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# FIRE PROTECTION Engineering

WINTER 2009

Issue No. 41

## Construction Fire Safety

Fire Sprinkler Systems During Construction

Supplying Water for High-Rise Construction Projects

Fire Detection and Alarm Systems in Buildings Under Construction



THE OFFICIAL MAGAZINE OF THE SOCIETY OF FIRE PROTECTION ENGINEERS

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# [ CONTENTS ]

# FIRE PROTECTION Engineering



## 8 COVER STORY

### Construction Fire Safety: Phase by Phase

Special considerations for each step of a construction, renovation or demolition project.

By Mat Chibbaro, P.E.

## Departments

- 2 From the Technical Director
- 4 Viewpoint
- 6 Flashpoints
- 46 Brainteaser
- 46 Resources
- 50 Case Studies
- 51 Products/Literature
- 52 Ad Index



## Features



WINTER 2009

### 20 Fire Safety in Buildings Under Construction

How FPEs can play a greater role in keeping buildings safe during the construction process.

By William Koffel, P.E., FSFPE

### 28 Fire Sprinkler Systems During Construction

When should a fire sprinkler system be brought online?

By Russell P. Fleming, P.E., FSFPE

### 36 Supplying Water for High-Rise Construction Projects

How to design standpipe systems for buildings in freezing temperatures.

By Edward J. Prendergast, P.E.

### 42 Fire Detection and Alarm Systems in Buildings Under Construction

The value of temporary systems and how to configure them.

By NEMA



# FIRE PROTECTION Engineering

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From the **TECHNICAL DIRECTOR**

## The Next Advancement in Performance-Based Codes

The last several decades have witnessed the publication of several performance-based codes. The British published the first performance-based code in 1985. New Zealand published a performance-based building code in 1992, and Australia followed suit in 1995. Since then, several other countries have written performance-based fire safety codes.

In all cases, performance-based codes are provided as an alternative to traditional prescriptive codes. In general, most performance-based codes share a common approach – qualitative description of acceptable performance and the hazards against which designs should provide protection. Terms like “sufficient” and “reasonable” are used to define acceptable performance. Similarly, design hazards are either not defined or are defined qualitatively. Therefore, the level of safety that is provided can vary depending upon how these qualitative terms are interpreted by designers and code enforcers.

While the publication of performance-based codes and design methods has harmonized the practice of performance-based design, the levels of safety provided by performance-based designs are not uniform. Fire safety engineering has not reached the state of modern structural engineering where building loads, properties of structural materials and design methods are quantitatively defined.

However, some countries have developed quantitative aspects of their performance-based codes, and others are following suit. Quantitative requirements have the advantage that uniform metrics are used for all designs.

The Japanese performance-based code provides three options, or “routes,” for compliance. The first, Route A, is the prescriptive option. Route B is a performance-based design that is prepared in accordance with a methodology that is specified in the Japanese code. The third option, Route C, is a design that is prepared using a methodology that is proffered by the designer.

Japan has quantitative requirements in their performance code associated with means of egress and fire resistance. They have observed that quantitative requirements have facilitated

providing a uniform level of safety, while minimizing differences in interpretation between designers and enforcement officials.<sup>1</sup> In the Japanese code, the design fire and the performance criteria are specified.

An approach similar to that used in Route B of the Japanese code is being considered in New Zealand. They are adapting the set of fire scenarios that are similar to those provided in codes published by the National Fire Protection Association, such as the *Life Safety Code*®.<sup>2</sup> However, the qualitative approach that is used in the NFPA codes would be augmented with quantitative requirements such as the fire growth rate, peak heat release rate, duration and soot yield. Similarly, quantitative performance criteria associated with life safety would be specified.

Performance-based codes in other countries will likely follow suit and develop quantitative performance-based requirements. This is just part of the natural evolution and maturation of the profession of fire protection engineering. SFPE and its members will continue to support these efforts.

For the foreseeable future, most fire protection designs will continue to be developed on a prescriptive basis. However, as fire protection engineering evolves and matures, as other engineering disciplines have already done, the use of performance-based design will likely increase.

**Morgan J. Hurley, P.E.**  
Technical Director  
Society of Fire Protection Engineers

#### References:

- 1 Tanaka, T., and Kadoya, M., “AIJ Recommendations On Performance-Based Fire Safety Design of Buildings,” *Proceedings – 6th International Conference on Performance-Based Codes and Fire Safety Design Methods*, Society of Fire Protection Engineers, Bethesda, 2009.
- 2 NFPA 101®, *Life Safety Code*®, National Fire Protection Association, Quincy, MA, 2009.

# Flexhead Ad

By Jon D. Nelson, P.E.

To make decent predictions for the future of anything, one must know something about the past and have a good understanding of the present; but even then, predictions are difficult. When it comes to engineering licensure, the past exhibits several truths: making changes to the laws or rules in 55 U.S. jurisdictions will always be difficult and time-consuming, and most efforts to affect change will almost always produce variable results. Still, productive change can occur and at times must take place.

In 2001, the National Council of Examiners for Engineering and Surveying (NCEES) convened the Engineering Licensure Qualifications Task Force (ELQTF). The task force was made up of representatives from 12 different engineering societies and spent over two years considering how the existing licensure system might be improved. They completed their report in 2003 and made several recommendations for change. Many have been or are still being considered by the NCEES. The following are some predictions based on the work of the ELQTF.

ELQTF recommended that the educational qualification for licensure be strengthened. This recommendation, plus encouragement from other engineering societies, induced NCEES to consider changes to the Model Law. While there are significant differences in opinion as to what should be done, the votes of the NCEES provide a strong indication that a significant majority of the state boards agree that the educational standard needs to be strengthened. Some believe that accreditation needs to address the issue, while others think the best course is to add requirements over and above the current accredited bachelor's degree. Although not all of the profession agrees that any change is needed, the profession is getting more and more engaged, and the debate is proving productive. It is difficult to say how the issue will end, but the educational qualification will likely be strengthened, most likely by adding to the current accredited degree. This will take some time.

The experience qualification has long been thought of as the weakest of the three licensure qualifications. ELQTF agreed. They spent significant time learning about Canada's formal mentoring system and considered it for the U.S. However, they ultimately recommended against that level of rigor, opting instead to recommend that guidance be prepared to help individuals on a licensure track to plan and manage their experience. This qualification will likely stay much the same for some years to come. The state boards seem more focused on education and examinations. Perhaps some improved guidance and improved reporting will occur.

The licensure examinations will almost certainly change. ELQTF decided that the current technical exam system was doing its job well and did not recommend any changes. However, they did recommend that a "practice" exam be added. Such an exam would add nontechnical questions addressing such items as contracts, law and ethics. One difficulty the task force noted, however, was a new exam would not fit into the current exam structure, and it was unlikely that the addition of a third exam would be acceptable. This proved correct, but salvation for the practice exam may come in the form of computer-based testing (CBT). NCEES has been considering a move to CBT for many years, but concerns over infrastructure and item banks, among others, have prevented the conversion. CBT will happen some day, and when it does, the exam structure will change in such a way to permit the addition of practice items.

National licensure is something greatly desired by those licensed in multiple states. Varying requirements make obtaining and maintaining licenses in several states time-consuming and expensive. For national licensure to be realized, the states would have to delegate the authority to the federal government. State legislatures seem very particular about their laws and are not likely to give up control. Also, in some states, licensure is a revenue source that they may not want to give up. Although national licensure makes sense to most engineers, it will probably not happen in the foreseeable future. Comity licensure will remain for a long time, but there will probably be further improvement in the comity process. The relatively new Model Law Engineer designation, along with the NCEES records program, is facilitating "fast" comity, and more and more states are adopting rules that allow for a streamlined process. This trend will continue.

There are some in the profession who question whether licensure has a place at all in the long-term future. After all, the percentage of graduate engineers getting licensed is low and appears to be getting lower. Licensure will maintain its current role, applying mainly to the built environment. The industrial exemption is entrenched in business and in the minds of many engineers, plus it is a fact that the regulation of engineering is more difficult to fit into many industrial settings. Engineering licensure will probably not expand, even though it could mean much more to the profession and the public it serves if it were more widely embraced.

*Jon D. Nelson, P.E., is with Tetra Tech and is a past president of the National Council of Examiners for Engineering and Surveying.*



# System Sensor Ad



The SFPE Corporate 100 Program was founded in 1976 to strengthen the relationship between industry and the fire protection engineering community. Membership in the program recognizes those who support the objectives of SFPE and have a genuine concern for the safety of life and property from fire.

## USFA Releases Highway Vehicle Fires Topical Report

The Department of Homeland Security's United States Fire Administration (USFA) has issued a special report, part of its Topical Fire Report Series, examining the causes and characteristics of highway vehicle fires. An estimated 258,500 highway vehicle fires occur annually resulting in 490 civilian deaths, 1,275 civilian injuries and \$1 billion in property loss.

"Highway vehicle fires account for nearly one out of every six fires," says U.S. Fire Administrator Greg Cade. "It is important to focus on vehicle fire prevention and public safety to help reduce the number of vehicle-related fire deaths and injuries."

The report, *Highway Vehicle Fires*, was developed by the National Fire Data Center, part of the USFA. The report is based on 2004 to 2006 data from the National Fire Incident Reporting System (NFIRS).

According to the report, 84 percent of highway vehicle fires occur in passenger vehicles. Unintentionally started fires (29%) and the failure of equipment (28%) are the leading causes of highway vehicle fires. Sixty-two percent of highway vehicle fires originate in the engine, running gear or wheel areas of the vehicle.

Copies of the reports can be downloaded at  
[www.usfa.dhs.gov/statistics/reports/index.shtm](http://www.usfa.dhs.gov/statistics/reports/index.shtm).

## Insurer FM Global Announces Expansion of its Premier Research Campus to Better Meet Clients' Growing Loss Prevention Needs

US\$38 million project will feature a new natural disaster laboratory, an upgraded fire technology laboratory and a stadium-style multimedia center, scheduled for completion in 2009.

FM Global, one of the world's largest commercial property insurers, announced the US\$38 million expansion of its 1,600-acre one-of-a-kind Research Campus located in West Glocester, Rhode Island, USA. The Research Campus currently employs 108 people, with plans to increase the workforce by seven percent when the expansion is complete.

Scientific research and product testing conducted at FM Global's existing US\$85 million Research Campus — the world's largest center of its kind — replicates warehouse-size fires, dust explosions and nearly every natural disaster that Mother Nature can muster.

The Research Campus expansion project adds new capabilities for natural hazards such as wind, flood and earthquakes, as well as the highest quality test environment in the world's largest fire testing laboratory.

For more information, go to [www.fmglobal.com](http://www.fmglobal.com).

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# Silent Knight Ad



A photograph of two men at a construction site. The man on the left is wearing a yellow hard hat, safety glasses, and a high-visibility orange and yellow vest over a white shirt. The man on the right is wearing a white hard hat and glasses, dressed in a suit. They are both looking at a large set of blueprints held by the man in the vest. In the background, a tall building under construction is visible, with many floors of concrete and steel framing. Scaffolding and construction cranes are also visible against a clear blue sky.

# CONSTRUCTION FIRE SAFETY: Phase by Phase

By Mat Chibbaro, P.E.

**B**uildings of all types, while under construction, renovation or demolition, are both more susceptible to fire and at greater risk of the effects of fire. A wide variety of ignition sources increase the likelihood of fires starting. Concentrations of combustible materials, incomplete compartmentation and other passive systems, and unfinished fire protection systems allow fire to spread unimpeded.

Wind conditions can increase the rapidity of fire spread.

This places at greater risk the workers occupying such buildings and the emergency responders that may be called upon to operate within or near them. Accident statistics and reports tell a tale of many construction workers being killed or maimed over the years by fires and explosions. In May 2008, 14 employees were injured in a natural

gas explosion in a hotel under construction in California.<sup>1</sup>

In 2007, two firefighters were killed at a fire incident during the demolition of the Deutsche Bank Building in New York City.<sup>2</sup>

Typically, building and fire codes, such as those promulgated by the National Fire Protection Association (NFPA) and the International Code Council (ICC), contain comprehensive lists of the provisions that are to be



followed during construction. However, being model standards or codes, they tend to focus more on the “what,” and give less attention to the “who,” “how” and “when” of implementation. This article presents protection and prevention features of different phases in construction, and discusses ways that the fire protection engineering profession may contribute to efficient and effective implementation of these features. See Figures 1–4.

### BUILDING ALLIANCES

An important concept affecting the efficiency of a project is the creation of lines of communication between the various stakeholders.

First, a fire protection engineer can serve as a liaison between disciplines. There is a network of fire safety-related interrelationships between structural fire protection; architectural layout; mechanical, HVACR and plumbing systems; fire suppression systems; electrical features; and fire alarm, detection and control systems. The fire protection engineer is in a unique position to understand how these items work together to achieve overall fire safety goals and thereby work to coordinate them.

The fire protection engineer can also consult with the owner on various concepts. One is the plan for partial occupancy if the owner expects to do this in stages. In some cases, the owner or their insurer will desire protection above and beyond what the fire and building codes require.

Two critical alliances that must be built early, and maintained through a project’s life, are those that link the design team with both the code authorities and the emergency response organization in the project’s jurisdiction. In some cases, this can be done with one alliance – when the code authority has the ability to speak for the responders within the same fire department or fire brigade. Certainly, the two roles are different – code authorities need to do enforcement, while the responders are in need of information for preincident planning.



Figure 1. Site work in preparation for construction.



Figure 2. A building under construction.





Figure 3. A building nearing completion.



Figure 4. A building ready to be occupied.

Early and regular contact with code authorities can establish communication that is vital to efficient incorporation of code requirements, both those that address construction hazards and those that apply to the finished building. Jurisdictions frequently have amendments to the model codes. Both the base codes and local amendments can be interpreted to accommodate a wide array of sites and structures. The earlier the authority's interpretations and expectations can be learned, the more efficiently the design and construction phases can proceed. This, in turn, translates into cost savings for the owner or developer and valuable time saved for all parties.

Emergency responders face significant challenges during a fire situation in any occupied building. They must deal with an extremely dynamic environment, with limited information on the fire, its byproducts and the building occupants. These challenges are compounded in a building under construction because the protection features and systems are constantly changing, as is the building itself. The more information they have at hand when an incident occurs, the better their decision-making can be, especially during a rapidly unfolding situation.

## DESIGN PHASE

It is becoming more common to see fire protection engineers as members of design teams from the beginning of projects, especially large or unusual ones. A previously published article describes the benefits of utilizing fire protection engineers in the design process.<sup>3</sup> As the complexity of a project increases, these benefits multiply. A number of federal agencies and local code authorities require fire protection engineering participation in projects above a certain threshold of size or complexity, especially those utilizing performance-based designs.

A basic function of the design team is to ensure that all fire protection features and systems required for the finished building are included in the design documents. Giving additional consideration during design to fire safety in all phases of construction will increase the safety of both construction workers and emergency responders.

The plans and specifications should reflect as much information as possible regarding the phasing of the features discussed in the following sections. Planning in advance can avoid conflicts. For example, the locations where hazardous materials will be stored and where unloading of construction materials will occur can be identified – and then this can be coordinated with the emergency access points, location of water supply and temporary connections. Advance consideration of these features can pay dividends later through more efficient and effective emergency operations.

It is also helpful to consider the stages in which a building will be constructed and occupied when designing the fire protection systems. In this manner, necessary items such as water lines, fire pumps and control panels can be located to support the various phases as well as the complete building. The owner may be in a position to provide early input, which would preclude conflicts.





Figure 5. A temporary walkway.

Advance planning during design can also increase the safety of construction workers. Many fire-related construction worker injuries involve hazardous operations and materials. If the design documents indicate proper phasing and location of egress, extinguishers, hazardous operations and combustible storage, then it follows that the risks will decrease during operations such as welding or handling of flammable and combustible liquids.

Factors beyond the site or facility being designed can also be considered. This consideration could include how egress from adjoining occupied structures will remain clear during all phases of construction. For example, a typical, 4-foot (1.2 m) wide temporary pedestrian walkway might not suffice if more than two exit door(s) from an existing, occupied building discharge into it. The fire protection engineer can perform exit capacity calculations to determine the proper width of temporary egress routes.

Figure 5 shows a temporary walkway being constructed next to a construction site to serve an occupied building.

Permits must be obtained before the corresponding work begins. Early on, foundation and building permits will

be required. Additional permits may be required for electrical, plumbing, gas, fire alarm, sprinkler and other fire protection systems. The fire protection engineer can assist the design team to prepare complete plans, specifications and shop drawings; submit required documentation; and navigate the permit system in a timely manner, especially if communication begins early with code authorities and emergency responders regarding key aspects of fire protection and prevention.

### SITE WORK PHASE

By the time work begins at a construction site, a fire protection program should be in place, with a designated responsible program manager. The fire and building codes promulgated by the ICC and NFPA contain examples of program elements, including prefire plans; maintenance of fire protection devices and training on their use; hot work permits; system impairments; and temporary covers on fire protection devices. Other considerations include physical security features, guard service

during nonworking hours and means for reporting fires or requesting emergency assistance.

Preincident plans, also known as prefire plans, are a compilation of information to assist emergency responders, including access, water supply, construction features, fire protection systems and special hazards. The fire protection engineer can be instrumental, with the building owner's permission, in providing construction plans or shop drawings to the fire service. In some cases, these plans can be transmitted and stored electronically and then retrieved during response and operations through computer-aided dispatch systems.

Site visits by the public fire department or private fire brigade allow them to coordinate with the fire protection program manager to develop and update preincident plans. The more frequently responders visit the site, the better information they are likely to have when an incident occurs, thereby facilitating more accurate and rapid decision-making. In jurisdictions with career response agencies, different shifts would likely need to be accommodated for site



Figure 6. A fuel tank located outside a construction trailer.

visits. Volunteer response agencies would probably prefer evening or weekend site visits.

NFPA 241, *Standard for Safeguarding Construction, Alteration, and Demolition Operations*,<sup>4</sup> calls for an on-site command post. This location contains plans, emergency information, communications, keys and other equipment for use by both emergency responders and the fire protection program manager.

As soon as site work commences, how to prevent fires and how they will be extinguished if they begin should be considered. Waste must be disposed of on a regular basis and must not be burned without the proper approvals and permits. Each storage shed or construction trailer should be located away from wildfire hazards or other occupied structures, and be provided with adequate fire extinguishers.

Figure 6 shows a fuel tank and fire extinguisher outside of a construction trailer.

Advance planning can ensure the timely provision of access and water supply for fire suppression. The water supply should preferably

be the permanent water supply; however, temporarily stored water in sufficient quantity may be acceptable to code authorities in certain situations. Planning by the fire protection engineer and design team can minimize the need for temporary water supplies. Temporary or permanent roads made of all-weather material and of the appropriate width are essential for efficient access, as are key boxes for emergency perimeter access. Dead-end roads may need turnaround provisions for fire apparatus.

Adequate means of escape for all employees should be provided – both from any temporary buildings and from the site itself. Multiple exits from the site perimeter would be beneficial during large fire or hazardous materials situations that can obstruct a single exterior exit route.

### INTRODUCTION OF HAZARDS

As each of the following hazards is introduced to the job site, proper precautions must be taken. Individual hazards may appear at different stages, i.e., some during site work, others at later stages.

The fire protection engineer may be involved in the design, permit process and acceptance testing for alarm, detection, sprinkler, standpipe and other fire protection systems.

- Smoking
- Open burning
- Motorized vehicles
- Materials subject to spontaneous ignition
- Welding and other hot work
- Temporary heating equipment
- Temporary electrical equipment
- Combustible formwork, scaffolding and other materials
- Flammable and combustible liquids
- Flammable gas
- Explosives

The fire protection engineer can help mitigate these hazards through planning and coordination. Assistance can continue through construction – in some cases helping to keep the lines of communication open between the fire protection program manager, the code authorities and the emergency responders.

Figure 7 shows welding at a building under renovation.

Labeling of hazards and permitting procedures are critical for the fire service. These issues emerged as significant in a 1988 incident in Missouri when a trailer containing explosive material detonated, killing six firefighters who were unaware of the presence of explosive materials.<sup>5</sup> There can be a



Figure 7. Welding at a building under construction.

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Figure 8. A fire department connection for a building under construction.



Figure 9. A building under construction.

potential conflicting security concern of keeping extremely hazardous material locations unlabeled so as not to attract the attention of criminals and terrorists.

One hazard not currently addressed directly in the codes covering building design and construction is arson. This can be perpetrated by juveniles, disgruntled employees or radical groups. In recent years, extremist environmental groups have added arson to their arsenal. Early recognition of arson potential can be partially addressed by additional security.

### BUILDING ERECTION

As the structure is erected, provisions must be made for alerting all employees of an emergency, allowing them to escape the structure, and allowing responders to gain access and mitigate emergency situations. Proper planning by the fire protection engineer help can increase efficiency and decrease costs.

Material combustibility is another important consideration. Combustible formwork may not be allowed or may be limited to below a certain elevation or floor level. Temporary enclosures for heating or health hazard contain-

ment should employ noncombustible bracing or fire-retardant lumber, and any fabric or plastic used should be fire-retardant. Further, such enclosures must not obstruct exits and must be secured so that they do not contact ignition sources. Combustible enclosures were reportedly a factor in the Deutsche Bank Building tragedy in two ways: their flammability and obstruction of exits.<sup>6</sup>

At least one stair must be constructed as the building rises – for use by both exiting construction workers and entering emergency responders. Under NFPA 241, this begins when the building is over one story, and under the *International Building Code*® (IBC), this begins at four stories or 50 feet (15 m).<sup>7</sup> The stair must be lighted, and under NFPA 241, it must have identification signs. Fire extinguishers should be placed on each level at each stair. Planning ahead to use permanent stairs to meet this requirement should be more efficient and effective than using temporary stairs.

Functional standpipe systems are crucial in buildings under construction. Plans and specifications should indicate when a standpipe is required during construction. Under the IBC, the threshold is 40 feet (12 m) in height, while NFPA 241 leaves this to the code authorities. A single manual dry standpipe within the stair with one hose connection per floor may suffice, and must be raised and capped as construction progresses. The fire department connection must be marked and accessible. The *International Fire Code*® requires connections to be within 100 feet (30 m) of fire vehicle access.<sup>8</sup> Signage can also include the highest floor served by the standpipe, but it must be kept current. The jurisdiction may require or request that the connection be outside the perimeter fence. The fire protection engineer can determine the requirements of the code authorities and the needs of the emergency responders, and specify both in the construction documents and shop drawings.

# Protecto- wire Ad



Figure 8 shows a fire department connection that is well-marked and accessible through an opening in a perimeter fence. However, the feed pipe may not be properly supported, and attached hose lines may contact sharp portions of the fence opening.

The availability of an elevator or hoist for fire service use may be required for very tall buildings when necessary for transporting hose and other equipment. The fire protection engineer should ask the jurisdiction at what point they would require this and how it should be phased in as the building rises.

Securing of construction materials on upper floors is not only a safety consideration for construction workers; this is also important to prevent materials from falling or being blown onto emergency responders during windy conditions. Likewise, protection of floor openings or edges will protect both construction workers and firefighters; the latter may operate with limited visibility.

Some jurisdictions require firefighter breathing air systems in tall buildings or long tunnels. In these locations, the requirement may be invoked during construction.

As the building tops off, roof operations become an issue from a fire safety standpoint. Codes contain specific procedures and protection for operations such as torch-applied roofing and tar kettles.

## INTERIOR WORK AND BUILDING ENCLOSURE PHASE

As trade workers begin interior work, fire protection systems are installed. The fire protection engineer may be involved in the design, permit process and acceptance testing for alarm, detection, sprinkler, standpipe and other fire protection systems. Requests for information and clarification often must be fielded by fire protection engineers. Two areas of concern during construction are an impairment notification system and the prompt removal of temporary

device covers that prevent damage during construction.

Before certain areas are concealed, inspections must take place, and the timing is important to prevent project delays. These items include fire-rated shafts, electrical work, sprinkler and standpipe hydrotests, fire-stopping and fire-proofing. The relationship built up between the design team, fire protection program manager, code authorities and responders could pay dividends as this work is coordinated.

Trash chutes should preferably be erected outside of the building.

Interior chutes should be of noncombustible construction.

When the building exterior walls are in place, the required stairway must be enclosed. This protects construction workers and responders from smoke and heat that cannot vent readily. Phasing of construction must be done so that egress is not adversely impacted. Before exterior wall enclosure begins, whether the jurisdiction will allow the stairway to be enclosed on a floor-by-floor basis along with the exterior walls or whether the stairway must be fully enclosed first should be determined.



Figure 10. A building being demolished.

# General Air Ad

Towards the end of this phase, acceptance testing of systems is conducted. It is a good idea to invite emergency response agencies to witness the testing of systems with which they will interact (especially alarm detection and control). Alternatively, separate demonstrations could be conducted to educate emergency responders on the use of these systems – preferably prior to occupancy.

### OCCUPANCY PHASE

Ideally, occupancy will take place only after a building is fully complete with all protection features in place. However, the reality is that buildings are almost always occupied with “punch list” items that remain to be done, or portions are occupied while other sections remain unfinished or actively under construction.

Another opportunity for the fire protection engineer to assist is in determining the adequacy of the level of life safety when one or more fire protection features is not yet in place or is impaired. Usually, some additional protection should be in place to compensate for the missing or inoperative feature. One example of this is a fire watch during a fire alarm impairment. In the fire watch example, the qualifications of the persons performing the fire watch, their training, standard procedures and equipment should be considered, as well as any particular requirements of the code authorities.

Partial occupancy is almost always a reality in business or retail buildings subdivided into separate tenant occupancies, as well as in building addition projects. NFPA 241 calls for occupied areas and those undergoing

construction or renovation to be separated by a one-hour fire-rated barrier with ¾-hour fire-rated opening protectives; nonrated fixed barriers (not tarps) are permitted where sprinkler protection is installed. The sprinkler requirement applies to both sides of the barrier. However, some jurisdictions may make some allowances, such as delayed placement of suspended ceiling tiles on the construction side where no combustibles are stockpiled. Here the fire protection engineer can serve as a knowledgeable intermediary to ensure an adequate level of temporary protection.

Figure 9 shows the first floor of a building being finished that contains a few occupied assembly occupancies. Considerations include whether these occupancies have adequate egress capacity through the temporary construction

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barricades and walkways, whether the discharge areas are all clear, whether the alarm system in service and whether the fire department connections accessible.

Of particular concern is the occupancy of floors or areas above those still undergoing construction, renovation or tenant work. In buildings with required sprinkler protection, NFPA 241 precludes occupancy until all portions of the systems are completely installed and tested. However, this standard also allows occupancy of lower finished floors when work is incomplete on floors above, as long as the upper-level sprinkler systems have separate control valves and the occupied area's sprinkler system remains in service. Another consideration for partial occupancy situations is the completeness of work in all exit enclosures and in all discharge areas.

Alteration and renovation work conducted in buildings will have many of the same fire safety concerns as outlined above. In particular, means of egress, fire protection system maintenance, impairment notification, temporary protection measures and partial occupancy should be considered.

## DEMOLITION PHASE

Many of the considerations during demolition work will generally be addressed in the reverse order of those for construction projects. Gas and electric service should be terminated where possible and labeled where remaining in service. Standpipes and stairs should be maintained as the building is brought down. Fire protection systems and fire barriers should remain in place and in service as long as possible (reportedly an inoperative standpipe system may have been a major factor in the fatal Deutsche Bank Building fire – in addition to the flammability of the temporary enclosures mentioned previously).

Unprotected openings in floors for any purpose should be avoided, including those for trash or debris removal. Special precautions are necessary with hazards such as oil-soaked floors or tanks that contained flammable or combustible liquids. Asbestos removal must be closely coordinated with code authorities and emergency responders.

Figure 10 shows a building under demolition.

The author thanks Jamie Barton, Assistant Fire Marshal, Gaithersburg City, MD, for reviewing this article.

*Mat Chibbaro, P.E., is with the U.S. Occupational Safety and Health Administration.*

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**CONSTRUCTION  
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# **FIRE SAFETY IN BUILDINGS UNDER CONSTRUCTION**

**By William Koffel, P.E., FSFPE**

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**F**ire protection engineers work in the design of new buildings, the rehabilitation of existing buildings and the analysis of conditions in existing buildings. In many instances, fire protection engineers also provide construction-period services, evaluating the construction or installation of fire protection features and systems.

Fire protection engineers are not used as frequently to address the level of fire safety during construction activities. However, since the fire hazards, mitigating factors and credible fire scenarios will vary during construction operations, consideration should be given to including fire protection engineers during periods of construction.

When fires do occur, proper consideration to passive and active fire protection features can minimize the extent of damage and loss that will occur. Such losses can include the owner's exposure to financial losses incurred due to delays caused by fires during construction activities, a concern that is often outside the scope of most regulatory requirements that apply to buildings under construction.

Also, due consideration needs to be given to ensure that emergency response personnel have adequate access to the construction site and within the building under construction.

### THE PROBLEM

Leading causes of fires in buildings under construction are incendiary or suspicious (39.5%); open flame, embers or torches (20.8%); and heating equipment (9.7%).<sup>1</sup> The leading causes of fires in buildings under demolition are open flame, embers or torches (51.7%), and incendiary or suspicious (35.9%). The property loss per fire incident resulting from fires in buildings under construction is higher than most structure fire losses. The requirements contained in NFPA 241<sup>2</sup> address many of these common causes in an attempt to prevent or minimize fire damage during construction, alteration and demolition operations.

Fire safety considerations addressing these common causes typically include good housekeeping and on-site security. These items often fall within the responsibility of an on-site fire safety program manager. Although it need not be the case, as increased emphasis is placed on site security, often it is at the expense of access for fire-fighting operations.

As with occupied buildings, fire departments must be provided with adequate access to and within construction sites. The fire department must be provided with access to the exterior of the building. The required access roadways must be maintained free of obstructions, and where site security includes secured openings and fences, the fire department should be provided with a means to gain access to the site. This can be accomplished with key boxes installed at accessible locations. In multistory buildings, access must be provided to upper floors in buildings under construction, and stairs should be maintained in buildings undergoing demolition.

A properly trained guard service can be beneficial in discovering fires in their early stages, notifying the fire

department of an emergency, knowing the presence and operational status of fire protection equipment, identifying fire hazards and in the use of construction elevators. When it comes to fire protection equipment and fire hazards, the project fire protection engineer is best able to identify the training requirements for the guard service. When the project fire protection engineer also provides construction-period services, the engineer can meet with guard service personnel to update them on changes, such as changes in the status of fire protection equipment, as they occur.

### PROTECTING AGAINST FIRES

While buildings under construction or rehabilitation can offer unique challenges in that membrane protection and structural fire resistance may not be complete, the severity of such fires is also impacted by poor housekeeping and the fact that fire protection systems are not often operational. In a separate article in this issue, Russ Fleming addresses some of the specific issues associated with providing operational fire protection systems in buildings under construction. This



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article explores the potential consequences when the automatic sprinkler system is not operational as required by NFPA 241.<sup>2</sup>


An example scenario is a fire that occurs in a non-high-rise building that is undergoing a major rehabilitation project. The construction activities are winding down, and the building is to be occupied in the near future. An accidental fire originates in the attic space of the building, and the roof assembly, floor/ceiling assemblies and interior partitions are of combustible construction. In addition, since the building is almost ready for occupancy, office furniture is provided in many of the occupied areas. The fire spreads unimpeded until manual fire suppression efforts are initiated by the public fire department.

Part of the rehabilitation project is to install a sprinkler system throughout the building. At the time of the fire, installation of the sprinkler system is essentially complete. As required by the applicable building code, a standpipe system is also required and again is available at the time of the fire. In order to meet the standpipe system demand requirements, a fire pump is to be installed; but due to a missing part, the pump is not installed at the time of the fire. The public water system would be of sufficient value to meet the sprinkler system demand without the fire pump. However, at the time of the fire, there is no automatic water supply for the automatic sprinkler system since the incoming supply pipe is not connected to the sprinkler system riser.

A consideration in this scenario is whether the incoming supply line should have been connected to the automatic sprinkler system. NFPA 241 requires where automatic sprinkler protection is provided, the installation shall be placed in service as soon as practicable.<sup>2</sup> The fire prevention program manager is likely the only person who would raise a concern that the sprinkler system is not functional since it is not connected

to a reliable automatic water supply. If the owner has retained the services of a fire protection engineer, it would be reasonable to presume that the fire protection engineer is monitoring the status of the installation of the building fire protection systems and could identify such concerns.

It should be noted that NFPA 241 states that there should be no delay in the installation of fire protection equipment, and it does allow the use of a temporary water supply. The project fire protection engineer



Open flames,  
embers and  
torches are a  
leading cause of  
fires in buildings  
under construction.

could evaluate whether the connection of the underground supply pipe to the overhead pipe, even absent the fire pump, would satisfy the requirement that the fire protection system be put in service without delay and as soon as combustible material accumulates.<sup>2</sup> The project's consulting fire protection engineer could also play a role in making sure the fire protection systems are installed in accordance with the proposed project construction schedule.

If one aspect of the construction activities has been delayed, as the installation of the fire pump was in this scenario, the contractor should have been required to establish interim fire protection features such as a temporary water supply for the sprinkler system. These delays could be discussed during regular construction progress meetings. The project fire protection engineer should be

involved in determining the installation schedule for the fire protection systems and fire protection features, and ensuring that the applicable code requirements are being met.

In addition to fire protection systems, compartmentation also provides a means by which fires can be managed. Consideration should be given to ensuring that any fire barriers or smoke barriers that are to be provided in the occupied building are installed and functional as soon as possible. A program of regular inspections should be in place to ensure that required self-closing and automatic-closing doors are not obstructed from closing by construction materials or equipment being placed in the door opening.

Temporary separation walls should also be constructed to separate areas with a higher level of hazard than other portions of the building. While typically considered for occupied buildings undergoing some rehabilitation, the use of temporary separation walls should also be considered in a new building under construction. Where construction materials and supplies are stored inside buildings under construction, such areas may represent a higher hazard and should be separated from other areas of the building by temporary separation walls. This concept and approach is similar to typical code requirements to separate hazardous areas in occupied buildings.

### SYSTEMATIC APPROACHES TO ADDRESSING THE PROBLEMS

Often considered as an approach to designing fire protection for new buildings or for evaluating fire protection in existing buildings, the *Fire Safety Concepts Tree*<sup>3</sup> also provides a means to analyze the potential impact of various fire protection strategies in buildings under construction. See Figure 1. The tool provides a systematic approach to evaluating the construction of the building, the combustibility of the contents and the

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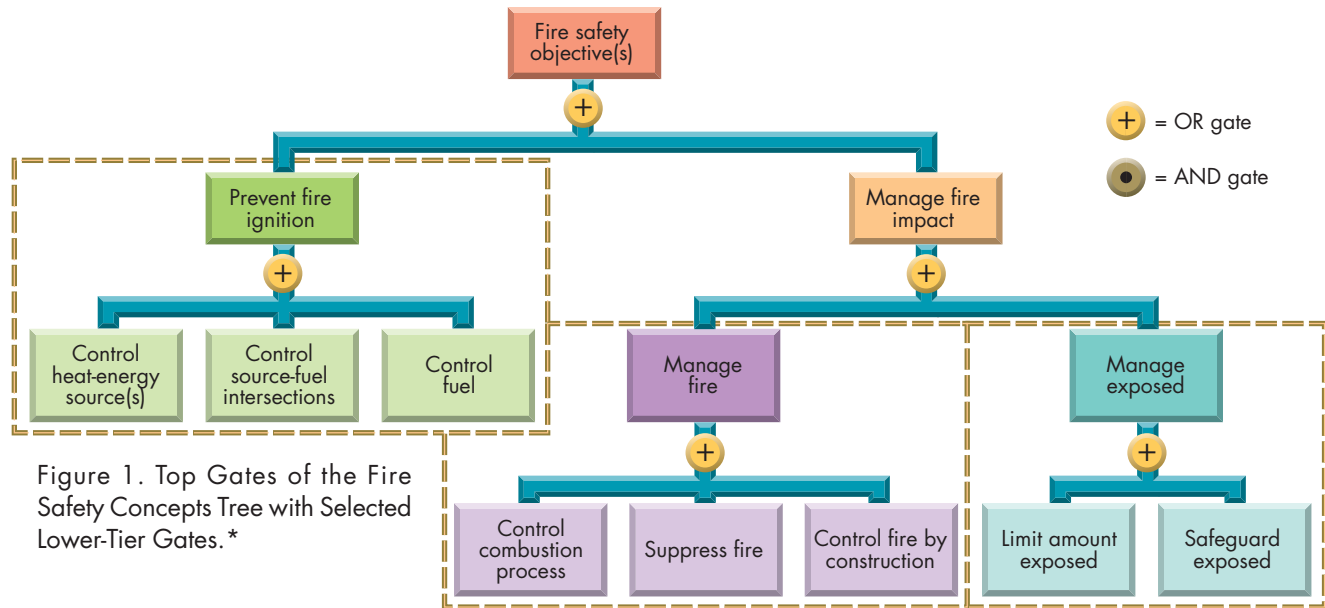


Figure 1. Top Gates of the Fire Safety Concepts Tree with Selected Lower-Tier Gates.\*

protection provided by fire protection systems and features as they change during construction activities. Consideration can be given to both means to prevent fire ignition and to managing fires that may occur.

Also, the owner's fire safety objectives may be different from those addressed by documents such as NFPA 241. Regulatory requirements that apply to buildings under construction typically attempt to provide a reasonable level of safety to life and property. However, the owner might also be interested in any delays that may occur to the construction progress resulting from an unwanted fire.

Another approach would be to prepare a fire risk assessment for the period of time that the building is under construction. The fire hazards, mitigating factors and credible fire scenarios for a building under construction may be substantially different from the building after construction is complete. The *SFPE Engineering Guide to Fire Risk Assessment* provides guidance for the use of fire risk methodologies that can be used in buildings under construction.<sup>4</sup> The documentation provided during the fire risk assessment will serve as a

useful reference for the project fire safety manager and contractors to ensure that the risk present is consistent with the fire safety goals and objectives established by the stakeholders.

An example of how fire hazards and credible fire scenarios may be different during construction involves roofing operations. Open flames, embers and torches are a leading cause of fires in buildings under construction. Many of these fires are related to roofing operations and involve the use of heat sources and hot processes in close proximity to combustibles, which typically cannot be avoided. The risks present during roofing operations are not typical of the risks that exist when the construction activity is not taking place. Therefore, a fire risk assessment prepared for the building during the design process may not include the risks and fire scenarios commonly found during construction activities.

*William Koffel, P.E., FSFPE, is with Koffel Associates.*

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# FIRE SPRINKLER SYSTEMS During Construction

By Russell P. Fleming, P.E., FSFPE



**N**FPA 241, *Standard for Safeguarding Construction, Alteration, and Demolition Operations*, includes a long-standing maxim on fire sprinkler protection: "If automatic sprinkler protection is to be provided, the installation shall be placed in service as soon as practicable."<sup>1</sup> Few would argue with the intent, but it's not as easy as it sounds. The word "practicable" provides a sizable gray area appropriate to the complex issues involved. These issues involve some technical considerations, but they are mainly related to potential damage to the system or the building and the potential liability resulting from such damage.

To begin with, any sprinkler system that provides less than complete sprinkler protection to a facility suffers from the same

limitation as any partial sprinkler system. A fire originating in a non-sprinklered area can grow to the point where it can overwhelm the adjacent sprinkler system. Sprinklers without the capability to put water on the fire can continue to activate from the heat of the fire until the available water supply is spread so thin that the limited discharge per sprinkler becomes ineffective, the building structure is compromised to the point where it can no longer support the sprinkler piping, and the sprinkler system fails.

If the fire begins in an area in which the sprinkler system has been completed and made functional, the opportunities for success are great. But the evaluation of when a system is completed is difficult. Because building codes now require alarm and supervisory service for most sprinkler systems other than those serving

one- and two-family dwellings, many sprinkler contractors want this service to be up and running before sprinkler system valves are opened. Otherwise, the failure of a fitting or accidental discharge of a sprinkler can go unnoticed for long periods of time, exacerbating water damage. In this view, the system is not completed until all flow alarms are connected and monitored.

Alarms are not the only issue. A new factor in the issue of when a sprinkler system should become an effective instrument of fire control was introduced in 2004, when Underwriters Laboratories® initiated a requirement for protective straps or caps on all glass bulb sprinklers.<sup>2</sup> The extra protection was intended to call attention to the need to handle sprinklers with care during shipping and installation, especially newer technology, fast-response sprinklers



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with bulb diameters on the order of 3 mm. Since most automatic sprinklers now utilize glass bulbs rather than solder links, the debate relative to the proper time for the removal of caps and straps was effectively a debate on when sprinkler systems could be brought online. It was generally agreed that it made no sense to place the systems in service with

In general, protective straps and caps should not be removed until construction activities or other events have progressed to the point where the sprinklers will not be subjected to conditions that could cause them to be damaged.

the plastic caps and straps still in place, since they would be expected to compromise sprinkler response and distribution. On the other hand, premature removal of the caps and straps could be expected to make the sprinkler more vulnerable to damage from ongoing construction activities. Experience suggests that when sprinklers are struck and damaged by other trades, they can experience changes in the mechanical loading on glass bulbs that can lead to

the accidental discharge of such sprinklers weeks or months later.

An emergency Tentative Interim Amendment was proposed to NFPA 13, *Installation of Sprinkler Systems*, to provide rules for when such protective covers are to be removed and additional guidance regarding proper handling of sprinklers. The TIA proposal was jointly developed by the fire sprinkler manufacturers and product listing organizations, and noted that the sprinkler manufacturers' literature generally stated that the orange caps or straps should be removed from the sprinklers only when the system is "placed in service."

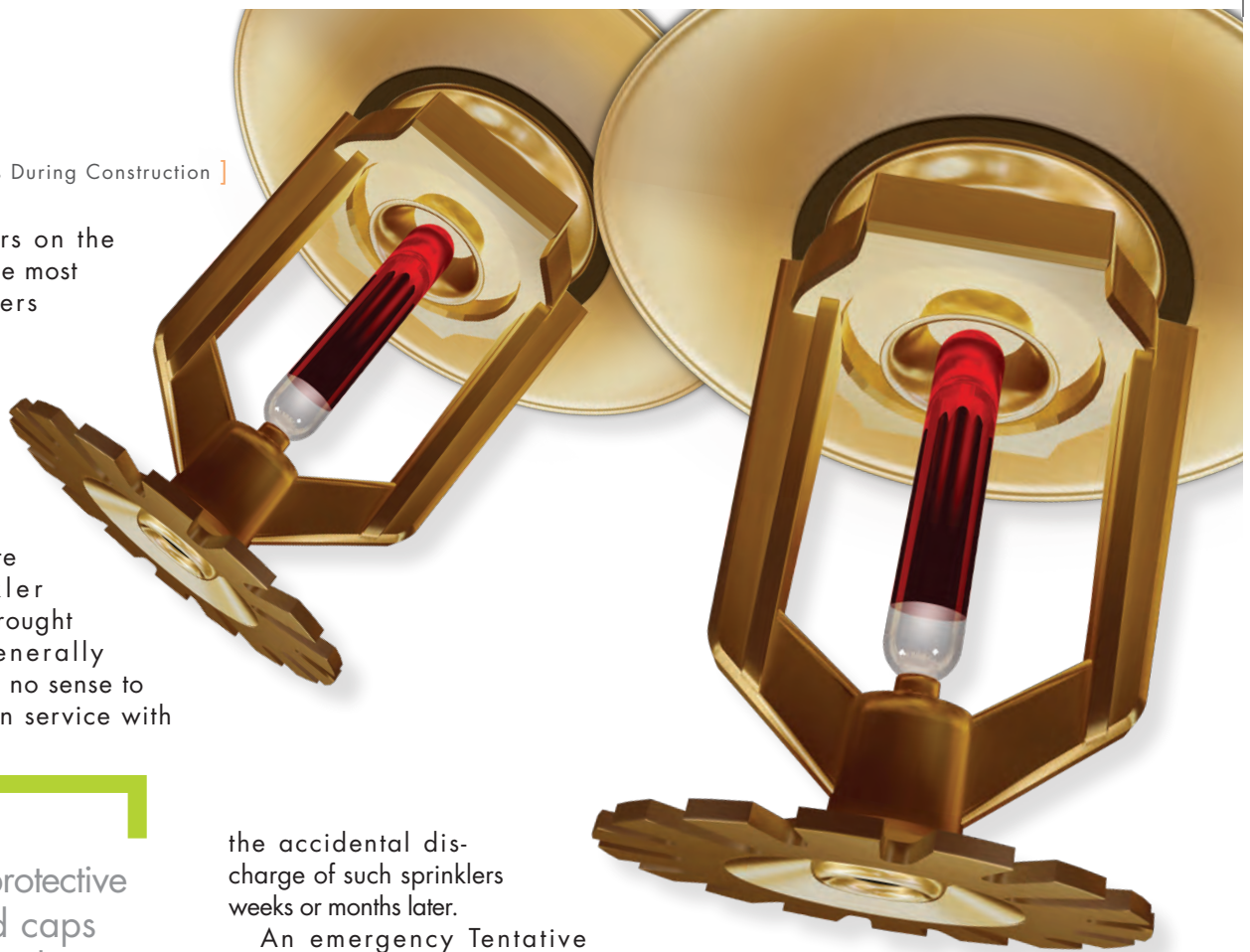
This led to the following wording found in the 2007 edition of the sprinkler installation standard:<sup>3</sup>

"8.3.1.5.2 Protective caps and straps shall be removed from all sprinklers prior to the time when the sprinkler system is placed in service."

The accompanying annex section provides guidance as to when these protective features can be removed:

"A.8.3.1.5.2 Protective caps and straps can be removed from upright sprinklers, from sprinklers that are fitted with

sprinkler guards, and from sprinklers not likely to be subject to damage due to construction activities or other events. In general, protective straps and caps should not be removed until construction activities or other events have progressed to the point where the sprinklers will not be subjected to conditions that could cause them to be damaged. Consideration should be given to leaving the protective caps and straps in place where other construction work is expected to take place, adjacent to the sprinklers following their installation, until that activity is complete. Protective caps and straps on sidewall and pendent sprinklers, for example, should be left in place pending installation of the wall and ceiling systems and then removed as finish escutcheons are being installed. In retrofit applications, with minimal follow-on trade construction activity, and with upright sprinklers, it would be reasonable to remove the caps



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and straps immediately following the installation on the sprinkler piping."

Under this concept, the sprinkler systems should only be placed in service when construction in the vicinity of the sprinkler system is essentially complete. Is this consistent with the NFPA 241 definition of "practicable"? The annex guidance within NFPA 241 is less far-reaching than the section cited at the beginning of this article would suggest:

"A.8.7.3.1 With proper scheduling and contracting, it is possible for the sprinkler installation to follow the building construction closely as it progresses. This is frequently done in multiple-story buildings to facilitate protection on the lower floors before the upper floors have been built."

If the phrase "before the upper floors have been built" is considered to mean "before the upper floors have been finished," then there is no conflict. In fact, sprinkler retrofit of high-rise buildings often is performed a floor at a time to correspond to tenant changes, minimizing business disruption. However, since sprinkler systems on individual floors of multistory buildings are generally

"With proper scheduling and contracting, it is possible for the sprinkler installation to follow the building construction closely as it progresses. This is frequently done in multiple-story buildings to facilitate protection on the lower floors before the upper floors have been built."

equipped with separate control valves and flow alarms, they can essentially be considered as separate systems. It would be much more challenging to try to provide sprinkler protection to successive sections of the same floor.

The NFPA 13 installation standard is silent on the issue of trying to provide sprinkler protection during construction, but what do building codes say on the subject? The *International Building Code*® contains only two sections containing requirements relative to sprinklers during construction:<sup>4</sup>

"3312.1 Completion before occupancy. In buildings where an automatic sprinkler system is required by this code, it shall be unlawful to occupy any portion of a building or structure until the automatic sprinkler system installation has been tested and approved, except as provided in Section 110.3 (addressing temporary certificates of occupancy).

"3312.2 Operation of valves. Operation of sprinkler control valves shall be permitted only by properly authorized personnel and shall be accompanied by notification of duly designated parties. When the sprinkler protection is being regularly turned off and on to facilitate connection of newly completed segments, the sprinkler control valves shall be checked at the end of each work period to ascertain that protection is in service."

As such, building codes do not take a strong stance on the subject, but acknowledge that some type of phased implementation of sprinklers may be part of the specified building design and construction process. Specifying engineers have the opportunity to develop phasing plans on behalf of property owners in cooperation with their insurers. Where such plans are included in the project documents, sprinkler contractors would obviously be obligated to follow them. But building codes tend to rely more

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on the building standpipe system for minimal fire protection capabilities during construction.

Unlike standpipe systems, sprinkler systems are not easily used in a dry condition corresponding to the time when piping has been connected but no automatic water supply has been provided. Various proposals have been advanced over the years for “manual” sprinkler systems, for which the fire department brings the water supply, but the NFPA committee on automatic sprinklers has traditionally opposed such proposals on the basis that they would present a false sense of protection. From a practical standpoint, water could be put into the sprinkler system through the fire department connection (FDC) as soon as it is installed. In a typical wet pipe sprinkler system without floor control valves, there are no intervening shutoff valves that can be closed between the FDC and the sprinklers. At the present time, however, there is no standardized method of warning the fire department against use of the FDC in cases where the integrity of the interior piping system has not yet been ensured. For that reason, some sprinkler contractors delay installing the fire department connection until system installation is nearly complete.

The current effort being made to develop a new NFPA standard on commissioning will need to address the entire issue of when a sprinkler system is “placed in service.” The “commissioning” of a sprinkler system has traditionally been considered to be the point in time at which the system is hydrostatically tested, and the contractors

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material and test certificate is completed. The opening paragraph in the certificate states the following:

"Upon completion of work, inspection and tests shall be made by the contractor's representative and witnessed by the property owner or their authorized agent. All defects shall be corrected and system left in service before contractor's personnel finally leave the job."

This concept of placing the system in service before the contractor's personnel finally leave the job is obviously oriented toward a single point in time of system delivery and acceptance. As such, it differs considerably from the concept of ascertaining that "protection is in service" at the end of each work period per the *International Building Code* and raises questions of semantics as well as options. Since the common definition of commissioning is to authorize or order something into duty or service, is there a difference between a system being "commissioned" and "placed in service"? Can a system be left in service before it is commissioned? Can a system be commissioned by itself as opposed to being commissioned in conjunction with related water supply and alarm components? Building systems must work together, and that testing system interaction is part of the commissioning process. The forthcoming standard on commissioning, tentatively known as NFPA 3, promises to add additional complications to the subject of when to bring a fire sprinkler system online during the building construction process.

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## CONSTRUCTION PROJECTS

By Edward J. Prendergast, P.E.

**L**arge construction projects can take many years to complete from start to finish. This is especially true when the final building height will be over 400 feet (120 meters).

As a building increases in height, it becomes necessary to provide fire protection in the upper floors. Typically, the building's automatic sprinkler system cannot be made fully operational until the building nears completion. Therefore, the primary means of providing fire protection in the upper floors of a building under construction is through the use of a standpipe system.

At first glance, providing a standpipe system would not seem to be a challenge since high-rise buildings are required to have standpipe systems. It would seem to be a simple matter to install the permanent standpipe with hose valves,

extending it upward as the construction progresses.

In warm climates, this is true. The standpipe system and its water supply can be installed and made operational once the first few floors are framed. The risers can be kept wet, and the water supply can be automatic. The risers can be periodically shut off to permit the installation of additional pipe as the building height increases. However, challenges can occur when construction is undertaken in locations where freezing temperatures are anticipated.

Since a building under construction will not have heat until it is enclosed, a wet riser cannot be used in freezing climates. A dry system of some type must be provided. In a building of moderate height [approximately 300 feet (90 meters)], a dry riser with a fire department connection could be utilized. The hydrostatic



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pressure in a 300-foot (90-meter) riser is approximately 130 PSI (9 bar). A typical two-stage fire department pumper can supply 250 PSI (17 bar), so there would be adequate residual pressure at the top of the riser for hose streams. A system of this type is referred to as a manual dry system by NFPA 14.<sup>1</sup>

A manual dry system has the virtue of simplicity. However, there are a few minor details which must be considered. In a manual dry system, no water is available until the fire department charges the fire department connection. Therefore, preconnected hoses are useless. The fire department must supply its own hose.

In addition, workers often try to use fire standpipes as a convenient source of water. They will open a hose valve on a dry system and may leave it open when there is no water. If a fire subsequently occurs and the standpipe is charged, water will be discharged from the valves that have been left open.

When buildings start to get taller than 300 feet (90 meters), the situation

Semiautomatic dry standpipes make use of a remotely operated valve to admit water to the standpipe. This eliminates the problem and potential danger of a system with high air pressure.

can get more challenging. In many jurisdictions, fire department pumps cannot provide adequate pressure to supply water beyond roughly 350 feet (100 meters) in elevation. This will vary somewhat depending on the hydrant pressure available. For

example, a hydrant pressure of 50 PSI (3 bar) would increase the effective working height by about 110 feet (34 meters). Some allowance would also have to be made for friction loss in the standpipe and connecting fittings.

Ultimately, a height is reached beyond which a building fire pump must be used. One method is to use an automatic dry standpipe system. This system would use a dry pipe valve similar to a conventional dry sprinkler system. Air pressure holds back the water through a differential dry pipe valve. When a hose valve is opened, the pressure is released, and the dry valve opens.

There are two difficulties with this method. One is the air pressure that would be required to hold the dry valve shut. As an example, using a water pressure of 300 PSI (20 bar) and a dry valve differential of six to one, the minimum pressure required to hold the dry valve closed would be about 50 PSI (3.4 bar). With a safety margin of 20 PSI (1.4 bar), the required air pressure is 70 PSI (4.8 bar).



**Victaulic Ad**



Figure 1. A standpipe hose station.



A firefighter opening a hose valve would encounter a substantial blast of air.

The second difficulty is the hydraulic forces that result when the dry valve operates. The opening of a dry valve results in a large volume of water suddenly discharging into a volume of much lower pressure. This is the normal situation in the operation of a dry valve. But in the case of a high-rise building, the forces may be greater than normally encountered due to the greater pressure. This requires special attention to the support and anchoring of pipe.

NFPA 14 makes provision for a semiautomatic dry standpipe system. Semiautomatic dry standpipes make use of a remotely operated valve to admit water to the standpipe. This eliminates the problem and potential danger of a system with high air pressure. NFPA 14 refers to a remote control device located at each hose station to operate the valve. The exact type of remote control device is not specified.

NFPA 14 makes reference to a deluge valve as the remotely operated valve to control the flow of water

into the standpipe system in a semiautomatic system. Although the use of a deluge valve eliminates the problem of air under high pressure, the problem of hydraulic forces remains.

One method which has been used to eliminate water hammer is to allow the water to fill the system slowly. This can be accomplished by the use of a motor to open the supply valve gradually rather than suddenly, as is the case with a deluge valve. The motor is arranged to operate the valve through a reduction gear and has a limit switch to stop the motor when the valve is fully open. Butterfly-style valves are suited to this application. The motor is controlled by switches located at the hose stations.

Figure 1 shows a standpipe hose station on a semiautomatic standpipe. The operating switch is located in the red box. This system makes use of pre-connected hose.

The only disadvantage to this method is that, as the project is completed, the remote control switches and the valve motor itself need to be removed. However, this is normally a small problem.

The most desirable means of providing protection to a high-rise construction project will depend on the nature and duration of the project. It will also vary with the capabilities of the local fire department. In all such cases, operating procedures of the fire department must be integrated into the system operation.

*Edward J. Prendergast, P.E., is formerly with the Chicago Fire Department.*

Reference:

- 1 NFPA 14, *Standard for the Installation of Standpipe and Hose Systems*, National Fire Protection Association, Quincy, MA, 2007.



# **Zurn Wilkins Ad**



# Fire Detection and Alarm Systems

## in Buildings Under Construction

**W**hen considering fire safety in buildings under construction, fire detection and alarm systems are often near the bottom of the list of available tools. The only consideration is usually about how to avoid putting the equipment in until the space is clean or how to protect existing equipment and wiring during the construction process. However, there are several scenarios where detection and alarm systems can play a valuable role in protecting buildings that are under construction.

It must be emphasized that the use of a fire detection and alarm system during construction is different than the normal installation of a building alarm system. There are situations where a system can be installed to provide early



warning during the construction process. However, in the normal course of constructing or renovating a building or a part of a building, the fire detection and alarm system that may be required or desired for the particular occupancy or use group is installed in stages to coordinate with the other trades. Even during the rough-in stages, wiring and electrical boxes for detection and alarm equipment are installed *after* the rough-in for lighting and certain

other trade work. It is only near the final completion of the construction project that the fire detection and alarm system is placed in its final, operational condition. This is done in part because fire detectors and alarm notification appliances need to be installed after many of the building's finishes have been completed. For example, smoke detector bases, strobe lights and speakers are not installed on backboxes until the surfaces have been painted so that there is no need for the painters to remove trim plates or to mask and paint around the equipment – or paint over them. The second, perhaps more important reason for not installing the devices and appliances until the other work is near completion is to avoid damage to the equipment, including contamination of smoke detectors with construction dust and dirt.

It is not uncommon for owners to ask for a system to be placed in service before the final construction work has been completed. Most often, this is requested because the owner or general contractor wants a partial certificate of occupancy to begin moving in furnishings or even to occupy part of the building while the final touches are being installed elsewhere. Many authorities having jurisdiction will not grant a partial certificate of occupancy unless the protection systems, including detection and alarm, are in place and operational. This practice has directly contributed to many nuisance alarms and maintenance problems. It also has caused some confrontations with contractors and suppliers.

When smoke detectors are installed too early, the final sweeping, sanding and painting can cause contamination of the detectors. Sometimes, this directly results in nuisance alarms. Other times, the detector sensitivity is increased so that some time later the detector alarms as the sensitivity drifts closer to the alarm point. Often, property managers, perhaps unaware that

the owner insisted on an early installation, will argue that the contractor or supplier fix the system under the terms of the warranty. To ensure that all parties are aware of the potential problems with early installation, the *National Fire Alarm Code*®<sup>1</sup> contains the following language in paragraph 5.7.1.11:

*"Detectors shall not be installed until after the construction cleanup of all trades is complete and final.*

*Exception: Where required by the authority having jurisdiction for protection during construction. Detectors that have been installed during construction and found to have a sensitivity outside the listed and marked sensitivity range shall be cleaned or replaced in accordance with Chapter 10 at completion of construction."*

The most common need for fire detection and alarm during construction arises in situations where parts of a building are being renovated while other parts remain occupied.

This provision protects owners against early installation by a contractor and protects contractors by pointing out to the owner that early installation is not normally permitted.

Normally during the construction of a building, the early warning to occupants and the early notification to the fire department provided by a fire detection and alarm system are

not warranted by the risk. In a new building, there usually are no people sleeping and few people that might need extended escape time. Fuel loads may be lower in many places, though higher in other storage areas. The alertness of the construction crew and containment around storage areas greatly reduce fire risk. However, there are situations where a fire detection and alarm system may be an integral part of fire safety during the construction process.

The most common need for fire detection and alarm during construction arises in situations where parts of a building are being renovated while other parts remain occupied. Where the occupancy requires a system, that system would have to be operation in the occupied space. If the occupied part of the building can be separated by passive fire protection (fire barriers), often there is no need for the fire detection and alarm system to be operational in the non-occupied parts. The ability to segregate such a system would depend on how it was originally configured and wired.

If the nature and details of the renovation work create a hazard that cannot be mitigated by containment alone, then some combination of detection, alarm and either manual or automatic suppression may be warranted. Selection of the exact combination of protection features is beyond the scope of this article. However, knowing what is available and how to use it allows fire protection engineers to make informed decisions regarding the use of fire detection and alarm during the construction process.

In spaces where automatic sprinklers are already installed and will remain operational, monitoring that system for waterflow alarm may be all that is needed. In some situations, good fire protection may warrant adding temporary sprinkler protection for specific hazards or areas, such as material storage spaces. Authorities may require temporary or early installation of standpipes. Waterflow alarms should be monitored on these systems.



For detection of a fire, the two most viable and economical choices are heat detection and smoke detection. If heat detection is capable of meeting the project's needs and a sprinkler system does not exist, a temporary heat-detection system can be installed. Contractors may use a temporary control panel or the one that will be used in the final system configuration. Spot-type heat detectors are hung loosely around the site, similarly to temporary lighting. An alternate solution is to use a line-type heat-detection cable (see Figures 1 and 2). Contractors can build a "temporary" system package by combining a small conventional control panel with several reels of heat-detection cable. The system can be quickly deployed without any need for cutting wires and connecting spot-type detectors that are easily damaged during construction activities. The heat-detection system can have several protection zones to permit localization of the alarm. Optionally, linear heat-detection systems that report the location of a hot spot along their length can be employed with a simple map of the installation to provide more exact location information. Linear heat-detection cable has the added advantage of being a continuous heat detector along its length, which may reduce detection time.

If the risk requires earlier warning than what can be provided by heat

detection, smoke detection may be required. Depending on the exact conditions of the site, the smoke-detection system may use the final system wiring and panel. Then, the detectors themselves may be installed as temporary units to be replaced before final occupancy, or they may be tested at the end of the project to ensure that their sensitivity is within the listed and marked sensitivity range. If the system is installed as a temporary measure, the contractor may create a construction package with a small panel and some relatively inexpensive detectors. The detectors may be abandoned at the end of the project or cleaned and deployed on a future construction project. Where smoke detection is desired and where ceiling heights permit, the use of projected-beam smoke detectors may reduce costs and increase detection effectiveness.<sup>2</sup>

Other factors must also be considered to ensure that fire detection contributes to fire protection. Is occupant notification required? If so, can several large appliances be employed within the work area? Can a system of manual notification be used effectively? This might involve notification of certain persons who activate an existing system or use radios and/or bull horns to provide notification. Where a temporary system is used in a partially



Figure 2. Linear heat-detection cable.

Photo courtesy of Fenwal Protection Systems

occupied building, how will the alarm system in the occupied portion be activated – manually or automatically? Should a temporary system have several manual fire alarm pull stations located at critical locations? Will the system need to automatically notify the fire department? If so, will it have its own means for transmitting an alarm, or will it tie into some existing system?

Most buildings under construction have many temporary systems used only during the construction process. These include temporary heating and temporary lighting. Fire alarm contractors can easily package temporary fire detection and alarm systems using heat-detection cables, small panels and cellular transmitters. Fire detection and alarm systems are like any tool or system – most effective when properly planned and used within their limits.



Figure 1. Line type heat-detection cable.

Photo courtesy of Tyco Fire Suppression & Building Products

#### References:

- 1 NFPA 72®, *National Fire Alarm Code*®, 2007 edition, National Fire Protection Association, Quincy, MA, 2007.
- 2 "Projected-Beam Smoke Detectors – More than Just a Substitute for Spot Detectors," *Fire Protection Engineering*, Summer 2004, pp.34-39.

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# RESOURCES > > >

## UPCOMING EVENTS

### March 18-19, 2009

Fire Safety International  
Conference  
Melbourne, Australia  
Info: [www.sfs.au.com/](http://www.sfs.au.com/)

### June 8-11, 2009

NFPA Conference & Expo  
Chicago, IL  
Info: [www.nfpa.org](http://www.nfpa.org)

### July 13-15, 2009

Human Behavior in Fire  
4th International Symposium –  
Fire Safety – Putting People First  
Cambridge, England  
Info: [www.intercomm.dial.pipex.com/html/events/hb09a.htm](http://www.intercomm.dial.pipex.com/html/events/hb09a.htm)

### September 24-25, 2009

Euro Fire 2009  
Belgium  
Info: [kathleen.decoaster@tmab.de](mailto:kathleen.decoaster@tmab.de)

### October 19-23, 2009

The Annual Meeting –  
SFPE Professional Development  
Conference & Expo  
Scottsdale, AZ  
Info: [www.sfpe.org](http://www.sfpe.org)

## BRAINTEASER



## Problem / Solution

### Problem

**F**ind the  
next three  
numbers  
in the following  
sequence:  
1, 1, 2, 3, 5

### Solution to Last Issue's Brainteaser

The following fire-related anagrams for "FIRE PROTECTION" were submitted by readers of *Fire Protection Engineering* magazine:

#### CITE REPORT INFO

(Submitted by Jane Lataille)

#### ENFORCER, I PITOT

(Submitted by Jane Lataille)

#### I FINE PROTECTOR

(Submitted by Jane Lataille)

#### I PRINT REC. TO FOE

(Submitted by Jane Lataille)

#### NICET FIRE TROOP

(Submitted by Jason Ward)

#### NICE RETROFIT OP

(Submitted by Robert Egli)

#### ONCE TO TRIP FIRE

(Submitted by Jane Lataille)

#### ORIFICE PORTENT

(Submitted by Jane Lataille)

#### POETIC FRONTIER

(Submitted by Robert Egli)



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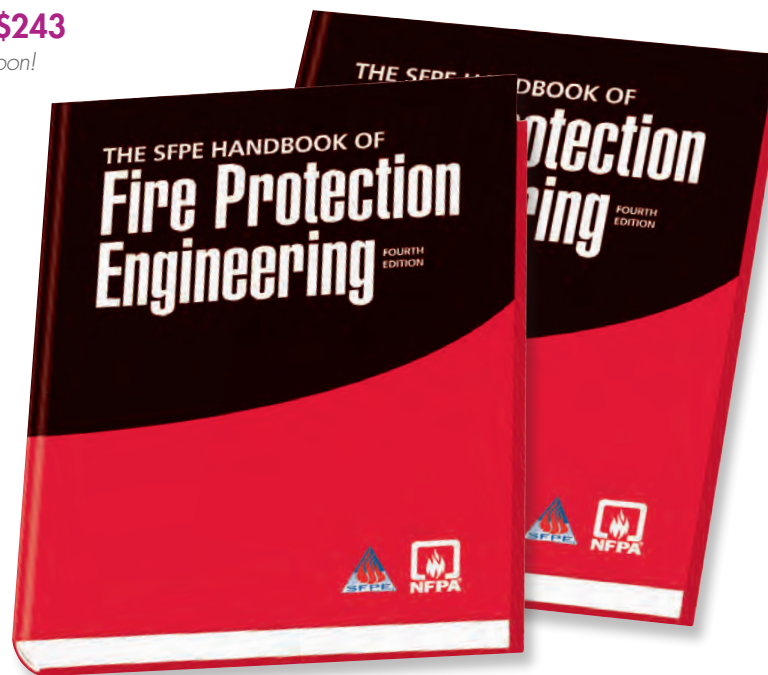
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## SIMPLEXGRINNELL

## SimplexGrinnell Introduces New Technologies to Streamline the Fire Alarm System Commissioning Process



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and support the timely issuance of occupancy permits," says Dave Baer, vice president of Marketing.

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## Intelligent Fire Alarm Control Panel

Equipped with addressable architecture such as individual point identification, drift compensation and maintenance alert, the new IFP-2000 Scalable Intelligent Analog-Addressable Fire Alarm Control Panel is designed for maximum flexibility and reliability. Targeted at medium- to large-size customers, it can be installed using existing fire system wiring and additional SLC loops using the 5815XL SLC expander to increase overall point capacity to a maximum of 636 points per panel. A complete array of IDP detectors and modules connect to the signaling line circuit.

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—Silent Knight



2

## New Dry Valve

Viking introduces its new G-4000 dry valve, which is UL-listed and FM-Approved. Features include simplified trim, reduced weight, a compact size and an external reset feature. Available in a 4-in. size, the G-4000 has a pressure rating of 250 psi and features a lightweight ductile iron body with black E-coat. The complete dry valve assembly includes the valve and trim package as well as the water supply control valve, alarm pressure switch and air supervisory switch. A 12-in. section of piping also is included to facilitate installation and future servicing.

**www.vikinggroupinc.com**

—Viking Corp.



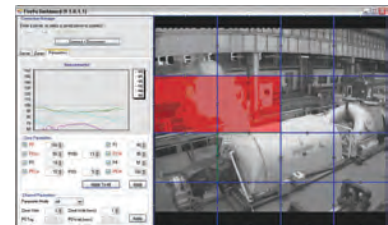
3

## Video Smoke Detection

NOTIFIER is now offering Video Smoke Detection (VSD) as part of its line of fire- and smoke-detection products and technologies. VSD is used in applications where traditional smoke-detection technologies may be impractical or inefficient, such as large open areas, very high ceilings or high air flows. VSD can detect smoke and/or fire in any area visible to a standard video camera. When fire or smoke is detected, the system alerts the operator at the operating terminal and at an unlimited number of remote locations.

**www.notifier.com**

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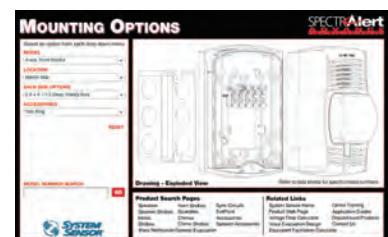
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## Online Mounting Options Tool

System Sensor has launched a new online tool to speed and simplify the choice of matching product models and mounting locations with the variety of back boxes and AV accessories for all SpectraAlert Advance notification device installations. Users click on a short series of drop-down lists to choose the details of their installation, including product model, mounting location, back box options and accessories. The application automatically limits subsequent available options based on the user's previous selections.

**www.systemsensor.com**

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### Index of Advertisers

Chemtron.....	35	Reliable Automatic Sprinkler.....	23
Draka Cableteq USA.....	45	RJA.....	IFC
EMCOR Group.....	25	Silent Knight.....	7
Fike Corporation.....	27	SimplexGrinnell.....	13, 50
FlexHead Industries.....	3	System Sensor.....	5
General Air Products.....	17	Tyco Fire & Building Products.....	BC
Grice Engineering, Inc.....	33	University of Maryland.....	29
Harrington Signal, Inc.....	21	Victaulic Co. of America.....	39
Honeywell Notifier – Fire Solutions.....	31	Viega.....	47
Hoover Treated Wood Products.....	18	Worcester Polytechnic Institute.....	37
HPAC Engineering.....	50	Zurn Wilkins.....	41
Janus Fire Systems.....	19		
KD & Associates, Inc.....	32		
Koffel Associates, Inc.....	IBC		
National Fire Protection Association.....	34		
Protectowire.....	15		



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