

A13.1 Standard of Practice - Fire Alarm Systems

OBJECTIVE OF STANDARD

- ❑ To acquaint designers and other interested parties with the University's provisions for protection of building occupants and property from life safety hazards.
- ❑ To insure consistent specifications for, and installation of, fire alarm hardware and software within campus buildings and campus-wide network interface between building systems.
- ❑ To extend the University's capabilities for remotely monitoring the life safety status of all campus buildings, including sprinkler systems to reduce property damage.

BACKGROUND

The University is concerned with its ability to protect building occupants as well as property from the threat of undetected and/or uncontrolled fire. In addressing this concern the University has provided a high level of fire detection and alarm in most buildings. Existing fire alarm/security management systems range from buildings with manual alarm signal initiation devices (pull stations) and local alarm outputs (horns) only, to buildings that are presently equipped with remote supervising station fire alarm/security management systems with fully-addressable devices and appliances. Most buildings that are presently equipped with remote supervising fire alarm/security management systems are connected to a fiber-optic campus-wide fire alarm network and have a severe weather alert system.

It is the University's long term objective to provide similar and compatible remote supervising stations at all main campus buildings and to provide a fault-protected, looped networking cable that interconnects all building stations.

While the University does not have a formal NFPA 72 certification program, key criteria for installation and operation of a proprietary fire alarm system, as defined in NFPA 72, have been adopted by the University to insure maximum life safety and property protection benefit from the campus-wide system.

BASIS FOR DESIGN

Any new building fire alarm system and any addition to an existing system should be designed as a "protected premises fire alarm system" in accordance with NFPA 72 - National Fire Alarm Code. It is the University's intent to make use of the fire alarm system equipment and network infrastructure to provide the following alarm and emergency notifications for campus buildings as they are added to the system:

- ❑ Pre-recorded voice notification utilizing KU chip-set for occupants to exit a building upon activation of and detection device or pull station.
- ❑ Pre-recorded voice notification for occupants to move to safe areas within buildings upon declaration of a local weather emergency by the KU-Public Safety Office.
- ❑ Alarm notification to the KU-Public Safety Office upon notification of a security breach.

DEFINITION CONVENTIONS

The designer should be cognizant of the following definitions from NFPA 72 as they pertain to details of the construction and operation of the University's fire alarm system:

- ❑ **Proprietary Fire Alarm System** – An installation of fire alarm systems that serve contiguous and noncontiguous properties under one ownership from a proprietary supervising station located at the protected property, where trained, competent personnel are in constant attendance. This includes the proprietary supervising station; power supplies; signal initiating devices; initiating device circuits; signal notification appliances; equipment for the automatic, permanent visual recording of signals; and equipment for initiating the operation of emergency building control services. This definition describes the University's campus-wide fire alarm system.
- ❑ **Active Multiplex System** – A multiplexing system in which transponders are employed to transmit status signals of each initiating device or initiating device circuit with a prescribed time interval. The University is developing a multiplexing system that conforms to operational criteria of NFPA 72 – National Fire Alarm Code.
- ❑ **Central Station Fire Alarm System** – A system or group of systems in which the operations of circuits and devices are transmitted automatically to, recorded in, maintained by, and supervised from a listed central station having competent and experienced servers and operators who, upon receipt of a signal, take such action as required by this code. Such service is to be controlled and operated by a person, firm, or corporation whose business is the furnishing, maintaining, or monitoring of supervised fire alarm systems. In the operation of its campus-wide fire alarm system network, the University maintains four separate central station service points. University Department of Public Safety personnel who are trained in areas of emergency dispatch staff one primary monitoring service point and one back up point. A third service point is staffed by University Facilities Operations personnel for testing and maintenance. A fourth point is for KU Housings testing and maintenance. FO and Housing technicians monitor a central station for non-alarm supervisory and trouble signals on the system.

CRITERIA FOR DESIGN

The design of fire alarm systems on University property, particularly the extent of coverage of both alarm initiating devices and notification appliances, will be based upon the use and occupancy of the project site. The designer should be guided by the project code analysis and code footprint in establishing the minimum fire alarm system requirements. Prior to commencing any fire alarm system design, the designer is expected to have determined, by

discussions with the University Fire Marshall and other design team members, the specific code-based occupancy designation for the project area. Additional requirements may result from one or more of the following considerations:

- Requirements of the Authority Having Jurisdiction – the designer should determine if the project area is subject to existing AHJ citations of fire code violations that can be addressed as part of each project.
- Code equivalencies deemed desirable by the University and acceptable to the AHJ – the designer should determine if budget or operational constraints make it preferable to develop designs that represent alternate solutions to life safety concerns within a particular project area.
 - The University prefers NOT to use code equivalencies in new buildings.
 - If an equivalency is proposed for a project, it must be approved in writing by DCM, DFM and the KSFMO.
- Special detection requirements - such as devices that are resistant to false alarms in areas like performance theaters and concession stands.
- Special signaling appliances - such as strobes and speakers appropriately placed for protection of disabled individuals in practice rooms or listening labs.

DESIGN SPECIFICS

The designer should consider the following specific items in completing a fire alarm system installation or upgrade design:

- All fire alarm equipment should be UL listed.
- Fire alarm systems should be the addressable type. If the system has more than 10 smoke detectors they shall be analog addressable type and have alarm verification, set at 60 seconds.
- Unless project area conditions require otherwise, the audible alarm function design should be based on voice speaker equipment with prerecorded emergency messages utilizing the KU chip-set, activated by system detection devices.
- Total system designs should incorporate requirements for fire command centers as detailed in chapter 3 of NFPA 72, particularly as they relate to requirements for audible alarm signals.
- The system should be equipped with secondary power supply for emergency voice/alarm communications service capable of operating the system upon loss of the normal primary energy source. The secondary source should be in the form of battery backup. The system should be equipped with 24-hours of battery capacity and should not be circuited to other building emergency power sources. The system should have capacity to provide backup power under maximum normal load for 24 hours and then shall be capable of operating the system during a fire or other emergency condition for a period of 2 hours. Fifteen minutes of evacuation alarm operation at maximum connected load shall be considered the equivalent of 2 hours of emergency operation. Operation on secondary power shall not affect the required performance of a fire alarm system. The system

should produce the same alarm, supervisory, and trouble signals and indications (excluding the ac power indicator) when operating from the standby power source as are produced when the unit is operating from the primary power source.

- The fire alarm control panel shall have three form C contacts (trouble, supervisory, and alarm) for connection to BACS. See section 15950 - Controls and Instrumentation. The BACS system wires will terminate in the fire alarm control panel.
- Magnetic hold-open devices shall be used on all fire doors where the occupants want the door open; this will discourage wedges or door stops from being used. The devices must be detailed on the construction documents.
- Provide raceways for fire alarm wiring; utilize conduit if concealed, and wire-mold if exposed. Junction box covers shall be painted red for identification.
- Water flow detection devices shall have one device per address.
- Each control relay shall be within three feet of the device being operated, in addition to being numbered and labeled.
- Specify mounting height for devices to comply with ADA requirements.
- Concealed initiating devices (duct smoke detectors, tamper switches, etc.) shall have remote alarm indicators identifying the location of the device. Locate remote indicators in public spaces (such as corridors). Duct smoke detectors shall have remote indicators with test stations.
- A weatherproof exterior strobe with optional speaker shall be mounted above the sprinkler system fire department's Siamese connection 8' to 10' above grade.
- An electrical outlet shall be provided within 10 feet of the fire alarm control panel.
- Contractor to program fire alarm control system to operate according to the design matrix.
- Signaling line circuits shall NOT be loaded greater than 75 percent of capacity. The panel shall have one spare signaling line circuit or capacity for 50 additional initiating devices.
- Notification appliance circuits shall be designed with reasonable spare capacity; verify number or percentage of used circuits to provide as spares with DCM and FO. Visual notification appliances shall not be on the same circuits as audible notification appliances. One spare audible notification appliance circuit and one spare visual notification appliance circuit shall be provided.
- Speakers located in public areas, usually suspended ceilings, shall be ceiling mounted "Atlas Soundolier" with labels stating "FIRE" on the face of the speaker.
- Service areas shall have standard 4" wall mounted speaker/strobe units.
- Speakers shall be tapped at 2 watts unless special conditions exist.
- Speakers shall be located and spaced independently.
- Strobes shall be located and spaced independently.
- Provide recessed KNOX Box at 6' above floor line at main entrance. Verify location with KU and City Fire Marshals.
- Where speakers are used, provide microphone at fire alarm main panel.

- Remote annunciator at building entrance shall be small type in 6 gang box.
- All circuits shall be Class B. The end of line resistor shall be located at the last device of the circuit; identified on drawings and in field. Limit circuits to one floor or major area. Label terminal strips. Provide terminal boards in control panels.
- Use door hold-open circuits from fire alarm panel in lieu of auxiliary contacts in the detector base or a local device.
- An over current protective device of suitable current-carrying capacity and capable of interrupting the maximum short-circuit current to which it may be subject shall be provided in each ungrounded conductor. The over current protective device shall be enclosed in a locked or sealed cabinet located immediately adjacent to the point of connection to the light and power conductors. Circuit breakers should not be installed in such a manner as to cut off the power for lighting or for operating elevators.

The central station equipment that is used to monitor campus-wide fire alarm status is “IMS” graphically-based. All spaces that are monitored are represented on the central station monitor screen in floor-by-floor scaled plans. It is critical that the designer include current and correct building names and numbers, floor designations, and room, corridor, stairway and elevator numbering on all documents that illustrate the fire alarm system design. Specify contractor to submit plans for approval before installation.

Minimum Construction Document Content – The designer should include the following minimum information in project construction documents:

- The address of the protected premises
- The owner of the protected premises
- The authority having jurisdiction
- The applicable codes, standards, and other design criteria to which the system is required to comply
- The type of building construction and occupancy
- The fire department response point(s) and annunciator location(s)
- The type of fire alarm system to be provided
- Calculations (e.g., secondary supply and voltage drop calculations)
- The type(s) of fire alarm-initiating devices, supervisory alarm-initiating devices, and evacuation notification appliances to be provided
- The intended area(s) of coverage
- A complete list of detection, evacuation signaling, and annunciator zones
- A complete list of fire safety control functions
- A complete sequence of operations detailing all inputs and outputs
- Specification of IMS graphic & programming changes

OPERATIONAL PLAN AND TEST

As early as possible during the design development phase of a project, the designer should confirm with the University if the Fire Alarm and the interface to related systems will be included in commissioned services. The designer shall include a test manual for the specific testing requirements for the fire alarm and related systems. The test manual will include test procedures to verify that the fire/life safety interface is operating correctly for the following systems:

- Elevators
- Sprinkler flow and tamper switches
- HVAC Systems
- Smoke/fire damper activation and reset
- Door Closures
- Fire Alarm System and Devices, every device shall be tested.

Each test procedure will include a detailed description of the following items:

- Sequence of operations for fire control functions of the fire alarm system.
- Recording Format
- Test Equipment Required
- Test Participants

The following table is a sample sequence matrix of operation for initiating devices:

- Water-flow
- Sprinkler Tamper
- Dry Pipe HI-Low Air
- Manual Pull Station
- Smoke Detector
- Duct Smoke Detector
- Circuit Or Panel Trouble
- 120V Loss at FACP
- Alarm Annunciation at FACP and BACS
- Supervisory Annunciation at FACP and BACS
- Trouble Annunciation at FACP and BACS
- Shut down HVAC/Close smoke dampers
- Drop door holders

The following parties shall sign off with date, indicating the system performed according to the sequence of operations above, before occupancy certificate can be issued:

- Fire Alarm Vendor
- Mechanical contractor
- Electrical Contractor
- Designer
- Fire Protection Contractor
- Authorities having jurisdiction

Final acceptance test to be conducted in the presence of the AHJ, project inspector, the University Construction Administrator and Designer.

- A typed NFPA 72 Certificate of Completion shall document the installation and acceptance testing with University supplemental documentation.

PRE-TESTING PROTOCOL

- Pre-testing: Upon completing installation of the system, align, adjust, and balance the system and perform complete pre-testing. Determine, through pre-testing, the conformance of the system to the requirements of the Drawings and Specifications. Correct deficiencies observed in pre-testing. Replace malfunctioning or damaged items with new, and retest until satisfactory performance and conditions are achieved. Prepare forms for systematic recording of the acceptance test results.
- Wiring runs shall be tested for continuity, short circuits and grounds before system is energized. Resistance, current and voltage readings shall be made as work progresses.
- Voice system audibility and dB level shall be tested and documented through out installation. Provide results on 11x17 floor plan sheets for final acceptance test.

Report of Pre-testing: After pre-testing is complete, provide a letter to the University certifying the installation is complete and fully operable, including the names and titles of the witnesses to the preliminary tests.

Final Test Notice: Provide a 10 day minimum notice in writing when the system is ready for final acceptance testing.

FORMAL ACCEPTANCE TESTING

Fire alarm system shall be ready for use, completely operational, and formally accepted at least 15 days before the date of Substantial Completion of each part of the work, and before a certificate of occupancy can be issued by the AHJ.

The Contractor shall provide all test equipment, instruments, tools and labor required to conduct the system tests. The following equipment shall be a minimum for conducting the tests:

- Ladders and scaffolds as required to access all installed equipment.
- Multi-meter for reading voltage, current and resistance.
- Addressable device programmer/tester.
- Laptop computer with programming software for any required program revisions.
- Two way radios, flashlights, smoke generation devices and supplies.
- Decibel meter for each team testing areas.

Final test and inspection shall be held in the presence of the Design Engineer, the University's Representatives and the Authority Having Jurisdiction representative. The Contractor shall supply personnel and required auxiliary equipment for this test without additional cost.

- Presence of a manufacturer's authorized technical representative shall be required at all acceptance tests and re-tests.

Formal system acceptance shall be in accordance with the procedures outlined in NFPA 72, the manufacturer's recommendations, and the University's direction. The formal system acceptance test shall include the following:

- University Fire Marshall Authority – “F.A. Inspection & Testing Form” –see appendix-
- A written procedure for testing the fire alarm system components and installation shall be prepared in accordance with NFPA 72 and this specification. The contractor shall be responsible for the performance of the test procedure, demonstrating the function of the system and verifying the correct operation of all system components, circuits, and programming.
- A program matrix shall be prepared by the contractor referencing each alarm input to every output function affected as a result of an alarm condition on that input. In the case of outputs programmed using more complex logic functions involving "any", "or", "not", "count", "time", and "timer" statements; the complete output equation shall be referenced in the matrix.
- The contractor prior to the test procedure shall prepare a complete listing of all device labels for alphanumeric enunciator displays.
- The University and State Representatives shall use the record drawings in combination with the submittal documents during the testing procedure to verify operation as programmed. In conducting the test procedure, the University Representative shall request demonstration of any or all input and output functions. The items tested shall include but not be limited to the following:
 - Megger test all conductors other than those intentionally and permanently grounded with electronic components disconnected.
 - Test for resistance to ground. Report readings less than 1 mega-ohm for evaluation.
 - With each circuit pair, short-circuit at the far end of the circuit and measure the circuit resistance with an ohmmeter.
- Record the circuit resistance of each circuit on the record drawings. System wiring shall be tested to demonstrate correct system response and correct subsequent system operation in the event of:
 - Open, shorted and grounded addressable signaling circuit.
 - Open, shorted and grounded network signaling circuit.
 - Open, shorted and grounded conventional zone circuits.
 - Open, shorted and grounded indicating circuits.
 - Addressable device removal.

- Primary power or battery disconnected.
- Incorrect device at address.
- System evacuation alarm indicating appliances shall be demonstrated as follows:
 - All alarm notification appliances actuate as programmed
 - The sound level of the evacuation system is 15dBA above the ambient sound level. Typical ambient sound levels of each typical representative room shall be recorded. The sound level of the evacuation system in each room or area shall be recorded to verify the performance of the system.
- System indications shall be demonstrated as follows:
 - Correct message display for each alarm input at the control panel and the remote alpha-numeric display.
- Transmission to Remote Station shall be demonstrated as follows:
 - Alarm signal is received at the University 911 Center.
- Secondary power capabilities shall be demonstrated as follows:
 - System primary power shall be disconnected for a period of 24 hours. At the end of that period, an alarm condition shall be created and the system shall perform as specified for 10 minutes.
 - System primary power shall be restored for 24 hours and system charging current shall be normal trickle charge for a fully charged battery bank.
 - System battery voltages and charging currents shall be checked at the fire alarm control panel using the test codes and displayed on the LCD display.
- In the event of system failure to perform as specified and programmed during the testing procedure, at the discretion of the University Representative or the Engineer, the test shall be terminated. The Contractor shall retest the system, correcting all deficiencies and providing test documentation to the University Representative and the Engineer.
- In the event that software changes are required during the test procedure, the contractor shall provide a printed list of the changes. The items listed shall be the minimum acceptable to be retested before calling for resumption of the test procedure. The printed list and the printer log of the retesting shall be submitted before rescheduling of the test procedure.
- The University Representative or the Engineer may elect to require the complete test procedure to be performed again if, in his/her opinion, modifications to the system hardware or software warrant complete retesting.
- All approved project submittals, drawings, specifications, certifications, test results, and current as-built/record drawings shall be available at test location.
- In addition to the testing specified to be performed by the contractor, the installation shall be subject to test by the University Representative or the Engineer.

WRITTEN CERTIFICATIONS AND TEST REPORTS

The following 4 written certifications and/or test reports shall be submitted by the installation contractor before final and formal acceptance will be scheduled:

- Written certification and test results confirming full compliance with these specifications, the manufacturer's latest recommendations, and NFPA 72.
- Written certification and test results confirming the system is free of ground faults, short circuits, and the absence of unwanted voltages between circuit conductors and ground as per manufacturer's recommendations and NFPA 72.
- Written report on final system programming configuration.
- Written certification and test results of the complete system checkout procedure as per manufacturer's published installation recommendations and NFPA 72. This shall include:
 - A complete list of equipment installation and wiring.
 - Indication that all equipment is properly installed and functioning, and conforms with these Specifications.
 - Technician's name, certification number, and data.

As-Built Submittals: After completion of all the tests and adjustments listed above, the Contractor shall submit the following information to the Engineer.

- "As-built" conduit layout diagrams, including wire color code and/or tag number.
- Complete "as-built" wiring diagrams.
- Detailed catalog data on all installed system components.
- Copy of the test report. Including results of sound levels of sample rooms and areas or "as-built" diagrams

System Stability Demonstration: Acceptance of the system shall also require a demonstration of the stability of the system. This shall be adequately demonstrated if the system operates for a 90 day test period without any unwarranted alarms. Should an unwarranted alarm(s) occur, the Contractor shall readjust or replace the detector(s) and begin another 90 day test period. As required by the Engineer, the Contractor shall recheck the devices using the fire test after each readjustment or replacement of devices.

- If the requirements provided in the paragraph above are not completed with one year after beginning the tests described therein, the Contractor shall replace the system with another acceptable manufacturer and the process repeated until acceptance of the equipment by the Engineer without additional costs.

Operating & Maintenance Manuals: Before final acceptance of work, the Contractor shall deliver four copies of a complete Operating and Shop Maintenance Manual.