of each size in system
- Manual Fire Alarm Boxes.....2% of installed quantity
- Addressable Control Relays.....4% of installed quantity
- Indoor Horns/Speakers with Strobes Lights.....4% of installed quantity
- Indoor Strobe-only Notification Appliances.....4% of installed quantity
- Monitor Modules (Addressable Interface).....4% of installed quantity
- Isolation Modules / Isolation Bases.....4% of installed quantity
- Addressable, Electronic Heat Detectors.....4% of installed quantity
- Spot-Type Smoke Detectors / Sounder Bases.....6% of installed quantity

No spares are required for projected beam, air sampling, or duct smoke detectors.

**9.0 Revision Record:**

This page contains a record of revisions to this specification. For information on previous changes, refer to this page in the 1998 and 2000 editions.

DATE	DESCRIPTION OF CHANGES IN DOCUMENT
1 OCTOBER 2001	Revised 1.1, 1.2, 1.7, 1.11, 1.12, 3.1, 5.1, 7.1, 8.4, and 8.6. In response to requests from engineers for more flexibility in how the document is used, revised 10.0 "Instructions to Designers" and the information page which precedes the separate, specification-ready text Section (no longer formatted as "hidden" text). Revised and expanded the Fire Alarm System Checklist. Globally changed "FACP" to "FACU," per current NFPA 72 terminology. Edited other paragraphs and fine print NOTES for clarity.
22 JULY 2002	Revised 1.1, 1.8, 1.11, 1.12, 1.13, 1.14, 2.4, 4.12, 6.7, and 6.8. Several helpful fine print notes added or expanded. Sections 3.0 and 6.0 renumbered. Edited other paragraphs for clarity, and corrected some formatting problems. Also edited Check List (pages 3, 4, 7, 8) and inserted an additional document usage option ("Reference") in 7.0 - Instructions to Designers.
(25 MARCH 2005)	This draft was not officially released. Use issue of 25 JULY 2005.
25 JULY 2005	Revised 1.1, 1.2, 1.9, 1.10, 1.11, 1.13, 1.15 NOTE, 2.4, 4.2, 4.11, 5.2, 6.1, 6.2, 6.3, 6.8, 6.9, 6.10, 8.7, Table I, Figure A, & Fire Alarm Inspection Check List. Other minor edits for clarity. Also reformatted the document with headers and footers to facilitate future revisions.
1 JANUARY 2008	Revised 1.11, 1.13, 2.1, 3.1, 3.4, 3.5, 6.2, 6.6, 7.1, 7.2, 7.7(1), and Check List (pages 1 through 6). Added new 6.7 CAUTION, 6.12, 6.13, 6.14, 6.15, and 7.9 NOTE. Made numerous editorial changes for clarity or better formatting. NCDol contact information was also updated.

## 10.0 Instructions to Designers:

This document is not intended to conflict with any Code or NFPA Standard. If conflict is observed, obtain a ruling from the AHJ who approved the plans, before proceeding.

Once the owner or design professional elects to use this optional document for a fire alarm project, there are three different methods of making its criteria a part of the specification. **Methods (1) and (2) are strongly preferred by NCDol and are accepted by all State agencies that manage facilities. Use of either one will automatically help keep your specification up-to-date:**

1. **Insert** this entire document at the **back** of the specification (as an Appendix). Require compliance by reference in the fire alarm system section (by title and revision date), **or**
2. **Reference** this document in the text by title and revision date, require compliance, and mandate that the contractor obtain a free copy from NCDol for use on the project, **or**
3. **Incorporate** all of the relevant portions of this document in the fire alarm specification. To facilitate that process, the electronic version of this document contains a separate, attached MS Word Section, comprised of all of the criteria herein, but with the following items deleted: Dol Letterhead, Introduction, all page headings, and fine print NOTES, the Instructions to Designers, Table of Contents, and Revision Record. This makes it very convenient for the engineer to cut and paste these criteria as **part of** the fire alarm system specification.

**Whichever of these 3 methods is selected, the specification written by the engineer must still document all project-specific requirements and installation details such as capabilities of the FACU, special job conditions or restrictions, the type and coverage of all fire detection devices and alarm notification appliances, the type of connection to a remote supervising station, plus representative styles, brands, and/or models of acceptable system components to be furnished.**

When method (3) is used and the project spec incorporates all of the relevant criteria contained in this document, the specifying engineer is required to indicate that at the beginning of the section covering fire alarm systems. This will help clarify the intent of the specification for alarm system contractors bidding, as they're very familiar with the package of features contained herein. It will also assist our review, and help us determine if upkeep of this document continues to be justified. However, if your specification is generally based on this optional document but omits or amends some portions of it, please provide specific information about that when submitting plans to us. That will facilitate our review and help guide future revisions of the criteria.

The engineer is to provide a **System Operation Matrix** to guide the fire alarm contractor in programming the FACU. The Matrix must clearly state the system response expected for different alarm inputs. For many buildings this is simply to sound the evacuation signal and shut down all recirculating AHU's upon any alarm. As buildings become rather large, shutdown is generally by HVAC zone, for any alarm from within the zone. Where smoke control measures are included such as exhaust or pressurization fans (typical for high rise and atriums), or roll down doors, etc., indicate which specific alarm inputs activate them.

The electrical engineer is responsible for coordination of fire alarm system details with the other design professionals. That includes incorporation of these criteria as needed in the plans and specifications for HVAC, fire suppression systems, elevators, building hardware etc. The location of all ceiling mounted smoke detectors must be shown on the Reflected Ceiling Plans, to prevent interference problems with light fixtures or HVAC air diffusers.

This document covers addressable fire alarm systems only, which represent perhaps 95% of new installations (all but rather small systems). Addressable systems have extensive self-diagnostic features that substantially improve operational reliability and reduce the owner's cost for Code-required periodic testing. They simply make good economic sense.

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Following is a Checklist for use by the design professional, or owner, to perform a sampling-type quality control inspection of the fire alarm system after contractor's Code-required 100% test and certification per NFPA-72. **We recommend that it also be provided to the fire alarm system contractor, to help assure a quality installation and checkout.**

The Checklist is a separate, 10-page Word document "Section" with its own formatting. Page numbering restarts, for convenient use by itself.

With the Checklist included, FireAlarm-2005 is a total of 31 pages. See **special instructions on Page 32** for information on use of this document, including which of the 4 Sections to include when you print copies.

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**FIRE ALARM SYSTEM CHECKLIST FOR ADDRESSABLE SYSTEMS**  
**Page 1 of 10**

BUILDING NAME: \_\_\_\_\_ LOCATION: \_\_\_\_\_

DESIGNER: \_\_\_\_\_ INSTALLER: \_\_\_\_\_

INSPECTION BY: \_\_\_\_\_ DATE: \_\_\_\_\_

- As required by Code, a "preliminary" copy of the NFPA 72\* "Fire Alarm System Record of Completion" form (with all but the Record of System Operation and associated signatures filled out) was submitted to the owner and the AHJ after the installation was completed and the wiring checked, but before the required 100% operational testing. \*Use only the NFPA form, or an identical reprint.
  
- The manufacturer's authorized distributor (by definition the "installer") who made final connections at the FACU and programmed the system gave the owner and AHJ advance notice of the required 100% operational tests, so they could elect to attend.
  
- After the required 100% system operational test was done, contractor submitted final copy of the NFPA 72 form, with Record of System Operation filled out. This verified proper operation of all (restorable) alarm initiating devices, audible and visible notification appliances, and other system functions including HVAC control, closure of smoke doors and dampers, pressurization fans, remote signaling, etc.

NOTE: The required 100% testing cannot properly be done by a single technician without a helper, even if the FACU has Walk-Test or an equivalent feature. Query the tech on how it was performed.

NOTE: If part or all of that testing was witnessed by a representative of the AHJ, the final line of the form is signed to indicate that. (Some design contracts give that responsibility to the electrical PE.)

- A copy of the System Operation Matrix, giving the FACU response for each initiating device input, has been provided by the fire alarm distributor to facilitate testing.
  
- All building occupants have been clearly notified of the system test. Fire authorities have also been notified of test, including any location where alarms are transmitted.
  
- Fire alarm control unit (FACU) is powered up and clear of alarms, supervisory signals, and trouble conditions.

**FIRE ALARM SYSTEM CHECKLIST FOR ADDRESSABLE SYSTEMS**  
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- Have technician disconnect a battery lead and verify the FACU indicates a local trouble signal within one minute of that action.
  
- Reconnect battery, **then** turn off 120vac. Batteries should measure approx. 13 volts, and differ  $\leq$  0.4 volt. (Also check batteries in any booster power supplies.)
  
- If system is connected to Remote Supervising Station, verify the FACU did **not** transmit AC Power Failure "trouble" signal, as it was not maintained for 1-3 hours.
  
- While on battery power, initiate Alarm. Batteries should remain at 12+ volts each, but dropping slowly. Let alarm continue during next step.
  
- Verify the Notification Appliance Circuit (NAC) voltage drop at the EOL is  $\leq$  3 volts. Do this separately for each NAC.
  
- Silence the alarm and verify that any Remote Supervising Station has received a fire alarm signal. Reset the FACU and verify the Station receives a subsequent "restore" signal, indicating the alarm condition has been cleared.
  
- Reconnect the 120vac. Have ground fault put on any alarm initiating or notification appliance (horn-strobe) circuit. FACU must indicate "ground" and general "trouble." Verify this ordinary "trouble" signal is not sent to any Remote Supervising Station.
  
- Verify requirements on wire type and gauge were followed and that the color code for circuits is proper throughout the system. (See attached table).

NOTE: Most manufacturers either require or recommend low capacitance, twisted, shielded pair cable for Signaling Line Circuits (addressable loops). All shielded cable must have the grounded "drain" wire maintained continuously around the loop. If unshielded cable was used, verify that the manufacturer's installation instructions require or state a preference for use of unshielded cable. For addressable system retrofit when a non-addressable system had previously been in service, if existing single-conductor wiring from the old system was used (sometimes done if in fine condition, properly color coded, with terminal strips, etc.), verify that the manufacturer's installation instructions do not require the use of twisted pair conductors or low capacitance cable and the installer also agreed to replace the existing fire alarm system wiring if unsatisfactory performance is caused by its re-use (e.g., spurious signals, cross-talk, etc.).

**FIRE ALARM SYSTEM CHECKLIST FOR ADDRESSABLE SYSTEMS**  
**Page 3 of 10**

- If any addressable control relays used, verify their contact ratings are suitable for connected load. (Some are rated for resistive loads only.) Also, if they require separate 24vdc power for operation, verify the circuit is electrically supervised.
  
- All field wiring in the system has wire markers where landed at the FACU, and also in the terminal cabinet(s) on each floor of multistory buildings.  

NOTE: Additional terminal cabinets are not required for floors having elevation changes less than a full story, or mezzanines. However, practical limitations on pulling wire / cable may result in multiple cabinets on a single floor of a large building, to accommodate the terminal strips required for splices.
  
- Operating instruction summary is framed and mounted at (or inside) the FACU.
  
- If system uses an LED "zone" annunciator to provide a quick visual overview of the fire scenario for responding public safety personnel (general fire area and type of alarms), a framed directory or typed/engraved LED labels provide clear information on "zone" (area) boundaries and the type(s) of alarms (i.e., smoke, waterflow, etc.)
  
- There are **no** splices in the system other than at terminal blocks. "Wire nuts" and butt splices are not permitted.
  
- All circuits are properly and securely terminated. Approved terminal fittings are used for any stranded wire terminations at screw posts that lack pressure connectors.
  
- Initiate alarm on a representative sample of devices by operating manual fire alarm box, blowing smoke in detector, flowing water from sprinkler system inspector's test station, etc., except do not test any non-restorable, fixed temperature heat detector. Check FACU indication (device type, location information) for each device tested.
  
- While doing above verify operation of audible-visible alarm notification appliances. Alarm must be 15 dBA above normal ambient sound level in all occupiable areas of building. (Use meter if in doubt.) Indoor strobes must flash 60-120 times/minute and those installed in a single space (room, corridor, etc.) must be synchronized.
  
- Verify that any strobes in walk-in coolers or freezers are listed for that environment or provided with heated Lexan enclosures for which they are specifically listed.

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- Also verify HVAC shutdown and closure of (any) smoke doors. These functions must be done by the FACU, rather than by integral smoke detector relay contacts. Shutdown must occur within 20 seconds, except gaspack units can be arranged for up to 60 seconds delay before the fan stops, to prevent heat exchanger damage.
  
- Have installing technician demonstrate that the system is programmed so all **spot-type** smoke detectors have automatic drift compensation and FACU will indicate when prescribed sensitivity limits are reached or exceeded.
  
- If system has provisions for "alarm verification" algorithm, arm it only if needed for the environment. Do **not** apply it to multi-sensor or multi-criteria smoke detectors.
  
- Verify the technician who programmed the alarm system was trained and certified by the manufacturer, for the specific FACU model being installed, within the past 2 years. (A copy of the cert. should have been submitted with the Shop Drawings.) NICET Level III certification will extend this to 36 months.
  
- Addressable loop controller circuits are Class "A", with isolation modules at FACU on the outgoing and return loop, after each 25 addressable devices (max) on the loop, and (if  $\leq 25$  devices) at midpoint. Have the technician apply a short circuit between pairs of isolation modules to verify their operation and device count between them.
  
- Isolation modules and addressable initiating device interface modules are located in conditioned space (not attics, boiler rooms, unheated warehouses, damp locations, outside corridors, parking decks, etc.). Exception: Any devices that are specifically listed for the ambient conditions expected (or likely) in the area where installed.
  
- If the system has more than 100 addressable points, or if the building exceeds 3 occupied floors or 60,000SF, an event printer is provided which uses ordinary non-thermal paper. If building is high rise, the printer must be FACU-monitored and on generator-supported circuit. NOTE: Printer does not have to be adjacent to FACU and, except for high rise buildings, does not have to be electrically supervised.
  
- If sprinkler system present, check operation of waterflow alarm switches by flowing water from Inspectors Test connection(s), unless dry pipe system. Alarm sounds in 20-45 seconds and any outside water motor gong rings properly in  $\leq 300$  seconds.

**FIRE ALARM SYSTEM CHECKLIST FOR ADDRESSABLE SYSTEMS**  
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- Inspectors Test Connection flow is limited to 1/2" stream (or actual orifice size of the sprinklers in the system, if different) by a valve or sight glass marked accordingly, or by a sprinkler head (minus deflector) mounted at discharge. NOTE: If a pipe union with an internal restrictor plate is used for this purpose, have the sprinkler contractor take at least one apart for inspection, to verify the orifice size.
  
- Close any electrically supervised sprinkler control valves to verify supervisory alarm at FACU within 2 turns of control wheel or, for Post Indicator Valve (PIV), within 1/5 of valve control mechanism's travel distance. Then reopen to verify "restore" signal.
  
- If dry pipe or pre-action sprinkler system, have contractor demonstrate waterflow alarm functions, and that both high and low air pressure supervised as required.
  
- Each fire extinguishing system, such as in a kitchen hood, is connected to give building fire alarm. Have contractor demonstrate that this functions properly, by manually operating the monitored switch, without releasing extinguishing agent.

NOTE: Kitchen hood fire extinguishing system activation must shut off the gas, if used, and, for wet chemical type, also operate a shunt trip breaker to shut off the electric power to all protected appliances under the hood. The exhaust fan(s) keep running but the make-up air must shut down. These functions are to be done directly by fire extinguishing system, rather than the FACU, since it is not appropriate to cut off the gas supply or to operate the shunt trip for other types of alarms not involving the kitchen hood extinguishing system (e.g., smoke detectors, fire alarm boxes, etc.).

- Verify that fire alarm system monitors power to any fire suppression system shunt trip breakers. (Look for kitchen hood systems and sprinklered elevator spaces.)
  
- Check any outside alarm bells and strobes for operation. Verify outside strobe is the weatherproof type with at least 100cd output, double flash, with clear lens.
  
- Green grounding wire is bonded to FACU cabinet, and also connected to designated terminal on motherboard (if any).
  
- If remote alarm annunciator in building, verify proper operation, including the audible "Trouble" signal. Check its "Lamp Test" and "Trouble Silence" features, if provided.

**FIRE ALARM SYSTEM CHECKLIST FOR ADDRESSABLE SYSTEMS**  
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- Surge arrestor model listed in project spec (feed-through type with "pi" configuration) is installed at electrical panelboard, on the 120vac branch circuit to FACU. Arrestor leads are trimmed as short as practical. See attached wiring diagram for more info.
  
- AC branch circuit to FACU does not share conduit with 24vdc alarm initiating circuits or notification appliance circuits. Placard inside FACU gives the following info on this circuit: **Panelboard location, panelboard identification, and branch circuit number** (The same applies to SNAC panels and any other system control equipment)
  
- The FACU and any transponders, sub-panels, and "ADA" booster power supplies are protected by a smoke detector within 15 feet of their location, measured horizontally, as required by Code (NFPA 72).
  
- Individual detectors of all types are identified on their bases (Loop # -- Device #), in sequence on the loop from the FACU.
  
- All smoke detectors are analog addressable model(s) having a separate plug-in head, concealed locking device, and terminal strips for circuit connections.  
  
NOTE: Snap-ring mounted models with removable terminal strip plug for connection to loop conductors do not comply with the intent of this requirement and typically do not have a locking device to deter tampering.
  
- Spot type smoke detectors are not located within 3 feet of a supply or return air diffuser, nor in a strong air stream from a supply diffuser at any distance.
  
- Any wall-mounted smoke detectors are between 4 and 12 inches from the ceiling (measured to the nearest edge of the detector), as required by NFPA 72, and do not have wall-mounted light fixtures or other obstructions below them. Ceiling mounted smoke detectors are at least 4 inches from a wall or any obstruction on the ceiling.
  
- Duct smoke detector intake tube has its holes / slot facing into the air stream, and a stopper installed to seal its far end. If over 36 inches long, the far end is supported for stability. If support is provided by extending the intake tube through the far side of HVAC duct (best for inspection, cleaning, testing), the duct penetration is sealed.

**FIRE ALARM SYSTEM CHECKLIST FOR ADDRESSABLE SYSTEMS**  
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- Each duct smoke detector has a Remote Alarm Indicator Light (RAIL) in nearest corridor or other public space. (Because addressable, test switch is **not** required.)
  
- At each duct detector a 12"x12" minimum access door, hinged or latched type, is provided to facilitate sampling tube inspection and cleaning. Air flow direction is permanently indicated on the duct by stencil or decal, to help assure the sampling tubes are installed and maintained in the correct orientation.
  
- Any DACT or other means of remote alarm signaling is connected and functioning properly, to transmit fire alarm, supervisory, and trouble signals as separate, distinct events. It's also programmed for 24-hour silent test call to the supervising station. Verify each type of signal is properly received and coded at the receiving station. (Supervisory signals include sprinkler valve tamper, fire pump off-normal, hi-low air pressure, etc.)
  
- Have technician confirm FACU is programmed to send an AC power failure trouble signal to Remote Supervising Station if power loss continues for 1 hour minimum to 3 hours maximum. Also, that no other types of "trouble" signals are reported.
  
- Contractor has submitted battery calculations to the designer, verifying the system meets applicable capacity requirement of NFPA 72. The minimum endurance is 24 hours plus 5 minutes of alarm load. For systems reporting to a Remote Supervising Station (any off-campus connection), the minimum endurance is 60 hours + alarm.
  
- Owner's designated personnel have received training in system operation: How to interpret, silence, and reset FACU signals, how to obtain service, etc. (8.6)
  
- When required by specification, owner's personnel have received more thorough, detailed training in system troubleshooting and repair, plus installation manuals and other documentation, as applicable. (This is standard for the UNC-Chapel Hill campus.)
  
- Contractor has provided diskette / CD of system's site-specific programming. (8.2)
  
- Contractor has provided spare parts in accordance with the spec. (See FDAS 8.7)

**FIRE ALARM SYSTEM CHECKLIST FOR ADDRESSABLE SYSTEMS**  
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**VERIFY THE FOLLOWING FOUR ITEMS WERE INCLUDED IN SHOP DRAWING SUBMITTAL:**

- Notification Appliance Circuit (NAC) calculated current draw, demonstrating that none exceed 80% of rated module output. (See FDAS 1.12)
- Battery sizing calculations verifying adequate Amp-Hour rating, that the worst case NAC voltage on battery is within alarm notification appliance listing, and that NAC alarm load voltage drop at EOL does not exceed **14%** of battery voltage. (1.14)
- If system is the Emergency Voice/Alarm type, amplifier load calculations. (2.5)
- Copy of factory training certificates for technicians who program the system. (7.1)

**VERIFY THE FOLLOWING INFORMATION HAS BEEN PROVIDED TO ENGINEER OR AHJ:**

- System Status and Programming Report, which includes the following 3 elements:**
  - Program settings for each alarm initiating device (7.4)
  - Current sensitivity reading of each smoke detector (7.4)
  - System operational matrix, giving response for each alarm input (7.5)
- NFPA 72 "Record of Completion" Form, filled out, with all signatures (7.7)**
- If building has smoke purge system, an HVAC balance report in purge mode (7.7)**
- Two bound copies of the following information on the system (may be combined):**
  - Manufacturer's technical literature (cut sheets) on system components (8.1)

**FIRE ALARM SYSTEM CHECKLIST FOR ADDRESSABLE SYSTEMS**  
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- Required maintenance schedule on system, to comply with NFPA 72 (8.1)
  - As-built drawings with loop #'s, device addresses, equipment terminals (8.1)
- 

- Basic operating instructions are framed and mounted at, or inside of, FACU (8.4)
- "Record of Completion" Form is at / inside FACU, or label indicates location (8.4)

**REFERENCE INFORMATION TO ASSIST SYSTEM INSPECTION**

**Wiring:** All addressable system wiring shall be color coded in accordance with following scheme, which must be maintained throughout system, without color change in any run:

- Addressable Loop Controller Circuits: Cable per spec, with Red Jacket and Red(+) and Black(-) Conductors
- One-way Voice/Alarm and Two-way (Fireman's Telephone): Wire per 2.8 of "FDAS"

**The following circuits use THHN / THWN conductors, of the size and color indicated:**

- Alarm Notification Appliance Circuits: AWG 14, Blue(+) and Black(-) conductors
- AHU Shutdown, Elevator Capture, other control functions: These are now done by addressable control relays on the loop. The relays may require separate power circuits, in which case use AWG 14 conductors, with Yellow (+) and Brown (-) color code. **NOTE: Check any power circuits to addressable relays for electrical supervision by disconnecting 1 lead.**
- Circuits that power door magnets from the FACU or SNAC panels: AWG 14, Orange
- Circuits from ZAM's to monitored initiating devices: AWG 16 or 14, Violet (+), Grey (-)

**FIRE ALARM SYSTEM CHECKLIST FOR ADDRESSABLE SYSTEMS**  
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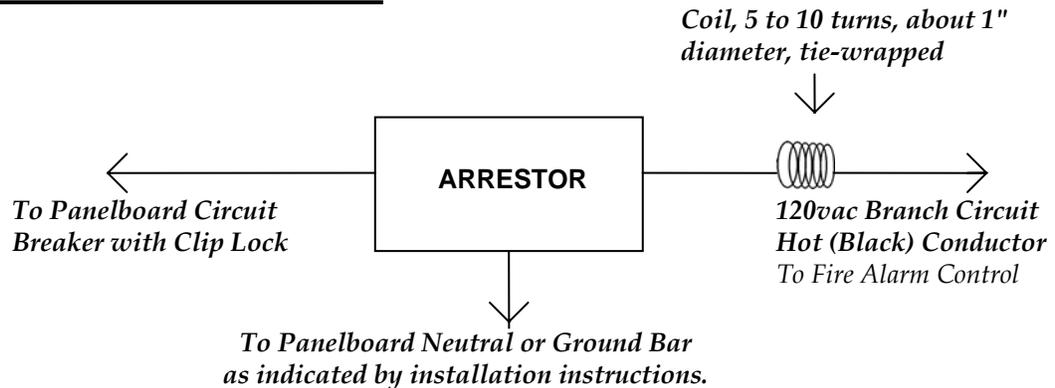
**Spares:** Provide the following spare parts with the system, each individually packaged and labeled. For multi-building project calculate separately for each building with FACU:

- Fuses (If Used).....2 of each size in system
- Manual Fire Alarm Boxes.....2% of installed quantity
- Addressable Control Relays.....4% of installed quantity
- Indoor Horns/Speakers with Strobes Lights.....4% of installed quantity
- Indoor Strobe-only Notification Appliances.....4% of installed quantity
- Monitor Modules (Addressable Interface).....4% of installed quantity
- Isolation Modules / Isolation Bases.....4% of installed quantity
- Addressable, Electronic Heat Detectors.....4% of installed quantity
- Spot-Type Smoke Detectors / Sounder Bases.....6% of installed quantity

**NOTE:** Increase decimal quantities of all spare parts to next higher whole number when calculating.

**NOTE:** No spares are required for projected beam, air sampling, or duct type smoke detectors.

**Transient Arrestor Installation Detail:**



**NOTE:** Securely mount transient arrestor in accessible junction box or other proper metal enclosure adjacent to the panelboard, and provide engraved label indicating its location.

**NOTE:** A separate electronic file of this Check List only is available on request. Ask for FASC-ADD-2008.doc

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**This page is a separate Section 3 and all pages following are Section 4, to permit unique formatting. Section 4 repeats the document's basic criteria but omits non-essential materials including letterhead, headers and footers, Table of Contents, and the helpful fine print NOTES. This page and subsequent are not used if the designer elects to follow either the "Insert" or "Reference" method of applying the document. **In that case, highlight and delete this page and all following it. Alternately, you can prevent them from being part of printed copies by doing the following:****

In MS Word, click on "File," then "Print..."

For "Page range" select "Pages [S1, S2]"

Type in "S1, S2" as shown, to print the main document and checklist.

(NOTE: If you do not wish to include the Fire Alarm Checklist, type in "S1" only.)

The three ways to use this document are summarized as follows:

(1) **"Insert"** method: Place the preceding main document and checklist in the *back* of the bound project specification, as an Appendix. Include a compliance statement in the fire alarm section written by the engineer, referencing this document by title and date, along with other standards applicable to the work.

(2) **"Reference"** method: Do not include this document with your spec. Instead, state that bidders are *required* to obtain a free copy from DoI. Again, include a compliance statement in the fire alarm section written by the engineer, referencing this document by title and date, along with other standards applicable to the work.

(3) **"Incorporate"** method: Only the special text following this page is used, by electronic "cut and paste" into the engineer's specification. This option does omit much helpful information in the main document.

**CAUTION:** Method (3) also requires constant effort to keep your specification's content up-to-date with changes in this document, driven by rapid evolution of system technology. NCDol's review is greatly complicated because designers frequently miss updates, or omit key criteria during the cut and paste process. Therefore, you must also provide more information to facilitate review if you've omitted or modified important criteria in this document. Conversely, use of either method (1) or (2) will automatically help keep your specification up-to-date. System contractors are very familiar with this document, as it's also frequently used by designers for their private sector projects. In fact, the Automatic Fire Alarm Association now conducts seminars written around NCDol's fire alarm criteria.

**NOTE:** Any alterations to page formatting may corrupt tables and/or pagination. Therefore, do not apply overall specification page formatting to this document.

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## 1.0 General Criteria for Addressable Fire Alarm Systems:

### 1.1 Authority Having Jurisdiction (AHJ) Defined, Building Permits:

**For State-owned facilities in North Carolina** the AHJ for Code compliance is the NC Department of Insurance -- Office of State Fire Marshal. The AHJ for construction administration and inspection purposes is the entity that contracted for the design services, either the State Construction Office or the owning Agency, as applicable. NOTE: Fire alarm system inspection or acceptance testing may be delegated to the design engineer by contract.

No building permit is required for construction or renovation of facilities that are funded by the State of North Carolina and located on State-owned land. However, privately-funded projects on land leased from the State (e.g., student housing) must still be submitted to local building officials for approval, permits, and inspections.. (See below.) Written NCDol approval of the plans and specifications submitted for review is considered the equivalent of a building permit for State projects but that alone does not give authorization to proceed with construction. Such authorization requires written clearance from the entity that administers the contract.

**For private sector or local government projects** the AHJ is the local government entity that approves project plans, issues building permits, and inspects construction.

### 1.2 Contractor's Shop Drawings, Review, Code Compliance, Completeness of System

The fire alarm contractor shall submit complete Shop Drawings to the engineer for review, prior to performing any work. These shall clearly demonstrate compliance with the engineer's plans and specifications, which have a System Response Matrix showing the fire alarm system's actions (outputs) required for each type of alarm, supervisory, and trouble signal. NOTE: Any non-compliant features must be fully described. Engineer's approval (with or without corrections) of contractor's Shop Drawings, samples, cut sheets, etc., is for general conformance with the contract documents and design concept. It shall not relieve the contractor of responsibility for full compliance with the project plans and specifications, EXCEPT for any specific non-compliant features for which the engineer gives written authorization.

The fire alarm system shall comply with applicable provisions of the NC Building Code (available for sale at NCDol), and the National Fire Alarm Code (NFPA 72). The Contractor shall furnish all parts, materials, and labor customarily required or provided for a complete and operating system, in accordance with all requirements applicable, even if each needed item is not specifically shown or described in the project plans or specifications.

- 1.3 The system is to be the addressable type, with a 24vdc nominal operating voltage. All equipment supplied must be specifically listed for its intended use and shall be installed in accordance with any instructions included in its listing. NOTE: The most common non-compliance with listings is exceeding environmental limits.
- 1.4 The system is to have multiple access levels so owner's authorized personnel can disable individual alarm inputs or normal system responses (outputs) for alarms, without changing the system's executive programming or affecting operation of the rest of the system. How to do this must be included in the training required to be given to the owner's designated personnel (see 8.6), and must also be part of the written documentation provided by the fire alarm equipment supplier.
- 1.5 The Fire Alarm Control Unit (FACU) shall be located for convenient, rapid access. When not located in a public or normally occupied area, a Remote Annunciator (RA)

with audible-visible trouble indication is required. Consult with facility manager and the local fire official, prior to locating the FACU and any RA or printer. (See 1.6)

- 1.6 The FACU and all other control equipment locations, including any transponders, sub-panels, and booster power supplies, must be protected by a spot type smoke detector located within 15 feet of the equipment (measured horizontally). The branch circuit breaker(s) supplying the system must be physically protected and identified with a 1/4" permanent red dot applied to handle or exposed body area.
- 1.7 A supervised "AHU Shutdown Defeat" toggle switch must be provided in/adjacent to the FACU or as a key-operated function in the Remote Annunciator (if provided). If the RA option is utilized, provide an informative engraved label at the FACU about this function. The switch must cause a system "trouble" indication when it's placed in the off-normal ("Shutdown Defeated") position.
- 1.8 If the building has smoke control system fans (pressurization or exhaust), or smoke purge fans, provide Hand-Auto-Off switch(es) in or adjacent to FACU. They must be clearly labeled, and FACU-monitored **or** provided with status indicator lights.
- 1.9 An event printer is required for all systems exceeding 100 addressable points, **or** if the building exceeds 3 occupied floors or 60,000 SF. Provide a 120vac printer that uses ordinary (non-thermal) paper. Install in location selected by the owner. For high rise buildings only, the printer is required to be FACU-monitored and powered from a 120vac circuit supported by the generator.
- 1.10 Each addressable fire alarm system must include an LED-type "zone" annunciator at (or in) the FACU, or in another location if acceptable to the AHJ. As a minimum, this annunciator is to indicate the specific type of alarm or supervisory signal (smoke detector, waterflow, sprinkler valve closed, etc.), for groups of addressable devices. The area ("zone") that is represented by each LED shall not exceed 1 floor or 22,500 square feet, and must not cross building fire walls or smoke compartments.

EXCEPTION #1: Systems in 1 or 2-story buildings, which have 30 or fewer initiating devices, are permitted to omit the LED-type "zone" annunciator.

EXCEPTION #2: Systems with a Graphic Annunciator (GA) are permitted to omit the LED-type "zone" annunciator.

EXCEPTION #3: The LED annunciator is permitted to be omitted if the FACU has a multi-line display that automatically defaults to displaying the first alarm, plus the first 3 (minimum) waterflow alarms and the last alarm. This is permitted to be done using 2 automatically alternating screens. If there is no sprinkler system, program the FACU to show the first 4 alarms plus the last alarm received.

EXCEPTION #4: Addressable systems that are not required to have an event printer by 1.9 are permitted to substitute a printer for the above LED annunciator. Locate for convenient access by responding emergency personnel, as directed by owner.

- 1.11 Alarm notification appliances (audible and visible) are to comply with NFPA 72, the North Carolina Building Code, and North Carolina Accessibility Code criteria for intensity and placement. The standard audible evacuation signal is the ANSI S3.41 three-pulse temporal pattern **except** it shall not be used if the planned action during fire emergency is to relocate occupants or protect in place, instead of immediate evacuation (e.g., some health care facilities, prisons). All strobe lights installed in a single space must be synchronized. See additional alarm notification appliance requirements in 2.4, including alternatives discussed in fine print NOTE for special situations. Contact the AHJ for additional information or to seek approval of any

alternative design. CAUTION: For Group R-2 occupancies see special requirement for strobe circuits in NCBC 907.9.1.4., and for Group I-1 or R-1 see NCBC 907.9.1.3

- 1.12 Alarm notification appliance (NAC) circuits shall be NFPA 72 Style Y (Class B). The load connected to each circuit must not exceed 80% of rated module output and the coverage of each circuit shall not exceed 3 floors (to limit the effect of faults, and to facilitate trouble-shooting). The NAC voltage drop during alarm must not exceed **14%** of the voltage measured across the batteries at that time. To achieve this, the design must consider wire size, length of circuit, device load, inherent voltage loss within the FACU's power supply, etc. The contractor shall use power outage testing to verify that the NAC circuit was designed and installed properly. (See 1.14)
- 1.13 The following protection against voltage transients and surges must be provided by the fire alarm equipment supplier, and installed by the electrical contractor:

On AC Input: A feed-through (not shunt-type) branch circuit transient suppressor such as the EFI E100HW120, Leviton 51020-OWM, Emerson/Northern Technologies TCS-HWR, Transtector ACP100BW series, or any equivalent UL 1449 - 2nd Edition Listed device submitted to and approved by the electrical design engineer. Install suppressor in a listed enclosure near the electrical panelboard, and trim excess lead lengths. Wind small coil in the branch circuit conductor just downstream of the suppressor connection. Coil to be 5 to 10 turns, about 1" diameter, and securely tie-wrapped. This series impedance will improve the effectiveness of the suppressor in clipping fast rise time voltage transients.

On DC Circuits Extending Outside Building: Adjacent to the FACU, and also near point of entry to outlying building, provide "pi"-type filter on each leg, consisting of a primary arrester, series impedance, and a fast acting secondary arrester that clamps at 30v-40v. Some acceptable models: Innovative Technology D2S33-2ML, Simplex 2081-9027/-9028, Transtector TSP8601, Ditek DTKxLVL series, Citel America B280-24V, Leviton 3824-OWM, Northern Technologies DLP-42. Submit data on others to the engineer for approval. UL 497B listing is normally a prerequisite for their consideration. Devices using only MOV active elements are not acceptable.

- 1.14 Systems are to be provided with a separate and independent source of secondary power. The State doesn't contract for full Central Station Service (with runners), so all systems that report to a Central or Remote Supervising Station shall have a minimum of 60 hours secondary power capacity, plus 5 minutes of full alarm load. Proprietary and other systems require 24 hours capacity plus 5 minutes alarm load.

EXCEPTION #1: For emergency voice/alarm systems, use **15** minutes for alarm load.

EXCEPTION #2: If single, automatic starting generator is provided, use **24** hours for battery endurance, plus the appropriate (5 or 15 minutes) alarm load. See NFPA 72.

**Include a copy of system battery sizing calculations with the shop drawing submittal to the engineer. Use manufacturer's battery discharge curve to determine expected battery voltage after 60/24 hours of providing standby power. Then use calculated Notification Appliance Circuit current draw in the alarm mode to determine expected voltage drop at EOL, based on conductor resistance per manufacturer's data sheet or NEC 2000, Table 8. Remember to double the ohms per foot since two conductors are required to power the circuit. Also, add any inherent voltage drop caused by the system's power supply.**

**The voltage drop at EOL must not exceed 14% of the expected battery voltage, after the required standby time plus alarm time. (Typically, for a 24 volt system, this limits the voltage drop from the battery to the EOL to 3 volts). Determine "worst case" voltage at far end of each NAC, by subtracting its calculated V-drop from the expected battery voltage. The result must be no less than the minimum listed operating voltage for the alarm notification appliances used.**

**All of these calculations must be placed on a dedicated sheet of as-built drawings, for future reference by fire alarm service technicians. NAC voltage drop is to be verified during system tests.**

- 1.15 Automatic fire/smoke detectors used shall be selected in accordance with Table I, **Applications Matrix for Selecting Detection Devices**, which follows this Section.

**TABLE I -- APPLICATIONS MATRIX FOR SELECTING DETECTION DEVICES**

SMOKE/FIRE DETECTOR APPLICATION	ACCEPTABLE DETECTOR TYPES*			
	ION	PHOTO	IR/UV FLAME	HEAT
Atriums/Auditoriums		B**		
Corridors - Any Occupancy		X		
Office Areas	X	X		
Cable Rooms (PVC)		X		
Elevator Equipment Rooms	X			
Furnace/Boiler Rooms				X
Gymnasiums		B**		
Laboratories (Chemical)			X	X
Linen Rooms		X		
Mech/Elect. Equipment Rooms	X	X		X
Motor-Generator Rooms			X	X
Attics (Non-Conditioned Environment)				X
Loading Docks			X	X
Non-Conditioned or Hostile Environment			X	X
Storage (Conditioned Environment Only)	X	X		
Duct Smoke Detectors		X		

\* Multi-sensor detectors employing the indicated technology are an acceptable alternative to the type of detector(s) indicated for any application.

\*\* "B" symbol indicates projected beam (linear beam) type smoke detector with separate transmitter and receiver, or with transceiver and prism reflector. Typical operating range limits are 30-300 feet but best service is obtained when the IR light beam spans 50-200 feet. Consider potential obstructions (banners, etc.) and accessibility for required maintenance.

CAUTION: Spaces which may be exposed to vehicle exhaust, fumes from nearby cooking, fireplaces, etc., high/low temperatures or high humidity (including dishwashing, laundry) are generally unsuitable for the use of smoke detectors. Heat detectors should include the rate-of-rise feature unless installed where temperatures may rise more than 15°F/minute from space heaters, vehicle exhaust stacks, furnaces, or following outside door closure. *Always consider detection device ratings vs. the environment of planned installations!*

## 2.0 Emergency Voice/Alarm Communications Option:

- 2.1 Where specified by the design engineer, or required by Code, the system shall have Emergency Voice/Alarm Communications capability. This may include just item (1), or both items (1) and (2), as follows:
- (1) One-way Emergency Voice-Alarm (PA Type) System
  - (2) Two-way (Firemen's Telephone) Communications System
- 2.2 Emergency Voice/Alarm Communications Systems installed in high rise buildings shall be designed for survivability in accordance with NFPA 72. An acceptable way to meet this is to have widely separated dual risers and to feed approximately half the speakers on each floor from each riser.
- 2.3 One-way Voice/Alarm (PA) installations in buildings classified as high rise shall be dual-channel, permitting the transmission of an evacuation signal to one or more zones and simultaneous manual voice paging to other zones, selectively and in any combination. For all buildings, the One-way Voice/Alarm (PA) Communications System, where provided, must meet the requirements of 2.4 through 2.8, below.
- 2.4 Each floor, stairway, elevator **bank**, and Assembly space (>300) is to be a separate communication zone. Speakers are to be spaced to provide required sound levels. Check audio levels in all areas; adjust taps or install additional speakers, if needed. Strobe lights are not to be installed in elevator cars, stairways, or photo darkrooms.
- 2.5 Normal audio amplifier power shall be a minimum of 120% of the system design load, per channel. For purposes of this calculation, use the amplifier's continuous two-tone output rating and the designed power setting of each individual speaker. **Provide a copy of this calculation with the shop drawing submittal to the engineer. Also include on the "calculations" sheet included as part of the as-built drawings.**
- 2.6 At least one backup amplifier shall be provided for each channel, equal in power to the largest primary amplifier. For systems with distributed amplifiers, provide one backup at each transponder location. Failure of any amplifier shall automatically result in the defective unit being switched off-line and replaced with the backup.
- 2.7 The audible emergency evacuation signal shall comply with 1.11. This does not preclude the system from providing additional (non-evacuation) notification signals, including recorded voice messages, for specific emergency situations. Visible alarm notification appliances must also be provided per NC Code and ADA requirements.
- 2.8 One-way Voice/Alarm and Two-way (Fireman's Telephone) digital audio circuits are to be wired with twisted pair copper conductors (AWG 18 minimum) in jacketed cable, or with fiber optic cable. Analog audio circuits are to be wired with AWG 18 minimum twisted pair copper conductors in shielded cable, Belden 8790, West Penn 293, or equal. Cable jacket color is to be gray, with red (+) and black (-) conductor insulation. For shielded cables, the shield must be continuously connected from the amplifiers to the end of line. Tape the shield splice at each speaker and handset, to insulate from ground. Single point ground the shield at the amplifier or control unit unless prohibited by system manufacturer. (See 6.7 and 6.9 for other wiring reqmts.)
- 2.9 The Fireman's Telephone system, if provided, shall indicate the location of each phone station in use and shall permit selective calling and party line operation. Provide stations per Code and also in each elevator machine room, at the fire pump, and in the room(s) containing the main switchgear and emergency generator.

## 3.0 Monitoring of Signals by Supervising Station:

3.1 Each system with automatic fire detection, or which monitors a sprinkler system, shall be equipped with a 4-channel (minimum) Digital Alarm Communicator Transmitter (DACT) for transmission of fire alarm, supervisory, and trouble signals to a Central Station, Remote Supervising Station, or Proprietary Supervising Station. The following signals shall be reported as applicable, in accordance with 3.4.

- **Fire Alarm**
- Sprinkler Waterflow Alarm
- Fire Pump Running Alarm (if pump provided)
- Fire Pump Abnormal Status Supervisory Signal (See 3.2)
- Sprinkler Valve Tamper (Closed) Supervisory Signal (See 3.2)
- Sprinkler Low Temperature / Air Pressure Supervisory Signal (See 3.2)
- Burglary / Intrusion / Duress / Other Security or Emergency Alarm (See 3.3)
- **Fire Alarm System AC Power Trouble (only if 120vac interrupted for 1-3 hours)**

EXCEPTION #1: In lieu of a DACT, the use of an addressable network is acceptable. Other appropriate means of transmitting fire alarm system signals off-premises may be permitted to be used, at the discretion of the AHJ who approves the plans.

EXCEPTION #2: With AHJ permission, the alternative described in 3.6 is permitted.

EXCEPTION #3: With AHJ permission, the transmission of signals to a supervising station may be omitted. This is typically done only for very small facilities or those so isolated that the probability of successful fire response is minimal.

3.2 With AHJ permission, sprinkler and fire pump *supervisory* signals are permitted to be combined by the DACT, for transmission. Contact the AHJ for more information.

3.3 When specified by the engineer, the DACT shall transmit a separate Computer Room Environmental Monitoring Supervisory Signal, to warn of dedicated cooling system failure and/or water under the raised sub-floor.

3.4 The precedence of signals transmitted to the Supervising Station shall be as follows:

1. Fire Alarm
2. Security Alarm
3. Supervisory Signal
4. Trouble Signal\*

\*Loss of AC power to FACU must not be sent transmitted until it has continued for **at least 1 hour but no more than 3 hours**. This avoids nuisance transmissions to the supervising station for brief power outages (switching transients, thunderstorms).

3.5 The Contractor must provide a type of DACT that is compatible with the owner's alarm receiving equipment, or the Supervising Station selected by the owner, as applicable. He must also program the PROM, connect each DACT to the telephone line(s) provided to him, and verify proper signal receipt by the Supervising Station. The transmission means shall comply with NFPA 72 (which does not permit VOIP).

3.6 For buildings where full-time on-site staffing assures response (prison camps), an outside bell and high power strobe light could be an effective means of signaling alarm. Where specifically permitted by the AHJ, the following shall be provided:

- Fire Alarm Bell, 10" diameter, weatherproof
- Strobe Light, 100 Cd minimum, **double flash**, clear lens, weatherproof vehicular) (Austin 2020, Federal Signal 131DSTxxxC, Wheelock MAX-24, or **approved equal**)

#### **4.0 Smoke Detector Application and Installation:**

- 4.1 All addressable spot type and duct smoke detectors shall be the analog type and the alarm system shall automatically compensate for detector sensitivity changes due to ambient conditions and dust build-up within detectors. This feature must be armed and sensitivities set prior to acceptance of the system. (See 7.2, 7.3, and 7.4)
- 4.2 Dormitory and student apartment sleeping rooms and suite areas shall have smoke detectors with "sounder" bases controlled by the FACU, to assure audibility, unless the AHJ approves otherwise. Program the detectors so that sleeping room smoke initiates local alarm in the room, pre-signal indication at the FACU, and notification at the Supervising Station. Any common area alarm must cause immediate general alarm throughout the building, including all sounder bases in the sleeping rooms.
- 4.3 Spot-type detectors must be the plug-in type, with a separate base (not a mounting ring), to facilitate their replacement and maintenance. The base shall have integral terminal strips for circuit connections, rather than wire pigtails (see 6.5 for details). Each detector or detector base shall incorporate an LED to indicate alarm.
- 4.4 Spot-type smoke detectors shall have a built-in locking device to secure the head to the base, for tamper resistance. For detectors mounted within 12 feet of the floor, activate this lock **after** the system has been inspected and given final acceptance.
- 4.5 Spot-type smoke detectors shall not be used where ceiling height exceeds 25 feet because it makes access for maintenance very difficult and could impede response.
- 4.6 Unless suitably protected against dust, paint, etc., spot type smoke detectors shall not be installed until the final construction clean-up has been completed. In the event of contamination during construction, the detectors must be **replaced**.
- CAUTION: Covers supplied with smoke detector heads do **not** provide protection against heavy construction dust, spray painting, etc., and must not be used for that purpose. They are suitable only during final, minor cleanup or touchup operations.
- 4.7 A detector installed where accidental damage or deliberate abuse is expected shall be provided with a guard that is listed for use with it and is acceptable to the AHJ.
- 4.8 Identification of individual detectors is required. Assign each a unique number as follows, in sequence starting at the FACU: **(Addressable Loop # -- Device #)**. Put on the as-built plans, and also permanently mount on each detector's base so that it's readable standing on the floor below without having to remove the smoke detector. Exception: For detectors with housings (i.e., air duct, projected beam, air sampling, flame), apply the identification to a suitable location on exterior of their housing.
- 4.9 All air duct/plenum detectors must have a Remote Alarm Indicator Lamp (RAIL) installed in the nearest corridor or public area and identified by an engraved label affixed to the wall or ceiling. Duct smoke detectors are permitted to be installed only inside an air duct. It is not appropriate to mount them in front of a return air opening. Duct detectors shall also be installed in a manner that provides suitable, convenient access for required periodic cleaning and calibration (see 4.11).
- 4.10 Duct detector sampling tubes shall extend the full width of the duct. Those over 36 inches long must be provided with far end support for stability.
- 4.11 Each duct detector installation shall have a hinged or latched duct access panel, 12x12 inches minimum, for sampling tube inspection and cleaning. Indicate airflow direction on the duct, adjacent to the detector, using stencil or permanent decal.

- 4.12 **Recommended** design for most occupancies: Install smoke detectors in interior exit access corridors, M/E rooms, computer rooms, and unsprinklered storage rooms.

## 5.0 **Fire and Life Safety Criteria for Doors Controlled by Fire Alarm System:**

- 5.1 For life safety reasons, any exit or exit access doors that are locked to delay egress, in accordance with 1008.1.8.6 of the NC Building Code (2006 edition), must utilize one of the following types of locking hardware:

- Magnetic Lock (fail-safe) utilizing a 24vdc magnet and contact plate
- Electro-Mechanical Lock (fail-safe) with reverse bevel type dead bolt.

These doors must **immediately** unlock upon any fire alarm signal, loss of building AC power, **disablement of the fire alarm system** (defined as loss of its 24vdc power), or upon manual operation of an unlock switch at a constantly attended location.

Where installed on smoke or fire doors, power failure shall cause these mechanisms to default to the egress mode with normal mechanical latching.

- 5.2 Smoke doors are permitted to be held open by 24vdc wall/floor-mounted magnets powered by the FACU, and released upon alarm. The resulting current drain shall be included in the standby battery calculations **or** the system must be programmed to drop the door hold-open magnet load 60 seconds after the loss of 120vac power.
- 5.3 For life safety reasons, all rolling steel fire doors must descend at a constant rate of 1 foot/second maximum, whether released by their thermal link or closed by FACU command. Also, in response to strong requests from many facility managers, these fire doors must either: (1) Automatically reset when raised to their normal position, **or** (2) Have a motor down - motor up mechanism controlled by the FACU.

## 6.0 **System Configuration and Installation:**

- 6.1 Signaling Line Circuits (SLC's, also called addressable loops) must be NFPA Style 6 (Class A) with no "T" taps. Each must have a minimum of 20% spare addresses, for future use. Individual loops are permitted to cover more than 1 floor of a building.

- 6.2 To minimize wiring fault impact, isolation modules shall be provided in all of the locations listed below. If ceiling height  $\leq 10$  feet, isolator base type initiating devices are permitted to be used to satisfy any or all of the following:

1. In or immediately adjacent to the FACU, at each end of the addressable loop. These two isolators must be in the same room as the FACU and within 15 feet.
2. After each 25 initiating devices and control points on the addressable loop, or a lesser number where recommended by the manufacturer. (Check instructions.)
3. For loops with less than 25 devices and control points, install an isolator at the approximate middle of the loop (in addition to those at the FACU).
4. Near the point any addressable circuit extends outside the building, except for those attached to the building exterior walls and well sheltered by walkways.
5. For loops covering more than one floor, install isolator at terminal cabinet on each floor (with additional isolator[s] on any floor with over 25 addresses).

Each isolation module must be clearly labeled, readily accessible for convenient inspection (not above a lay-in ceiling), and shown on as-built drawings

- 6.3 All fire alarm system wiring shall be in metal conduit, surface metal raceway, or (in finished areas only, for improved appearance) surface non-metallic raceway.

EXCEPTION #1: PVC conduit is permitted to be used underground, in concrete, and in locations subject to severe corrosion (such as coastal facilities or lab/process areas).

EXCEPTION #2: Buildings on the historic register, when permitted by the AHJ.

- 6.4 All conduits that penetrate outside walls from air conditioned space must have internal sealing (duct-seal), to prevent condensation from infiltrating humid air.
- 6.5 There shall be **no** splices in the system other than at device terminal blocks, or on terminal blocks in cabinets. "Wire nuts" and crimp splices will **not** be permitted. Permanent wire markers shall be used to identify all connections at the FACU and other control equipment, at power supplies, and in terminal cabinets (see 6.6).
- 6.6 In multistory buildings, all circuits leaving the riser on each floor shall feed through a labeled terminal block in a hinged enclosure accessible from the floor. If building layout requires the terminal cabinet to be above a drop ceiling, its location must be clearly and permanently identified with a placard readable from floor. Terminal block screws shall have pressure wire connectors of the self-lifting or box lug type.
- 6.7 Addressable loop (signaling line) circuits shall be wired with type FPL/FPLR/FPLP fire alarm cable, AWG 18 minimum, low capacitance, twisted shielded copper pair. Cable shield drain wires are to be connected at each device on the loop to maintain continuity, taped to insulate from ground, and terminated at the FACU. Acceptable cables include Atlas 228-18-1-1STP, BSCC S1802s19 (same as EEC 7806LC), West Penn D975, D991 (AWG 16), D995 (AWG 14), or equal wire having capacitance of 30pf/ft. maximum between conductors. Belden 5320FJ acceptable if only FPL rating needed. The cable jacket color shall be red, with red (+) and black (-) conductor insulation. (See 6.9 for other wiring.)

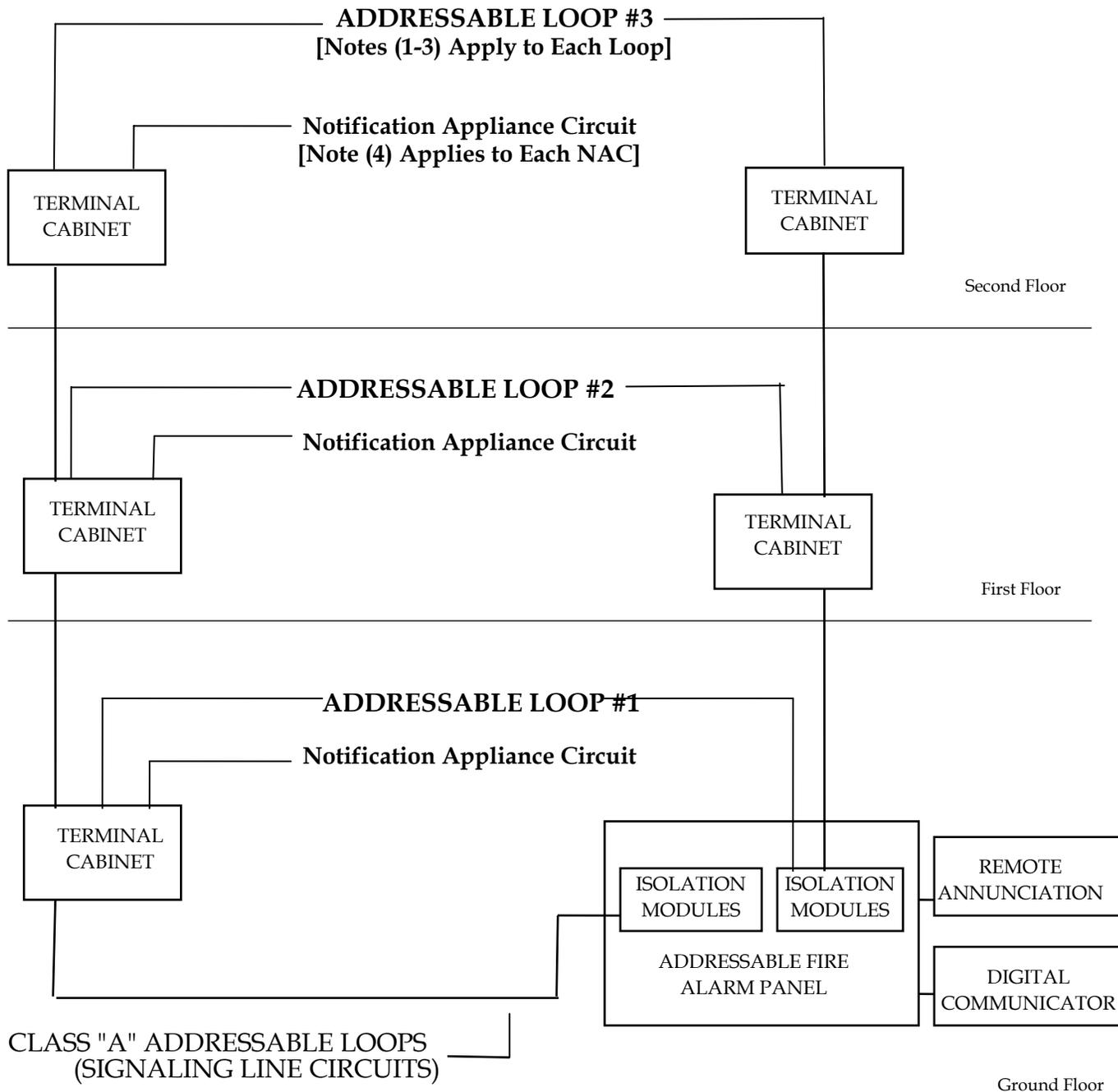
EXCEPTION #1: Unshielded cable, otherwise equal to the above, is permitted to be used if the manufacturer's installation manual requires, or states preference for, unshielded cable.

EXCEPTION #2: In underground conduit, use Type TC or PLTC cable (PE insulated) to avoid problems from moisture.

CAUTION: The previous requirement for 3/4" conduit no longer exists but cable size and the requirement to maintain a Class "A" loop on all Signaling Line Circuits frequently cause conduit fill to exceed specified maximums if the 1/2" size is used. Therefore, 3/4" raceway is still strongly recommended.

- 6.8 Addressable interface modules (used to monitor all contact type initiating devices) must be located in conditioned space, unless they are tested, listed, and marked for continuous duty across the range of temperatures and humidity expected at their installed location. With AHJ approval they may be permitted to serve as many as 3 sprinkler system valve supervisory switches, or 6 heat detectors, in a single space.
- 6.9 Except as required by 2.8 and 6.7, all other circuits in the system shall be wired with AWG 14, stranded copper, THHN/THWN conductors, installed in conduit. Color code as shown below throughout the system, without color change in any wire run:
- Alarm notification Appliance Circuits (horns/strobes).....Blue (+)/Black (-)
  - Separate 24vdc Operating Power (for equipment).....Yellow (+)/Brown (-)
  - Door Control Circuits (magnet power, if from system).....Orange
  - Circuits from ZAM's to Monitored Devices (AWG 14/16)...Violet(+)/Grey (-)

**FIGURE A: TYPICAL RISER DIAGRAM FOR ADDRESSABLE SYSTEMS (SEE NOTES)**



- NOTES:** (1) This shows 1 loop per floor, a common design for larger multi-story buildings. It also has the outgoing and return loops run in 2 separate vertical risers, to promote survivability during fire (critical for high-rise).  
 (2) Unless the specification requires otherwise, a single loop is permitted to serve a maximum of 3 floors and, except for High Rise buildings, the outgoing and return loops may share a common vertical chase. However, if any loop serves more than 1 floor, include an isolation module at each terminal cabinet it uses.  
 (3) Provide isolation modules (or isolator bases) along each SLC (addressable loop), in accordance with 6.2.  
 (4) Notification Appliance Circuits (NAC's) are permitted to be Class "B" and, unless specifically permitted by the specification (e.g., for very small footprint buildings), each shall serve a maximum of 3 floors

- 6.10 Notification Appliance Circuit booster ("ADA") power supplies must be individually monitored by the FACU and protected by a smoke detector per NFPA 72. They shall not be located above a ceiling, or in non-conditioned space. NOTE: A 24vdc power circuit serving addressable control relays must also be monitored for integrity.
- 6.11 All junction boxes shall be painted red **prior** to pulling the wire. Those installed in finished areas are permitted to be painted outside to match the finish color.
- 6.12 The branch circuit breaker(s) supplying the system must be physically protected by panelboard lock or handle lock and each must be identified with a 1/4" permanent red dot applied to handle or exposed body area.
- 6.13 Provide an engraved label at each fire alarm system control unit, system sub-panel or data gathering panel, supplementary notification appliance (SNAC) panel, digital alarm communicator, etc., identifying its 120vac power source, as follows:  
**Panelboard location, panelboard identification, and branch circuit number.**
- 6.14 The fire alarm system shall monitor 120vac power to shunt trip breakers used in conjunction with fire suppression systems. Examples include a shunt trip used for cooking appliance power shut-off when the kitchen hood fire suppression system shoots, or primary elevator power shut-down upon sprinkler flow in any elevator equipment space or shaft. Use an addressable monitor module to accomplish this **supervisory** function.
- 6.15 Unless the AHJ requires otherwise, all duct smoke detectors shall be programmed for fire alarm (not for supervisory annunciation).

## **7.0 Programming, Testing, and Certification:**

- 7.1 All connections to the FACU and the system's programming shall be done only by the manufacturer, or by an authorized distributor that stocks a full compliment of spare parts for the system. The technicians who do this are required to be trained and individually certified by the manufacturer, for the FACU model/series being installed. This training and certification must have occurred within the most recent 24 months, except that a NICET Level III certification will extend this to 36 months. **Copies of the certifications must be part of the Shop Drawing submittal to the engineer, prior to installation. The submittal cannot be approved without this info.**

The technician who makes final connections and programs the FACU is legally the "installer" even though most field connections to system devices and appliances are normally made by electrical contractor personnel. The responsibility for assuring a proper installation overall rests with this individual. In addition to doing the final hookups and activating the system, this individual is expected to check enough field connections to assure a proper job was done there. The absence of system "trouble" signals is not a sufficient measure of the field wiring, which could have "T" taps, the wrong type of wire, improper terminations, ground (drain wire) issues, etc.

- 7.2 When programming the system, activate the automatic drift compensation feature for all spot-type smoke detectors. Systems with alarm verification are **not** to have this feature activated without written direction from the owner's representative or the AHJ. Alarm verification must **not** be used with multi-sensor/multi-criteria detectors under any circumstances, as inadequate system response may result.
- 7.3 Set spot-type smoke detector sensitivities to normal/medium, unless directed otherwise by the design engineer/owner's rep.

- 7.4 Print a complete **System Status and Programming Report**, after the above steps have been done. This must include the program settings for each alarm initiating device and the current sensitivity of each analog addressable smoke detector. See 7.5.
- 7.5 The manufacturer or authorized distributor must 100% test all site-specific software functions for the system and then provide a detailed report or check list showing the system's operational matrix. This documentation must be part of the "**System Status and Programming Report**" described in 7.4.
- 7.6 Upon completion of the installation and its programming, the fire alarm technician shall test every alarm initiating device for proper response and indication, and all alarm notification appliances for effectiveness. Also, in coordination with the other building system contractors, all other system functions shall be verified, including (where applicable) elevator capture and the control of HVAC systems, door locks, pressurization fans, fire or smoke doors/dampers/shutters, etc. The engineer must be notified in advance of these 100% tests, to permit witnessing them if desired.
- 7.7 **The contractor must fill out and submit the following documentation to the owner, through the engineer, prior to the AHJ's system acceptance inspection:**
1. The NFPA 72-1999, Figure 1-6.2.1, "**Record of Completion**" Form. Use this form (no substitutes) to detail the system installation and also to certify that: (a.) It was done per Code, and (b.) The Code-required 100% test was performed. If a representative of the AHJ, owner, or engineer witnesses the tests, they sign the last line of the form to signify that fact only (annotating the form as needed).
  2. For buildings with a smoke control or smoke purge system, an HVAC balance report, in the smoke control/ smoke purge mode.
  3. The System Status and Programming Report described in 7.4. This must be generated on the day of the system acceptance inspection.
- 7.8 **After** completion of the 100% system test per 7.6 and submission of documentation per 7.7, the contractor is to request the **engineer** to set up an inspection. The system must operate for at least two days prior to this inspection.
- 7.9 The fire alarm system will be inspected, with portions of it functionally tested. This will normally include the use of appropriate means to simulate smoke for testing detectors, as well as functionally testing the system interface with building controls, fire extinguishing systems and any off-premises supervising station. Operation of any smoke removal system will be checked as instructed by the AHJ. This statistical (sampling) inspection is intended to assure that the contractor has properly installed the system and performed the 100% operational test as required by NFPA 72. The contractor normally provides two-way radios, ladders, and other materials needed for testing the system, included a suitable smoke source.
- 8.0 Documentation, Owner Training, and Spare Parts:**
- 8.1 In addition to the Shop Drawing submittal described in 1.1, the fire alarm system contractor shall provide the engineer two bound copies of the following technical information, for transmittal to the owner: (1) As-Built wiring diagram showing all loop numbers and device addresses, plus terminal numbers where they connect to control equipment, (2) Manufacturer's detailed maintenance requirements, (3) Technical literature on all control equipment, isolation modules, power supplies, alarm/supervisory signal initiating devices, alarm notification appliances, relays, etc, (4) The as-built "calculations" sheet referenced in paragraphs 1.14 and 2.5.
- 8.2 Complete configuration data (site-specific programming) for the system must be stored on electronic media and archived by the fire alarm system manufacturer or

authorized distributor. A diskette or CD copy of this data shall be submitted to the engineer for transmission to the owner on the day the system is commissioned.

- 8.3 The manufacturer, or authorized distributor, must maintain software version (VER) records on the system installed. The system software shall be upgraded free of any charge if a new VER is released during the warranty period. For new VER to correct operating problems, free upgrade shall apply during the entire life of the system.
- 8.4 Basic operating instructions shall be framed and permanently mounted at the FACU. (If the owner concurs, they may instead be affixed to the inside of the FACU's door.) In addition, the NFPA 72 "Record of Completion" (see 7.7) must either be kept at/in the FACU, or its location shall be permanently indicated there by engraved label.
- 8.5 Provide an engraved label inside the FACU identifying its 120vac power source, as follows: **Panelboard location, panelboard identification, and branch circuit number.**
- 8.6 The **manufacturer's authorized representative** must instruct the owner's designated employees in operation of the system, and in all required periodic maintenance. A minimum of 2 hours on-site time will be allocated for this purpose and, for those facilities operating on a 24-hour basis (prisons, hospitals, etc.), one additional hour of instruction will be individually provided for the 2nd and 3rd shift. Two copies of a written, bound summary will be provided, for future reference.
- 8.7 The following spare parts shall be provided with the system. For multi-building projects, calculate quantities separately for each building that contains a dedicated fire alarm control panel. If FACU also serves auxiliary buildings (e.g., storage, boiler/chiller), calculate as if one building. Increase decimal quantities to the next higher whole number:

- Fuses (If Used).....2 of each size in system
- Manual Fire Alarm Boxes.....2% of installed quantity
- Addressable Control Relays.....4% of installed quantity
- Indoor Horns/Speakers with Strobes Lights.....4% of installed quantity
- Indoor Strobe-only Notification Appliances.....4% of installed quantity
- Monitor Modules (Addressable Interface).....4% of installed quantity
- Isolation Modules / Isolation Bases.....4% of installed quantity
- Addressable, Electronic Heat Detectors.....4% of installed quantity
- Spot-Type Smoke Detectors / Sounder Bases.....6% of installed quantity

No spares are required for projected beam, air sampling, or duct smoke detectors.