

FIRE PROTECTION Engineering

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Peer Review and the Fire Protection Engineer

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A Modern Approach to Determining Building Height and Area



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REVIEW IN
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From the **TECHNICAL DIRECTOR**

Fire Protection Engineering and the Environment

A few decades ago, environmental impact was not a concern when fire protection strategies were developed. A popular sentiment was that fire protection, as a critical safety component, should be exempt from environmental regulations.

In 1974, two scientists theorized that chlorofluorocarbons (CFCs) could harm the ozone layer.¹ By 1985, a thinning of the ozone layer was observed, which was attributed to CFCs in the atmosphere.

A commonly used fire protection agent at the time, Halon 1301, was a chlorofluorocarbon. Halon 1301 had many qualities that made it a desirable fire-suppression agent. These included that it was relatively safe for people at design concentrations, and it would not harm critical electrical and computing equipment.

While Halon was more destructive to the ozone layer than other CFCs, there were thoughts that because Halon was produced in much lower quantities than many other CFCs, and because it was a very effective fire suppressant, it should not be subject to prohibitions that were applied to other CFCs. Initial efforts to limit the amount of Halon introduced into the environment focused on eliminating full-discharge testing.² However, the production of Halon 1301 was ultimately prohibited by the Montreal Protocol in 1994.

The fire protection community responded to the prohibition of Halon by developing replacement clean-extinguishing agents that shared some of the benefits of Halon, but that were not as harmful to the environment.

More recently, other fire protection systems have come into focus from the perspective of their impact on the environment. Concern has been expressed in the U.S. state of California that emissions from diesel-driven fire pumps can have a negative impact on the environment. These concerns have led to nationwide regulation of emissions from diesel-driven fire pumps in the U.S.³ Specifically, the concern is that the emissions from some diesel engines can be particularly harmful when the engines are operating under no- or low-load conditions. *NFPA 25* requires testing of fire pumps under no-flow conditions weekly,⁴ which would correspond to a low-load on the diesel driver.

It could be argued that diesel drivers for fire pumps constitute a small percentage of the diesel engines and that fire pumps are critical fire protection equipment. However, this argument did not work for Halon, and it did not work for fire pumps either.

Another area where fire protection equipment is coming under increased scrutiny is the testing of sprinkler systems in Australia.⁵

With the country suffering from severe drought conditions, water conservation is necessary. In the past, water for fire protection purposes could be used without restrictions. Now, water-saving measures call for reduced testing frequency of sprinkler systems and recirculation or reuse of water used in sprinkler system testing.

Some areas in Australia have the added challenge that the pressure in underground mains has been reduced in an effort to lessen the frequency of water main failures. This has the unintended consequence of possibly forcing existing sprinkler systems out of compliance.

Over the last few decades, it has become clear that fire protection is not immune from environmental protection requirements. This leaves the fire protection engineering profession with a choice: be driven by the requirements, or participate in the development of the requirements. The Society of Fire Protection Engineers has chosen the latter and has assembled a task group on fire protection and the environment. This task group will review the issues and develop a planned path forward.

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

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- 2 DiNenno, P., & Forssell, E., "Evaluation of the Door Fan Pressurization Leakage Test Method Applied to Halon 1301 Total Flooding Systems," *Journal of Fire Protection Engineering*, 1 (4), 1989, pp. 131-140.
- 3 *Federal Register*/Vol. 71, No. 132/Tuesday, July 11, 2006, pp. 39154-39185.
- 4 *NFPA 25, Standard for the Inspection, Testing, and Maintenance of Water-Based Fire Protection Systems*, National Fire Protection Association, Quincy, MA, 2008.
- 5 Thomas, R., "Water Conservation and Sustainable Use in Fire Suppression Systems," Proceedings - SUPDET 2009 Suppression and Detection Conference, Fire Protection Research Foundation, Quincy, MA, 2009.

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Dear Editor,

Re: "Impact of Fires on the Built Environment Over the Past 10 Years," By Michael A. Crowley, P.E., FSFPE.

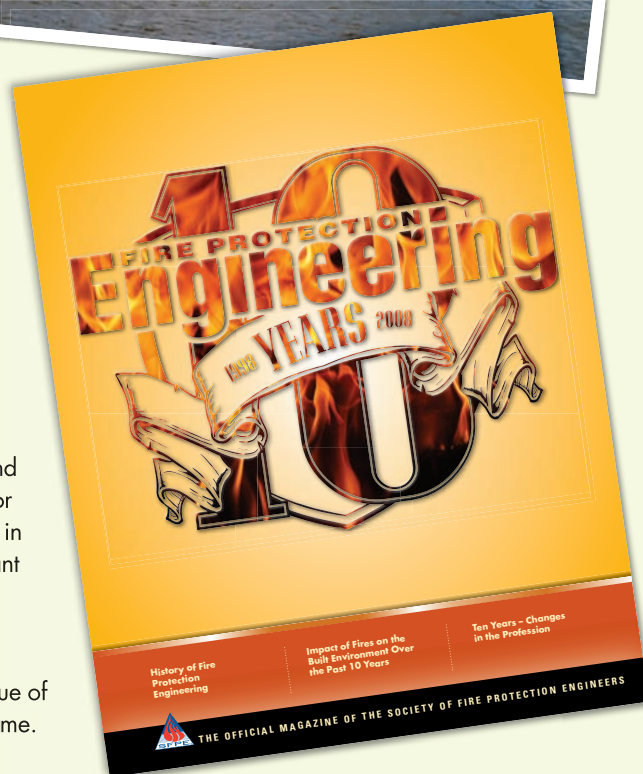
The wallpaper on my personal computer is an aerial photograph of the Twin Towers of the World Trade Center, with the Statue of Liberty in the foreground. This photo was taken from a Port Authority helicopter at the time the Port Authority moved its offices into the North Tower, while the South Tower and perimeter buildings were still under construction. This depiction is the way I prefer to remember the World Trade Center.

After the tragedy of 9/11, media reports stated that because the Port Authority, as a bistate agency, was exempt from compliance with local codes, the Twin Towers had inadequate exits. These inaccurate media reports angered me. First, the Port Authority Engineering Department had an independent unit that insured voluntary compliance with the New York City Building Code. Second, codes at the time only required two exit stair towers. The World Trade Towers provided three exit stair towers.

The subject article, mentioning the NIST World Trade Center investigation and recommendation reports, mentioned that the NIST report identified a need for two-directional flow for responders in the up direction and occupants exiting in the down direction, and then stated the ICC's Task Force for Terrorism-Resistant Buildings was successful in having the 2009 IBC® to require a third stair for "super-tall high-rise buildings" perpetuates those false media reports.

I expect better accuracy in *Fire Protection Engineering*. Incidentally, this issue of *Fire Protection Engineering* is one of the most informative issues in a long time.

Sincerely,
Dennis Kirson



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By Fredrik Nystedt

Performance-based codes are developing throughout the world, and countries are continuously being added to those who already have adopted this procedure of regulating fire safety. Many of the countries that introduced functional requirements in the mid-'90s are now revising the codes and using design methods to incorporate gained experience, as well as filling gaps where knowledge has been insufficient in the past. Such gaps exist, e.g., in design fires and in treatment of variability and uncertainty in the design of fire safety in structures. The book by David Yung serves a clear purpose in providing useful information on how to work with the concept of risk assessment when using a performance-based approach in the design and assessment of building fire safety.

This 227-page book is divided into two parts: the first part (Chapters 2–5) covers traditional fire risk assessment methods, and the second part (Chapters 7–13) is a straightforward guide with useful information on how to conduct a fire risk assessment based on what the author defines as a fundamental approach. This fundamental approach is introduced in Chapter 6 and links the information in the first part of the book with the information presented in the second part. The book is structured in a logical and useful way, suitable both as a textbook for students and as a reference guide for fire protection engineers, regulators and academics.

The introduction on fire risk assessment in Chapter 2 groups fire protection measures into five major groups, a concept which is used throughout the book. These groups involve controlling fire initiation, fire growth and smoke spread as well as expediting occupant evacuation and fire department response. The grouping concept is useful to fire protection engineers when developing trial designs and enables the engineer to value the effectiveness of the strategies used in terms of reliability and robustness.

Chapters 3–5 cover techniques for fire risk assessment based on past fire experience and qualitative as well as quantitative methods. Examples introduced in earlier chapters are analyzed

and discussed from different perspectives as new concepts are introduced. This approach adds nuances to the various aspects of fire risk assessment that are helpful to the reader. The part of Chapter 5 that deals with the event tree method is, however, quite dense and requires professional experience in fire risk assessment for complete understanding.

Chapters 7–11 provide useful information on scenarios related to the five groups introduced in Chapter 2 and examined in Chapter 6. Each chapter is a concise source of information, and the author provides

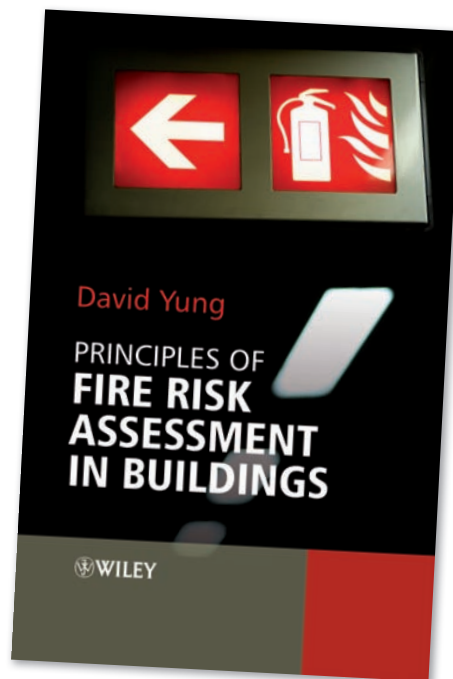
his reflection on key issues associated with developing and evaluating the various scenarios. Chapter 10, on occupant evacuation, contains some tables linking fire growth to occupant notification signals that are helpful in selecting events to be included in the risk assessment.

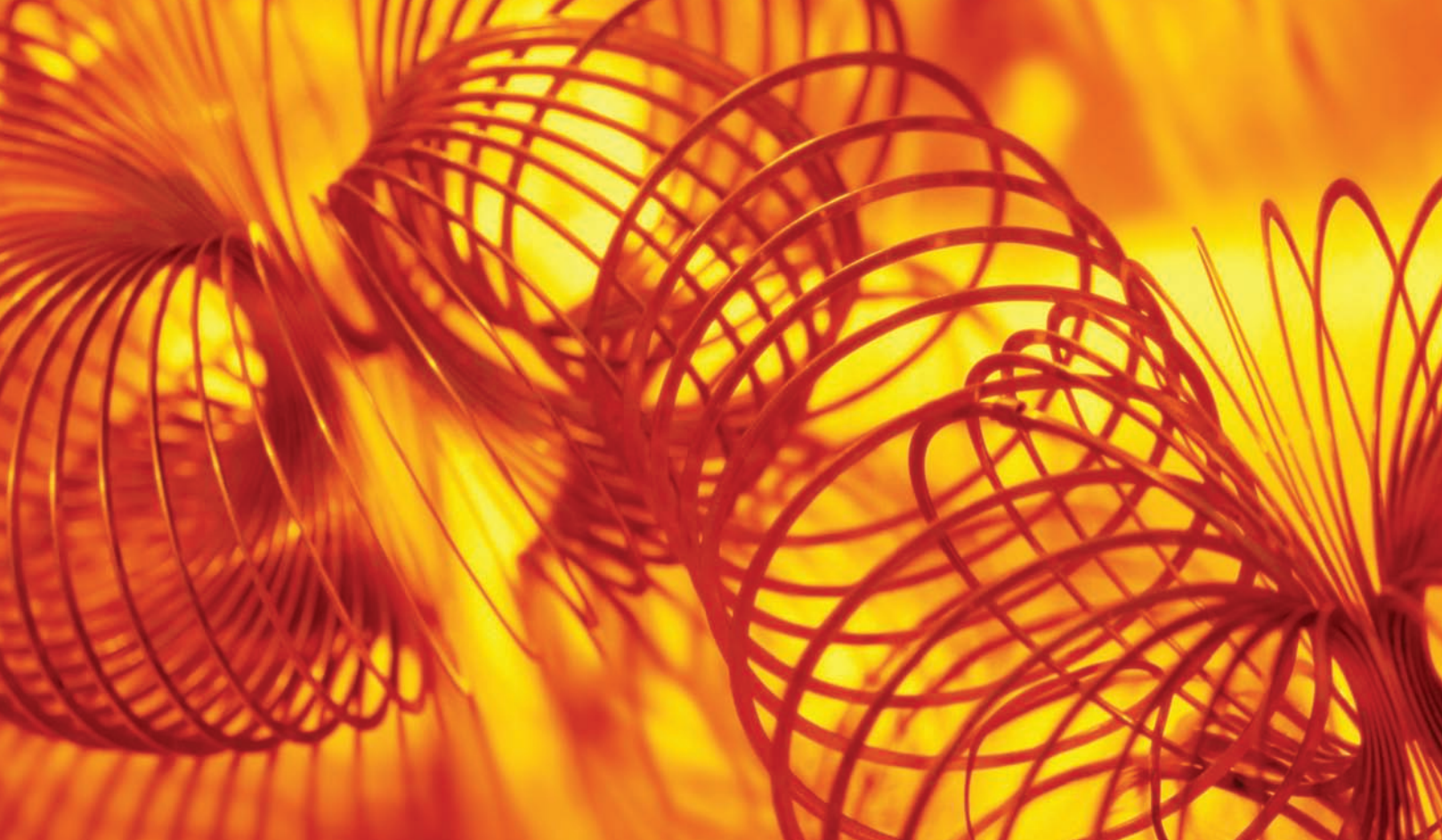
Chapter 12 contains some techniques that could be used when treating uncertainties in calculations. The chapter requires mathematical skills that many fire protection engineers may not possess. A few examples on how to treat uncertainties with less-complex methods, such as interval analysis or switch-over analysis, would have been helpful. Chapter 13, on fire risk management, covers some aspects of evaluating trial designs with comprehensive risk assessment models as well as discussing the impact of maintenance and drills on the expected risk to life.

Some additional information on how to evaluate fire risks and compare different trial designs would have been useful, as risk assessment adds a complexity that doesn't always have easy answers.

Each chapter in the book concludes with a summary that provides a brief view of major findings and important aspects of fire risk assessment in buildings. These short summaries give the time-stressed professional an opportunity to cover the book in less than an hour.

Fredrik Nystedt is with Wuz Risk Consultancy AB.





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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.

Marshall Earns Prestigious Early Career (PECASE) Award

Andre W. Marshall, Ph.D., associate professor in the department of fire protection engineering, A. James Clark School of Engineering at the University of Maryland, is the recipient of a 2007 National Science Foundation (NSF) Presidential Early Career Award for Scientists and Engineers (PECASE).

Marshall was one of 20 young scientists honored at a White House ceremony at the Eisenhower Executive Office Building on December 19, 2008. He was recognized with this prestigious award for his research entitled, "Exploring jet fragmentation and atomization for combustion and fire suppression systems."

"Dr. Marshall is a leader in research and education," says Darryll J. Pines, dean and Nariman Farvardin professor of engineering. "His PECASE Award not only honors his excellent work as a young investigator, it also highlights the quality of our nationally recognized fire protection department and indicates the strength of the Clark School's research program today and going forward."

Marshall earned a Ph.D. in Mechanical Engineering from the University of Maryland in 1996, and M.S. (1992) and B.S. (1991) degrees in Mechanical Engineering from the Georgia Institute of Technology. His research is focused on characterizing turbulent flow transport processes in fires and flames using advanced diagnostics and models. In addition to his research activities, Marshall directs the Fire Testing and Evaluation Center (FireTEC) at the University of Maryland.

For more information, go to www.enfp.umd.edu.

Building Security Remains at Top of Americans' List

A recent nationwide survey conducted by the Society of Fire Protection Engineers (SFPE) reveals that building security topped a list of characteristics as Americans' most important feature in public buildings. The list included comfort, fire safety, environmental friendliness and other amenities.

"The findings are not surprising given the threat from crime and terrorism that we face today," says Chris Jelenewicz, engineering program manager at SFPE. "However, Americans should recognize that thousands of people die each year in fires, and fire safety features are critical to protect people and property."

The results of this survey revealed 28 percent of Americans feel security is the most important feature, while 12 percent of respondents indicated that fire safety is the most important aspect of a building's design. Americans also ranked comfort and amenities higher than fire safety.

"Throughout history, the desire for increased building security has contributed to countless deadly building fires. The most notable fire occurred at the Triangle Shirtwaist Factory in New York City in 1911, where locked exit doors contributed to 146 fatalities," Jelenewicz says. "That threat can still exist today if security is not balanced with fire protection."

Among several noteworthy findings, the survey showed that more than 58 percent of those surveyed worry about the dangers of fire less than once a year.

"We face widespread misconceptions about fire safety, and that's worrisome," Jelenewicz adds. "That is why it is important that fire protection engineers devote their careers to protecting people and property from fire."

For more information, go to www.sfpe.org.

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PEER REVIEW AND THE FIRE PROTECTION ENGINEER

By Carl F. Baldassarra, P.E., FSFPE



INTRODUCTION

The peer review process is becoming increasingly important in the profession of fire protection engineering. Buildings have become larger, taller and more complex than just 20 years ago, and the technology of the various building systems has also grown more complex. Similarly, buildings housing complex processes, such as semiconductor manufacturing, present special hazards in which many regulatory officials have little or no experience. In order to address these buildings of ever-increasing complexity, the codes and standards which govern their design and installation have also become more complex.

Furthermore, performance-based design guidelines published by the International Code Council, the National Fire Protection Association and the Society of Fire Protection Engineers¹ identify the rigorous methodology to be utilized as an optional alternative to compliance with the traditional prescriptive requirements of building and fire codes. While the number of projects using the performance-based design approach is small, few regulatory officials are trained to participate in the process.

Regulatory officials may very well feel overwhelmed at times in keeping up with changes in design criteria and changes in technology, but they certainly need not feel ashamed. Design firms do not have individual staff members with the expertise to deal with the broad spectrum of occupancies, processes and building systems. Each project employs the services of dozens of architects, engineers and technicians – each with his or her own special expertise in the project – who collectively may produce hundreds or even thousands of drawings and pages of specifications.

Given that, it is not reasonable to expect that all building departments and fire departments have competent staff members to address occupancies

It is no surprise that numerous regulatory officials or authorities having jurisdiction (AHJs) have employed fire protection engineers to review the work of other fire protection engineers and designers for various issues.

ranging from single-family homes to hospitals and from high-rise casinos to sprawling manufacturing facilities – including the special hazards, sophisticated building systems and construction techniques associated with each.

Even the largest and most experienced departments are likely to be faced with a unique building or issue from time to time.

The peer review process – a process in which a third party (other than the design team or the authority having jurisdiction) is used to review the work of others on behalf of one of the stakeholders – allows the various stakeholders of the project to be reasonably assured that such challenging buildings provide the

expected level of safety and that the designs and installations comply with the applicable regulations. The stakeholder of a project is any party who has an interest in the successful completion of the project, the interest of whom may be financial, public safety, functional, etc. Stakeholders may include the owner/developer, lenders, architect, engineers, consultants, contractors, building and fire officials, tenants and even the public. However, not all stakeholders will have an “equal” level of authority or final approval in the project.

It is no surprise that numerous regulatory officials or authorities having jurisdiction (AHJs) have employed fire protection engineers to review the work of other fire protection engineers and designers for various issues, such as:

- Proposed “alternate methods” for specific design features allowed under the provisions of the applicable codes;
- Performance-based designs, such as for smoke-control systems and calculated fire resistance ratings of structural members;





- Fire models demonstrating safe egress designs for large or complex facilities;
- Designs not meeting the specific criteria of applicable standards;
- Designs for which no specifically adopted design criteria exist; or,
- "Single" issues involving a difference of opinion among the stakeholders.

A number of jurisdictions employ outside (contracted) plan review services, in lieu of maintaining full-time staff, for even routine projects in order to control costs and to provide improved turnaround time for applicants.² These services may involve the full scope of design review, including architectural, structural, electrical, plumbing, mechanical and fire protection drawings and specifications. The contracted service providers act as agents of the jurisdiction and report their findings to the jurisdiction, unless directed otherwise, as if they were employees of the jurisdiction. While these are technically third-party services, they do not constitute the formal "peer review" process contemplated by this article.

In some cases, sophisticated owners have engaged fire protection engineers to perform a peer review of the work of the project's fire protection engineer of record for large, high-profile or high-value facilities. The purpose of this peer review may

be to provide a second opinion, reducing the risk to the owner; to facilitate the plan review performed by the AHJ; to perform a value engineering function; or to simply resolve a difference of opinion. This role may take place behind the scenes, i.e., without the knowledge or involvement of the AHJ. In fact, this role is typically performed prior to the designs being submitted to the AHJs for review and approval in the permitting process. Peer reviewers have also been hired by both owners and AHJs to witness the acceptance tests of fire protection systems to assure the systems have been installed in a manner consistent with their expected performance.

Further still, some parties may engage peer reviewers to review completed projects after construction and acceptance tests have been performed, typically because of an alleged deficiency. Such post-construction and due diligence reviews are beyond the scope of this article.

RESPONSIBILITIES

Engineers have their first duty to public safety, health and welfare, and are required to limit their professional practice to their areas of competence. This, of course, also applies to engineers engaged in

performing peer reviews, regardless of who may have engaged the peer reviewer. The *NSPE Ethics Reference Guide* states, "Professionalism and ethics are twins, inseparably bound together in the concept that professional status and recognition must be based upon public service under a higher duty than mere compliance with the letter of the law."³ Accordingly, the peer reviewer should be as qualified to undertake an assignment as the engineer of record for a project similar in scope and complexity to the one being reviewed. This qualification is established by having both the necessary education and experience to perform the review. In addition, the peer reviewer must be free of any conflict of interest with the assignment, or such potential conflicts should be disclosed to the stakeholders.

The owner or authorized representative is responsible for engaging qualified designers and contractors to design and build the project. In addition, the owner may suggest a list of qualified engineers to serve as peer reviewers to the AHJ.

The selection of the peer reviewer can be the result of a cooperative process with the AHJ approving potential peer reviewers from a list and the final selection being made by the owner. In some cases, the selection is solely made by the AHJ from a list of qualified engineers familiar to the AHJ. In still other cases, the AHJ may have a preselected consultant to serve as a peer reviewer for all issues which may arise in the jurisdiction.

While this may eliminate the potentially time-consuming selection process, the AHJ may suffer the same fate as if there was no peer reviewer, i.e., as stated previously, most individuals do not have expertise in all technical matters that may arise within the jurisdiction. The AHJ should verify that the peer reviewer is technically qualified and has no conflict of interest or bias associated with the assignment.

In any case, the approval of the peer reviewer by the AHJ does not

Cooperation,
excellent
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and a "can do"
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engagement
and a successful
project.

necessarily need the unanimous consent of all stakeholders. It must be understood that, although the fees of the peer reviewer may be paid directly or indirectly by the owner, the peer reviewer's principal in such cases is the AHJ, not the owner. The legal authority to mandate that the jurisdiction may retain – and that the owner pay for – the peer reviewer is typically included in the building and fire codes.

To validate the relationship, many jurisdictions require that the owner pay for the peer review through permit fees to the jurisdiction rather than the owner paying the peer reviewer directly. The peer reviewer is encouraged to execute an agreement for professional services with the contracting entity, including the scope of the assignment, schedule and fee schedule.

Some jurisdictions have specified that certain fire protection features, such as spray-applied fire-resistive materials and smoke control systems, be subject to third-party review under the "special inspection" provisions of the codes. Again, such inspections

are not considered to constitute "peer review" as intended by this paper and do not necessarily follow the guidelines included in the SFPE's *Guidelines for Peer Review in the Fire Protection Design Process* (SFPE Position Statement 03-02).⁴ Nevertheless, it is prudent for the affected members of the design team to learn of such local requirements and the procedures to be followed prior to beginning the design process.

The peer reviewer is expected to provide timely services, complete and technically-based comments concerning the subjects being reviewed. Particularly in larger and more complex projects requiring the engagement of a peer reviewer, time is of the essence for all parties. Cooperation, excellent communication and a "can do" approach in working together with all of the stakeholders are important for a successful engagement and a

successful project. This does not mean any less diligence should be exercised on important matters involving public safety however.

Engaging a peer reviewer experienced with such projects will be viewed as a good investment by the owner and the design team. If utilized to his/her full potential, an experienced peer reviewer can play an important role by identifying potential issues before they occur, anticipating construction and operational problems, and working together with the other team members to affect an efficient design and construction process. However, the peer reviewer is not part of the design team and is not expected to offer design solutions or value engineering suggestions.

Occasionally, the AHJ may wish to engage the services of a peer reviewer without the knowledge of other stakeholders. Such an engagement can lead the peer

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reviewer to make erroneous or incomplete assumptions about the engineer of record's design basis. Rather, peer reviewers are encouraged to communicate with the engineers of record, disclose their assignments and engage in discussions concerning the design engineer's assumptions, goals, etc. When it comes to communication in peer review assignments, less is not more.

Recognizing that most projects have tight schedules, the peer reviewer can facilitate the process through regular and open communication. In some cases, the peer reviewer has been invited to have a dedicated on-site office in a construction trailer and attend weekly team meetings during the review process, eliminating the delays normally associated with generating review letters, waiting for replies, performing second reviews, responding to those comments, etc. In weekly meetings, spontaneous questions can be simply raised and answered, eliminating a time-consuming process and a potential for misunderstanding and errors.

Of course, the peer review process will vary from project to project, and will reflect the needs of the AHJ, the design team and the other stakeholders. A thorough discussion of the process at the beginning of the assignment will greatly aid the team in defining the process deemed most appropriate for the project's stakeholders. The peer reviewer's work should be documented in a manner acceptable to the AHJ and the other stakeholders. A suggested degree of documentation includes a statement of the applicable codes, standards and other criteria; design objectives; assumptions made by the designer; models and methods employed; input data, if any; and a statement concerning the appropriateness of the design approach.

A potential area prone to erroneous work by a peer reviewer involves being brought in on a single issue to resolve a conflict or to provide a second opinion. Such situations can lend themselves to incorrect conclusions on the part of the peer reviewer because,

Recognizing that most projects have tight schedules, the peer reviewer can facilitate the process through regular and open communication.

in the interest of limiting the time and expense of the peer reviewer, the owner may provide only limited information associated with the single issue, and the peer reviewer might be unable to view the issue in the context of the overall facility. Accordingly, it is important for peer reviewers engaged in such limited assignments to be inquisitive, inquire about any previously approved alternate methods or performance-based designs, and to fully understand the issue as it affects the general fire protection strategy of the facility.

Unfortunately, reports of some fire protection engineers serving as peer reviewers and using their positions on projects in a competitive manner against the fire protection engineers of record have been brought to this writer's attention in recent years. Specifically, the peer reviewers were reported as giving the engineers of record a difficult time by repeatedly asking for more and more information on subsequent technical submittals in an apparent attempt to embarrass the engineers of record before their clients and the AHJs. In another case, the peer reviewer applied an arbitrary (personal) standard to a submittal and delayed the approval of the design team, again in an apparent attempt to embarrass the engineer of record and demonstrate the superior technical skills of the peer reviewer.

Clearly, such conduct is inappropriate and unethical. It does not serve

the stakeholders or advance public safety, and it reflects poorly upon the profession. In fact, rather than enhance the peer reviewer's image, the owner involved in one such case was clearly irritated by the peer reviewer and vowed never to hire him or his firm again – neither as a peer reviewer nor the engineer of record. In another similar instance, the AHJ involved indicated that the jurisdiction would avoid using the peer review process in the future because of the contrived conflict.

While everyone may have their own preferences of how to approach a given fire protection analysis or design, it is necessary to recognize other, acceptable design approaches that do not materially affect the performance of the design and be respectful of colleagues in the profession. Moreover, it is necessary to ensure that the SFPE Canon of Ethics and the "standard of reasonableness" included in the SFPE's *Guidelines for Peer Review in the Fire Protection Design Process* are employed in all peer review assignments.

Finally, it is the responsibility of the peer reviewer to respect the confidentiality and intellectual property of the owner and the design team, and not to use the information or concepts included in the reviewed materials for other purposes.

Carl F. Baldassarra, P.E., FSFPE, is with Schirmer Engineering Corporation.

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- 1 *SFPE Engineering Guide to Performance-Based Fire Protection Analysis and Design of Buildings*, National Fire Protection Association, Quincy, MA, 2007.
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USE OF THIRD-PARTY **FIRE PROTECTION SERVICES**

TO AUGMENT **FEDERAL FIRE
PROTECTION** PROGRAMS

By Joshua W. Elvove, P.E., FSFPE, and
David P. Klein, P.E.

The U.S. Department of Veterans Affairs (VA) and the U.S. General Services Administration (GSA) own and operate a number of federal buildings in the 50 U.S. States, Guam, Philippines, Puerto Rico and the U.S. Virgin Islands. In order to safeguard these assets and the public from the potentially devastating effects of fire, the VA and GSA have each established their own in-house fire protection engineering program consisting of fire protection engineers located in the national office, as well as engineering program staff located in field offices throughout the country. National office staff develops and promulgates agency-wide fire protection policies, while the field staff is responsible for implementing national office fire protection policies. These policies require that their respective buildings are designed, constructed and maintained in accordance with national codes and standards, and agency-wide fire protection requirements.

In order to meet this charge for design and construction projects, both VA and GSA require fire protection expertise on the design team. In addition, both VA and GSA require a review of the design by a qualified fire protection engineer independent of the design team (see the sidebar for the qualifications of the fire protection engineer).

WHO IS A QUALIFIED FIRE PROTECTION ENGINEER?

A qualified fire protection engineer is defined as an individual with a thorough knowledge and understanding of the principles of physics and chemistry governing fire growth, spread and suppression, meeting one of the following criteria:

(a) An engineer having an undergraduate or graduate degree from a college or university offering a course of study in fire protection or fire safety engineering, plus a minimum of four years' work experience in fire protection engineering.

(b) A professional engineer (P.E. or similar designation) registered in fire protection engineering.

(c) A professional engineer (P.E. or similar designation) registered in a related engineering discipline and holding member-grade status in the International Society of Fire Protection Engineers.

Source: Federal Management Regulations §102-80.135, November 8, 2005.



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DESIGN ISSUES FREQUENTLY FOUND DURING PROJECT REVIEWS

The following is a sample of issues commonly identified during fire protection reviews of healthcare projects. Some issues would also be applicable to projects in other occupancies. Most issues, if not corrected, could result in change orders during construction or operational problems that would require correction after occupancy.

- The code analysis and/or plans do not identify the NFPA occupancy and construction type. Without this information, the design cannot be properly reviewed.
- Fire protection specifications are not properly edited (e.g., spec writer notes are not deleted, fire protection water supply is not provided). Specifications should be edited so that they are project-specific.
- Fire and smoke barriers are shown only on architectural and/or fire protection drawings but are not shown on the drawings for other engineering disciplines. Fire and smoke barriers should be shown on all floor plans to ensure that subcontractors are clearly aware of the location of such walls so that penetrations can be adequately sealed.
- Door schedule shows doors with incorrect or no fire protection rating.
- Exit sign locations are not properly coordinated between the reflected ceiling and electrical lighting drawings.
- Improper locking arrangements are specified. For example, access control egress doors are not equipped with a manual "Push to Exit" button.
- Insufficient clearance specified between stair handrails and wall.
- Smoke barrier doors that are likely to be propped open by the occupants are not designed with magnetic door holders connected to the fire alarm system.
- Nonlatching manual push plate door hardware is specified where positive latching hardware is required (e.g., corridor doors serving radiology and cardiology areas located within a healthcare occupancy).
- Fire-rated glazing (e.g., wire glass) in mental health treatment areas is not also rated for impact resistance. Where provided, glazing in mental health units must be resistant to potential abuse by patients.
- Sprinkler zones do not correspond with smoke compartments. This results in staff, who must respond to the location to assist patients, not being able to identify the specific smoke compartment that is affected by a water flow.

Conducting a fire protection review is particularly important because VA and GSA serve as the authority having jurisdiction (AHJ) for their owned buildings. Typically, local code officials do not review the designs of buildings on federal property, nor do local code officials typically inspect these buildings. Therefore, for buildings on VA and GSA property, it is the responsibility of each agency to ensure that qualified fire protection engineers perform plan reviews as well as approve contractor fire protection submissions, witness final fire protection systems acceptance testing and, in the case of GSA, issue certificates of occupancy. It should be noted that for projects involving leased space, agency fire protection staff may still conduct a review; however, since these projects do not involve federal property, the projects must go through the same plan review submission, building-permitting, approval and acceptance testing processes as any other project in the local jurisdiction.

Ideally, fire protection reviews are conducted during each stage of the design submission process (e.g., concept/schematic, design, construction). However, depending upon resources available and/or the complexity of the project, reviews may be conducted less frequently. These reviews are generally conducted by in-house professional staff where such staff is available and has sufficient expertise. Alternatively, these services may be contracted to third-party firms. If services are contracted, both VA and GSA require that these reviews be conducted by qualified fire protection engineers.

DEPARTMENT OF VETERANS AFFAIRS (VA)

The VA includes three separate administrations – the Veterans Health Administration (VHA), the Veterans Benefits Administration (VBA) and the National Cemetery Administration (NCA) – as well as a number of department-wide programs that do not fall within any one administration. For example, "major" construction projects (i.e., those that exceed \$10 million) are managed by the Office of Construction and Facilities Management (CFM), the office that oversees large construction projects for the entire VA. Individual hospitals will typically handle the contract administration, design and construction for smaller "minor" or "nonrecurring maintenance" projects. Regardless, all VA projects are expected to be designed in accordance with a number of design manuals, including the *VA Fire Protection Engineering Design Manual*.¹ In addition, VA policy requires that a fire protection engineer be on the design team for projects of a significant scope (e.g., major projects, minor projects and nonrecurring maintenance projects where 50 percent or more of the project involves fire protection) and requires that those same projects are reviewed by a qualified fire protection engineer. Having a fire protection engineer on the design team does not eliminate the requirement for having that same project undergo a separate fire protection plan review.

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VHA, which is responsible for managing the VA health-care delivery program, is organized into 21 regions, known as Veterans Integrated Service Networks (VISNs). Each VISN provides at least one employee responsible for safety-related activities including occupational safety, fire protection, industrial hygiene and environmental protection. In some VISNs, this position is held by a fire protection engineer. Where this occurs, the VISN fire protection engineer will generally perform the fire protection plan review. However, in most VISNs, this position is held by an occupational safety and health manager, safety engineer, industrial hygienist or environmental protection specialist who may not be sufficiently trained to conduct fire protection reviews.

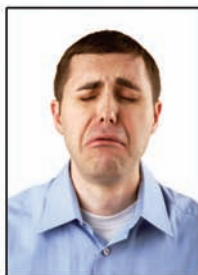
Consequently, VHA has established a nationwide, indefinite-delivery-indefinite-quantity (IDIQ) contract with a third-party engineering company having qualified fire protection engineers. Any VISN or individual hospital can use this company as needed to conduct fire protection reviews during the design process. In 2006, this contract was expanded to include additional fire protection services such as preoccupancy inspections, witnessing of acceptance tests for fire protection equipment and systems, as well as assistance in developing equivalency requests for designs and conditions that do not meet specific code

A thorough review helps to reduce the potential for design errors, leading to costly change orders later or inadequate levels of fire protection.

requirements. VHA facilities are permitted to use any qualified fire protection engineering firm, but having an IDIQ contract with at least one firm makes the procurement process easier. VHA national office is also using this firm to perform on-site inspections at 12 residential buildings nationwide that were donated to the VA. It was decided to use a single independent fire protection engineering firm rather than VA staff so that the same team of fire protection engineers would perform these inspections, thereby resulting in consistency across the country.

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Projects managed by CFM are also provided with a third-party fire protection plan review through the CFM peer review process. For these projects, CFM has established IDIQ contracts with several architect-engineering companies. Many of these companies do not have fire protection engineers on staff, so they subcontract the fire protection plan review to separate fire protection engineering firms. Since there are a limited number of fire protection engineering companies, it is not unusual for the same third-party fire protection engineering company to be part of the design team on some projects and to be part of the peer review team on other projects. Of course, the same company cannot participate in both the design and review of the same project.

Since healthcare facility fire protection is unique and fairly complex, one cannot overstate the importance of having a qualified fire protection engineer perform fire protection reviews, whether the individual is in-house or contracted. A thorough review helps to reduce the potential for design errors, leading to costly change orders later or inadequate levels of fire protection. Fire protection engineers who are familiar with the healthcare environment not only help to ensure that VHA facilities are built in accordance with nationally recognized codes and standards

and applicable VHA criteria, but also help to ensure that features are not incorporated that may not be necessary ("overdesign"). For example, during plan reviews, fire protection engineers familiar with healthcare requirements may identify smoke dampers that are not required in smoke barrier walls, corridor walls that are not required to extend to the floor slab above, smoke detectors that are not required or duct smoke detectors that are not required in return air handling systems. Conversely, these same fire protection engineers can point out potential life safety issues that can be problematic. The benefit of reviews that are conducted by qualified fire protection engineers is illustrated by the list of actual issues that have been identified during plan reviews for VHA (see the sidebar on page 13 for examples).

U.S. GENERAL SERVICES ADMINISTRATION (GSA)

GSA consists of two services: the Public Buildings Service (PBS) and Federal Acquisition Service (FAS). PBS is responsible for managing the design and construction of public buildings and for acquiring lease space. The Office of the Chief Architect within PBS is responsible for managing large-scale (prospectus-level) projects (projects in excess of \$2.66 million). Project management is the responsibility of the individual

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PBS region. The *Facilities Standards for the Public Buildings Service*² (PBS-P100) establishes design standards and criteria for new facilities, or for alterations of GSA-owned or leased construction with government option-to-purchase buildings. PBS-P100 is the PBS building standard and includes a chapter specifically dedicated to fire protection and life safety.

PBS owns and operates more than 1,500 federal buildings and maintains leases in more than 7,000 buildings. PBS is divided into 11 geographic regions, all of which employ fire protection engineers. The PBS regional fire protection engineer is involved with construction projects from project inception through final acceptance of newly installed fire protection equipment, and is thus typically responsible for conducting the fire protection plan review during project design. PBS is also unique in that the PBS fire protection engineer issues certificates of occupancy after construction has been completed, all fire protection and life safety systems have been satisfactorily tested, and all outstanding deficiencies corrected to afford a reasonable degree of safety.

PBS regions may contract for third-party fire protection services when a region lacks sufficient staffing or when the regional fire protection engineers do not have sufficient time to perform the work. At these times, fire protection engineering services may be contracted out to fire protection engineering firms to review fire protection drawings during design, to review equipment submittals and shop drawings during construction, and to witness final acceptance testing. Third-party contracts may also include conducting fire protection engineering building surveys.

PBS has also utilized third-party services to review and validate performance-based designs or complex designs. For example, third-party fire protection services were used during the design of an atrium smoke management system for the U.S. Courthouse in Phoenix, AZ (see sidebar).

This building was part of the GSA Design Excellence Program and featured an architecturally defining atrium that spanned the entire length, height and width of the building.

Due to the height of the building, the size of the atrium and the unusual aspect that the atrium was to be passively cooled (a real challenge in Phoenix where the daytime temperature regularly exceeds 110°F/43°C in the summer), the design team approached PBS and asked them to develop an engineering alternative to the required atrium smoke control (exhaust) system.

The design team fire protection engineer believed that the size of the atrium along with openings placed along the upper level for the passive cooling system would meet the performance requirements and the intent of atrium smoke exhaust systems required by the building codes. The design engineer proposed using Computational Fluid Dynamics (CFD) to demonstrate the appropriateness of the design. The PBS regional fire protection engineers were willing to accept this approach. However, it was clear that the PBS regional fire protection engineers would not have the time to devote to reviewing the modeling results.

Therefore, they recommended that the design team contract for the services of a professional fire protection engineer to review the design team's CFD submittal and then submit the evaluation report to the PBS regional fire protection engineers for approval. After a thorough review by the third-party fire protection engineer, including revisions to the proposed modeling, the engineering alternative design was approved by the PBS regional fire protection engineer and was incorporated into the project.

Joshua W. Elvove, P.E., FSFPE, is with the U.S. General Services Administration, and David P. Klein, P.E., is with the U.S. Department of Veterans Affairs.

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SFPE'S GUIDELINES FOR PEER REVIEW IN THE FIRE PROTECTION DESIGN PROCESS

By Morgan J. Hurley, P.E.

Peer reviews have been used in the research and scientific communities for centuries as a means to establish the quality of work prior to publication. When a paper is proposed for publication in a "peer reviewed" journal, the journal's editor sends the paper to people who have expertise in the subject matter of the paper. These reviewers evaluate the quality of the paper and make a recommendation as to whether or not it is suitable for publication. The reviewers may also provide comments that they feel should be addressed before the paper is published.

Peer reviews of articles provide confidence in the findings of the paper. People who are not peers of the authors might not be able to judge the quality of the work since they might not have expertise that is similar to that of the authors. It is for this reason that peer-reviewed articles are typically viewed more favorably in the scientific community than articles that are not peer-reviewed.

Review of building designs has been a long-standing method used to determine the quality of a design. Building designs are typically reviewed by enforcement officials to determine whether or not they meet the requirements of the

applicable codes and standards. In many cases, where prescriptive codes are used, evaluation of a design is a relatively straightforward task. However, as designs become more complex, enforcement officials might not have the time, tools or expertise necessary to adequately review the design.

Peer review has been used in the building process in specialty areas such as wetlands, traffic and structures to augment or better inform the review conducted by enforcement officials. Enforcement officials might not have the time or expertise needed to thoroughly review complex designs in these areas, so peer review can be a valuable tool. Also, other stakeholders of a performance-based design (e.g., building owner or developer) may wish to better understand the underpinnings of the design.

Peer review is increasingly being used to evaluate fire protection designs as performance-based design is more widely used. Performance-based designs may be developed using sophisticated engineering or scientific principles. In cases where the basis for the design is outside of the enforcement official's expertise, or where reviewing the design would consume too much time, the enforcement official might use a peer reviewer. As with peer reviewers of scientific journals,

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peer reviewers of fire protection designs typically have expertise in the types of analysis that are used in the design.

IMPETUS FOR SFPE'S PEER REVIEW GUIDELINES

Peer reviews have been used to assist enforcement officials and other stakeholders understand performance-based designs for many years. However, until SFPE published a set of guidelines on peer review, there were no published criteria available about how a peer review of a fire protection design should be conducted.

In 2001, SFPE assembled a task group to develop a set of guidelines for peer reviews of fire protection designs. Task group members were a broad collection of participants in the field of fire protection engineering and included representatives from enforcement agencies, academia, consulting and research.

When the task group first met, they established a list of items that they felt should be addressed. This list included:

Initiation of peer review

- When in the design process to use a peer reviewer
- In what cases should peer review be used
- Identification of agreement to perform a peer review

- Who can request a peer review
- How to choose a peer reviewer
- How to deal with an impasse between reviewer and designer

Scope of peer review

- When a peer review is conducted, what should be reviewed
- Identification of the scope of the review
- Necessary documentation from reviewer
- The review should only be technical – not personal
- Standard of reasonableness

Technical issues

- Tools required for review
- Validity (external vs. internal)
- Review assumptions and methods, and use of the methods
- Judgment by reviewer of which issues must be addressed by the designer and which are not expected to significantly affect performance

General issues

- Ethics – practice only in area of expertise
- Objectivity of reviewer
- Confidentiality
- Relationships between designer and reviewer – avoid possible biases
- Respect for intellectual property of designer
- Third-party inspection vs. third-party review
- Goal not necessarily to improve design (journal peer reviews are intended to improve quality of papers)
- Identification of standard of care for peer review

The task group developed a draft guide that addressed the issues identified. Once the draft was nearly finished, it was made available for review and comment by the fire protection engineering community. Comments that were received on the draft guide were considered, and the draft was modified accordingly.

The remainder of this article summarizes the content of SFPE's "Guidelines for Peer Review in the Fire Protection Design Process."

GENERAL ISSUES

The SFPE "Guidelines for Peer Review in the Fire Protection Design Process" were written to address the initiation, scope, conduct and report of a peer review of a fire protection design. The guidelines define "peer review" as "the evaluation of the conceptual and technical soundness of a design by individuals qualified by their education, training and experience in the same discipline, or a closely related field of science, to judge the worthiness of a design or to assess a design for its likelihood of achieving the intended objectives and

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intended outcomes." A peer review could be conducted on an entire design or on one or more discrete elements of a design.

The use of peer reviews will likely increase as the use of performance-based design increases. Peer review can add time to the design process, so a peer reviewer should be selected as early as possible.

INITIATION OF A PEER REVIEW

A peer review is typically undertaken at the request of a project stakeholder. In most cases, an enforcement official is the stakeholder that initiates a peer review. This decision might be made at the initiation of the project or when the stakeholder is presented with a complete set of design documents.

The guidelines identify three reasons why a peer review might be conducted. A stakeholder might wish to have a better understanding of the quality, technical basis or completeness of a design. Or, a stakeholder might not have the resources (time, tools or expertise) necessary to evaluate the design. Another reason might be that additional quality assurance is sought in the design.

The independence and technical expertise of the peer reviewer are emphasized in the guidelines. The peer reviewer should be objective and have no conflict of interest in the project.

The peer reviewer should have sufficient knowledge of fire protection engineering to understand and evaluate the design. The guidelines suggest that if the peer reviewer has the knowledge and experience needed to prepare the design, then they would have the expertise necessary to serve as a peer reviewer. The peer reviewer should be able to demonstrate that they have the necessary knowledge and experience to perform the peer review.

Once a peer reviewer has been selected, they should execute an agreement with the contracting stakeholder. The American Consulting Engineers Council publishes a model agreement for peer review services. This agreement is available at www.nspe.org.

SCOPE OF A PEER REVIEW

As with any professional services, the scope of the peer review should be determined at the time the agreement to conduct a peer review is executed. Any changes to the scope should be agreed upon by both the stakeholder who contracts for the peer review and the peer reviewer.

The peer review should evaluate both the internal and the external appropriateness of a design. External appropriateness reflects whether the correct problems are being solved. Internal correctness deals with whether the problems are solved correctly.

Regardless of the scope of the peer review, the guidelines identify several items that should be considered when a peer review is conducted. These include:

- The codes, standards and guides that are applicable to the design;
- The objectives of the design;
- Any assumptions that are made by the designer;
- The technical approach used by the designer;
- Any models that are used by the designer;
- The input data that is used for the models;
- The appropriateness of the recommendations and conclusions of the design and whether they are supported by the results of the calculations performed; and
- The correctness of the design approach.

In some cases, stakeholders will seek third parties to conduct inspections of fire protection installations in buildings. While these inspections utilize third parties, they do not constitute a "peer review" as described in the guidelines.

CONDUCT OF PEER REVIEW

As with any fire protection engineering endeavor, peer reviews should be conducted in accordance with the *SFPE Canons of Ethics*. When a fire protection engineer becomes aware of a problem, even if it is outside of the scope of the peer review, the engineer should bring it to the attention of the contracting stakeholder. If necessary, professional ethics would require bringing the problem to the attention of others.

The main purpose of a peer review is to ensure that public safety goals or the goals of stakeholders are met by a fire protection design. It is not the responsibility of a peer reviewer to improve an acceptable design or to provide value engineering.

A peer reviewer should not be influenced by matters of individual design preference. Generally, there will be more than one acceptable method to achieve a set of fire safety goals. Any technical issues that would not be expected to significantly affect the performance of the design should not be identified as deficiencies.

To adequately conduct a peer review, it will be necessary to evaluate the appropriateness of the calculation tools and data that were used in the analysis. While some models may be proprietary, it would still be necessary for the peer reviewers to be provided with sufficient access to the models and associated documentation to judge whether the models are appropriate. Additionally, it may be necessary for the peer reviewer to use additional tools and data to check the original modeling results.

Where commercial or proprietary software was used to prepare the design, it may be necessary to bring in additional people who have experience with the software as part of the peer review. The peer reviewer



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should respect any confidentiality issues associated with any tools to which he or she becomes exposed. This also holds true if the peer reviewer becomes aware of other intellectual property associated with the design.

In most cases, the peer reviewer would communicate the results of the peer review to the contracting stakeholder. With the concurrence of the contracting stakeholder, the results could be sent to the engineer of record. When dictated by professional ethics, communication with the appropriate enforcement officials may be necessary. This might be necessary in the unusual case where the peer reviewer becomes aware of a potentially unsafe condition, and neither the contracting stakeholder nor the engineer of record is willing to make the necessary corrections.

REPORT OF A PEER REVIEW

The peer reviewer should prepare a written record that identifies the scope of the peer review and the findings. A key element of this report is a statement as to whether the peer reviewer believes that the design meets the objectives. Any comments as to the appropriateness of the design should be substantiated with references to published technical documentation.

In some cases, the opinions of the designer and the peer reviewer may differ. In these cases, additional technical documentation may be necessary to reach a conclusion. Both the designer and the peer reviewer should understand that the purpose of the peer review is for the contracting stakeholder to make an informed decision.

The full text of SFPE's "Guidelines for Peer Review in the Fire Protection Design Process" can be found at www.sfpe.org. Additionally, in recognition of the importance of peer review to the fire protection engineering professional, the Society of Fire Protection Engineers will permit other organizations to reproduce the "Guidelines for Peer Review in the Fire Protection Design Process," provided that the guidelines are reproduced in their entirety.

Morgan Hurley, P.E., is with the Society of Fire Protection Engineers.

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A MODERN APPROACH TO DETERMINING BUILDING HEIGHT AND AREA FOR FIRE SAFETY

By John F. Devlin, P.E.

The *International Building Code*®¹ (*IBC*®) incorporates significant changes from the previous editions including limiting mercantile, light- and moderate-hazard storage occupancy buildings of unprotected, noncombustible construction (*IBC* Type IIB) to a maximum of two stories high (three stories when protected throughout by automatic sprin-

klers). This is a reduction from the previously permitted four stories in height (five stories with automatic sprinklers).^{2, 3} The code change is not in response to a life loss or property damage experience; rather, it's an attempt to make the *IBC* 2009 consistent with the most restrictive requirements of the three legacy model building codes from which the *IBC* was formed.

When considering the merits of a code change, there are three questions that should be asked:

- What is the desired end result?
- How will success be measured?
- What possible ways might success be achieved?

BUILDING HEIGHT AND AREA ORIGIN

The International Code Council was formed by the merger of three predecessor organizations: Building Officials and Code Administrators International, Inc.; International Conference of Building Officials; and Southern Building Code Congress International, Inc. The origin of the IBC height and area table is the *Building Officials and Code Administrators (BOCA) Basic Building Code* 1950 edition,⁴ and is a function of the formula:

$$\text{Allowable Area} = U \times C \times \text{Base Building Area}$$

Where:

U = Relative Risk to Fire (use factor)

C = Relative Construction Value to Fire (construction factor)

Base Building Area = Assumed allowed areas under

critical conditions, i.e., highest risk and lowest construction type.

The Relative Risk to Fire use factor, U , was determined by a study of fire experience data reported in the *National Fire Protection Association Quarterly* for the years 1930 to 1942. The analysis tested the number of fires in each occupancy use group, the number of lives lost per fire and the amount of property damage per fire. A construction factor, C , was developed for each construction type based upon fire resistance rating and combustibility of the floor construction and exterior walls. The *Base Building Area* was originally a constant 1,000 square feet (93 m²) and was increased to 1,200 square feet (110 m²) in 1970.

Increases in the base building area for excess street frontage (openness of the other building sides) were permitted. The number of stories permitted was an arbitrary value based upon limited substantiation.⁵ The allowable areas in the early editions of Southern Building Code Congress International's *Standard Building Code* and International Conference of Building Officials' *Uniform Building Code* possibly were derived from a similar analytical method.

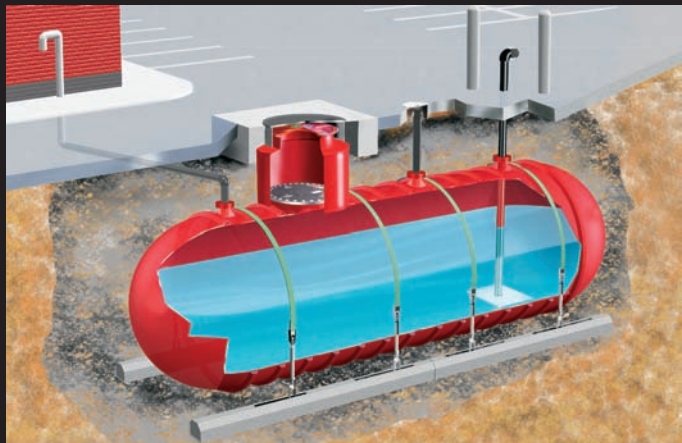
Revisions to the code over the years have altered whatever relationship on which the original analysis was

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based. In the late 1970s, the model building codes recognized the effectiveness of an automatic fire sprinkler system in controlling fire. Thus, a doubling of the maximum allowable building area was permitted and the maximum number of stories permitted increased by one.

There are many possibilities of the desired end result of limiting a building's height and area as a function of its structural fire resistance. The most obvious are:

- Achieve safe evacuation of all building occupants in a fire condition;
 - Maintain structural integrity in a fire condition to facilitate manual firefighting operations; and
 - Limit the value of the fire loss.
- As with any code provision, there

are likely other methods of achieving the goals and objectives of the restriction of maximum height and area of a building as a function of building construction type.

A significant percentage of all commercial and residential buildings (i.e., multifamily, hotel/lodging) constructed each year in the United States in the affected use groups are of heights three to 10 stories. These buildings are required by the code to be provided with both passive fire protection features (i.e., structural fireproofing, fire barriers and walls) and automatic sprinkler protection. Whether all of these systems are necessary to achieve success is a function of the goals and objectives of the design and the risk acceptable to society.

To answer this question, it is necessary to take a quantitative risk-based approach.

QUANTITATIVE RISK-BASED APPROACH

The *IBC®*, the *Life Safety Code®*⁶ and the *NFPA Building Construction and Safety Code®*⁷ all identify an acceptable level of risk. For example, each of these codes accepts the risk associated with permitting a maximum of 50 persons in a room/space served by a single exit. The current process for determining height and area is also risk-based, albeit not quantitative by engineering standard.

Quantitative risk-based approaches to fire safety are not a new concept. The *Goal-Oriented*

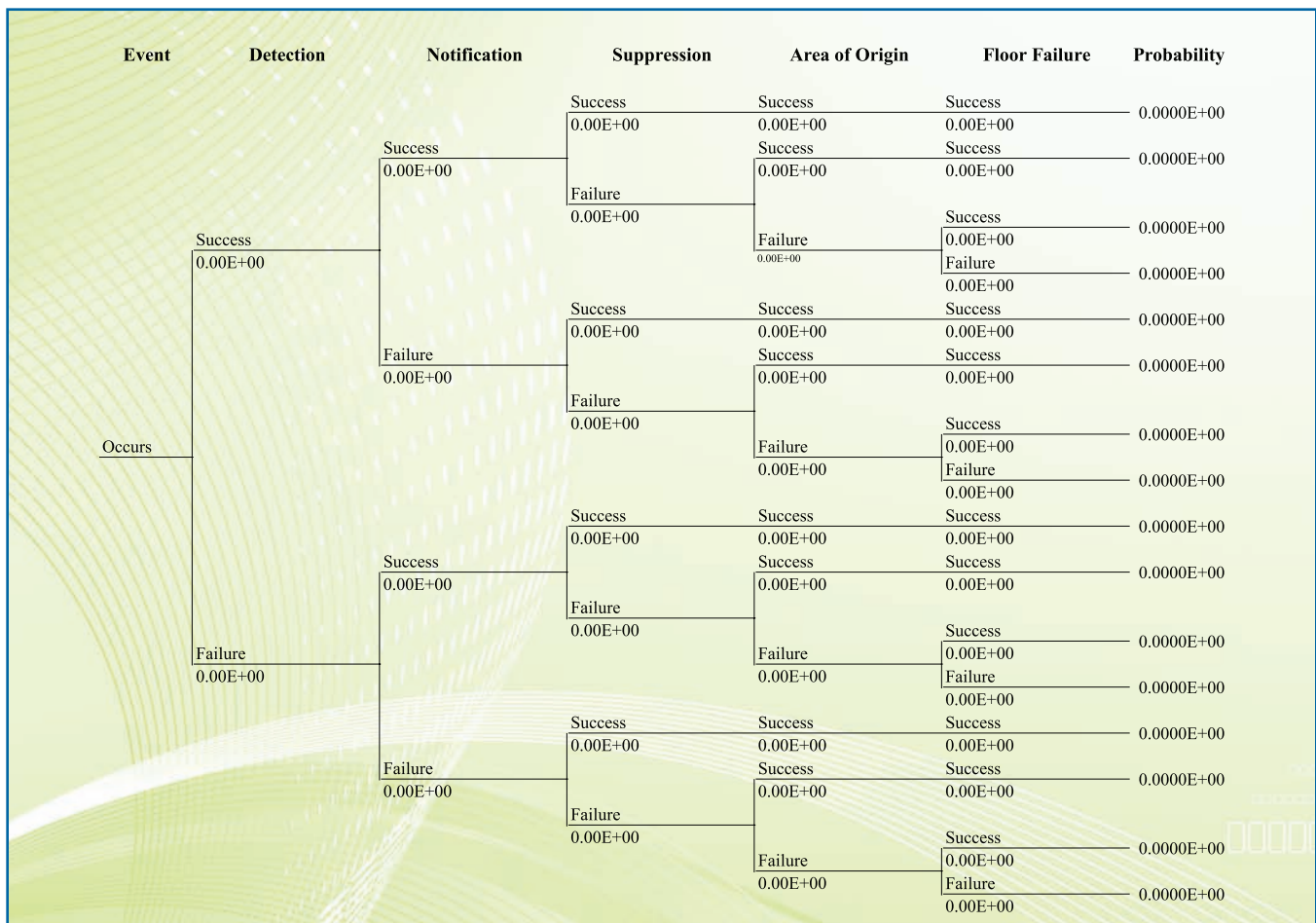


Figure 1. Event tree with associated fire safety subsystem branches.

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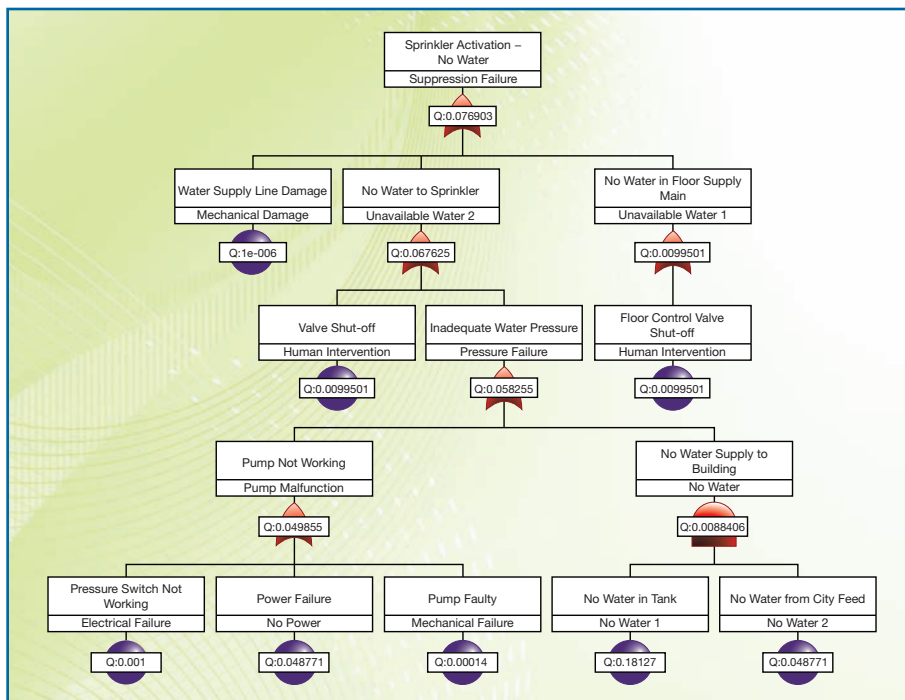


Figure 2. Fault tree for sprinkler activation failure – no water condition.

Systems Approach to Building Fire Safety introduced in the early 1970s was one of the first risk-based fire protection engineering approaches employed.⁸

A quantitative risk-based approach measures the total risk as function of the probability of an event and the consequences, and is expressed as:⁹

$$Risk = \sum P_i \times C_i$$

Where:

$Risk$ = Calculated Risk

P_i = Probability of Event i

C_i = Consequence of Event i

“Event trees” can be used to determine the risk associated with a initiation event. (See Figure 1 on page 34.) The total risk is the sum of the probabilities and consequences of each branch of the event tree.

Fault trees can be used to determine the failure probabilities used in the event tree. (See Figure 2.) The overall probability of failure or success can be determined by examining the possible failure modes using “and” and “or” logic gates.

Determining whether the calculated total risk determined for the event tree results in an acceptable design solution depends upon the acceptable risk of the project stakeholders.

The *Guide to the Fire Safety Concepts Tree*¹⁰ provides an effective framework for identifying the various fire safety subsystems that can be used to achieve success. Figure 3 on page 38 illustrates the “top gates” of NFPA 550 with selected lower-tiered gates. Controlling the fire by construction is just one of three possibilities to manage the fire. Building fire safety objectives identified by NFPA 550 are achieved through various fire safety subsystems that reduce the likelihood or consequence of a fire. These subsystems can be classified according to their functions:¹¹

- Control of fire ignition and development;
- Control flame spread;
- Control spread of smoke and toxic products;
- Provisions of means to allow occupant avoidance; and
- Provisions of sufficient structural integrity.

By assigning probabilities of success and failure to each subsystem to achieve their desired outcome, one can quantify the relative risk.

QUANTIFYING ENHANCEMENTS

Quantitative risk-based approaches afford the ability to holistically identify building fire safety subsystem enhancements that improve overall building fire safety while also allowing for cost-benefit comparison. Adding additional branches – additional or redundant subsystems – increases the probability of success. For example, fire sprinkler system reliability can be greatly increased by simply supplying the system from two separate risers – risers already required by the building code for fire standpipes – on each floor. Recognizing that all Class A fire department pumping apparatus is capable of providing 100 psi (6.9 bar) to standpipe outlets on floors up to 150 ft. (45.7 m) above the fire department connection and thus affords a level of redundancy to the fire sprinkler/standpipe booster pump system.

The effect of an extraordinary event such as an earthquake and resulting fire can be evaluated to determine whether or not the building fire safety objective is achieved and what enhancements, if any, are needed.

The recognition of performance of automatic sprinklers, more specifically their reliability, to achieve the fire safety objectives in lieu of passive fire protection remains a contentious issue. A quantitative risk-based approach identifies the various subsystem failures that must occur before a building’s structural frame is subjected to excessive thermal exposure.

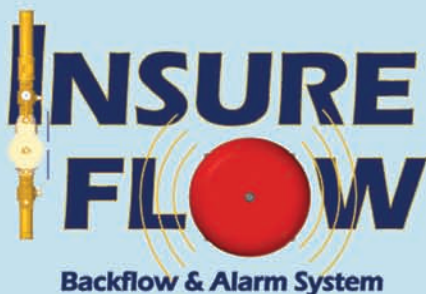
A fundamental fire safety goal of a building’s structural frame is to maintain structural integrity in order to facilitate safe evacuation of the building occupants and permit interior manual firefighting operation.

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techniques – it's possible that no adverse effects may occur as a result of exposing the structural framing system to elevated fire temperatures for the short duration associated with initiating manual fire suppression. Beam failure/yield in a fire condition might not adversely affect the integrity for various types of conventional steel framing. Column failure/yield inherently is of greater concern than beams and their submembers. Accordingly, a quantitative risk-based approach can focus attention on those building's elements deemed critical to achieve the overall fire safety goal if the various other fire safety systems were to fail.

A quantitative risk-based approach provides a more holistic understanding and quantifiable outcome of the interaction of various building fire safety systems.

THE FUTURE

Numerous technical papers have been written over the past decade on the virtues of a risk-based approach to building fire safety design. Some building professionals remain skeptical that such an approach could be effectively

applied, in part, due to the lack of understanding and technical competency. Building regulatory authorities in Australia and New Zealand, where quantitative risk-based approaches are used, seem to have addressed this concern. The quantitative risk-based analysis and fire testing associated with *140 Williams Street Building*, Melbourne, Australia, serves as reference guide for such analyses.¹²

Recent publications of textbooks and standards covering the topic of performance-based design for building fire safety based upon risk assessment, coupled with the various document publications by the SFPE on performance-based fire protection, have filled the previous void of technical documentation.^{9, 11, 13}

Perhaps the greatest challenge currently facing the fire protection engineer in the United States building regulatory arena is the acceptance of a risk-based approach. Replacing the current basis for determining building height and area with a quantitative risk-based approach will provide more flexibility, while ensuring an adequate level of safety. Quantifying building enhancements affords the ability for cost-benefit analysis

for potentially more economical building construction.

John F. Devlin, P.E., is with Schirmer Engineering Corporation.

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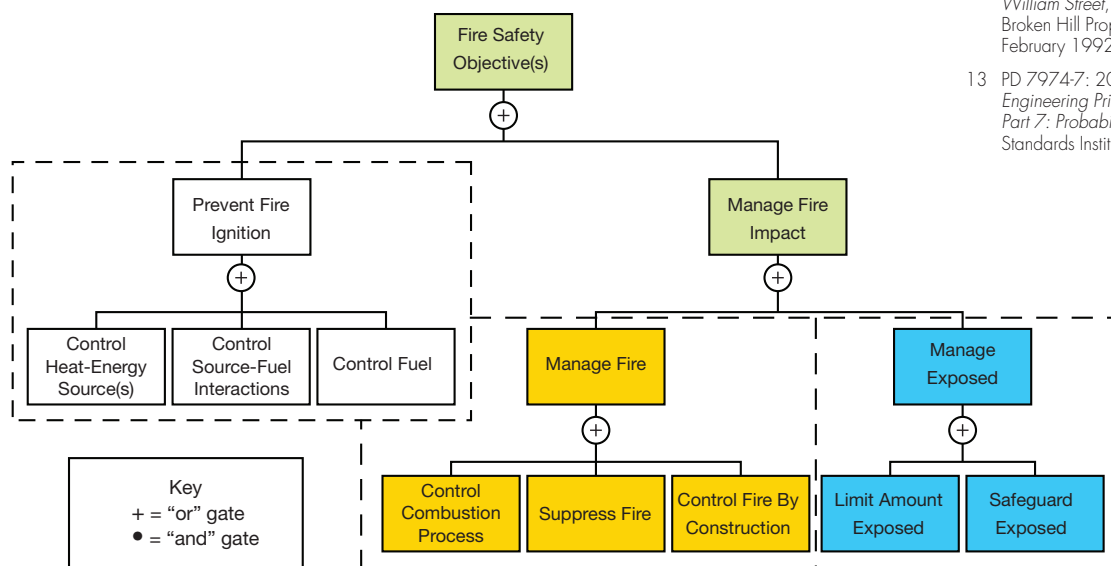


Figure 3. Top gates of NFPA 550 *Guide to the Fire Safety Concepts Tree* with selected lower-tier gates.*

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BRAINTEASER >

Problem / Solution

Problem

The first terms of a series are:

1, 2, -1, -2, 5, 26, 67

What are the next 3 terms?

Thanks to Jane Lataille for submitting this month's brainteaser.

Solution to Last Issue's Brainteaser

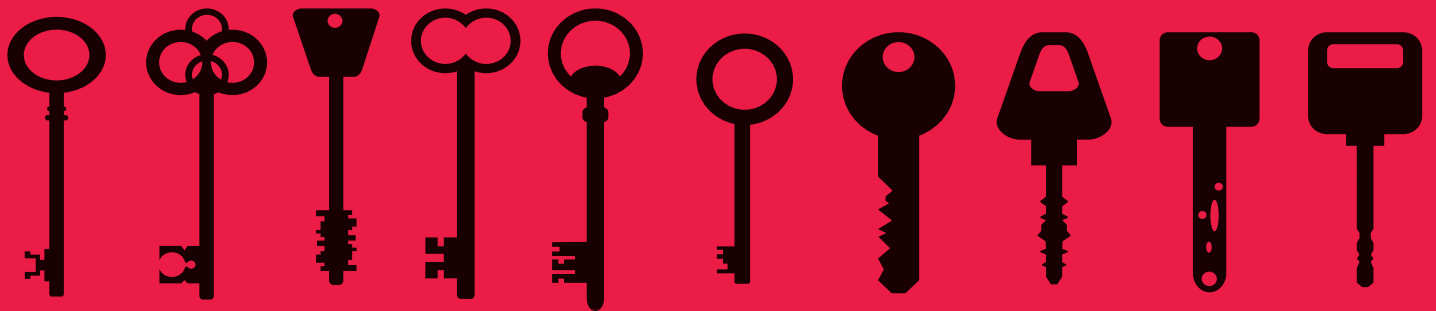
Find the next three numbers in the following sequence:

1, 1, 2, 3, 5

The classic solution is the Fibonacci series: start with 1, 1. Then, add the previous two terms together to get the next term. This gives:

1, 1, 2, 3, 5, 8, 13, 21 ...

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The extended abstracts should identify the topic being addressed, the approach used or suggested for addressing the topic, and results or recommendations. All topics relevant to performance-based codes or fire safety design methods will be considered.

Please include the name, address, phone number and e-mail address of the corresponding author with all submitted abstracts. If accepted, **completed papers will be due by February 22, 2010.**

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3

Visual Flame Detection

MICROPACK's third-generation Visual Flame Detector, Model FDS-301, offers enhanced-quality color video images and greater sensitivity for high-hazard environments. The new levels of sensitivity are achieved without affecting the detector's false alarm immunity and its ability to detect fires in the presence of sunlight, rain, fog and hot objects. Sensitivity is not affected by water on the optics, and detection is not blinded by contamination typically found in offshore environments.

www.micropackamericas.com

—MICROPACK Detection (Americas) Inc.



4

Pressure-Reducing Fire Valves

Wilkins introduces its new 1-1/2-in. ZW4100 Series pressure-reducing fire valves, suitable for high-pressure standpipes or sprinkler systems. Compact and factory-set, these valves are available with an optional built-in supervisory switch and NPT or integral grooved connections to save installation time. UL and C-UL Listed for flow rates up to 200 gpm.

www.zurn.com

—Wilkins, a Zurn Company



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**Extended Coverage with No In-Rack Sprinklers
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Covering Solid-Pile, Palletized and Single, Double, Multiple Row Racks for Class I-IV and Cartoned Unexpanded and Cartoned Expanded Plastics

Building Height: 30' Storage Height: 25' Coverage: up to 196 sq ft (14'x14')

K-14.0 ESFR	K-16.8 ESFR	K-25.2 ESFR	K-16.8 CMDA	Ultra K-17	N252 EC
100 sq. ft.	100 sq. ft.	100 sq. ft.	100 sq. ft.	100 sq. ft.	196 sq. ft.
50 psi	35 psi	15 psi-UL 20 psi-FM	22.7 psi (.80)	22 psi	30 psi
12 sprs	12 sprs	12 sprs	2000 sq. ft.	15 sprs (1500 sq. ft)	7 sprs (min. of 1200 sq. ft.)
1200+ gpm	1200+ gpm	1200+ gpm-UL 1352+ gpm-FM	1600+ gpm	1200+ gpm	Sys. demand 966+ gpm
250 gpm HS	250 gpm HS	250 gpm HS	500 gpm HS	500 gpm HS	250 gpm HS

Building Height: 35' Storage Height: 30' Coverage: up to 144 sq ft (12'x12')

K-14.0 ESFR	K-16.8 ESFR	K-25.2 ESFR	N252 EC
100 sq. ft.	100 sq. ft.	100 sq. ft.	144 sq. ft.
75 psi	52 psi	20 psi-UL 30 psi-FM	40 psi
12 sprs	12 sprs	12 sprs	9 sprs (min. of 1200 sq. ft.)
1455+ gpm	1452+ gpm	1352+ gpm-UL 1656+ gpm-FM	Sys. demand 1435+ gpm
250 gpm HS	250 gpm HS	250 gpm HS	250 gpm HS

- Wet Pipe or Pre-action Systems (when they meet the equivalency of a wet system).
- Approved for Non-combustible Obstructed Construction.
- Refer to Reliable Bulletins 008 & 908 for more information.
- Refer to FM Global's Data Sheets 2-8N, 2-2 & 8-9 for installation and design of CMSA and extended coverage sprinklers.

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FIRE PROTECTION Engineering

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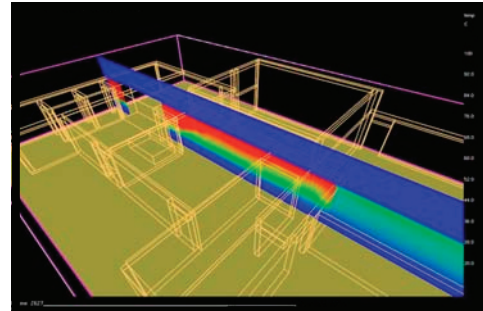
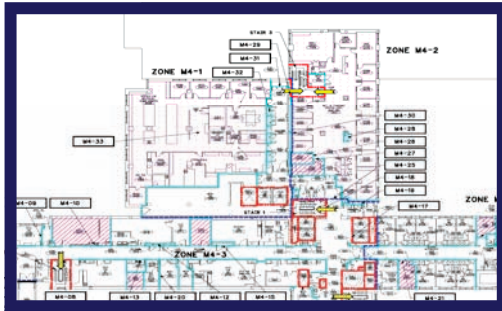
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