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The Future of Fire Alarm Systems

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Notification

The first fire alarm systems appeared in the mid-19th century as a replacement for watchmen patrolling industrial buildings in the night for fire. Telegraph systems soon allowed the alarm system to summon the fire department directly or through private Central Stations. Automatic smoke detection came along in the mid 20th century for the protection of high value assets but the focus was primarily on property protection until the Our Lady of the Angels school fire in 1969 (Chicago) triggered a new interest in early warning for life safety. Local alarm systems were sometimes provided which were manually actuated and sounded bells to warn other occupants.

Besides notification of the fire department or occupants fire alarm systems have a few additional functions. Supervision of fire sprinkler systems includes surveillance of control valves, indication of water flow, and monitoring of fire pumps. Releasing device service includes release of fire doors or some extinguishing systems. Activation of smoke control systems and elevator recall round out the list.

A new functionality for fire alarm systems is called Mass Notification. First introduced by the Air Force, this refers to the ability to provide intelligible messages to large numbers of people both indoors and outdoors, such as on a military base. This requires special speakers and designs that project voice information clearly above ambient noise and without echoes that can interfere with understanding. New requirements have been incorporated into the next edition of NFPA 72.

Real Time Information

The traditional notification functions share a common thread in that they are all performed on the initial detection of a fire and, once carried out, require no further action. Thus, fire alarm systems were designed such that once activated they were no longer needed to function during the fire. This changed in the 1980's when tall buildings began to be designed for phased evacuation. Since occupants were being asked to remain in place until it was their turn to evacuate, the system needed to continue to operate until everyone had left. This led to the incorporation of requirements for Survivability into the 1985 edition of NFPA 72F Emergency Voice Communications Systems.

This provision of continuing functionality during the fire pointed to the possibility of a number of real-time functions that could benefit the fire service by improving safety or operational effectiveness. The primary barrier to this was that the fire service did not use the fire alarm system information and reported that they were confused by the myriad of arrangements of controls and displays among manufacturers.

In 1996 NIST proposed to the fire alarm industry, a collaborative program to enhance the functionality of fire alarm systems beginning with the development of a standard fire

service interface. The idea was to define an interface "look and feel" with common icons and operation that allowed the companies flexibility in implementation but which could be operated by anyone familiar with the basic arrangement. This project was begun in 1998 and completed with the adoption of the interface specifications in the National Fire Alarm Code in its 2002 edition.

The interface is an enabling technology for a broad range of additional functionality since it provides a means of reliably collecting and displaying information in real time. This information can come from the alarm system, from other building systems, individual sensors, or even from groups of buildings. Based on XML or other dynamic graphical languages the displays are capable of interfacing wirelessly with accessibility (applying suitable security protocols) from anywhere in the world. NIST has demonstrated these abilities including display of real time information in responding fire vehicles, on-site or mobile command posts, or remote sites coordinating activities at a large-scale incident. These capabilities are of particular interest to the Department of Homeland Security, who is providing funding for further development and incorporation into other programs such as the National Incident Management System (NIMS).

Protected Elevators

In some countries (U.K. and several former British colonies) a BSI Standard for firefighter lifts is used to provide protected elevators for fire department access to incidents in buildings exceeding 30 m (100 ft) in height, however there are currently no countries where elevators are routinely used for occupant egress in fires. Following the collapse of the World Trade Center buildings on September 11, 2001 interest in both areas has increased and NIST is pursuing the development of relevant technologies in cooperation with the elevator and fire alarm industries, disability interests, and others.

A key aspect of this development is the provision by the fire alarm system of real time monitoring of the safety of the elevator system and of information systems that provide communication to the fire command and status information to occupants using the system. Such features are considered crucial to the safe and reliable operation and acceptance of the systems by fire service and regulatory officials.

Tactical Decision Aids

The more data available to make decisions, the better the decisions that are made. Thus real time sensor data at the panel added to information from other building systems that are reporting to the fire command center through the fire service interface can provide a better picture of what is happening and the best ways of dealing with the unfolding incident. For example, building energy management systems turn lights off and reset HVAC after hours in unoccupied areas of a building. Such systems could provide valuable input to the fire service on unoccupied areas that do not need to be searched. Video fire sensors, consisting of CCTV cameras equipped with special software, are being developed for Navy ships and other applications where the video image can detect multiple events of interest. These could also determine the number of occupants in an area.

Gas sensors such as CO_2 are useful in controlling ventilation systems and their energy use, and are also of value to firefighting. Other species (CO/ CO_2 ratios, halogens, oxides of Nitrogen, …) all have potential to provide information on the threat level of the fire and the progress of suppression. NIST is developing specific algorithms that can predict the onset of flashover, conditions that threaten to fail firefighters protective clothing, visibility distance, and other conditions of interest. Provisions for the display of the current location and physical condition of firefighters in real time are incorporated into the display for use with any tracking technology under development. Coupled with a database of firefighter skills the system will provide a unique tool for fireground resource management.

Surveillance and Enhanced Reliability

Buildings are provided with numerous features and systems that work together to address safety objectives. Alarm systems notify occupants to move to a safe place and the fire service to respond for suppression and incident management. Compartmentation limits the spread of fire and smoke and protects vital structural components to prevent collapse. Sprinklers and other suppression systems control or extinguish the fire to limit damage to life and property. But to be effective, each system must be properly installed and maintained, and in full operational readiness whenever fire starts.

One of the best ways of improving the operational reliability of fire protection systems is to increase the frequency of testing. Data from the US Department of Energy showed that fire sprinkler systems subject to testing frequencies in excess of the minimum standards applied to most commercial systems under NFPA 25 exhibited an operational reliability of 99% compared to a typical system of about 95%. The primary disadvantage to increased testing frequency is cost, since testing is labor intensive.

Modern fire alarm systems can be utilized to automate the testing of sprinkler systems and to monitor other systems and equipment such that operational reliability is maximized. Sprinkler flow tests can be conducted nightly to ensure the condition of everything from the water supply and piping to valves and pressure. Other components such as fire door positions and safety controls can be arranged to report status with only marginal additional cost. Since most major losses involve systems failures that permit fires to reach damaging size, high reliability systems should qualify for insurance credits which can reduce or even eliminate increased equipment costs, particularly when offsetting costly required testing and maintenance.

Concluding Remarks

The features and functions discussed herein will bring new value to the fire service and to building owners. Benefits to the fire service relate to the provision of real time information that enhances operational effectiveness and safety. Benefits to the owner involve enhanced reliability and reduced costs of maintaining safety systems. The building alarm system is the best candidate for the performance of these functions since they have the needed infrastructure, reliability, and survivability needed to accomplish the objectives.