DEVELOPMENT OF A STANDARDIZED FIRE SERVICE INTERFACE FOR FIRE ALARM SYSTEMS

by

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Reprinted from Fire Protection Engineering, No. 6, 4,6-8, Spring 2000

NIST
National Institute of Standards and Technology
Technology Administration, U.S. Department of Commerce

Development of a Standardized Fire Service Interface for Fire Alarm Systems

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Background

The National Fire Alarm Code (NFPA 72-1996) in paragraph 1-5.7.1 requires that,

"Where required, the location of an operated initiating device shall be visibly indicated by building, floor, fire zone, or other approved subdivision, by annunciation, printout, or other approved means."

Paragraph 1-5.7.1.1 states,

"The primary purpose of fire alarm system annunciation is to enable responding personnel to identify the location of a fire quickly and accurately and to indicate the status of emergency equipment or fire safety functions that might affect the safety of occupants in a fire situation."

Paragraph 3-12.6.5.1 requires a fire command center,

"... near a building entrance or other location approved by the authority having jurisdiction. The fire command center shall provide a communications center for the arriving fire department and shall provide for the control and display of the status of detection, alarm, and communications systems." ... "Operating controls for use by the fire department shall be clearly marked."

In light of these requirements it is disconcerting that many fire departments report that they seldom use the provided features because every system (from different manufacturers or even different systems from the same manufacturer) has a different interface. Displays and controls are not consistent and there is no time to study the manuals. To address these issues the National Fire Alarm Code, Technical Correlating Committee established a task group to develop proposals for a standard interface for the 2002 Code cycle (the author chairs that task group). NIST's Building and Fire Research Laboratory (BFRL) established a cooperative research project through the National Electrical Manufacturers' Association (NEMA) and the major fire alarm panel manufacturers to develop the technical basis for these proposals. This paper describes the work done to date and planned activities that should lead to an interface that addresses the needs of the fire service.

Fire Service Needs

The first step was to determine the information needs of the fire service. This was done by arranging meetings with representative groups of fire service officers who have incident command experience. These meetings were structured like "focus groups" and were arranged by the International Association of Fire Chiefs (IAFC) at regional and national conferences.

The participants were asked to address three questions:

- What do they want to know?
- When do they want to know it?
- How can the information be presented to be most useful?

The first two were closely linked because fire service information needs differ with time, but most relate to the most effective allocation of (usually limited) resources. The observations from these meetings were:

- AT DISPATCH: The most important item is to provide some metric for the likelihood that the alarm is genuine – particularly when it derives from a single device. Perhaps a 3 level metric (low, moderate and high confidence) would be enough. The basis for assessing confidence is currently unclear but may involve heuristic algorithms based on sensors keeping history data and reacting to excursions from that history. There is significant concern among the fire service over liability for damage they cause by forced entry when an incident turns out to be false. They would also like information they could use to decide what resources are required. For small fires growing slowly a single unit may be enough. For a fast growing major incident, additional units dispatched early can be of great help in minimizing losses and assuring firefighter safety.
- AT ARRIVAL: (of first due units) The most important information (in order) is (1) the location of the fire within the building, (2) the location of occupants, (3) how to get to the fire, (4) a safe location to stage, location of standpipes, and other points of interest (hazardous materials, locked areas), (5) how fast is the fire growing, Temp/CO/O_2 conditions to determine if the OSHA "2 and 2" conditions[1] have been met, since violating this rule incurs liability to the department and has firefighter safety implications.
- DURING THE INCIDENT: (1) location and rate of spread of smoke/gas and of fire, (2) conditions relative to the (2 and 2) regulation, measures of operational effectiveness and safety of crews, (3) potential benefits or dangers of ventilation.

The "how can the information be presented" was less clear. Concerns were expressed about graphical displays of building layout and fire location that do not clearly relate landmarks since most firefighters are unfamiliar with any building. Thus "how to get to the fire" must give clear orientation, e.g., from stairwells or other points of entry. There seemed to be consensus that they did not want information displayed on which no immediate actions are required (concerns about "information overload") but some indication that all is right may be reassuring.

There is "traditional wisdom" that firefighters need large controls that can be operated while wearing gloves. The fire service groups indicated that gloves are not a problem for operating controls unless the controls are outside in the winter. The ability to do remote monitoring from the chief's car or mobile command post or even headquarters was of interest. They explained this is because the obvious point of entry to the building is not always the best location from which to

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[1]OSHA promulgated a regulation for firefighting that establishes environmental criteria which when exceeded requires that no fewer than two firefighters may make entry for firefighting or rescue only when not fewer than two firefighters in full protective gear are available at the fire scene to provide assistance if needed.

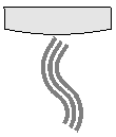
direct operations, and the incident commander usually wants to be free to go to where he/she can best view ongoing operations. If the attack is largely exterior that may be outside the building, across the street, or wherever one can see what is happening.

Developing a Concept

Germany and Sweden have adopted standard fire service interfaces for fire alarm systems. These are hardware specifications that detail the specific switches and lights to be used, and each manufacturer produces a panel that looks and works identically to interface with their system. We decided not to follow this approach because it can limit innovation and the ability to adapt to specific situations. Also, U.S. manufacturers prefer a more general specification that can be implemented in innovative ways that become opportunities to compete in the marketplace.

Rather, we decided to develop a "look and feel" based on standard icons and functions similar to the user interface of personal computers. PC software use numerous standard icons for common functions such as file open, save, print; cut, copy, or paste; and dragging a file to the trash can deletes it. By defining standard icons for fire alarm system components and functions of interest to the fire service it is possible to produce an interface that is intuitive to use, even if implemented in different ways.

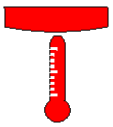
The icons, their meaning, and how users access information and functions associated with them would be standardized in the National Fire Alarm Code (NFPA72). However, these could be implemented in many ways such as graphical displays over hard buttons, labels on hard buttons with lights, or on touch screens. Features such as local display only, wireless transmission nearby or off site, local control functions, and non-emergency status displays could be included as optional functions allowing individual manufacturers to be innovative and local authorities to require features that meet their needs.



Smoke detector

Fire Alarm Icons

An initial set of icons was developed from icons used for similar purposes in Japan and from standard symbols for engineering drawings from NFPA170. Like most aspects of this project these icons are subject to change if the fire service thinks they are not meaningful or if industry think they would be difficult to implement. Mostly they represent a starting point by which the concepts can be presented. Examples from the initial set of icons are presented to the right.



Heat detector

Several constraints on the icons were initially identified. First, the icons need to represent three states – function not present, function present but not active (no additional information available), and function present and active (more information is available). Thus, simply having an icon shown or not shown is insufficient.

Most people are unaware that fire alarm systems have few universal functions. There are systems with no automatic detectors, being only activated by manual devices or primarily provided for supervising sprinkler systems. There are fire alarm systems with no local indicating appliances (bells or horns) that primarily notify people at a remote location. Thus, it is important to be able

differentiate functions not present and functions present but not active.


Elevators

Three states could be shown by the use of color, but we were cautioned by the fire service that firefighters may be color blind so this was considered inadvisable, and some may wish to implement monochrome displays. Thus we decided to use the logic that if a function is present but not active the icon would be presented with a diagonal slash as is done with traffic signs. Icons are not present for functions not provided. Active functions are indicated by the icon being displayed. Another approach would be to use a flashing icon for an active function and a steady icon for inactive, but flashing indicators have another meaning on fire alarm panels.


fan

A related issue is whether the system would provide information in non-emergency conditions. For example, systems might allow the fire service to query the status of devices or systems when there are no alarms present. Extracting data on ambient temperatures, background smoke, status of elevators, or pressures in stairways during normal building operations may be of interest to test the system function or to verify that areas are as yet unaffected during a response. While these would be optional system arrangements the system design and operation needs to allow for them. If non-emergency status information were provided then functions would not need to be active (in alarm) for information to be available and this needs to be communicated to the fire service in an unambiguous way.

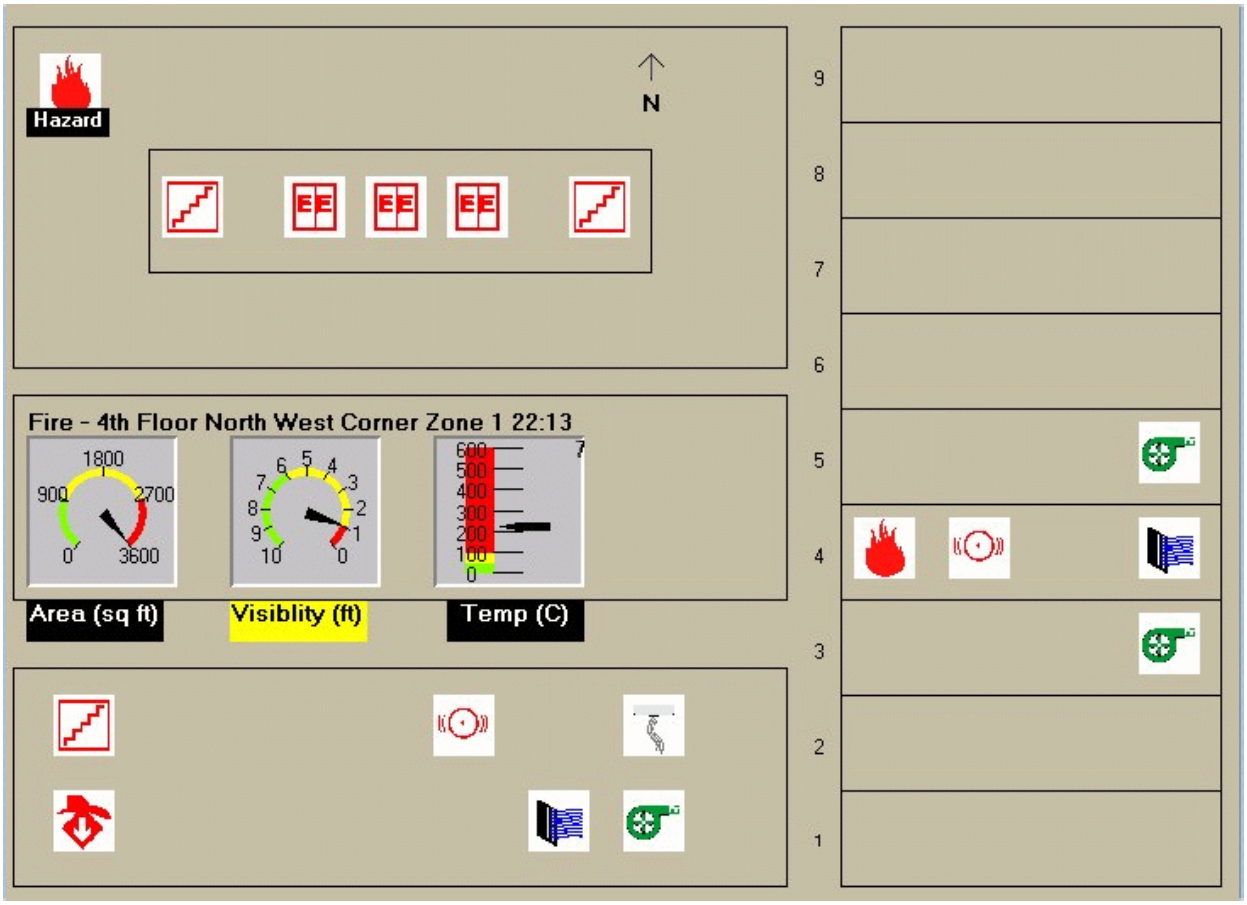

Exhaust


Sprinkler

A final issue is the provision of specific control functions. The fire service performs some systems control as part of their incident management. These currently include manual use of the emergency voice communication system, alarm silence and reset, signal acknowledge, and a few others. The fire service groups interviewed identified interest in very limited manual ventilation control to exhaust the top of stairways. There may be more. Generally, the fire service feels that they would like to see all information and interaction with the building routed through the interface panel to provide a consistent means of providing such interactions.

Developing a Prototype

Applying the concepts discussed above to the fire service needs derived from the initial focus groups, we began to develop ideas for a fire service interface prototype that could be used to test concepts and refine ideas. The prototype would incorporate features and arrangements that would be part of any proposed standard and demonstrate optional approaches that could be utilized or not in any specific product.



Prototype of a standard Fire Service Interface in a nine story building

The interface should be useable on a range of fire panel sizes from small systems with only a few zones to large systems with thousands of addressable devices. Thus, the prototype was laid out with an icon display section and a separate text display section, similar to current small systems that have a row of programmable buttons and a four or five line text display. An active icon indicates that additional information is available and is displayed in the text window by pressing (clicking) the icon. This information is displayed as text and data is displayed on gages. Fire service apparatus use dial and bar gages (e.g., pump panels on engines) so firefighters are accustomed to reading such gages. These gages typically show normal operating ranges for rapid status assessment.

The prototype incorporates building graphics in two other windows – one for a plan view of the floor of origin and one for a building elevation. With respect to these graphics, the industry complains that they have frequent problems obtaining accurate drawings and in maintaining correct information as buildings are remodeled. The fire service reported current graphical displays are inadequate for their purposes. Thus, we attempted to address both these problems by suggesting the use of diagrams rather than drawings. The diagrams would show the information needed by the fire service without the details they don't need and which are the main source of problems for the industry. The diagrams relate important locations to stairways and compass directions with details

such as room numbers relegated to the text messages produced by point addressable devices. Initial examination with the fire service indicates that this meets their needs and will minimize problems for industry.

Incident Management Information

Currently, fire alarm systems (other than Proprietary[2] systems) report only that an alarm has sounded at a property. Annunciator panels located at the protected property display the number of zones or devices in alarm and their location within the building.

Incident commanders reported that they generally use the information on zone or devices in alarm to estimate the area of the building involved in fire or smoke. For the older zoned systems, multiple detectors installed on a floor or subdivision of a floor report an alarm within the zone but not which device nor how many devices in the zone are in alarm. Thus they cannot provide much additional detail. However, with point addressable devices that industry sources report represent about 70% of new installations, each device alarm is individually identified. Since each detector has an associated protected area (under the NFAC, for smoke detectors this is not more than 900 sq ft), it is possible to determine the area of the building with smoke levels in excess of activation levels or for heat detectors the area with temperatures in excess of the alarm threshold. Further, addressable detectors could provide real time data that could be transmitted to the fire service in the form of temperatures or visibility distances through smoke. Such information could be used to assess risk to lives and property, and therefore to make informed decisions on allocation of resources to mitigate these risks.

Of course, point addressable devices identify the exact location of the device in alarm and they will so identify every device on the system. It is usually assumed that the first devices in alarm are the closest to the point of fire origin, but this is not always true. However where analog devices are arranged to report conditions such as temperatures or smoke levels in real time, such data can be used to decide where suppression activities are needed to mitigate hazards to people and property. Further, with the development of suitable models or criteria for protective equipment, such data can be used to assess hazards to firefighters. Informed decisions on safe staging areas and crew rotation could improve operational efficiency and safety.

Other building systems and components have specific roles to play during a fire emergency. The fire service needs to know that these systems and components are performing without providing so much information that it is distracting from the primary job at hand. Thus, the fire service interface would provide assurance that the system or component is performing within its design envelope but also be capable of providing more detail on request. An examples is stairwell pressurization systems producing pressures that are not so high as to interfere with door opening not so low was to allow smoke infiltration.

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[2]In the 1996 edition of NFPA 72, a Proprietary Supervising Station Fire Alarm System is defined as one that " ... serves contiguous and non-contiguous properties, under one ownership, from a proprietary supervising station located at the protected property, at which trained, competent personnel are in constant attendance. "

Some of the information needed by the fire service is not available from the fire safety systems themselves, but may exist in other building systems. Thus, the fire service interface should be capable of obtaining and displaying such information. Building energy management systems often have room occupancy monitors that can identify the location of building occupants. Elevator systems also know which cars are occupied and some systems know how many people are in those cars.

Other building systems may have useful information as well. By implementing a common protocol communications gateway it is possible to share such information among systems without giving up control or incurring liability. One such approach that allows fire alarm and HVAC systems to communicate is BACnet. Originally developed and standardized as a HVAC industry protocol, BACnet has recently been embraced by the fire alarm industry and most of the systems manufacturers now offer BACnet gateways.

Much of the fire service information needs from non-fire systems involves status information. HVAC and elevator systems have emergency operating modes related to fire. The incident commander would like to know if the HVAC system is operating properly in smoke management mode and if the elevators are in Phase I or II recall. There are operational and safety implications to knowing from energy management systems whether high voltage systems that might present a shock hazard to hose teams have been shut down or whether lighting systems are still operational.

Another category of information need concerns building features provided for fire service use. This may be internal firefighter communication, location of hazardous materials or secure areas, propositioned equipment such as air bottles, special extinguishing agents or aids for evacuating disabled occupants. Such information may be permanent or may change with time, but is more likely to by accessible to the fire service if integrated into their interface system. The greater the amount of information available to the firefighter about building conditions the safer and more efficient would be the firefighting operations.

Next Steps

Currently, NIST has developed an interactive prototype suitable for testing concepts with fire service people representing end users. The prototype will be refined through more “focus group” sessions. The National Fire Alarm Code task group has a number of people who have expressed interest in participation in the development of a related standard, but currently needs more fire service input. The task group is open to any interested party, more information can be obtained by contacting the author.