Design Guideline 283100
Fire Detection and Alarm

Scope

This guideline defines the requirements and standards for design of a new fire alarm system or the expansion of an existing system. The guideline covers basic requirements for system design, fire alarm control panels, initiating devices, notification appliances, wiring, and central station monitoring.

Related Sections

U-M Design Guideline Sections:

1.0 DG – Codes and Regulatory Agencies
2.1 DG - Owner's Project Requirements and Basis of Design Documents (OPR and BOD)
5.11 DG - Fire Command Center
6.3 DG 260513 - Medium, Low & Control Voltage Cables
6.3 DG 260526 - Grounding and Bonding for Electrical
6.3 DG 260533 - Electrical Materials and Methods
6.3 DG 260800 - Electrical Acceptance Tests
6.3 DG 273523 - Emergency Responder Radio Coverage

U-M Master Specification Sections:

7.3 MS 283100 Fire Detection and Alarm System

U-M Standard Details:

Standard Details 9.3-Series Details

Reference Documents:

- Michigan Building Code (MBC)
- Michigan Electrical Code (MEC)
- Michigan Elevator Code
- NFPA 101 - Life Safety Code

Design Requirements

Use U-M Master Specification 283100, “Fire Detection and Alarm Security”, as Basis for Design (BOD) and specifying fire detection and alarm systems. Edit the specification and details to make them project specific. When editing the specification, turn on hidden text and follow the Spec Editor notes.

The U-M Fire Marshal Office reviews fire alarm system designs and inspects installations for all applicable U-M projects. U-M Electrical Inspectors along with U-M Fire Alarm Electricians will witness fire alarm system testing on all applicable U-M projects.

Michigan Bureau of Fire Services (BFS) reviews fire alarm system designs and inspects installations for health care, instructional, dormitory, and child care spaces.

Fire alarm systems and accessories shall be UL listed and FM Global approved.

For new buildings, that by code, are not required to have a fire alarm system installed, perform a risk analysis in coordination with NFPA 550 and U-M Risk Management Department, and submit to the Design Manager. Through this analysis and in conjunction with approval from the Assistant Vice President for AEC, determine if a fire alarm system should be installed even though it is not required by code. Include a risk analysis report in the BOD.

If an existing building is not protected by a sprinkler system or area smoke detectors, or is only partially sprinkled or partially protected by area smoke detectors, follow the new building risk analysis guidelines above for renovation and expansion projects.

New fire alarm systems shall have one or more fire alarm control panels (FACP's) as required by the size of the project area. In addition, new fire alarm systems shall be installed with 25% (additional) spare capacity in all initiating circuits, notification appliance circuits, power supplies, amplifiers, batteries, and related components of the overall system.

Whenever possible, expand and/or extend the existing system unless otherwise directed by the Design Manager. Existing fire alarm systems shall always maintain 5% spare capacity in all power supplies, amplifiers, batteries, and related components of the overall system. If a system's capacity is found to be below this requirement notify the Design Manager.

The fire alarm system shall also include provisions for connection to the University MOSCAD system which is monitored by the U-M Division of Public Safety & Security (DPSS).

See Design Guideline 5.2, 'Animal Facilities' for the specific fire alarm sound and strobe requirements in animal housing areas.

Project plan view drawings for fire alarm systems shall include room names and furniture layouts. Coordinate design with reflected ceiling plans noting locations of soffits, beam pockets, skylights, etc.

FACP's and Remote Annunciators

FACP's shall incorporate the following:

- Modular design with solid state, microprocessor based electronics, power-limited design.
- Programs stored in a non-volatile flash EPROM memory within the FACP. Loss of primary and secondary power shall not erase the program stored in memory.
- Capable of being programmed by the Owner on site to accommodate expansion or sequence of operation changes.
- Display only those primary controls and displays essential to operation during a fire alarm condition.
- Audible signals that sound during alarm, supervisory, or trouble conditions.
- Battery capacity (secondary power) to operate the entire system (except door hold-open and door control devices) upon the loss of primary power for a period of 24 hours in a normal supervisory mode followed by 5 minutes of evacuation alarm operation or 15 minutes of voice/alarm operation as applicable.

The system shall be capable of being walk tested by one person.

Locate FACP and remote annunciator panels in the fire command center, building lobby or in a secure, clean, dry, heated, and ventilated closet or electrical room near the building entrance. The panels shall not be located in a vestibule, loading dock area, or other high traffic area. One panel should be located in an

accessible location visible and adjacent to the building entrance selected for emergency response. Coordinate locations with Design Manager, DPSS, and Fire Safety Service.
Remote annunciators shall duplicate the display, programmable function keys, alarm functions/controls, and alarm audible signals of fire alarm control panels.

Microphones shall be included with remote annunciators when the fire alarm system includes emergency voice/alarm communications or a mass notification system, along with the same pushbuttons as the FACP for selecting pre-recorded voice messages, and the same controls to choose total building or selected areas communications.

Provide an empty 1" conduit from FACP to Building Entrance (BE) telecommunications room.

Initiating Devices
Initiating devices shall be addressable. In general, provide Class B initiating device circuits except where an applicable code requires a different circuit class.

Locate area smoke detectors, duct smoke detectors, and heat detectors so that they are readily accessible for maintenance. Provide accommodations for accessing all devices; no lifts or scaffolding shall be required for maintenance. Those devices in restricted areas such as elevator shafts shall be easily accessible, from a non-restricted area, via access doors. Avoid locating detectors above sloped auditorium floors or above steps.

Initiating devices shall be listed for the environment they are to be installed. These areas include but are not limited to locations with temperatures below 32F, wet/damp locations, and areas where the room will be occasionally hosed down.

Manual Pull Stations
Manual pull stations shall be located at all exit doors.

Pull stations in Residential buildings, areas where children are present, and as noted in BOD shall have protective covers with audible alarm (when cover is lifted).

Smoke Detectors
Smoke detectors are required above FACP's, remote annunciator panels, and NAC panels.

Michigan Elevator Code requires smoke detectors be located in elevator machine rooms, above machine room-less elevator equipment, elevator lobbies, and at the top of sprinklered elevator hoist ways to initiate an elevator recall. These smoke detectors shall be provided with the building fire alarm system and be connected to the FACP.

When the need for door hold-open devices (and associated door release service devices) is defined during schematic design, the associated devices shall be powered by a normal power 120V branch circuit. The associated smoke detectors shall report to the fire alarm system, and the normal power door hold open circuits are then opened by the fire alarm system via control modules. Carefully coordinate associated fire system components and door hardware specified in the architectural section.

Provide smoke detectors in the following locations:

- Substation rooms

- Telecommunication/data rooms
- Electrical power rooms
- Mechanical rooms
- Recycling and trash rooms

Smoke detectors in resident areas of residence halls and as noted in BOD shall have wire screen covers that are UL listed for the fire alarm system being installed.

Do not locate smoke detectors at the top of atriums or skylights. In these applications use beam or aspirated type detectors where applicable. Avoid locating smoke detectors where direct sunlight, high humidity, stagnant air, or turbulent air will cause maintenance problems.

Smoke detectors, when not in plain view and more than 10 feet above the floor, provide smoke detector remote alarm indicators and test switches mounted in plain view at 44 inches above the floor.

Duct Smoke Detectors

Locate duct smoke detectors at locations defined by manufacturer and/or by the mechanical contractor to have a laminar flow across the detector. Do not locate duct smoke detectors downstream of humidity injection points or in outside air intake plenums.

Duct smoke detectors shall be visible and accessible to responding personnel, requiring no more than the use of an 8'-0 step ladder to access. If the duct detector must be located where it is concealed and/or in accessible, provide a remote indicator light and test pushbutton in a nearby accessible location.

Duct smoke detectors shall report to the FACP, and the FACP shall operate a control module to stop the associated fan and close associated dampers.

All duct smoke detector installations shall include a 'duct detector interface box' as shown in Standard Details 28310006, 28310007, or 28310008. The Temperature Control Contractor shall provide the interface box. Locate the duct detector interface box so that a ladder is not needed for access. Typically the boxes are located near the associated temperature control panel.

If the fire alarm system is connected to a MOSCAD panel for transmission of alarm, supervisory, and trouble signals to DPSS, program the duct detectors as supervisory rather than alarm devices. Duct detectors shall only alarm the building if the fire alarm system is not connected to MOSCAD.

Duct smoke detectors shall be installed in the return and supply ducts of air handling units of more than 2000 cfm. NFPA 101 references NFPA 90A - Standard for the Installation of Air Conditioning and Ventilation Systems, which requires duct smoke detectors to be installed in the supply duct. MBC references the Michigan Mechanical Code which requires duct smoke detectors to be installed in the return duct.

Duct smoke detectors shall be mounted to the outside wall of the duct with a rigidly mounted sampling tube protruding into the duct. Installing area smoke detectors inside the duct work in lieu of duct smoke detectors with sampling tubes is not acceptable.

Sampling tubes of duct smoke detectors shall not be installed in the ducts until after the ducts have been cleaned and the air handling unit filters have been changed.

Heat Detectors
Careful consideration shall be given to providing heat detectors, rather than smoke detectors, in high humidity locations such as bathrooms with showers and laundry areas, and/or in areas with occasional smoke present such as kitchens.

Notification Appliances
In general, provide Class B notification appliance circuits except where an applicable code requires a different circuit class.

Combine horns or speakers with strobes when both are required at the same location.

Audible Notification Appliances
Audible notification appliances shall produce a three-pulse temporal pattern evacuation tone. If an emergency voice/alarm communication system is provided, the audible evacuation alarm signal shall produce a three-pulse temporal pattern evacuation tone followed by a pre-selected voice evacuation message. The alarm tones and voice evacuation messages shall alternate until they are silenced.

Specify speakers and horns with multiple adjustable taps. Audible notification appliances shall be capable of being adjusted to increase the sound level if needed based on final inspection and testing. Spare system and circuit capacities requirements shall be maintained.

The sound level in sleeping rooms shall be not less than 75 dBA measured 3'-0" from the most remote wall with a square wave low level frequency of 520 Hz.

Do not provide horns or speakers in elevator machine rooms or in elevator cars.

Do not provide horns or speakers in exit stair enclosures unless the building is equipped with an emergency voice/alarm communication system or a mass notification system. Emergency voice/alarm communication system exit stair enclosure speakers shall be on a separate paging zone.

High Rise buildings, Educational Group E buildings, and Assembly Group A buildings having more than 1000 occupants and/or other buildings as noted in the BOD, shall have emergency voice/alarm communication systems throughout the building.

Provide a speaker in each sleeping room and a sounder base in each sleeping room smoke detector. The speaker shall provide the general alarm and the sounder base shall alarm upon smoke within the room.

In rodent rooms, the sound shall be a three-pulse temporal pattern with a peak frequency below 500 Hz.

Note the following issues when designing audible notification systems:

- Assume that all interior doors will be closed.
- Office system furniture with sound dampening partitions may be installed.
- The ambient sound level in each space, the distance from the nearest notification appliance to each space, and the sound attenuation of the intervening walls and doors.
- Many laboratories and mechanical rooms have high average ambient sound levels.
- Alarm sound level measurements will be taken during fire alarm system testing, and audible appliances may have to be added if the alarm sound levels do not meet Code.

Visual Notification Appliances

Provide visual notification appliances in all common and public spaces as required by the applicable codes. Common and public spaces are defined as corridors, toilet rooms, auditoriums, classrooms, single or multi-person offices 200 square feet or larger*, conference rooms, and laboratories. Also provide visual notification appliances in the following locations:

- Elevator machine rooms
- Mechanical rooms and other areas that have an average ambient noise level exceeding 95 dBA
- Sleeping rooms and in living spaces of suites or apartments

Do not provide visual notification appliances in the following locations:

- Exit stair enclosures
- Elevator cars
- Single or multi-person offices less than 200 square feet*
- Closets and coat rooms
- Electrical closets
- Mechanical pipe chases
- Crawl spaces
- Small bathrooms within classrooms
- Janitor closets
- Storage rooms less than 200 square feet
- Unoccupied spaces
- Animal rooms

** For UM Hospital and Health Center facilities, verify with design manager*

Specify strobes with multiple adjustable taps. Visual notification appliances shall be capable of being adjusted to increase the candela level if needed based on final inspection and testing. Spare system and circuit capacities requirements shall be maintained.

Size and locate visible notification appliances in strict accordance with the "Visible Characteristics, Public Mode" Section of NFPA 72. Select the strobe candela outputs in accordance with the spacing tables, and indicate their outputs on the plan drawings for all strobes. Locate strobes at the halfway distance on the longest walls as shown in the NFPA 72 figures and appendices. Do not install strobes near room corners without increasing their candela ratings appropriately.

On all buildings on the Ann Arbor Campuses, install a NEMA 3R, 110 candela strobe and speaker outside above the location of the 'Siamese' (fire hose) fire department connection.

Monitor and Control Modules

Provide individually addressable monitor and control modules for interface with other building life safety systems. Monitor and control modules shall use Class B circuits. Control modules shall be within 3'-0 of the associated device.

Provide FACP modules and individual modules for control of other systems and equipment. These systems and functions include but are not limited to the following:

- Shut down of ventilation systems via normally closed control module contacts after an alarm report

from associated duct smoke detectors.
- Control module output contacts (minimum of three) for each elevator to control elevator recall (designated and alternate floors) and in-cab warning signaling. See Standard Details 28310010, 28310011, & 28310012.
- Control, via normally closed control module contacts, electrified door locking hardware, magnetic door locks, door hold-opens, and to disable electrically operated door proximity sensors.
- Interfacing with MOSCAD system for relaying status of supervisory signals of Emergency Responder Radio Systems (ERRC).

Provide FACP modules and individual modules for monitoring the status of other systems and equipment. These systems and functions include but are not limited to the following:
- Fire protection system (see additional requirements below) and other safety protection systems.
- Fire Pumps - Supervisory signals; Pump running, Loss of ac power, Phase reversal, Controller connected to alternate source, Selector switch not in auto, Control panel trouble.
- ERRC - Supervisory signals; Antenna malfunction, Signal booster failure, Loss of normal ac power, Failure of battery charger, Low-battery capacity.
- Pre-action fire protection systems - Monitor each zone of the pre-action system in addition to general system alarm, supervisory, and trouble signals.

In a building with a sprinkler system, provide water flow switches to detect sprinkler activation and valve tamper switches at all shut off valves (inside and outside the building and also including elevator machine room sprinkler shut off valves). FACP descriptors shall specifically note the sprinkler system coverage area of the associated water flows, and the locations of the tamper switches.

Emergency Responder Radio Coverage (ERRC)

Refer to Design Guideline DG 273523 for ERRC design and installation requirements.

A hard wired fire department communication system shall not be specified in lieu of, or in addition to an ERRC system.

Mass Notification System

If noted in the Owner's Project Requirements, provide necessary equipment, initiating devices, notification appliances, conduit, wiring, programming, and appurtenances to the base fire alarm system scope of work to incorporate building-wide mass notification into the fire alarm system. The system shall be specified as an Add Alternate so associated additional costs can be quantified.

Provide speakers for audible notification appliances in lieu of horns if the base fire alarm system scope of work specifies horns. Provide sufficient speakers to meet NFPA 72 voice intelligibility requirements.

In the main fire alarm control panel and in each remote fire alarm annunciator panel provide a minimum of 8 pushbuttons to initiate the alert strobe lights and the building-wide evacuation or alert tone followed by a unique pre-recorded voice message.

Provide a Local Operating Console (LOC) cabinet with microphone for use by Facility Manager. Locate the LOC in a secure location acceptable to DPSS.

Alarm and supervisory signals shall be sent through MOSCAD (or other supervised system acceptable to AHJ) to DPSS.

Provide system interconnecting raceways, wiring, and routing in compliance with the system “survivability” requirements contained in NFPA 72.

MOSCAD (Central Station Monitoring)

DPSS remotely monitors essentially all of the fire alarm systems on the Ann Arbor campuses. The connection from the building to DPSS is by the University MOSCAD (Motorola SCADA) system. This system performs the functions of a Central Station Monitoring facility and the DPSS office is considered to be a constantly attended location.

In offsite locations and/or when noted in the BOD, the fire alarm system shall be connected by digital dialer to a listed Central Station Monitoring facility which in an emergency will notify the authorities and appropriate emergency personnel in that jurisdiction.

The FACP and fire pump controller shall have output contacts that will interconnect with the MOSCAD remote transmitting unit (RTU). These contacts, in their normal state, shall be closed, and in the 'alarm' state they shall open. Provide form “C” contacts, plus needed conduit and wiring to the MOSCAD alarm junction box (also referred to as interface junction box) for signal inputs. Signal inputs shall include, but are not limited to, the following:

- FACP - Alarm
- FACP - Supervisory
- FACP - Supervisory Maintenance Alert
- FACP - Trouble
- Fire Pump - Pump Running
- Fire Pump - Supervisory
- ERRC - Signal booster supervisory, Power supply supervisory

The MOSCAD RTU, RTU box, alarm junction box, and antenna equipment will be furnished by the University. All wiring in the RTU, between the RTU and alarm junction box, as well as all of the programming and work needed at DPSS will be by the University. Wiring to the antenna shall be furnished by the University and installed by the contractor. (*Note to U of M Design Manager, include $8,000 in the project budget to pay for these U of M provided equipment and services).* The contractor shall furnish and install all conduits and install RTU box and alarm junction box furnished by the University. Include Detail 28160015 for installation details.

Note that the MOSCAD system is connected by radio to DPSS on Kipke Drive on south campus. The MOSCAD system is often used to transmit other alarm messages to that central security office. These other alarms might include security, and/or monitoring points of critical systems.

Installation and Testing

Fire alarm systems shall be connected, programmed, tested, and certified, by NICET, Level 2 (minimum) certified fire alarm persons.

Fire alarm system wiring shall be segregated from other system wiring. Wiring shall be installed in raceways, cable trays, or in J-hooks. In mechanical rooms, unfinished spaces and other areas wiring may be subject to physical damage wiring below 10'-0 shall be installed in conduit.

Fire alarm system control panels, equipment, and other components shall not be painted. Conduit and/or

couplings, junction boxes, and covers, however, shall be painted red.

Require the contractor to fully test the system prior to arranging witness testing by the University. Witness testing shall include the contractor, U-M Fire Marshal, U-M Electrical Inspector, U-M Fire Protection Shop, and Commissioning Authority. On classroom, in-patient medical, and Housing projects, the contractor shall also be required to support a system test by the Inspector from the Michigan Bureau of Fire Services. Provide the University Project Manager and Commissioning Authority with test reports.
Training on fire alarm system operation and programming shall be provided as part of the system. The training shall consist of two training programs. One program shall be for the U-M Fire Protection and Radio Shop personnel and the second shall be for the Building Facility Management, FSS, and DPSS.

The fire alarm contractor shall provide the University, on CD, a complete 'Windows System' compatible copy of the operational and application programs. This electronic documentation shall reflect the system as configured after the certification testing is completed and accepted.