

Functional Challenges of Integrating Mass Notification and Fire Alarm Systems

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February 12, 2007

Abstract:

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Mass notification systems (MNS) are not a new concept. The concept of notifying large numbers of people in emergency conditions has been around for many decades. They have continued to exist in communities, chemical plants, and military installations. In 1998 following some significant losses of life due to terrorist actions, the United States Air Force (USAF) started to develop standardized design criteria. In December 2002 formal design criteria (UFC 4-021-01) was issued. While MNS criterion was being developed, significant changes were taking place with fire alarm systems and their listings. Unfortunately, the first edition of the UFC did not fully appreciate these advancements. MN Systems were required to be circuited and supervised in the same manner as fire alarm systems, yet required to have separate autonomous control panels. Integration of the two autonomous systems with the ability to momentarily silence audible fire signals upon MNS activation while maintaining visual fire signals created some unique challenges for simplicity and reliability. Fortunately, manufacturers and the UFC are trying to address some of these challenges. This paper will review challenges of the currently adopted UFC, proposed changes, and new application challenges.

Definition of MNS:

Mass Notification (As defined in UFC 4-021-01 December 2002): *Mass notification is the capability to provide real-time information to all building occupants or personnel in the immediate vicinity of a building during emergency situations. To reduce the risk of mass casualties, there must be a timely means to notify building occupants of threats and what should be done in response to those threats. Pre-recorded and live voice emergency messages are required by this UFC to provide this capability.*

Although UFC 4-021-01 addresses Wide Area MNS (great voice) and Individual Building MNS, the scope of this paper is limited to Individual Building MNS.

UFC December, 2002:

In 1998 following some significant losses of life due to terrorist actions, the United States Military lead by the Air Force (USAF) started to develop standardized design criteria for Mass Notification Systems (MNS). In December 2002 formal design criteria (UFC 4-021-01) was issued. While MNS criterion was being developed, significant changes were taking place with fire alarm systems and their listings. Unfortunately, the first edition of the UFC did not fully recognize these advancements. MN Systems were required to be circuited and supervised in the same manner as fire alarm systems, yet required to have separate autonomous control systems. Integration of the two autonomous systems created some unique challenges for simplicity and reliability.

Putting 2002 UFC Into Action:

Let's look at some of the challenges of putting the original UFC into action.

One major challenge is that the 2002 MNS criteria require an autonomous control unit. Autonomous and independent of the fire alarm system, yet interfaced and having the same requirements of a fire alarm system. One statement says that "for strobes shared by the mass notification system/fire alarm system, existing strobes marked "FIRE" may remain in use. New strobes are to be unmarked".

Question: If the MNS is to be "autonomous" from the fire alarm system, than how is it allowed to share strobes?

There is a requirement that the autonomous control unit provide "adequate discrete outputs to temporarily deactivate fire alarm audible notification appliances, initiate optional textual displays, and initiate/synchronize strobes".

Question: What is a "discrete output" within this circuit? American Heritage Dictionary defines "discrete" as being separate or unconnected. In terms of a fire alarm/MNS circuit is "discrete" mean placing various relays in the middle of the audible circuit? How does this impact simplicity and reliability?

The UFC requires "conductor integrity monitoring for strobe, display, temporary deactivation of fire alarm audible notification appliances, and speaker wiring".

Question: How do you maintain monitoring of conductor integrity for a fire alarm audible circuit when you have to temporarily disable the circuit or otherwise stop the audible tones just for the duration of a MNS voice message while keeping the strobes flashing?

The definition of MNS states that “there must be a timely means to notify building occupants of threats and what should be done in response to those threats”. This has been identified as a problem with some of the military Barracks bombings over seas in that the on duty personnel did not have a readily available means to notify all occupants. However, provisions of the autonomous control unit include “secure local operator console for initiating recorded messages, strobes, and displays; and for delivering live voice messages”.

Question: How can the system be readily available to personnel and secured at the same time?

“Deactivation of the fire alarm audible notification appliances must cause a supervisory signal in the fire alarm system. The Army requires that this supervisory signal be separate from other fire alarm system supervisory signals, be annunciated at the building’s fire alarm control panel,...” “The visual annunciation of the separate supervisory signal shall be distinctly labeled or otherwise clearly identified.”

Question: Now that you have a separate “discrete” relay module to interrupt the audible signals, do you now have to provide an addressable module specifically supervising that the relay functioned and opened the audible circuit?

Question: To clearly identify this operation on the main fire alarm panel, is an LCD text description OK, or does the fire alarm manufacturer need to install an additional dedicated supervisory LED?

Question: If you rely on the LCD display, how will this be indicated when the higher priority fire “alarm” signal is being displayed over the “supervisory” signal?

Remembering that this signal would only occur if the fire alarm panel was in evacuation mode and the MNS system was also operating.

Question: If the fire alarm “supervisory” signal is activated indicating that the fire alarm audible signal has been “temporarily” overridden by the MNS, does this signal automatically reset itself when the “temporary” MNS message is over?

Question: What is meant by “temporary”? Does the MNS voice message run through a cycle and then the fire alarm tone activate for a second or so until the MNS message starts over again (or is silenced)?

The UFC also states that “the Army requires that a readily accessible means shall be provided for use by emergency response forces to manually override the fire alarm deactivation function so that the fire department can sound the fire alarm notification appliances independently of the mass notification system. Use of the manual override feature must cause a supervisory signal in the fire alarm system”.

Observation: Let me make sure we understand this! The Army fire department wants to override the silence feature, meaning that they can reactivate the fire alarm signal “independent” of the MNS voice message. This means that you would have temporal tones going off while (independently) the MNS voice messages are going off and people

are supposed to understand what to do (evacuate or stay). Also, this requires that there be another supervisory signal to be activated within the fire alarm panel.

Question: Do we reset the first dedicated supervisory signal indicating that MNS is still trying to take priority over an evacuation signal?

Question: How do we provide another supervisory signal that can be detected by the users with all the other signals going off?

Question: Why would anyone even care about the supervisory signal if the fire department is on scene trying to respond to a fire and/or potential terrorist event, and there is total chaos taking place at the scene? Isn't there enough confusion going on?

Now, don't get me wrong. This author commends the group that initially developed the UFC as we had to have something to start from. This was no easy undertaking and getting agreement from the various military branches is not an easy task.

Our problem is that as specifying engineers, designers, and installers, we must establish how to make the requirements work. Many of us can appreciate what the intent of the system is. After all, it is simply an expanded voice fire alarm system incorporating additional messages and a new priority. We could accomplish this and have a very reliable system. The challenge is that many local authorities do not have the technical background or comprehension to realize that you can not achieve literal compliance with the original UFC, let alone have any type of reliable or beneficial system. Yet, they will still require literal compliance and expect all the things called out in the UFC. Otherwise your system fails and you do not get a certificate of occupancy.

Although there are many recent revised drafts to the UFC, these very specific requirements are still the officially adopted requirements as of writing this paper.

NFPA Task Group 2004:

In 2003 the United States Air Force, under guidance of Ray Hansen, approached the National Fire Protection Association (NFPA) Standards Council for assistance in establishing mass notification criteria that could be marketed to the private sector as part of homeland security efforts. The Standards Council delegated this effort to the Technical Correlating Committee on Signaling Systems for the Protection of Life and Property (TCC), or in other words the NFPA 72 committees. In February 2004 the TCC established a task group that would start meeting in March. Proposed changes for the 2007 edition of NFPA 72 had to be turned in by September of 2004. To meet this deadline, the task group met several times over several months accomplishing great strides in a very short period of time.

A key component for the success of the task group was representation by various government entities. Many of these were either actively enforcing MNS criteria or were preparing for enforcement. Representation included the Navy, Air Force, Army, Coast Guard, and the General Services Administration. These individuals were responsible for coordinating with other members of their respective agencies to ensure that our final NFPA criteria would still be applicable and used by those agencies. Other key members of the task group included manufacturer representatives and consulting engineers.

Simplicity:

Experienced task group members knew that a critical component to reliability would be simplicity. Keeping the design, integration, expectations, and performance simple was critical to the ultimate success of global implementation. It was important to identify who the anticipated designers and installers would be for most of the MN Systems. By evaluating this, task group members could identify the typical experience levels of designers and installers. Recognizing that fire alarm installers would likely be tasked with the majority of installations, the criteria needed to maintain consistency with current terminology and practices of this trade.

It was recognized that the benefits of being able to use this highly reliable and thoroughly evaluated systems for building paging, background music, weather alerts, and fire alarm systems would be a win-win situation. One limiting factor for years was the ability to supervise speaker circuits while still delivering signals such as paging or background music. Based on the rapid push for the new technology these obstacles have been overcome by some of the manufacturers. As a result it is possible to have a reliable system with all these functions.

Where to Place Criteria:

Significant discussion of the task group involved where to put the new criteria. Should it be within a new NFPA installation document just for MNS, or should it be incorporated within the scope of NFPA 72 for fire alarm systems. Although this final decision would not be made by the task group, it was essential to understand how to present the material, and the level of detail necessary. After discussion at several meetings with guidance of many NFPA committee members and staff including the Technical Correlating Committee it was decided to incorporate MNS into NFPA 72. There were significant conflicts within NFPA 72 as it was currently worded. Most conflicts were based on the general reference to “fire alarm” within the code. The objective was not so much for fire alarm as it was for emergency notification systems in general. To better facilitate the incorporation of MNS into NFPA 72, significant editorial changes were necessary. As a result there were over 700 changes made to the 2007 edition of NFPA 72. There was also extensive discussion about changing the name of NFPA 72 from National Fire Alarm Code to a more general title better addressing its new generalized applications. Although this change has not occurred yet, watch for it in future editions.

Manufacturer Limitations and New Features:

There were a number of product manufacturers represented on the task group. Some of these manufacturers had products listed for fire alarm service and were familiar with NFPA 72 and general fire alarm practices and requirements. However, several manufacturers had good technology that provided benefit to MN Systems, but lacked background or product listings for fire alarm service. Many hours were spent discussing and evaluating system requirements to identify product benefits with and without UL listings for fire alarm service. The primary concern of some was integration of these

products into combined fire alarm and MN Systems. Members were concerned not to reduce the level of protection and reliability achieved over the years with fire alarm systems, yet interested in allowing new technology and features for MNS. Examples included textual message boards, Intranet popup messages for networked computers, and highly secure scrambled radio/wireless communication systems. It was felt that by maintaining certain requirements for primary A/V devices, while allowing alternative criteria for optional or supportive delivery means, we were able to balance reliability with technology.

Using Latest FA Technology:

As mentioned earlier, fire alarm technology was changing quickly around the time that MNS was being implemented. Because of the active enforcement of the UFC document and the recognized changes that were needed by the task group members un-precedent changes have been taking place to meet these challenges. Active enforcement combined with tremendous progress by manufacturers has resulted in some of the most significant changes for fire alarms and building paging systems in decades.

UFC Changes:

Following recommendations of the NFPA task group, the United States Air Force and other federal agencies began revising UFC 4-021-01. Although a basic concept of having “Unified Facilities Criteria” is to achieve consistency between government agencies, several branches wanted different designs. As a result, although there are many similarities, there is not “Unification” of criteria. The following will summarize a few key differences based on the latest available UFC 4-021-01 Draft issued 15-February-07.

Unless identified separately below, the following general criteria are required of all Individual Building Systems.

- Although combined systems are not required, the UFC does recommend the use of combined systems and provides the following information. “For new construction, the ACU shall be integrated with the building fire alarm control panel (FACP) to form one combined system that performs both functions. The building Public Address (PA) system for smaller buildings may be integrated with the combined system so that all three functions – mass notification, fire alarm, and PA – are provided by one building system.”
- Building systems shall provide real-time information to all building occupants and personnel in the immediate vicinity of a building (30’) including exterior egress gathering areas.
- Systems shall be designed to operate from one or more locations within the building. This can be provided by multiple Local Operator Control (LOC) panels incorporating remote microphones, in addition to interface into a telephone network.

- The Department of Defense (DoD) MNS systems are required in all new inhabited and new billeting buildings. This includes leased buildings, building additions, and expeditionary and temporary structures. Definitions can be found in UFC 4-010-01 DoD Minimum Antiterrorism Standards for Buildings. As a general rule the term “inhabited” means that there are more than 11 people normally working within the building. As such, many storage buildings may not require Individual Building Systems unless required by the local jurisdiction.
- Recognizing that simplicity is critical to a successful system, the UFC provides the following note: “In most cases the simplest and most economical approach for new construction will be to install a combined system that performs both as an Individual Building MNS and as the building fire alarm/voice evacuation system”.
- There is specific guidance for MNS systems in medical occupancies and other occupancies with persons not capable of self preservation.
- Systems shall be designed under the supervision of a registered fire protection engineer, by a registered professional engineer having at least four years of current experience in the design of fire protection and detection systems, or by an engineering technologist qualified at NICET Level IV in fire alarm systems.
- Systems shall be capable of interface with Wide Area MNS. At a minimum, the Individual Building System shall be able to receive an audio line level input.
- It is recognized that “effective voice communication within buildings occurs by using a system design of many speakers, each with low audio intensity.”
- MNS shall temporarily override fire alarm audible and visual signals. (Note the simplification of silencing both signals in the new UFC.)
- Systems shall be capable of initiating pre-recorded messages. Sample language is provided in UFC if not provided otherwise by the AHJ.
- Systems are required to satisfy speech intelligibility requirements. Specific Common Intelligibility Scale (CIS) scores are provided in the UFC for various conditions and branches of military.

Air Force:

Systems shall use clear strobes for fire and amber strobes for MNS. Text signs are optional and at the discretion of the DoD installation. If test signs are provided they shall comply with Navy criteria for locations.

Army:

Systems shall use clear strobes for fire and amber strobes for MNS. Text signs are optional and at the discretion of the DoD installation. If test signs are provided they shall comply with Navy criteria for locations.

Army systems still require that if the MNS system overrides the fire alarm system, a supervisory signal separate from other fire alarm system supervisory signals be provided.

Navy:

Navy MNS systems shall be designed only by a registered fire protection engineer who has passed the fire protection engineering written examination administered by the National Council of Examiners for Engineering and Surveys (NCEES).

A combined MNS/fire alarm system is required by the Navy and shall use single clear strobes instead of clear and amber strobes. Navy systems also require text signs over the door to each egress stairwell and over (or adjacent to) substantial means of egress from the level of discharge. Exits from single rooms such as mechanical or electrical rooms do not require text signs.

Marines:

Marine Corps Individual Building MNS are not required to provide the capability to initiate messages from any location within the individual building as the Marine Corps only requires a single control station and point of use.

For Marine installations, the local AHJ shall provide guidance on visual notification appliance types and criteria.

Activation of pre-recorded messages is not required for Marine Local Operator Control (LOC). Marine system LOC may be locked.

Where Do We Go From Here

This paper has only touched on a few specific areas of MNS. Significant progress is being made every month with regards to technology, guidelines, and understanding of system objectives.

Most military installations have now been exposed to MNS and can better work with designers to scope out objectives up front. There has been a significant acceptance in the private sector for MNS. Many educational facilities, industrial sites, and large corporate facilities have embraced the concept and are installing the systems. As with any life safety system, understanding of the original objectives is critical to providing successful systems. Designers must work closely with the local jurisdictions and users to establish the most effective approach for their needs. NFPA members are encouraged to actively participate in the next code cycle where many additional changes are anticipated as we clean up and learn from existing criteria.