FIRE PROTECTION
Engineering
SPRING 2007
Issue No.34

Fire Protection Engineers and the Regulatory Process

Modeling Smoke Movement

Performance-based Design

Evacuation of Fire Models

THE OFFICIAL MAGAZINE OF THE SOCIETY OF FIRE PROTECTION ENGINEERS

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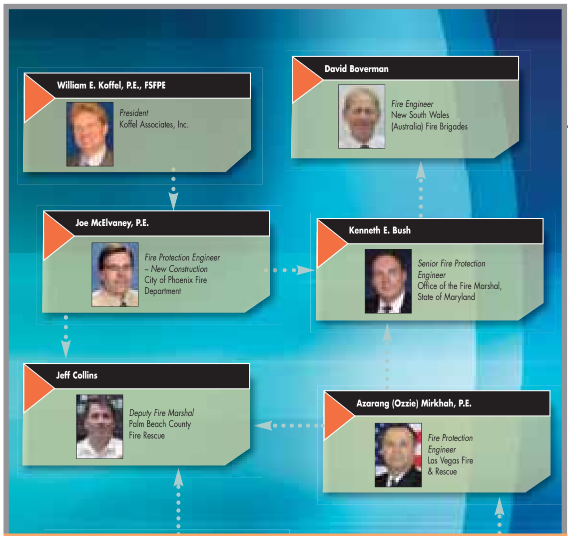
FIRE PROTECTION Engineering



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FIRE PROTECTION Engineering

Online versions of all articles can be accessed at **www.FPEmag.com**.

SFPE

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For information on article submission to *Fire Protection Engineering*, go to www.fpemag.com/articlesubmit.asp.

Subscription and address change correspondence should be sent to *Fire Protection Engineering*, Penton Media, Inc., 1300 East 9th Street, Cleveland, OH 44114 USA. Tel: 216.931.9180. Fax: 216.931.9969. e-Mail: bsprague@penton.com.

From the TECHNICAL DIRECTOR

Ensuring Confidence in Model Results

The last several decades have seen a dramatic increase in the use of computer fire models. Early computer fire models were primarily used as a research tool, while today the use of computer fire models is commonplace where engineered alternatives are designed in lieu of strict code compliance and in forensic fire reconstruction. Some clients of engineering services now request the use of specific fire models on their projects.

Early fire models were algebraic formulae that permitted the prediction of simple fire effects – such as flame heights, plume temperatures and mass entrainment rates. Subsequent fire models enabled prediction of non-steady-state fire effects in enclosures, such as smoke layer temperatures, smoke layer elevation or the response of heat detectors or sprinklers.

> As models have increased in sophistication, so, too, have the types of limitations of which users should be aware.

More recently, computational fluid dynamics (CFD) modeling has increased in popularity. The increase in use of CFD models was enabled by the rapid increase in desktop computer power and the availability of nonproprietary models. Unlike zone models, which represent a space as two uniform volumes, CFD models allow model users to discretize a space into a user-defined number of volumes. With this computational power comes the possibility to make more detailed predictions.

All computer models have limitations. For example, correlations of flame heights and smoke entrainment rates assumed an axis-symmetric, unobstructed fire plume. While the correlations could be used in other cases, for example, fires against a wall or in a corner, they require more than simple input of variables. As models have increased in sophistication, so have the types of limitations of which users should be aware. With the use of a computer fire model in an engineering application comes a responsibility on the part of the engineer to be able to demonstrate that the model is appropriate for the case at hand.

The *SFPE Code Official's Guide to Performance-Based Design Review* states that there are two ways that an engineer can demonstrate that a model is appropriate for a given application: the engineer can show that the model has been accepted by the relevant professional community, or the modeler can demonstrate that the model is appropriate.

The former case is the simplest. If the engineer can reference an independent evaluation of a model, then there may not be anything else that needs to be done to show that the model is appropriate. Unfortunately, few models have been independently evaluated. This is true in part because of the amount of effort that is needed to evaluate a model.

In other cases, it falls to the engineer to demonstrate that the model is appropriate. This may involve review of the model's documentation, comparison of model predictions with test data or other types of analysis. Demonstration that a model is appropriate is complicated by the fact that there are no uniform guidelines available that describe acceptable ways of doing this. Existing guidelines that describe how to evaluate computer models are not appropriate because they identify how to evaluate a model for broad cases of application, and the engineer only needs to show that the model is appropriate for a specific situation.

To make the job of demonstrating that a model is appropriate for a given application easier for the engineer, the Society of Fire Protection Engineers has undertaken development of guidelines on how this can be done. It is anticipated that these guidelines will be similar in format to SFPE's *Guidelines for Peer Review in the Fire Protection Design Process.* For more information, visit *www.sfpe.org/technical.aspx.*

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

Fire Protection Engineering welcomes letters to the editor. Please send correspondence to engineering@sfpe.org or by mail to *Fire Protection Engineering*, 7315 Wisconsin Ave., #620E, Bethesda, MD 20814.

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LETTERS to the EDITOR

DEAR EDITOR,

I read the editorial in the Winter 2007 issue of *Fire Protection Engineering* magazine, in which you discussed the problem of incomplete performance code design service in New Zealand due to inadequate client fees.

In the 1960s and 1970s, the American Institute of Architects tried to control the professional standard of architects' service by publishing minimum fee schedules and enforcing sanctions against any architects who worked for less. In the late 1970s, the U.S. Justice Dept. filed a lawsuit for practices that violated the Sherman Antitrust Act. A result was that the AIA signed a Consent Decree with the Justice Dept. that required the following: We stopped advocating or using any fee schedules. We were prohibited from discussing fees at any meetings or otherwise making deals that controlled prices. We threw out all our ethics for maybe 10 years on the fear that they might stifle competition. And every single component of the society had to listen to a teaching and reminders each year of why we couldn't do things like that. Each component's leader had to make an annual report to the national organization on the teaching and compliance. No one liked the sanctions, and it took a decade or more to end them.

That law, of course, may not apply to New Zealand. But another approach that I believe would work better for both our organizations would be for us to become a much stronger community, teaching the standards in every component; to lose our reluctance to talk about errors; and to voluntarily provide help to other professionals who seem to have trouble understanding or following the accepted procedures. Finally, when all else fails, we need to file organizational, if not legal, complaints against those of us who won't comply with the standards. You've made a good start by discussing the specific needs for improvement at the international level.

Yours truly,

Jeri L. S. Morey

DEAR EDITOR,

I read the editorial in the Fall 2006 issue of *Fire Protection Engineering* with interest. The last paragraphs of the editorial are very germane, especially as many fire protection engineers practicing in this country are members of the SFPE. Unfortunately, designers in this country are not insisting on "responsible fees" but instead undertaking work for insufficient fees. The net result of this approach is that the quality of the fire engineering undertaken in this country is substandard.

I am in a unique position to judge this as I manage the New Zealand Fire Service engineering unit. We have a legal mandate to review and provide advice to regulatory building authorities on "performance-based" fire engineering designs. As such, we review the fire engineering designs produced in this country and lodged for building consent. We have now been in operation for two years and have been distressed at the poor quality of the design work we have seen. This concern is shared by other organizations involved in the regulatory review process. Because of this concern, two independent auditors where appointed to review a random selection of the fire engineering designs received and the information the NZFS provided. These reports where concluded late last year (the link to these reports is *www.fire.org.nz/building/dru.htm*).

As noted above, many of the authors of these designs are SFPE members. We are attempting to engage with the local chapter to rectify this situation.

Regards,

Simon Davis

VIEWPOINT > Review of *Risk Analysis in Building Fire Safety Engineering* by Hasofer, Beck & Bennetts

By John R. Hall, Jr.

The field of fire risk assessment has been growing by leaps and bounds in the past few years. Every major international standards-developing organization has a new guide on the subject, as do many nations.

Fire risk assessment has taken three principal forms. The oldest is the risk index method, primarily associated with the insurance industry. These can be thought of as checklists on steroids: not strong on explicit empirical parameters or fundamental physics, but arguably quite useful and successful over their century-plus existence. Next oldest is the classic risk analysis model (e.g., a fault tree or event tree) converted to fire safety, a mostly or wholly probabilistic approach. And the newest is probability-weighted hazard analysis, in which the probabilities are reserved for ignition and reliability, while physics models are used for everything else.

The first of the globally publicized probability-weighted hazard analysis models came from a collaboration between Canada and Australia. The latter effort, centered at Victoria University of Technology under the direction of co-author Beck, led to CESARE Risk.

Oddly, given this history, the book does not focus on probability-weighted hazard analyses but favors stochastic modeling for most modeling components as its approach to fire risk analysis (not fire risk assessment because there is also no discussion of evaluation). Buyer beware: This is an original and useful book, but readers will be disappointed if they are looking for something different than what the authors have chosen to address.

Chapter 2 is a conceptual overview of fire and building safety from fire. Chapter 3 covers the basics of probability theory. The latter is a bit more detailed than the corresponding chapter in the *SFPE Handbook* but stops well short of a full course. The reader will probably find it more useful as a refresher than as a tutorial.

Chapter 4 is a short chapter on the Beta reliability index, which can be associated with Häkan Frantzich of Lund University. This is the first published treatment of this increasingly popular index in a book for the general reader. Chapter 5 covers the basics of Monte Carlo simulation. It would have been preferable if the authors included a warning that Monte Carlo is not a substitute for empirical information on probabilities but rather a practical method for working with probabilities with limited information or common assumptions.

Chapter 6 introduces event and fault trees. The oddly titled Chapter 7 on performance-based optimal design is in a location where one would expect a transitional chapter and overview of fire risk analysis, but the chapter does not provide a general conceptual model, settling for a few paragraphs on criteria, uncertainty and some other topics not covered elsewhere. The book would have benefited from a stronger transitional chapter and some integrative concepts for the chapters to follow.

> This is a useful book that will fill an important gap on the engineer's bookshelf, but it is not a definitive tome for the ages.

Chapter 8 begins a string of chapters on the modeling of particular phenomena, in this case fire initiation. With Chapter 9 (on "personal factors"), these play to the strengths of national fire incident databases and discuss them at some length. Chapter 10 is on barrier resistance. It was a little surprising that this chapter did not reference the work of Teresa Ling and Brady Williamson. Chapter 11 is about fire growth and the CESARE Risk one-zone model. Chapter 12 is on smoke spread and combines deterministic and stochastic simulation. Chapter 13 is on human behavior as handled by a submodel of CESARE Risk. Chapter 14 is on performance assessment of (active) fire safety systems, using empirically based probability measures. Chapter 15 is on fire brigade response, which has historically been the most undertreated component of these models; the authors' full chapter is most welcome.

Chapters 16-17 complete the book with two case studies. Like most well-done, well-chosen case studies, these are very helpful, though there will be a temptation to use them as a shortcut guide on how to use the general methods in all situations.

Putting it all together, this is a useful book that will fill an important gap on the engineer's bookshelf, but it is not a definitive tome for the ages. This book is recommended for those involved in fire risk assessment and those who would like to consider using these methods in such assessments, but there is a more comprehensive and ambitious book still to be written on this subject.

John Hall is with the National Fire Protection Association.

Artworks courtesy of B.D. Mallon Gallery, Geneva, IL.

ICC and SFPE Collaborate on Key Initiatives

The International Code Council (ICC) and the Society of Fire Protection Engineers (SFPE) are working together on key strategic initiatives to expand services offered to the membership of both organizations. The partnership will facilitate fire protection design education and application, and improve public safety nationwide. Under this new agreement, SFPE will offer ICC members a discounted rate on its six new online training seminars.

"Fire protection is a crucial part of building safety and code compliance," says ICC CEO Rick Weiland. "Performance-based fire protection designs are being used more and more. The Code Council's relationship with SFPE allows us to further the science of fire protection engineering and provide code officials with the technical assistance needed to review and evaluate these designs."

Other areas of cooperation include the joint development and distribution of new publications and training, the exchange of technical articles and cross-promotion.

"The new SFPE and ICC initiatives will enhance the already strong working relationship between our members," says SFPE Executive Director David Evans. "Knowledge gained will facilitate the use of science and technology to protect people and property from fire around the world."

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

NFPA World Safety Conference & Expo Set for June

The 2007 World Safety Conference & Exposition (WSC&E) of the National Fire Protection Association (NFPA) will be held June 3-7, 2007 in Boston. More than 5,000 attendees are expected. The keynote speaker will be Pulitzer Prize-winning author David McCullough, whose best-selling books include *Truman* and *1776*.

Opening remarks will be made by Warren McDaniels, NFPA chairman, and James M. Shannon, NFPA president. Awards will be given to industry leaders in recognition of achievements in fire safety education, research, development of codes and distinguished service.

The event will feature over 150 education sessions and a series of one- and two-day preconference seminars. Continuing Education Units are available for most sessions. The exposition will feature more than 250 companies displaying sprinkler systems and services, fire detection and extinguishing equipment, alarm and control panels, and more.

Among the features of the event will be a presentation on the 2003 Rhode Island Station Nightclub fire and the resulting code change, research and legislation issues; a presentation on the Cocoanut Grove nightclub fire that claimed 492 lives in 1942 in Boston; discussions on the World Trade Center investigations; NFPA's new Emergency Evacuation Planning Guide for People with Disabilities; and more.

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

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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.

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New Online Degree to Launch in Fall

Beginning this fall, Eastern Kentucky University will offer its Bachelor of Science in Fire & Safety Engineering Technology completely online. Online classes toward the degree will begin August 20, 2007.

In addition to the bachelor's degree, Eastern Kentucky will offer an online Fire & Safety Engineering Technology Certificate option for fire safety professionals who do not wish to enter the full degree program. The Fire & Safety Engineering Technology Certificate is comprised of core courses focusing on fire protection administration offered by Eastern Kentucky and will also be available this fall.

"Eastern Kentucky's expert faculty, internationally known for their teaching, research and dedication to the fire and safety fields, will now be available to students worldwide," says Dr. Larry Collins, chair, Department of Loss Prevention & Safety.

The online degree, designed to accommodate different learning styles and schedules of working professionals in the fire and safety industry, can be completed in as little as 24 months.

For more information, go to www.firescience.eku.edu.

Fire Protection Engineers in the Regulatory Process – A Roundtable Discussion

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

Roundtable Participants

William E. Koffel, P.E., FSFPE

President
Koffel Associates, Inc.

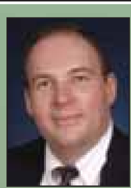
David Boverman

Fire Engineer
New South Wales
(Australia) Fire Brigades

Joe McElvaney, P.E.

Fire Protection Engineer – New Construction
City of Phoenix Fire
Department

Kenneth E. Bush



Senior Fire Protection Engineer
Office of the Fire Marshal,
State of Maryland

Jeff Collins

Deputy Fire Marshal
Palm Beach County
Fire Rescue

Eric J Ellis, P.E.

Fire Protection Engineer
Maine State Fire
Marshal's Office

Azarang (Ozzie) Mirkhah, P.E.

Fire Protection Engineer
Las Vegas Fire & Rescue

Yan Ru

Senior Engineer
Shaanxi Provincial
Fire Protection
Bureau (China)

The Society of Fire Protection Engineers has established a goal of increasing the use of fire protection engineers by regulatory agencies. The purpose of this roundtable discussion is to gain a better understanding and appreciation of the responsibilities of fire protection engineers who are employed by regulatory agencies. The participants in the discussion (see sidebar) are employed by fire marshal agencies at various levels of government and include participants from around the world. The following is an excerpt of the responses received. The complete version can be found at *www.FPEMag.com*.

1. I am aware that some fire protection engineers report to a building official and some to a fire official. To whom in the jurisdiction do you report?

Yan Ru: In China, regulatory fire protection work is separated into several levels: state, province, municipal and county (district). I serve in the provincial-level fire department, and I report to the supervisor in the jurisdiction.

Ozzie: I report directly to the deputy fire chief/fire marshal for the City of Las Vegas.

Eric: The Maine State fire marshal and his assistants.

David: I report to the manager of the Fire Safety Division – this would be comparable to the fire marshal in U.S. terms.

Jeff: I report to the Palm Beach County fire marshal.

Ken: I report directly to the chief fire protection engineer.

Joe: I report to the City of Phoenix fire marshal.

2. Fire protection engineers in regulatory agencies can provide a wide range of services. What specific tasks do you perform?

Ozzie: I manage four assistant fire protection engineers. We review various types of plans and submittals that include planning and zoning maps, civil drawings, building plans and fire protection reports and design submittals for all types of fire protection and detection systems and smoke management systems. We also participate extensively in project management and coordination, from the conceptual stages all the way to the completion of major projects. Considering the complexity of fire and life safety systems in major projects, we also are involved in the inspection, testing and commissioning of the life safety and smoke control systems.

> I am often contacted at the conceptual stage to find out what codes and standards apply, how they interrelate and how they apply to real-life scenarios.
> — *Eric*

Eric: My primary responsibility is to regulate the fire sprinkler industry for the state. This begins with reviewing license applications, writing and administering licensing tests, issuing licenses and seeing that license standards are upheld during license terms and for renewals. In addition, I review fire sprinkler system plan submittals and perform field inspections to verify that installations are according to the permitted design. These inspections include observing the installation and testing of systems, water storage tanks, fire pumps, alarms, building construction and other components related to fire protection.

David: I assist fire safety officers in their assessments of performance-based alternative designs for compliance with the building code and related standards. This includes consulting with brigade officers, reviewing fire engineering design reports, reviewing plans, performing and reviewing engineering calculations and modeling, consulting with project stakeholders and building officials (private and public), conducting building inspections, reviewing and commenting on risk analysis reports and reviewing and commenting on systems. Additionally, I assist with fire investigations where fire engineering and/or modeling/calculations are requested, and assist the organization with risk assessment, risk management and building code development.

Ken: My position is involved in all aspects of code enforcement activities, including participating on various code-writing committees; reviewing and preparing recommendations for amendments to nationally written documents for incorporation into state and local codes and regulations; reviewing plans, specifications and other documentation for construction and alterations of new and existing buildings; conducting field surveys of new and existing building projects, including associated fire protection systems, for compliance with applicable laws and regulations and accepted engineering and industry practices; and assisting in the investigation of fires involving loss of life, large property loss or special building construction or fire protection system designs and operations.

Yan Ru: I am involved in the acceptance of fire protection items for medium and large-sized building projects, and I conduct audits to verify the quality of installations.

3. When do you typically get involved in the design of a large, new project (concept, final design, etc.)?

Ken: We are often involved in all aspects of any construction project. This

includes pre-construction meetings with potential project designers, zoning and planning officials, local code enforcement officials and building design teams through the inspection of buildings for occupancy permits. Additionally, we remain involved in the continued resurvey of buildings to ensure compliance with all applicable laws and regulations, and accepted fire safety practices.

Eric: I am often contacted at the conceptual stage to find out what codes and standards apply, how they interrelate and how they apply to real-life scenarios.

Ozzie: We are involved from the planning and zoning stages of the project, even prior to the development of the conceptual building designs, all the way to the very end where the certificate of occupancy is issued. At times, our involvement goes even further on major complex projects, where we are involved in the annual acceptance testing and approval of the fire and life safety systems.

Jeff: We, too, are involved with all new construction projects, both large and small, during the planning stage. We have input and are required to sign off prior to the developmental review process.

David: Our experience is different, in that we most commonly get involved at the building approval stage, which would be at about the 80 percent design stage. On some projects, the involvement might be at the preliminary stages.

4. What is the most challenging aspect of your position?

David: Working in an environment where the building code is performance-based; where the building official is commonly employed by the project proponent; where performance-based alternatives to prescriptive compliance for major issues can be justified without complete and robust fire engineering; where lines of accountability and responsibility are vague; and where compliance is fundamentally based on self-certification.

Ozzie: Dealing with the politics involved with smaller projects. Because in our process the major complex projects are well-coordinated, things proceed quite smoothly and there are no surprises at the eleventh hour. But little tenant improvements for existing old churches, schools or restaurants that were not required to have fire sprinklers at the time they were constructed, and now are required to have such protection, at times will generate considerable political concerns. Handling these types of situations in a tactful way, and yet not compromising on the fire and life safety requirements of our codes, is at times rather challenging.

Eric: No doubt the most challenging thing is to find the time to meet the growing workload. Electronic technology has been a tremendous help to maximize efficiency of time. My office has been very supportive with providing the latest and best in electronic tools, including a laptop with software for accessing my desktop computer when I am out of town. In the pressure of the daily workload, it is also imperative for the fire protection engineer to manage his or her time to keep up with code and technology changes and any training that they may involve.

Jeff: The most challenging aspect is trying to apply the existing sections of the fire code to buildings that do not always fit, in other words, working in the "gray" areas of the code.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Ken: Probably the most challenging aspect is the coordination and application of codes and standards to a particular project or design. With a variety of codes and code editions adopted by a number of different governmental jurisdictions, the specific application to a particular project can be quite a challenge. There are often a number of different officials involved in projects which are governed by this office, which leads to a variety of differing applications and interpretations of requirements. This can introduce a real coordination challenge for any project.

Yan Ru: The science and technology are changing with each passing day. Conventional technological protection methods cannot meet the requirements for many applications, which leads to increased use of performance-based design.

I think there are two rewarding aspects – one is on a material level and the other is on a spiritual level. The material aspects includes promotions and salary increases, and the spiritual aspect comes from the sense of satisfaction after triumphing over the difficulty of the work and reaching completion.
—Yan Ru

5. What is the most rewarding aspect of your position?

Joe: Watching a project go from concept to completion and knowing that I play a role in making someone's dream come true.

Ozzie: Our department's slogan is "striving for a safer community." Knowing the important role that the fire protection engineering section plays in providing the highest levels of fire protection and life safety, not only to our citizens and the 40 million annual visitors, but also to our own firefighters is the most rewarding aspect of my position.

David: Working on very real issues that have an effect on firefighter and public safety, working in an environment where fire protection engineering and performance-based design and compliance are fully embraced, and having the opportunity to shape a maturing fire protection engineering industry here in Australia are all rewarding aspects of my job.

Ken: The most rewarding aspect of this position has to be the completion of a construction project and the successful occupancy and operation of a building which has been designed, evaluated and constructed with life safety and property protection in mind. It is also gratifying when a number of code officials and building designers and operators can mutually agree on a cost-effective approach which satisfies the needs and desires of all involved parties.

Yan Ru: I think there are two rewarding aspects – one is on a material level and the other is on a spiritual level. The material aspects includes promotions and salary increases, and the spiritual aspect comes from the sense of satisfaction after triumphing over the difficulty of the work and reaching completion.

6. At what stage of the project do fire protection engineers on the design team typically get involved?

Ozzie: We require that, for high-rise buildings, the design team have a professional fire protection engineer on board from the earliest phase of conception of a project in the planning stages, all the way through the very last minute when the final certificate of occupancy is granted.

Eric: There is a need for fire protection engineers to get involved in the early stages of design. This is because fire protection features have an impact on the construction type to be used, the building layout and the underground water supply. For these reasons, the fire protection engineer is often part of the architectural design team. Alternatively, an independent fire protection engineer may be subcontracted early in the process to both verify and provide critical design information.

David: Fire protection engineers com-

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monly get involved at the building approval stage, which would be at about the 80 percent design stage, although on some projects the involvement might be at the preliminary stages (i.e., the pre-planning approval application stage). It is quite common for fire protection engineers to become engaged only when a building code review of the final design shows areas of noncompliance.

Yan Ru: Together with other areas of building design, the fire protection design of a building project is completed by a building design institute. The fire protection design is completed by a designer from a discipline other than fire protection engineering.

7. When fire protection engineers are part of the design team, what differences do you see in the quality of the submittals?

Ozzie: The design quality is much higher, and projects run much smoother and tend to be completed on time when fire protection engineers are part of the design team. The owners are the ones who really reap the benefit from the fire protection engineer's involvement in the project. While they might have doubt at first as to what value fire protection engineers provide, at the end they are sold on the benefits of having a fire protection engineer on the design team.

Eric: The submittals by fire protection engineers are typically very detailed, professional, and reflect a working knowledge of their designs. Those by others are sometimes very good and sometimes they are not.

Joe: Having fire protection engineers on the design team ensures a true understanding of what needs to be done to complete the project and comply with all the codes.

David: While it depends on the individual practitioners in question, generally speaking, the quality of submittals is much better when fire protection engineers are part of the design team.

Ken: A fire protection engineer is specifically trained and experienced in the application of fire protection principles and can relate better to fire protection terminology, the intent of specific code requirements and adaptation of recognized prac-

tices in order to maintain an adequate level of safety. Where other design professionals are associated with fire protection activities, they are more likely to specify only what is noted in the exact code language and have less feel for adaptation or application of alternative features, which may provide a cost-effective measure to similar, if not superior, life safety measures.

8. If you could make one comment to a prospective fire protection engineer, what would you say to encourage them to do what you do?

Eric: I would say to come spend some time with me while I work so that he/she can see just what it is that I do, with the richness and the variety of challenges as well as the balance of both office and field work.

David: If you want to have the opportunity to use your education, training and experience in a rapidly changing and evolving profession that embraces fire protection engineering and performance-based building code compliance, then this would be the place to do it.

Jeff: At the end of the day, my duty is to serve the public, and I never have had to compromise my ethics or values to serve the needs of my clients. I work under the fascinating umbrella of public trust and love serving the community.

Ken: I believe that being involved in the code development process has proved to be invaluable in the overall application and understanding of the enforcement process and the procedures for modifications to address specific issues and conditions.

Yan Ru: The work is full of challenges and offers a bright future.

At the end of the day, my duty is to serve the public, and I never have had to compromise my ethics or values to serve the needs of my clients.
—Jeff

9. Do you make use of fire protection engineers to provide third-party services? If so, what tasks do they perform?

Ozzie: During the construction phase of the projects, fire protection engineers provide third-party services in commissioning of smoke control systems prior to our final inspection, testing and approval. Fire protection engineers are also involved in the annual inspection and maintenance of smoke control systems.

Eric: We require the seal of a licensed fire protection engineer on fire protection plans on projects that involve fire protection systems that cost over a million dollars.

Joe: Yes, we have used fire protection engineers to provide third-party services. Most of the time, these services were for reviewing the work of other fire protection engineers or when the design team and the city disagree and a third party is needed to review the submittal.

David: We have requested third-party services for major projects where we serve as the approval authority (e.g., large infrastructure projects such as road tunnels). Fire protection engineers are used to review all documentation, installation and commissioning so that they can review, comment on and hopefully concur that compliance with adopted requirements has been achieved.

I believe that we should involve fire engineers for third-party review more frequently for major projects.

10. Have you seen an increase in performance-based designs?

Ozzie: In my mind, Las Vegas is the birthplace of performance-based design. We have had various levels of performance-based design for more than a decade, so for me, it is hard to tell if there is any increase.

David: We have seen an increase since building officials (private and public alike) are forwarding more projects to us for review and comment. We do not typically get involved in projects that are strictly prescriptive.

Jeff: We have significantly made use of the alternate methods and materials, and equivalency language in the fire code since my employment here at Palm Beach County. I have yet to see a full-blown performance-based design on an entire project. We typically encounter alternatives when the specific requirements of a particular section of the fire code or life safety code cannot be met or is impractical to meet.

Yan Ru: Yes. In recent years, the economy of China has developed very rapidly. The number of new buildings being planned has increased. The original prescription-type standard has been unable to satisfy the fire protection design requirement for all buildings. Therefore, performance-based design is frequently required.

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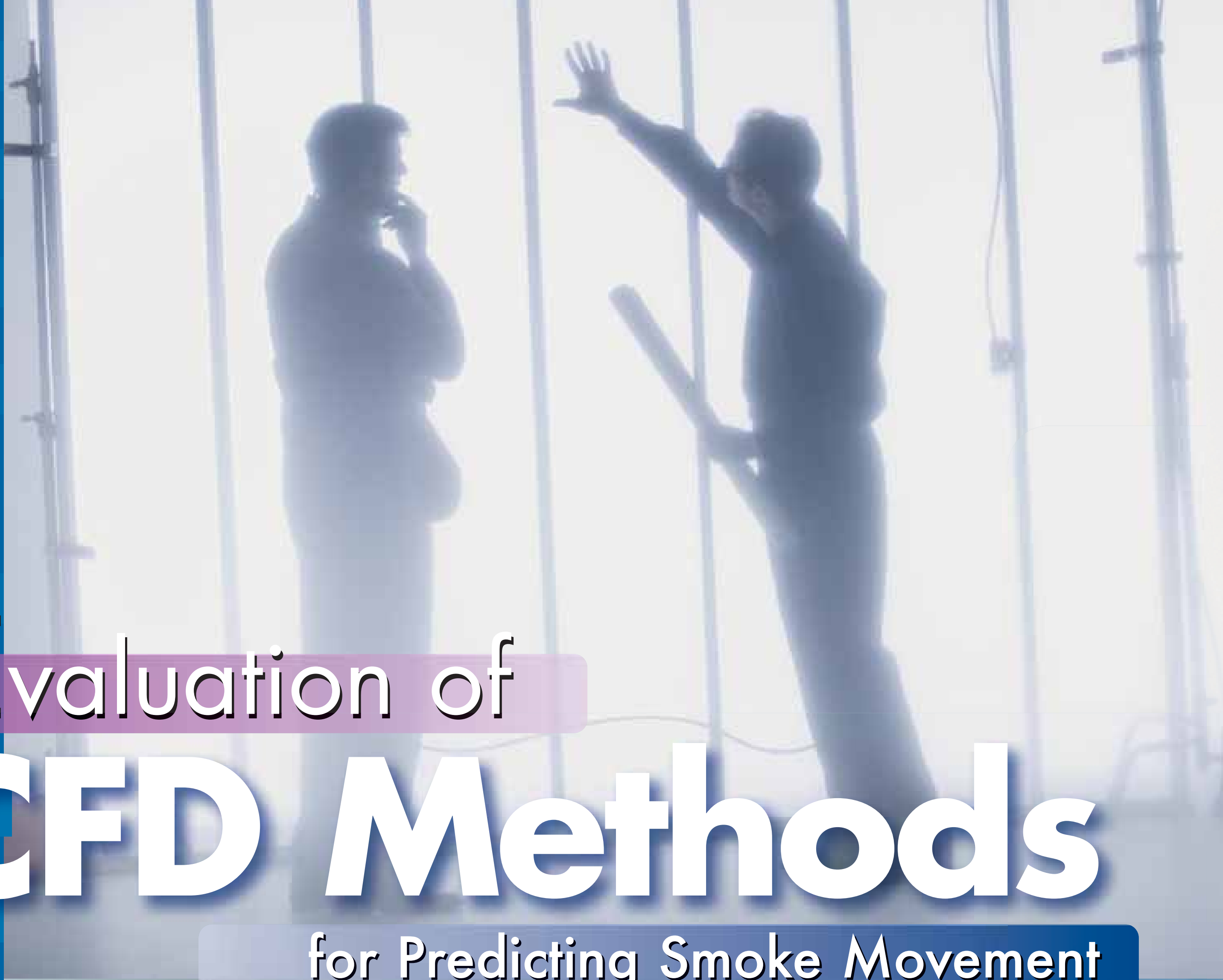
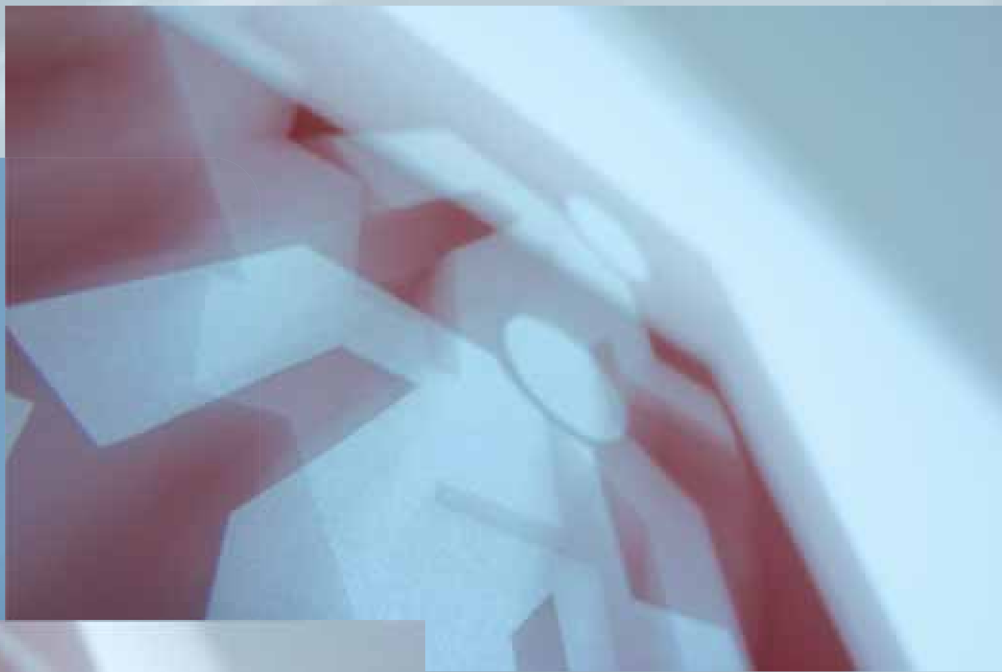


Evaluation of CFD Methods for Predicting Smoke Movement in Enclosed Spaces

By Nathalie Gobeau

A new study from the Health and Safety Laboratory (HSL), Buxton, Derbyshire, United Kingdom, provides guidelines, recommendations and best practices for the practical application of Computational Fluid Dynamics (CFD) to the modeling of smoke movement in enclosed spaces.[1] HSL modeled three fire safety engineering cases: a subway station, an accommodation module on an offshore platform and a high-rise building under construction.[2] Aspects of the modeling process, including the computational grid, the discretization scheme and the turbulence model, were varied for each scenario and resulting predictions of smoke transport were compared.




[All of the different approaches provided realistic results, indicating they can be used as the basis for an engineered approach to fire safety.]

Since it was impractical to gather experimental data for these scenarios and compare the predictions with the real behavior of smoke, laboratory-scale experiments were designed. Although the geometries of the four configurations investigated were relatively simple, they still retained some of the complex features found in the real scenarios, for example, inclined corridors, a corridor leading to a hall and a corridor leading to an atrium. Measurements of temperatures and visualization of smoke by a laser technique were undertaken. Each small-scale configuration was reproduced by CFD, and the predicted smoke behavior was compared with the experimental data, allowing the level of agreement to be quantified. As for the real scenarios, several CFD modeling approaches were employed and compared.

All of the different approaches provided realistic results, indicating they can be used as the basis for an engineered approach to fire safety. However, a comparison of quantitative data, such as the temperature of the hot layer, showed that key output results can vary greatly depending on the modeling approach used. Recommendations developed as part of this study[1] provide guidelines that will help both CFD practitioners and regulators identify the most appropriate CFD modeling approach for the scenario under investigation and for the purpose of the simulation – whether it is, for example, to evaluate the time available for evacuation before smoke becomes too dense or to check the effectiveness of a ventilation design in clearing the smoke from exit routes.

Use of CFD as a Fire Safety Engineering Tool

CFD is a powerful technique that provides an approximate solution to the coupled governing fluid flow equations for mass, momentum and energy transport. The flexibility of the technique makes it possible to solve these equations in very complex spaces, unlike simpler modeling methods that are sometimes used to predict smoke movement. CFD is now being increasingly used in fire protection engineering to predict the movement of smoke in complex enclosed spaces such as atria, shopping malls and warehouses. It is likely that regulatory agencies will increasingly be faced with assessing fire safety cases that are either entirely or partly based on the results of CFD simulations.

The main aim of the project is to quantify the advantages and limitations of CFD for predicting smoke movement in complex enclosed spaces. The project began with modeling of real scenarios. Investigators next checked the sensitivity of CFD results to a range of modeling approaches widely employed by the fire protection engineering community. This is because when setting up a model, CFD practitioners have to make numerous numerical and physical approximations. For example, the physical processes of the fire itself can

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be described by a variety of different submodels of varying complexity.

Small-scale experiments were performed in order to focus on areas identified by the initial simulations as potentially challenging for CFD. Then the small-scale experiments were modeled with CFD and the results were compared against the experimental results. The ANSYS® CFX® code was used for all cases. ANSYS CFX is a commercial CFD package with a wide range of physical and numerical submodels suited for fire safety engineering, and CFX has been widely used for smoke movement applications.

Modeling the Three Scenarios

A four-level underground station on the Jubilee Line Extension of the London Underground was used as one representative fire scenario. It was assumed that the main source of the fire was a suitcase containing clothes. In the underground station, none of the fittings or equipment are highly flammable. It was therefore assumed that the main fire source in the public areas could be the suitcase. The fire was assumed to occur in the ticket hall, in front of the shops on the unpaid side of the ticket barrier. This location was suggested by fire services. An unstructured mesh was created, and the mesh was refined at strategic locations.

An offshore accommodation with four main floors was modeled as the second case. The fire was assumed to start in the first-floor laundry, and smoke was transported into the corridors and upper levels via the stairwells. In this work, linen was assumed to burn in the laundry on the first floor. The main interest is in the transport of smoke out of the laundry into corridors and upper levels via the stairwells. The reduced complexity of the interior space compared to the underground station made it possible to use a structured grid.

An18-story office building under construction in London was selected as the third example. Buildings under construction where fire safety equipment often is not operational are particular fire risks. The fire was assumed to start on the first floor when an armchair caught on fire. The main interest here was the transport of smoke to remote upper stories of the building via the stairwell and atrium. This was also a relatively simple geometry, so a structured mesh was also used in this application.

In the underground station, a fire with a peak heat output of 0.2 MW was used. For both the offshore accommodation module and the building under construction, a 1 MW fire was used. The offshore accommodation module and the building under construction were considered to be completely sealed, so no inlet or outlet boundary conditions were defined and quiescent

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conditions were imposed at the start. Large fans were provided in the underground station to generate a ventilation flow in the event of a fire to clear smoke from the ticket hall and exhaust it via the passenger exits. To model this situation, imposed flow boundary conditions were applied on the surfaces that correspond to the exits. A small background ventilation flux was used as the initial condition.

The ANSYS CFX results for the underground station show that in the five-minute period before forced ventilation is initiated, smoke is transported throughout most of the ticket hall and appears to extend to the main exit routes. Other emergency routes existed that enabled passengers and staff to escape without going through the ticket hall. Following the startup of forced ventilation, smoke is cleared from the large parts of the paid side of the ticket hall, the part past the ticket barrier, by being convected towards the exits and into the dome. Analysis of the results in the offshore accommodation module showed that at approximately 60 seconds after ignition, smoke makes its way into the adjoining corridor and 120 seconds later it has risen halfway up the nearest staircase. In the building under construction, smoke spreads as a ceiling layer within the third floor open-plan office. Shortly after one minute, smoke has entered the atrium and 120 seconds later it has risen five stories. At four minutes after ignition, it has reached the highest floor and is also rising in the stairwell.

Design of Small-Scale Experiments and Evaluation of CFD

A series of small-scale experiments was undertaken to provide data for the evaluation of CFD modeling of smoke movement. A number of CFD modeling approaches were evaluated against this data. Experiments were performed at approximately one-tenth scale in four different test configurations. The movement of a hot layer was studied in a horizontal and an inclined tunnel. The evolution of the temperature field was studied in two larger spaces connected to the tunnel, a domain with a large floor area and a domain with a large ceiling height, representing a booking hall and atrium, respectively. A well-characterized heat source was used. Laser light


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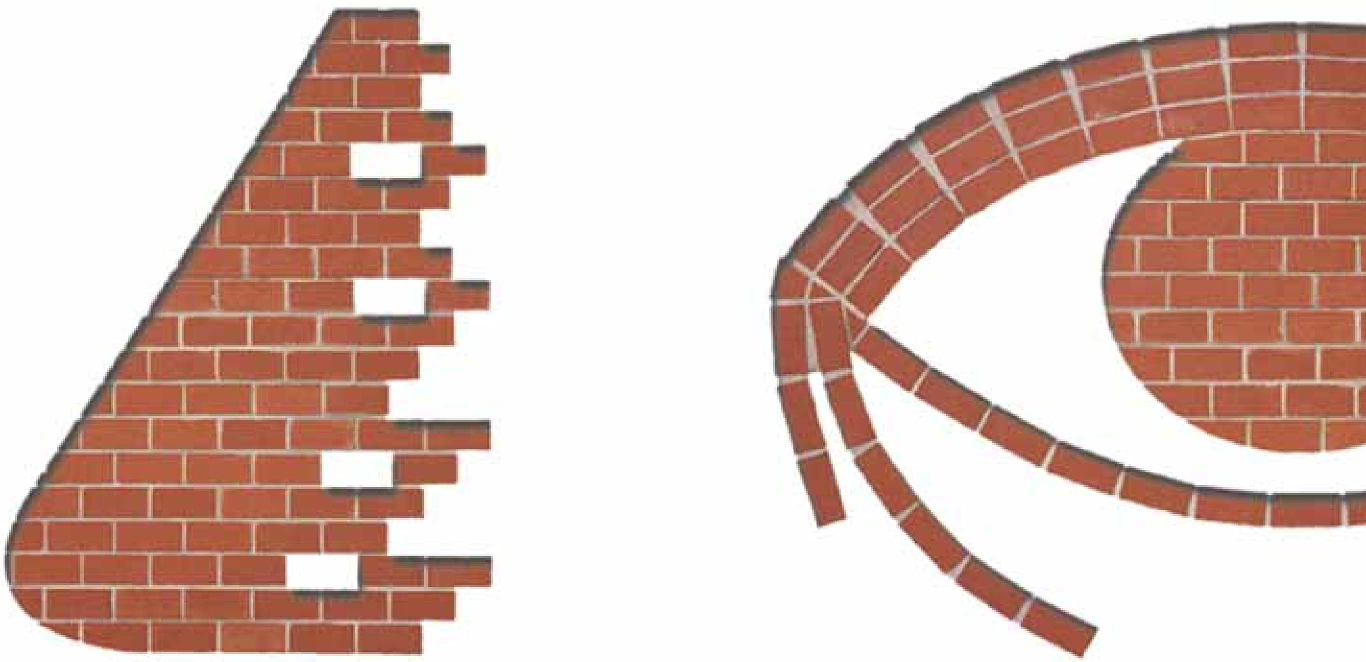

These days, it's not enough to install an alarm system that can sniff out a fire. Progressive office relocation experts know that to fully protect the lives of their employees and the very life of their business, they need a multi-sensory system so perceptive, it's almost human.

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sheet flow visualization and time-dependent temperature measurements were performed.

Overall, the CFD simulations captured many of the observed gross flow conditions.[2] In some cases, details of the temperature field were also well-predicted. However, the simulations were very sensitive to the wall heat transfer boundary condition. For example, the CFD simulations of hot gas flow in the horizontal and inclined tunnel configurations tended to overpredict the measured temperature. This overprediction is particularly pronounced with an adiabatic wall boundary condition. The CFD-predicted flow behavior for the booking hall configuration generally matched the experiments, but the temperatures were too high as the smoke entered the booking hall. In the atrium configuration, the simulated hot layer rose immediately when it entered the atrium while the experimental plume propagated across the atrium and rose along the far wall.

Sensitivity of the Results to Key CFD Parameters

The sensitivity of the results to the following CFD parameters was investigated: grid resolution, convection discretization scheme, compressibility of the flow, inclusion of buoyancy effects in the k-epsilon turbulence model, volumetric heat source and eddy breakup combustion models, and boundary conditions of heat transfer at the walls. There was not enough time to make all of these sensitivity tests for all three scenarios, but some general lessons learned were readily apparent. Surprisingly, different grid resolutions did not lead to significant differences in smoke movement. This was because both size grids employed in these problems were fine enough to capture adequately the key flow phenomena. The use of a high-order convection discretization scheme resulted in the prediction of more flow detail and a more rapid rate of smoke spread.

A Boussinesq approximation, used to account for the thermal effects of flow compressibility, underpredicted the temperatures and the rate of smoke propagation when compared to calculating the air density from an equation of state. A standard k-epsilon turbulence model also failed to predict the correct behavior of the flow. When an additional buoyancy-related production term was added (so buoyancy terms existed in both turbulence equations), the model successfully reproduced the features of the flow. A volumetric heat source model and an eddy breakup combustion model both provided acceptable and similar results for smoke propagation.

However, a realistic prescription of the fire source was found to be crucial for both models. Since a volumetric heat source model requires more assumptions than an eddy breakup model, the latter is likely to provide more realistic results where the fire shape is not well-defined initially or may vary with time. The boundary conditions for heat transfer at the walls were found to have an impact on the transport of smoke, but this was highly dependent upon the scenario. They were more important for a confined fire and in the absence of forced ventilation.

Nathalie Gobeau is with the Health and Safety Laboratory.

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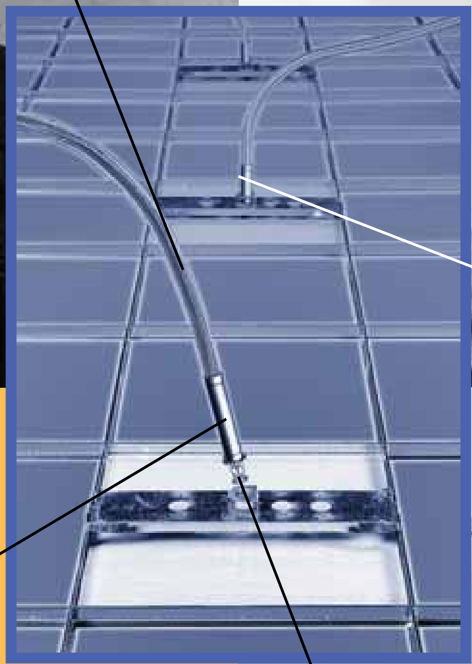
VERIFICATION and VALIDATION – How to Determine the Accuracy of Fire Models

By Mark Henry Salley, P.E.; Jason Dreisbach; Kendra Hill; Robert Kassawara, Ph.D.; Bijan Najafi; Francisco Joglar, Ph.D., P.E.; Anthony Hamins, Ph.D.; Kevin McGrattan, Ph.D.; Richard Peacock; and Bernard Gautier

Fire Modeling in Nuclear Power Plant Regulation

Worldwide, risk-informed and performance-based analyses are being introduced into fire protection engineering practice, and the commercial nuclear power industry is no exception. In the last 15 years, the U.S. Nuclear Regulatory Commission (NRC) directed a change in its policy to use risk-informed methods, where practical, to make regulatory decisions. As a result of this change, in the area of fire protection, the National Fire Protection Association (NFPA) completed development of the 2001 edition of *NFPA 805*, "Performance-Based Standard for Fire Protection for Light-Water Reactor Electric Generating Plants."[1] The NRC amended its fire protection requirements in July 2004 to allow existing reactor licensees to voluntarily adopt the fire protection requirements contained in *NFPA 805* as an alternative to the existing prescriptive fire protection requirements.[2] This allows plant operators and the NRC to use fire modeling and fire risk information, along with prescriptive requirements, to ensure that nuclear power plants can be safely shut down in the event of a fire.



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This article provides a brief description of the work performed to assess the relative accuracy of fire models for nuclear power plant applications. Ever since the 1975 Browns Ferry fire, there has been a great deal of interest in predicting the effects of fires in nuclear plants. The NRC and plant operators use fire models in probabilistic risk assessment calculations to identify fire scenarios with safety risks. They also use these tools to determine compliance with, or exemptions from, existing fire protection regulatory requirements. To provide the regulator and the plant operators with confidence in the calculation results, *NFPA 805* requires fire models to be verified and validated. To this end, the NRC's Office of Nuclear Regulatory Research, along with the Electric Power Research Institute (EPRI) and the National Institute of Standards and Technology (NIST), has conducted an extensive verification and validation (V&V) study of fire models that support the use of *NFPA 805* as a risk-informed/performance-based alternative within the NRC's regulatory system.

The V&V Process

Given the complexity and range of features in current fire models, it is impractical to evaluate the accuracy of every model output. Thus, the NRC and EPRI identified critical fire protection concerns for nuclear power plants, such as the integrity of electrical cables and fire barriers, the effectiveness of smoke removal systems and the movement of smoke and hot gases from compartment to compartment. In all, 13 predicted quantities were chosen, including the depth and average temperature of the hot upper layer, ceiling jet and plume temperatures, the radiant and total heat flux onto walls and "targets," and the major gas species and smoke concentrations.

The study does not cover the entire spectrum of possible fire scenarios, either in nuclear plants or in other types of structures. To clarify its range of applicability, the study examined a variety of nondimensional and normalized parameters that bound the spectrum of scenarios it does cover and recommends that users of the report be aware that scenarios falling outside of these bounds have not been rigorously validated. The final report[3] includes a discussion of the limits of applicability of the results of the study.

Also, the validation study used the heat release rate of the experimental fires as an input, rather than a predicted output. The study provides an assessment of the accuracy of current fire models in predicting the trans-

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port of a fire's heat and combustion products throughout a compartment. While some of the models evaluated do have the physical mechanisms to predict fire growth and spread (for example, Fire Dynamics Simulator[4]), this study did not include an assessment of those functions. From the standpoint of nuclear power plant safety, it is important to assess how accurately the models predict the transport of energy from a specified fire, because that is how these models are currently used in the nuclear industry. A major finding of this study is that the current generation of fire models predict transport fairly well.

This V&V study began in earnest in 2003, resulting in the seven-volume report, "Verification and Validation of Selected Fire Models for Nuclear Power Plant Applications,"[3] (NUREG-1824). The report is available to the public on the NRC's Web site (*www.nrc.gov/reading-rm/doc-collections/nuregs/staff/*). Five of the seven volumes contain individual evaluations of five fire models: (1) the NRC Fire Dynamics Tools (FDTS),[5] (2) the EPRI Fire-Induced Vulnerability Evaluation (FIVE),[6] (3) the NIST zone model Consolidated Fire And Smoke Transport (CFAST),[7] (4) the Electricité de France zone model MAGIC[8] and (5) the NIST computational fluid dynamics (CFD) model Fire Dynamics Simulator.[4]

Experimental Uncertainty as a Metric for Evaluating Fire Models

NUREG-1824 is based upon ASTM E1355, "Standard Guide for Evaluating the Predictive Capability of Deterministic Fire Models."[9] The guide describes four steps in the evaluation process for a given model: (1) definition of the model and scenarios, (2) assessment of the appropriateness of the model's theoretical basis and assumptions, (3) assessment of the mathematical and numerical robustness and (4) quantification of the uncertainty and accuracy of the model results in predicting the course of events in similar fire scenarios.

It is this last step, model validation, on which the study focuses. This entails comparing model predictions with full-scale fire experiments and quantifying the results. ASTM E1355 provides some guidance for identifying and selecting experiments and measurements, but it does not define explicitly how the results should be quantified. A useful method to quantitatively evaluate the hundreds of point-to-point comparisons of predictions and measurements arose through consideration of uncertainty in the experi-

mental measurements. In selecting experiments for the model evaluations, an emphasis was placed on well-documented uncertainties in both the measurement of the 13 parameters of interest, and also the measurement of model inputs, like material properties and the heat release rate of the fire. The combination of the experimental uncertainty associated with both the model input parameters and the measured model outputs served as a benchmark for evaluation of the models. Photographs of a few of the selected experiments are shown in Figure 1 and Figure 2.

Figure 1. An experiment conducted in a large compartment (7 m by 22 m by 4 m high) at NIST for the US NRC fire model validation study. A 2 MW heptane spray fire is seen through the open doorway, which was instrumented to measure the temperature and velocity fields. Photograph by Anthony Hamins, NIST.

Figure 2. A heptane pan fire experiment at VTT, Finland. This experiment was conducted in a large fire test hall with a ceiling height of 19 m. Photograph courtesy of Simo Hostikka, VTT.

An example of the process to determine experimental uncertainty is as follows: Suppose that the uncertainty in the measurement of the heat release rate of a fire was determined to be about 15 percent. According to the McCaffrey, Quintiere, Harkleroad (MQH) correlation,[10] the upper-layer gas temperature rise in a compartment fire is proportional to the two-thirds power of the heat release rate. This means that the 15 percent uncertainty in the measured heat release rate that is input into the fire models leads to a 10 percent uncertainty in the prediction of the upper layer temperature. Combining this with the uncertainty associated with the thermocouple temperature measurement leads to a combined uncertainty in the reported temperature of about 13 percent. In short, the fire model cannot be shown to be more accurate than about 13 percent. If all of the temperature predictions for the five models and 26 experiments are plotted on a single graph, along with the combined experimental uncertainty as seen in Figure 3, a much better picture of model performance results. In some sense, the experimental uncertainty provides the modeler with a very tangible goal – to predict the outcome of a fire to within experimental accuracy.

How Accurate Are the Models?

To simplify the use of experimental uncertainty as a metric for model accuracy, a simple color system was devised to indicate to what extent the

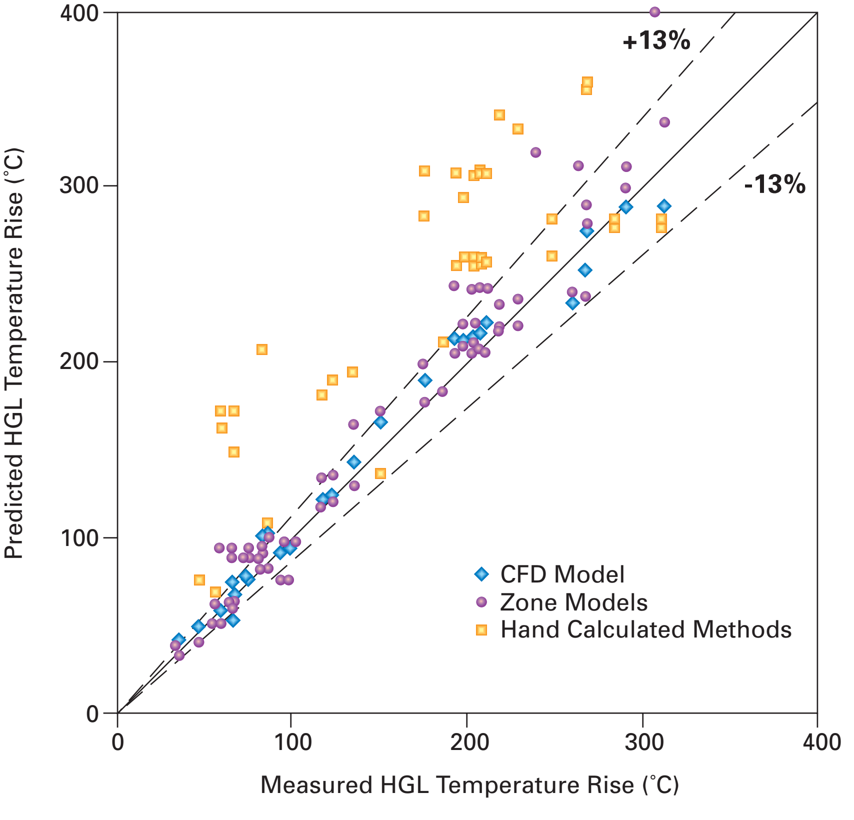

Figure 3. Measured vs. Predicted Hot Gas Layer Temperature Rise.

model predictions agreed with the experimental measurements. "Green" was used to indicate that a particular model predicted a particular parameter with accuracy comparable to the experimental uncertainty. "Yellow" indicated that the model predictions were clearly outside of the uncertainty bounds, indicating that the difference between model and experiment could not be explained solely in terms of measurement uncertainty. In cases where the model consistently overpredicted the severity of the fire, a ranking of "yellow+" was used to emphasize the point.

For example, the predicted average hot gas layer temperature rise (determined using a simple two-layer reduction method[3]) from all the models was compared to the experimental measurements (Figure 3). The hand calculation methods showed the greatest deviation and scatter when compared to the measurements, and were rated "yellow+". Both the zone and CFD models showed less scatter and very similar accuracy for the experiments under consideration, and all were ranked "green" for this parameter.

Next, the predicted heat fluxes onto various horizontally and vertically oriented targets were considered (Figure 4). The CFD model, overall, was more accurate for this parameter, even though the zone and CFD models are of comparable accuracy in predicting the gas temperature. Why is the CFD model more accurate in predicting heat flux? The heat flux at a target is dependent on the thermal environment of the surroundings, the details of which the CFD model is inherently better able to predict. Hand calculations and zone models predict average temperatures over the entire compartment, and thus are less accurate in predicting a heat flux to a single point. Nevertheless, all of the models were assessed as "yellow" for this category, merely to indicate to the model user that even though CFD might be more accurate, it is still challenging to predict a heat flux, especially very close to the fire, with any model.

Whereas the CFD model was more accurate in predicting heat fluxes and surface temperatures, the simpler models performed equally well, sometimes better, for plume and ceiling jet temperatures and flame heights. The reason is that hand calculations and two-zone models use well-established correlations for these fire phenomena. A CFD model solves the basic transport equations, making it truly predictive of these quantities, but not necessarily more accurate. And the increased cost of a CFD calculation is substantial. The spreadsheet and two-

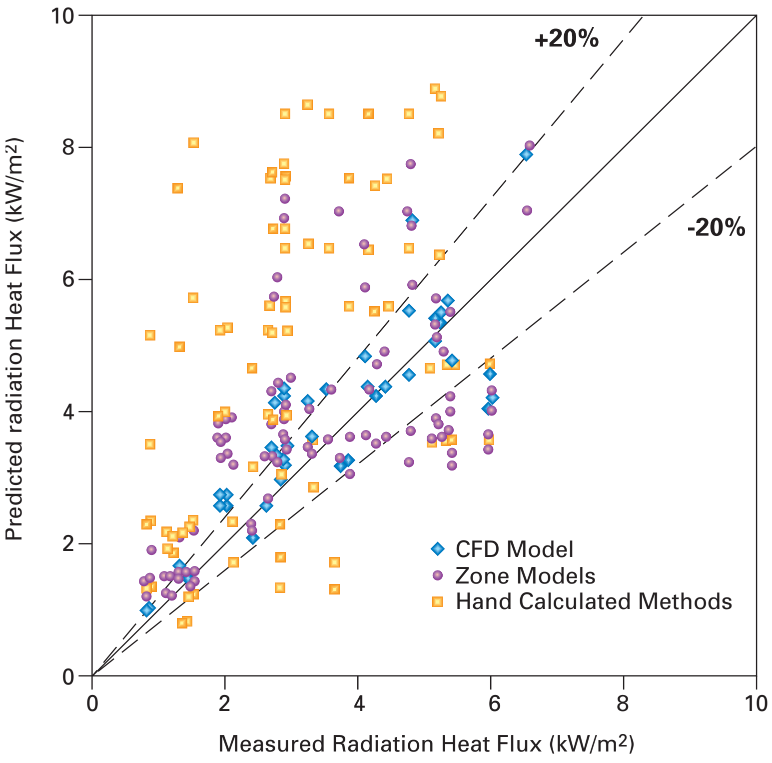

Figure 4. Measured vs. Predicted Radiation Heat Flux onto Horizontally and Vertically Oriented Targets.

zone models produce results in seconds to minutes, versus a CFD model which takes hours to days. If hand calculations and zone model results are obtained faster and are as or more accuracte than CFD results, why should an engineer use a CFD model? Real fire scenarios can be more complex than the experiments used in this study and may not conform to the assumptions inherent in the hand calculations and zone models. Fire plumes may not be free and clear of obstacles, because fires sometimes occur in cabinets or near walls. Ceilings might not be flat and unobstructed, because duct work, structural steel and cable trays are often present. Although hand calculations and zone models can be applied in these instances, the results require more extensive explanation and justification. Since CFD models can make predictions on a more local level with fewer assumptions, the results are likely to be more applicable in these more complex situations.

Mark Henry Salley, Jason Dreisbach and Kendra Hill are with the U.S. Nuclear Regulatory Commission. (This paper was prepared in part by employees of the U.S. NRC. The views presented do not represent an official staff position.) Robert Kassawara is with the Electric Power Research Institute. Bijan Najafi and Francisco Joglar are with SAIC. Anthony Hamins, Kevin McGrattan and Richard Peacock are with the National Institute of Standards and Technology. Bernard Gautier is with Electricité de France.

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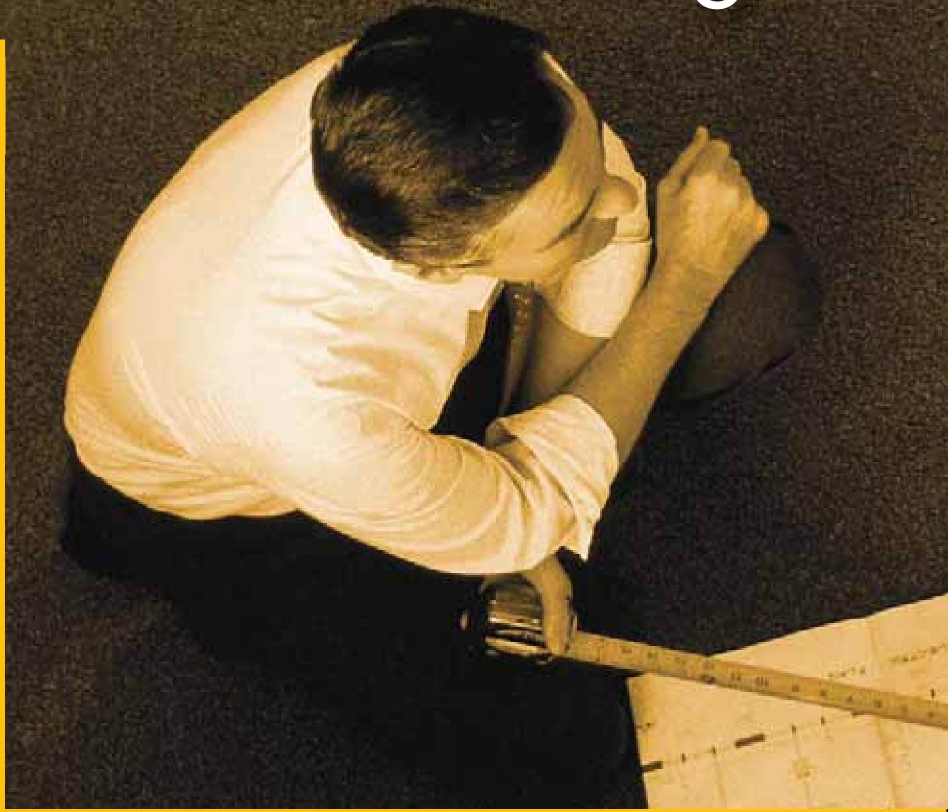
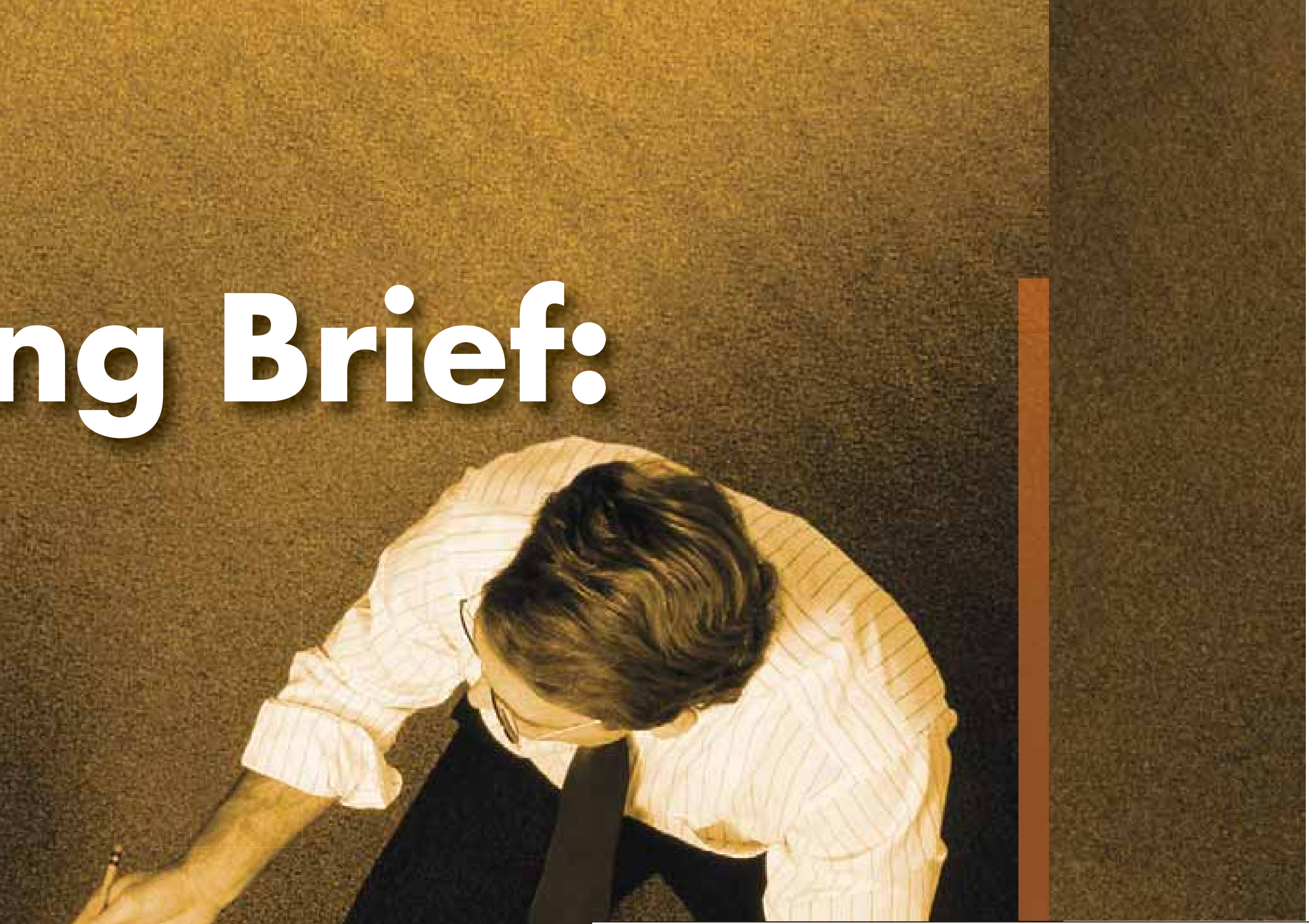
An Essential Tool for Regulatory Approval of Performance-Based Design

By Martin Feeney and Judith Schultz



For fire safety designs that are not constrained by prescriptive solutions but are instead designed in accordance with performance objectives, there is great flexibility in the choice of soutions. However, the process of confirming that these objectives have been met demands much more detailed justification. Delays for regulatory approval can be significant while designers and the regulatory authorities discuss and agree on appropriate criteria and methods for assessing fire safety.

ng Brief:



New Zealand adopted performance-based fire engineering in 1992 with the inclusion in the New Zealand Building Code of qualitative performance requirements for life safety, protection of other property and facilities for firefighting. Acceptance criteria and analysis methods are not included in the regulations. There are prescriptive documents available[1] that are deemed to meet the performance objectives, but their use is not compulsory.

For projects where fire safety design solutions differ from the "deemed to satisfy" prescriptive solution and rely on performance-based design, there are risks of delay and nonapproval. The risks are higher if the details of the performance-based design have not been identified and discussed with the regulatory authorities early in the design.

The Fire Engineering Brief (FEB)* process, outlined in the *International Fire Engineering Guidelines*,[2] is gaining acceptance as the most effective tool for minimizing risks during the regulatory approval of performance-based designs. This benefit is achieved by outlining the approach to be used in the detailed design in as much detail as possible.

This article describes how this FEB process was successfully used for approval of a large atrium office building in Auckland, New Zealand. The building was designed using a deterministic method of quantitative analysis as part of a performance-based fire safety design.

Case Study: Sovereign Building

The Sovereign Building is a seven-story building constructed in Auckland, New Zealand, which is used predominantly for offices. A basement carpark is located below a podium in which there are tenant spaces for a gymnasium and childcare facilities, car parking and the entry to main office levels on the floors above.

The main office floors extend from the first to the fifth floors, with a large central atrium connecting all five levels. This article focuses on the design for the atrium office levels. This is one of the first buildings of this scale in New Zealand with large open-plan office levels connected to an atrium, and this building is already setting a trend for new office developments in Auckland.

The architectural design arranged the office space into three main areas, all linked with bridges and stairs for easy occupant movement between levels. The three areas together provide a floor area of approximately 2000 m^2 per level, which is used for open-plan office space, meeting rooms and associated support spaces. The largest plank is also punctuated with void spaces creating visual links between levels.

Challenges for the Fire Safety Design

The architectural vision of an open atrium for the office area contrasts with the approach commonly used in New Zealand to create barriers for containment of fire and smoke. It was clear from the outset that the prescriptive solutions would not be suitable for this project as they do not adequately cover this kind of architectural design. Therefore, building code compliance for the Sovereign Building was assessed using performance-based design techniques, as this was the only way of determining with confidence that this open-plan concept would satisfy the fire safety objectives while keeping the architect's vision intact. The collaborative process of developing a fire engineering brief was the obvious choice to address the risks associated with regulatory approval.

The key challenges for the fire safety design in this building arose from the open interconnection of floors to the atrium. Smoke from a fire in any location in the building could spread uncontrolled to all levels above the floor where the fire is located, affecting all occupants more or less simultaneously and therefore requiring simultaneous evacuation of all floors. This in turn places extra demand on the egress system capacity.

The aim of the design is to enable evacuation in a sufficiently short time from those parts of the building vulnerable to smoke spread before conditions in occupied areas reach untenable limits.

The final solution was developed by coordinating solutions from a "first principles" performance-based design approach for the following interrelated subsystems:

- Determining occupant numbers and distribution using the tenant's long-term occupancy plans, in addition to "deemed to satisfy" occupant densities. This identified critical occupant scenarios, allowing for specific tenants' needs such as large functions in the atrium.
- Designing the egress stairs with sufficient capacity to accommodate simultaneous evacuation of all occupants over five stories and quantifying the time taken for occupants at various levels to reach a place of safety.
- Controlling the smoke spread with a combination of barriers around void spaces and adjacent to critical access paths to stairs, together with a smoke control system in the atrium.
- Modeling the extent of smoke spread and the time at which untenable conditions are reached in various locations for various fire scenarios.
- Providing refuge areas for people with disabilities.

* Editor's note: The "Fire Engineering Brief" discussed in this article is identical to the "Fire Protection Engineering Design Brief" described in the *SFPE Engineering Guide to Performance-Based Fire Protection*.

- Providing good wayfinding, legibility of the escape routes and early warning to occupants to facilitate expeditious evacuation.

The safety provided by the egress and smoke control systems was established by computer modeling of occupant egress and smoke movement, and comparing available safe egress time (ASET) to the required safe egress time (RSET).

ASET was determined using Fire-Dynamics Simulator[3] (FDS) to track critical tenability parameters, such as visibility and temperature throughout the computational domain. A number of design fires were modelled, assessing different worst-case fire locations and sizes.

RSET was calculated using the method outlined in BS 7974 – Part 6[4] with additional safety margins applied to movement time. Occupants were tracked until they entered a place of safety, such as a smoke lobby or fire-isolated stair.

Content of the Fire Engineering Brief

The New Zealand Building Code requires fire protection engineering design to ensure that three main objectives are met:

1) Life safety in the event of a fire;
2) Protection of other property from the effect of fire (i.e., the neighbors' buildings); and
3) Facilitation of firefighting. It does not include the protection of the owners' or tenants' property.

The FEB for the Sovereign Building project included a description of the fire protection engineering design methods and the performance criteria for these three objectives, with a strong focus on life safety and means of escape. In addition, it addressed property protection and business continuity issues.

Two occupant scenarios and five design fire scenarios were agreed upon as the reasonable worst cases to be analyzed in more detail during the detailed design. One scenario was the day-to-day use of the building as an office building, with a design occupant density of approximately nine square meters per person. The second scenario reflected the infrequent use of the atrium as a function space with a much higher occupant population on the floor of the atrium and lower-than-usual occupant populations on the office floors. The expected frequency of this second scenario was limited to approximately 0.1 percent per year on average, or around 12 hours per year.

All occupants were characterized as awake, alert and able to evacuate without assistance.

Parameters for assessing smoke development and spread, smoke control, occupant egress, tenability limits, methods of calculation and analysis, structural stability and configuration of fire protection systems were all discussed and included in the FEB as a matter of record for building code approval.

Role of the Fire Engineering Brief in Performance-Based Design

A significant degree of consensus has been established over the years with local councils (AHJs) for solving common design problems where, for instance, only a minor deviation from the prescriptive solution occurs. However, for significant deviations from the prescriptive solutions, there is always a risk that consent for construction may not be granted without substantial redesign after plans have been completed.

Fire protection engineering design for large complex building projects in

New Zealand has often been carried out using a Fire Engineering Brief process as described in the *Australian Fire Engineering Guidelines,*[5] *which are now superseded by the International Fire Engineering Guidelines.*[2]

Encouraging a collaborative process is the most important part of developing a FEB. This process is helpful in addressing risks as early as possible in the design phase, resolving conflicting requirements and maintaining support for, and ownership of, the final solution.

The importance of agreeing on the overall design approach, the methods of analysis and associated acceptance criteria is obvious – the design solutions cannot be approved until agreement on these factors is obtained. In addition to reviewing these factors, the FEB development included the following stakeholder contributions to the FEB and the overall design solution:

- The building owner was interested in minimizing initial capital cost, long-term maintenance cost and cost of fire damage to the building. A limit on the future increase of occupants was identified by the fire protection engineer in the design and was accepted by the owner.
- The tenant wished to minimize the effect of a fire on business interruption as well as the impact of fire safety features on the day-to-day operation of the building. Evacuation scenarios were reviewed to minimize disruption from potential false alarms. Occupant and design fire scenarios were based on the long-term use of the building and included an allowance for above-average fuel loads in the atrium for special occasions and higher-than- normal occupant populations in the atrium for special functions.
- The local council (AHJ) required a thorough, robust review and approval process. Agreement was reached on alternative certification methods for design elements that did not formally comply with all aspects of relevant standards.
- The peer reviewer, on behalf of the local council (AHJ), was instrumental in achieving agreement on the methods of engineering assessment, the acceptance criteria and the relevant fire and occupant scenarios that were assessed.

- The New Zealand Fire Service was involved in the selection of their attendance points, location of fire control room, fire department connections, indicator panels and coordination of firefighting access. They also provided valuable suggestions on performance criteria for means of escape and the selection of the most critical scenarios.
- Various other designers, including the architect and the building services engineer, provided specific requirements for inclusion in the Fire Engineering Brief.

Peer Review and the Regulatory Approval Process

The role for the local council (AHJ) was not only to review the final design solution at the building consent stage, but also was as stakeholders in the FEB development process to agree on the acceptability of the design, the calculations and the analysis methods used to demonstrate building code compliance. This involvement occurred long before the application for building consent, which is much earlier in the design process than is usual for the council and was integral to the success of the FEB process.

For regulatory approval, the council relied on the opinion of a qualified peer reviewer and feedback from the fire service to ensure the performance targets set out in the building code were met.

The peer reviewer's role was to provide feedback during the FEB and building consent stage, and to check that the design solution met the performance objectives of the building code, based on the performance criteria developed in the FEB. When satisfied with the overall fire safety design, the peer reviewer provided a statement to the council confirming their acceptance.

Figure 1 (see page 52) summarizes the four steps of the building consent application for this example project, which is representative of larger projects in New Zealand.

How This Fire Engineering Brief Process Worked for the Sovereign Building

The FEB document was introduced and discussed in a total of three two-hour meetings involving all the project stakeholders. These meetings were held at approximately three-month intervals. Feedback on the FEB was provided by all of the stakeholders during the meetings and in writing within the two weeks following the meeting. Amendments were incorporated into the next version of the FEB, which was circulated for further review prior to the next meeting.

Design meetings were also held separately with other consultants (architects, building services engineers and tenants) to advance the design. Outcomes from many of these meetings affected details of the FEB and the design solution developed at that time.

The preferred building contractor attended the last FEB meeting. Their concerns regarding regulatory approval for specifically engineered fire safety systems were incorporated into the FEB.

The final FEB document was accepted by all stakeholders prior to applying for building consent and was welcomed by the contributing parties as a very successful and worthwhile effort.

The approval process for the building consent stage was relatively smooth, considering that "first principles" performance-based design was applied without any reference to "deemed to satisfy" documentation.

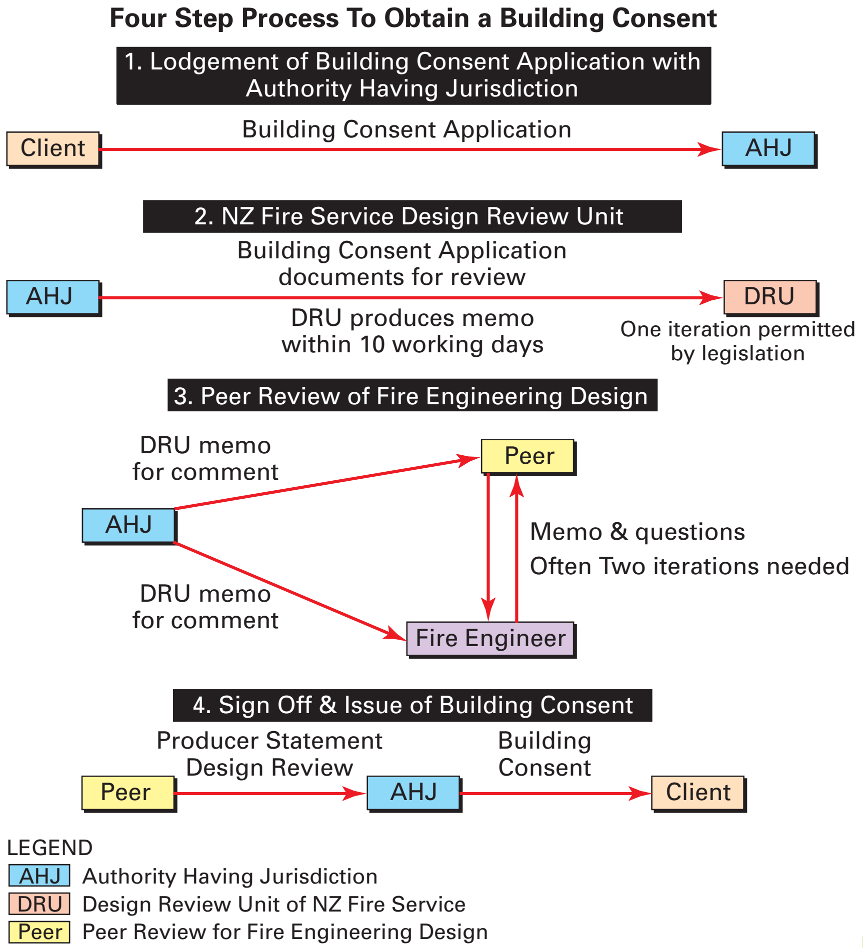


Figure 1: Building Consent Process in New Zealand.

Instead of following prescriptive standards, a number of systems needed to be specifically engineered to fit the Fire Engineering Brief developed for this project. If there had not been input and ownership of the overall solution from the stakeholders, it is likely that some of these variations would have been major obstacles to regulatory approval. Concerns and contributing ideas to solve these potential problems were provided early in the desig process.

This success is the result of a process in which all stakeholders had the opportunity to state their requirements so that they could easily be included in development of the design. This gave them a sense of ownership of the overall design and an interest in achieving the vision for the design contained in the FEB.

Martin Feeney and Judith Schultz are with Holmes Fire & Safety.

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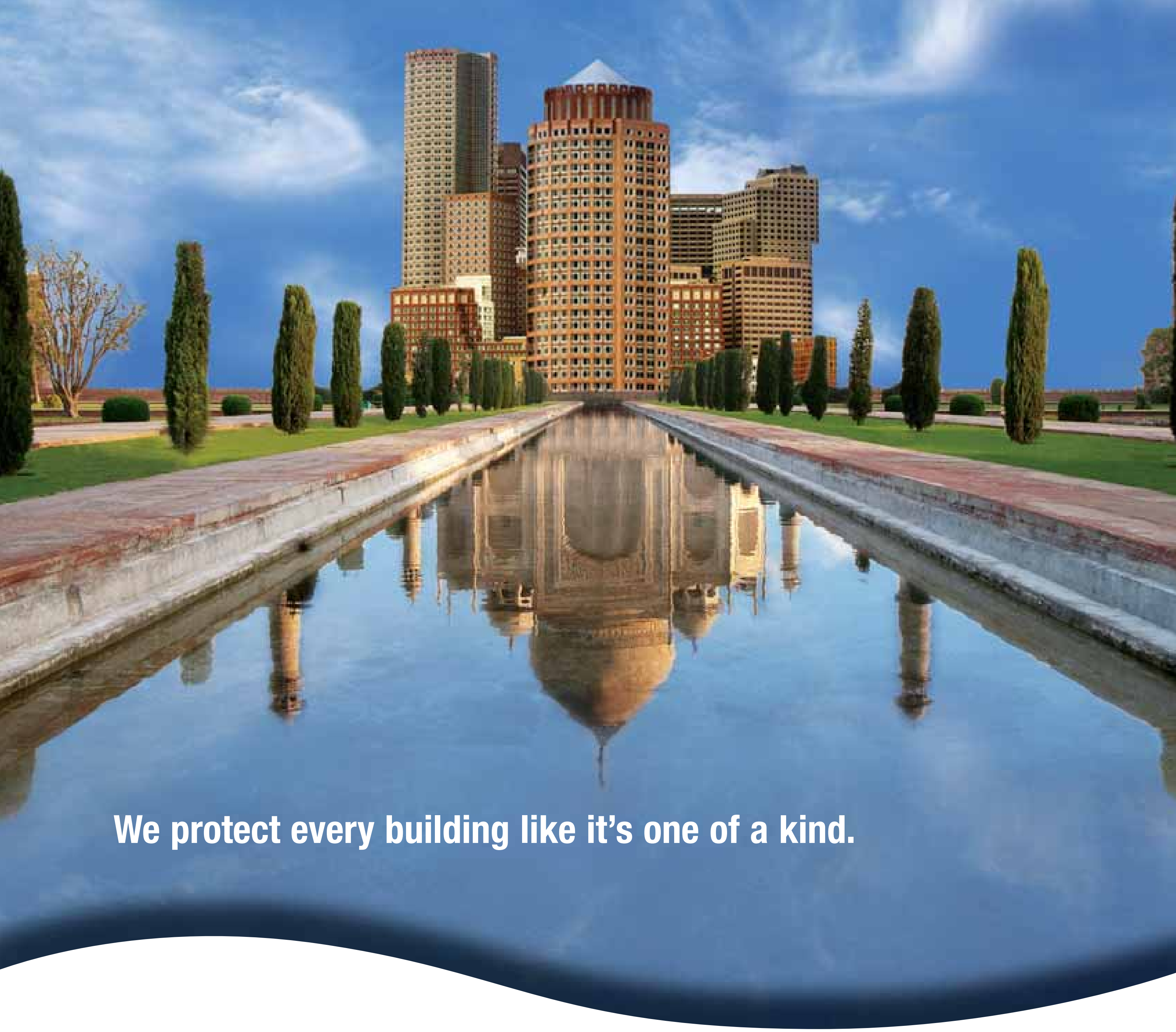
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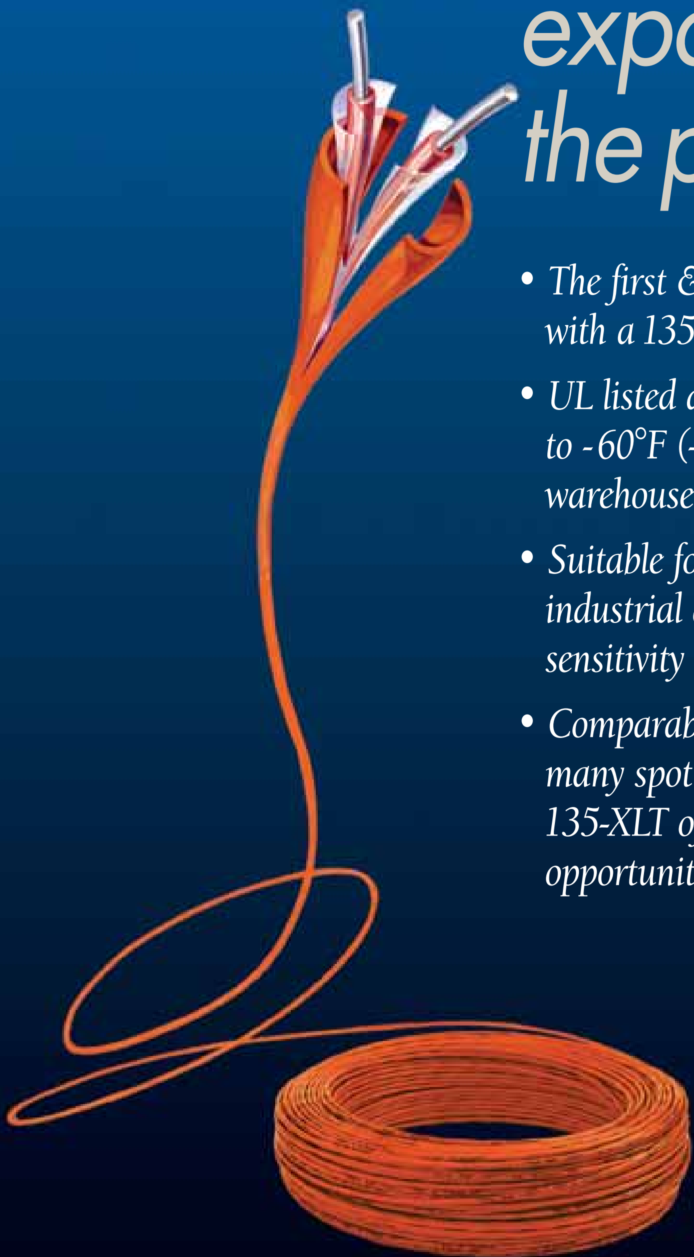

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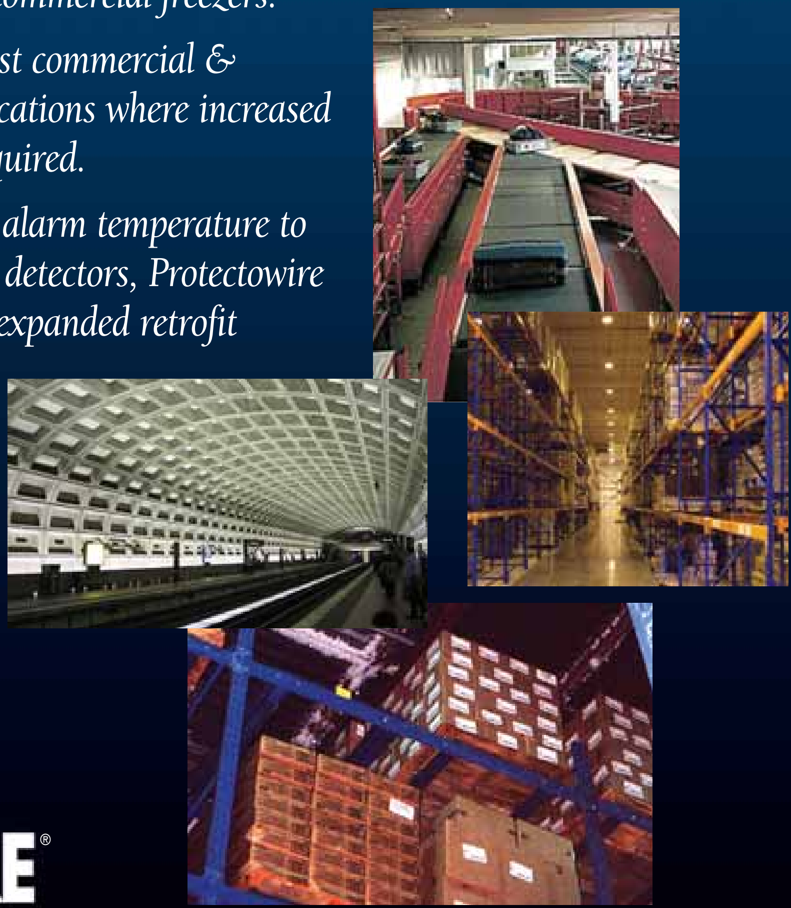

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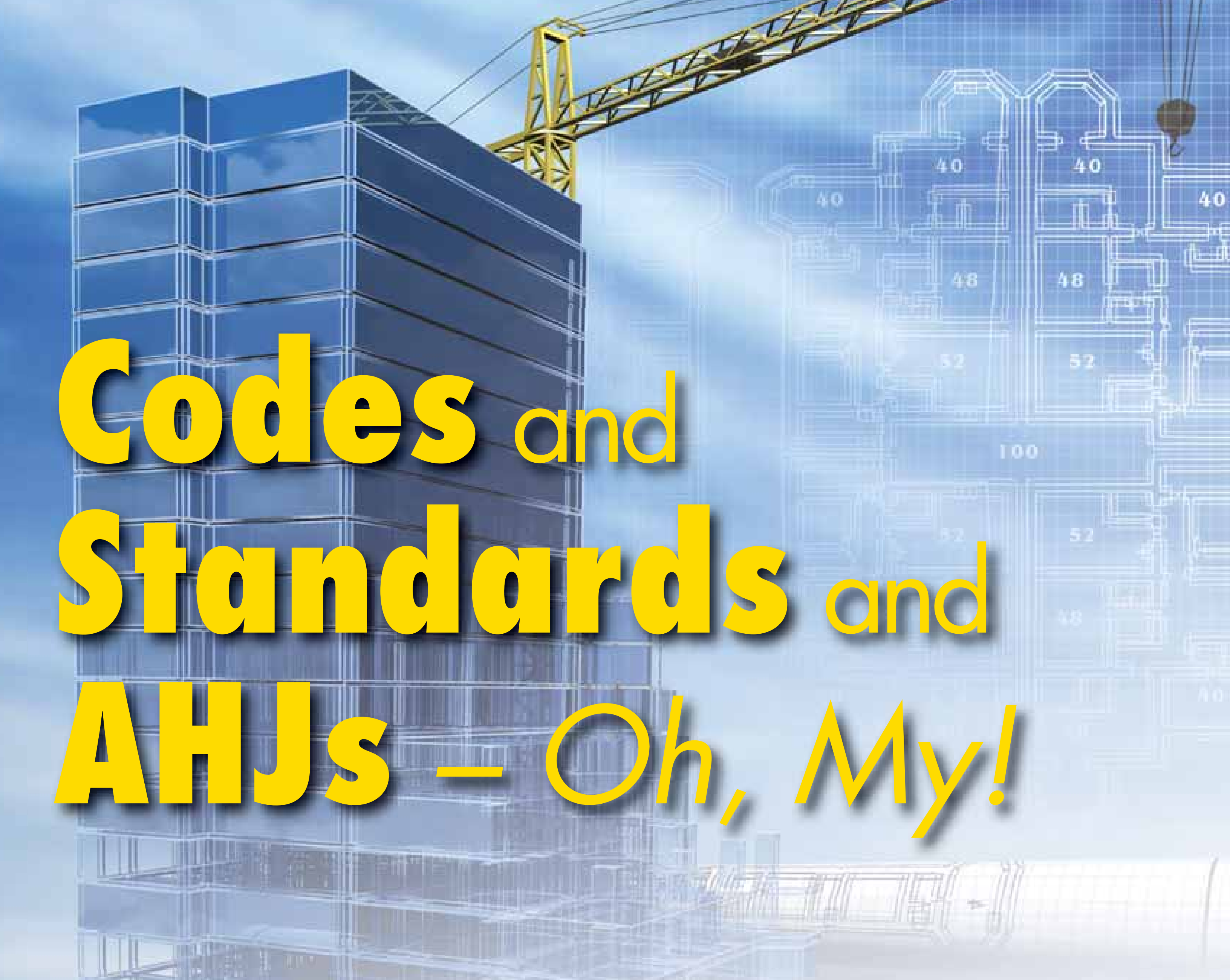

Codes and Standards and AHJs – Oh, My!

If one walks into a local diner and asks for directions to the nearest post office, they will get lots of suggestions. Many will be different, and some may even be incorrect. Which path should they choose? This is an analogy that applies well to fire protection. Identifying the codes and standards that might apply to a particular project is only part of the challenge. The practicing engineer must also identify the many Authorities Having Jurisdiction (AHJs) and their roles and relative ranks on specific projects. Engineers should also understand the interdependency, balance and coordination among related codes and standards. Often, there are multiple paths or options in the codes and standards that ultimately lead to the desired goals.

Who or what is an AHJ? The National Fire Protection Association defines the AHJ as "An organization, office or individual responsible for enforcing the requirements of a code or standard, or for approving equipment, materials, an installation or a procedure."[1] On any one project, there may be many different AHJs – the owner, architect, engineer, building official, fire official, insurance company, etc. Identifying the many AHJs on a project is important because each may impose different requirements. While there may be a clearly defined set of legally adopted state or local codes and standards, there may be several other codes and standards imposed by other AHJs – corporate policies and standards, insurance company standards, local fire department requirements, etc.

With respect to codes and standards, in many jurisdictions it all starts with a law. The law might simply empower an agency or office (AHJ) to write a regulation. For building construction, the law might be passed by a state legislature requiring a state agency to write, adopt or administer a building code. For fire protection, the law might empower the state fire marshal to write, adopt or administer a fire code.

Setting Standards for Excellence

Building codes and fire codes both require certain features of fire prevention and fire protection. Typically, a building code will apply to new construction, including alterations or renovations. Fire codes often contain requirements for fire prevention, licensing requirements, regulations and permitting requirements for specific occupancies and uses. Fire codes typically also contain requirements for the maintenance and use of fire protection systems or features installed pursuant to the building code, fire code or for any other reason. They also refer back to the building code for any new construction, alteration or renovation and may specify conditions where fire protection systems or features must be upgraded or retrofitted even if the building had been constructed and approved under a past building code that did not require those features. An example might be the retrofitting of all high-rise residential properties with automatic sprinklers by a certain date.

Although building codes and fire codes might require certain fire protection systems such as fire barriers and fire doors, automatic sprinklers or fire detection and alarm systems, they typically do not list the specific application, design, installation, location and performance requirements. Instead, they refer or require compliance with specific parts of standards. For example, a building code might require that a certain occupancy or use group have a fire alarm system with smoke detection in the corridors and exits, and occupant notification throughout. It might further specify that the occupant notification use audible appliances throughout, with visible appliances in the corridors. The building code would require that the smoke detection and occupant notification be designed, installed and tested in accordance with *NFPA 72, The National Fire Alarm Code.*[2] Although the title of *NFPA 72* includes the word "code," in the context of this article it is actually a standard. Similarly, a building code might require a building to be protected throughout by a complete automatic sprinkler system in accordance with *NFPA 13, Standard for the Installation of Sprinkler Systems.*[3] The code might require that the *NFPA 13* sprinkler system be monitored by a supervising station fire alarm system in accordance with *NFPA 72*. In that case, there is no code path that requires other fire alarm features such as occupant notification or duct smoke detectors. Codes specify what and where, while standards say how.

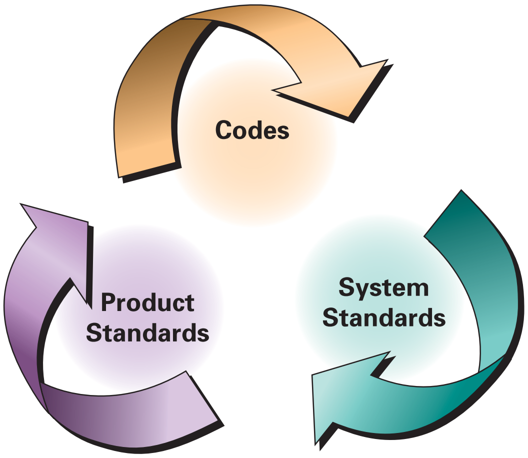

Figure 1. Interdependency of Codes and Standards.

Standards contain requirements concerning the application, design, installation and location of the fire protection systems or features required by the codes. For example, where a building code requires complete automatic sprinkler protection, under certain circumstances *NFPA 13* does not require sprinklers at the top and in the pit of elevator hoistways. Where a code requires automatic smoke detection, *NFPA 72* defines the spacing and coverage requirements. Similarly, audible occupant notification required by a building or fire code must have a certain decibel level specified by *NFPA 72*. Any required strobes would have an intensity and spacing as specified in *NFPA 72*.

Where a building or fire code requires sprinklers, there is an expectation that they will suppress a fire. Smoke detectors may be required to ensure a minimum available safe egress time. The codes have a certain expectation of system performance. To achieve these results requires compliance with certain application, design, installation and location requirements contained in the applicable system standards. But that's not all. To achieve an expected level of system performance, the system standards are based on an expected level of component performance and reliability. The system standards have an expectation that the equipment or components will perform in a certain way. In some cases, certain equipment performance requirements may be contained in the system standard itself. But for most equipment and components, there exists another standard – the product or equipment standard.

These three codes and standards are dependant upon each other. See Figure 1.

For example, a building code may require occupant notification by audible appliances. The system standard (*NFPA 72*) may then require that the system provide 15 dBA above the average ambient noise level in the spaces required by the code to have occupant notification. To achieve that level of system performance, the designer must space audible appliances that have a certain rated output – 84 dBA at 10 ft (3 m), for example –

based upon testing to a certain product standard (UL 464[4]).

Similarly, a code may require smoke detection in certain spaces in order to achieve occupant and emergency forces notification early enough to ensure safe egress of the occupants and manual suppression by responding firefighters. The system standard (*NFPA 72*) specifies the spacing of individual smoke detectors in order to achieve the expected performance of smoke detection. However, the individual smoke detector response or sensitivity is based upon performance requirements specified in the product standard (UL 268[5]). If the individual smoke detectors are significantly less sensitive than normally permitted by the product standard, then they must be spaced closer than normally permitted by the system standard if they are to achieve the same level of performance. A sensitivity that is different than that normally permitted by the system standard may be permitted under a "special listing" or as part of a performance-based design. Alternately, the code might permit a slower response if other protection features are added as mitigation – such as automatic suppression, smaller fire zones, greater barrier ratings, etc.

In other words, if one of the triad shown in Figure 1 shortens, one or both of the other elements must change to maintain balance. The challenge to fire protection engineers is to first identify the AHJ and the applicable codes and standards, and to recognize the interdependency among them. To design creative, cost-effective solutions, the fire protection engineer (FPE) must thoroughly understand the relationships and balance between the codes and standards, and be able to effectively communicate these to owners and AHJs. In addition, the FPE needs the tools, expertise and knowledge to measure, model or estimate system performance in order to assess the impact of proposed changes and to ensure acceptable performance.

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BRAINTEASERS > Problem/Solution

Problem

The distance from Washington D.C. (Dulles) and Paris, France (Charles de Gaulle) is 6,200 kilometers. A Boeing 777 makes the flight from Washington to Paris in 7 hours, 23 minutes. The return flight takes 8 hours, 34 minutes. If the two flights take the same path, and the wind blows in the same direction during both flights, what is the average airspeed of the plane and the average wind velocity in the direction parallel to the planes' travel?

Solution to Last Issue's Brainteaser

Eight people have dinner seated at a single table. How many possible seating arrangements are there?

The number of arrangements of *n* items into *r* groups can be expressed as:

$$\frac{n!}{(n-r)!}$$

This is also known as the number of permutations of n items taken r at a time.

Substituting n = 8 and r = 8, the result is:

$$\frac{8!}{(8-8)!} = 40{,}320 \text{ possible seating arrangements.}$$

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2006-2007 Courses

Fire Alarm Systems for the Fire Service/Fire Prevention Officer – $99.00 [0.80 CEU]

This Web-based seminar was designed specifically to provide fire service, fire prevention personnel and others with a basic level of understanding of fire alarm systems. The course describes the types of fire alarm systems and the basic components that make up a code-compliant fire alarm system. Basic installation instructions will be described along with important factors to be considered in the design and construction process.

Sprinkler Systems for the Fire Service/ Fire Prevention Officer – $99.00 [0.80 CEU]

This Web-based course provides fire service, fire prevention personnel and others with a basic level of understanding of fire sprinkler systems. The course describes the types of sprinkler systems and the basic components that make up a code-compliant sprinkler system. In addition, this seminar will discuss how to evaluate water supplies and hydraulic calculations for sprinkler systems.

Code Official's Guide to Performance-Based Design – $99.00 [0.80 CEU]

This course was designed to provide guidance on how to evaluate the adequacy of a performance-based fire protection design. It will provide an introduction into the performance-based design process and define the roles of major stakeholders that may be involved with a performance-based design. An overview of fire dynamics and the strategies used by engineers will be discussed.

Human Behavior in Fire – $99.00 [0.80 CEU]

This seminar identifies and reviews the key factors and considerations that impact the response and behavior of occupants evacuating a building during a fire. It describes how key occupant characteristics and cognitive functions affect how a person behaves during a fire. Participants will also learn how to design for the evacuation of occupants with disabilities, evacuation procedures and some alternatives to evacuation.

Principles of Structural Fire Protection – $99.00 [0.80 CEU]

This seminar provides a basic understanding of how structural elements are protected from fire. Participants will learn about fire resistance and standard tests used to determine fire resistance of structural members. Students will explore the properties of steel, masonry, concrete and timber, and how elevated temperatures affect these materials. Additionally, participants will learn the principal factors used to determine fire resistance.

Principles of Fire Protection Engineering – $149.00 [3.20 CEUs]

This Web-based instruction is equivalent to a four-day classroom seminar. It provides a basic overview of the principles of fire protection engineering. The following topics are discussed: combustion and ignition phenomenan, fire endurance evaluation, construction and structural features, materials application, fire protection design evaluation, life risk analysis, detection and alarm systems, sprinkler system developments, design of water suppression systems, and egress and exits.

Additional information, registration, instructions and payment options are available on the SFPE Web site (www.sfpe.org).

Study Online for the

2007 Fire Protection Engineering PE Exam!

Presented in partnership with GE Global Asset Protection Services.

Class Description: Prepare for the 2007 Fire Protection Engineering PE Exam from wherever you can access the Internet – your home, office or even your hotel room while traveling. This effective, online review class will help you organize and navigate through the massive amount of reference material.

Each session is taught live by an expert instructor using advanced Web conferencing technology. You will work with a live instructor over several weeks and can ask questions as they arise throughout the review period.

Revised to meet the current NCEES exam specifications, this course is an excellent exam preparation tool. The 14 live 1.5-hour sessions allow for maximum retention.

Who Should Attend? Anyone preparing for the PE Exam! Even if you are not taking the exam this year but want to assess your readiness for a future exam, this course is for you.

The course is also an excellent refresher for existing engineers, fire marshals, loss control specialists and anyone else who needs to understand the principles of fire protection engineering.

Topics Include:

- Exam Preparation & Exam-Taking Strategies
- Fire Protection Analysis
- Fire Protection Management
- Human Behavior
- Fire Dynamics
- Fire Protection Systems
- Fire Alarm Systems
- Smoke Management
- Explosion Protection
- Passive Building Systems

Additional information, registration, instructions and payment options are available on the SFPE Web site (www.sfpe.org).

Enrollment Fee: $1,150 Member OR
$1,295 Nonmember

Enrollment Includes:

- Participation in either the Tuesday or Thursday session.
- Two hours of access to instructors outside class hours.
- A copy of the *SFPE Exam Reference Manual*, 3rd Edition.
- Electronic copies of the course slides.

Course Schedule:

14 live 1.5-hour online sessions
July 10 - October 9 (Every Tuesday)
2:30 p.m. - 4:00 p.m. EST
~ OR ~
July 12 - October 11 (Every Thursday)
6:30 p.m. - 8:00 p.m. EST

You may attend either the Tuesday or Thursday session. You may switch between sessions each week as your schedule dictates.

October 14-19, 2007

SFPE Professional Development Conference and Exposition

Mark your calendars for the 2007 SFPE Professional Development Conference and Exposition being held in Las Vegas, NV. This year's event will feature a new two-day format highlighting cutting-edge presentations on advanced practices in fire protection engineering.

***Leading the conference** with keynote presentations are: Dr. John L. Bryan, USA • Dr. Charles Fleischmann, New Zealand • Dr. Jose L. Torero, United Kingdom • Dr. Kevin B. McGrattan, USA • Ronny J. Coleman, USA*

Following the conference is the Exposition and a series of seminars taught by the profession's leaders.

***Seminars to be held are:** Egress Modeling – Principles and Applications; Advanced Fire Dynamics Simulator and Smokeview; Advanced Fire Alarm Systems Design; Introduction to Fire Risk Assessment; Introduction to Industrial Fire Protection Engineering; Principles of Fire Protection Engineering; Smoke Control; and Sprinkler Design for the Engineer.*

UPCOMING EVENTS

May 15, 2007
Symposium on High-Rise Building Egress Stair
New York, NY
Info: www.asce.org/conferences

June 3-7, 2007
World Safety Conference and Expo
Boston, MA
Info: www.nfpa.org

June 10-12, 2007
NSF Workshop on Structures and Fire: State-of-the-Art and Research Needs
East Lansing, MI
Email: fireworkshop@egr.msu.edu

September 3-5, 2007
Interflam 2007
London, UK
Info: www.intercomm.dial.pipex.com

October 14-19, 2007
SFPE Professional Development Conference and Exposition
Las Vegas, NV
Info: www.sfpe.org

October 19, 2007
Advanced Research Workshop - Fire Computer Modeling
Santander, Spain
Info: http://grupos.unican.es/gidai

March 12-14, 2008
3rd International Symposium of Tunnel Safety and Security
Göteborg, Sweden
Info: istss2008@sp.se

April 16-18, 2008
7th International Conference on Performance-Based Codes and Fire-Safety Design Methods
Auckland, New Zealand
Info: www.sfpe.org

MARKETPLACE

CASE STUDY

THE PROTECTOWIRE COMPANY, INC.

Protectowire Linear Heat Detector Prevents Warehouse Fire

The Protectowire Company, Inc.
40 Grissom Road
Plymouth, MA 02360-7205
781.826.3878
www.protectowire.com

In the pre-dawn hours of New Years Day, 2007, a hidden fire almost caused devastating damage to a freezer warehouse located in the Pacific Northwest.

The freezer, which is owned by an independent operator, stores supplies and products that are shipped to a major fast food restaurant chain. The freezer portion of the warehouse is equipped with a double-interlock pre-action system that utilizes Protectowire Linear Heat Detector as the system's detection device. Protectowire LHD was located on the ceiling grid as well as in the racking systems.

During the night, a roof-top refrigeration unit fan motor caught fire, melting a small section of the adjacent wall insulation. Although the fire did not generate enough heat to fuse a sprinkler head, there was sufficient heat to actuate the Protectowire Linear Heat Detector.

Upon actuation, the Protectowire SRP 4X4 Control Panel sounded the alarm. The Control Panel was connected to a fan shut-down circuit and turned off the refrigeration unit, thereby preventing further damage to the cooling unit and the structure.

That same day, the fan motor was repaired and a small section of the Protectowire Linear Heat Detector that initiated the alarm was easily and quickly replaced by the local Protectowire distributor, Westfire Coastal in Tacoma, WA, bringing the system back to full operation.

For more information contact The Protectowire Company, Inc. at pwire@protectowire.com or visit www.protectowire.com.

RELIABLE AUTOMATIC SPRINKLER CO.

The N252 EC Pendent Sprinkler by Reliable

An Extended-Coverage, Control-Mode Storage & Extra-Hazard Sprinkler

Reliable Automatic Sprinkler Co.
103 Fairview Park Drive
Elmsford, NY 10523
800.431.1588
www.reliablesprinkler.com

As the newest addition to Reliable's sprinkler line, the N252 EC, with a K factor of 25.2, is a density/area sprinkler that can provide coverage up to 196 sq. ft. and spacings up to 14 ft. x 14 ft. for storage and extra-hazard applications. They are UL-listed for use in NFPA 13 applications for obstructed, noncombustible construction. The N252 EC sprinkler can be used for "big box" applications if the systems are designed under NFPA 13, 2002, paragraph 12.7.2 requirements.

The N252 EC can be installed in the pendent position, directly on the line-piping of an exposed wet-pipe system. This eliminates the need for spring-ups, if using an upright on piping larger than 2-1/2 in. Pendent sprinklers can also be installed with hangers 6 in. or less in length, thus eliminating the need for seismic bracing on the line-piping.

This N252 EC pendent sprinkler can also be recessed for installations below finished ceilings. The recessed version uses Reliable's FP push-on, thread-off escutcheon, and is available in white or chrome finish.

These storage/extra-hazard sprinklers differ from other EC sprinklers in their calculation procedure. Light and ordinary-hazard EC sprinklers are calculated based upon a flow and pressure-derived from fixed incremental spacings of 2 ft. The N252 EC sprinklers are calculated based upon the actual coverage area per sprinkler, which prevents overdesign of the total calculated water flow. As an example: 10 x 14 ft. = 140 sq. ft. At a .60 density, the sprinkler demand would be 84 gpm at a pressure of 11.1 psi.

The savings on the quantity of line-piping and the large K factor, which reduces the starting pressure, make these sprinklers a very attractive protection method for storage and extra-hazard installations.

For more information, please refer to Bulletin 008.

CASE STUDY

VIKING ELECTRONIC SERVICES

Viking Electronic Services Enhances Comprehensive Detection

Viking Electronic Services
A Division of Viking Group
620 Allendale Rd., Suite 175
King of Prussia, PA 19406
800.274.9509
www.vikingservnet.com

You won't settle for partial protection, and neither will Viking Electronic Services.

Now, with the addition of its new networked releasing capabilities to the eLAN Fire Alarm System, Viking Electronic Services enhances the single fire alarm system you and your clients can depend on.

Based on proven Internet and IP-networking technologies, eLAN Fire Alarm Systems are currently protecting various sites including retail, power plants, schools, cultural institutions, military bases and multi-family units. The system is ideal for medium to large projects, ranging from 50 to over 100,000 points of protection.

"By integrating releasing with the building's fire alarm system, the eLAN system eliminates the need for a separate releasing panel and provides enhanced status information on the releasing functions to the fire alarm system monitoring center," says William Larrabee, president of Viking Electronic Services.

eLAN releasing is suitable for pre-action, FM200 and deluge systems, and its intuitive networking features include the capability for detectors from one panel to initiate releasing from another panel. The system is UL-listed and FM-approved; CSFM approval is pending.

eLAN systems can be accessed by authorized users from anywhere, via the Internet, using only Microsoft's Internet Explorer Web browser. System programming, status reports, service scheduling, testing and other features are available at any time. Reports are generated "on the fly" in one easy-to-read Web page on the user's browser.

One of the industry's first Microsoft Certified Developers, Viking Electronic Services' eLAN Fire Alarm Systems are available through the company's network of authorized dealers.

Specifiers, get in touch with us to learn more about the value and protection offered by the eLAN Fire Alarm System - and get a free lunch! For information, or to learn about becoming an authorized dealer, call Viking Electronic Services now at 800.274.9509; e-mail info@vikingservnet.com; or visit www.vikingservnet.com.


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1

White Paper on UL 864 Ninth Edition

NOTIFIER has produced a white paper entitled, "UL 864 Ninth Edition: The New Standard in Fire Protection." Changes to UL 864 will take effect on June 30, 2007, and will require fire alarm manufacturers to redesign or update a significant portion of their product lines. It applies solely to fire alarm equipment, so it will have no effect on how systems are installed. It will, however, be a springboard for better, safer fire alarm products. Download the white paper at www.notifier.com.

www.notifier.com

–NOTIFIER

2

Flexible Pipe Loop

AnvilStar™ announces the new flexible Tri-Flex Loop®, designed to move independently from the building, protecting fire protection systems during story drift. It simultaneously absorbs and compensates for pipe movements in six degrees of freedom – three coordinate axes, plus rotation about those axes simultaneously. Designed to provide a wider range of installation options, whether for new construction or renovation, and specially designed to withstand large and irregular movements such as seismic activities.

www.anvilintl.com

–AnvilStar™

3

Viking Offers CPVC Fire Sprinkler Pipe

The Viking Group announces the creation of Viking Plastics, a new business unit dedicated to producing CPVC fire sprinkler pipe. Viking CPVC pipe is produced from BlazeMaster® compounds and is another addition to the company's Freedom® residential fire protection package. With its inherent corrosion resistance, ease of installation and superior flow characteristics, Viking CPVC pipe can lower the installed cost of a fire sprinkler system in both residential and commercial applications.

www.vikinggroupinc.com

–The Viking Group

4

Marine Fire Suppression

Sea-Fire's Fire Control Panel with FireStop technology is an integrated fire suppression management system designed for modern marine vessels. A modular and expandable system, it provides intuitive operation and monitors cylinder pressure, fire, heat, smoke and carbon monoxide for early detection. Programmable for up to eight specified onboard devices, including engines, generators and ventilation systems.

www.sea-fire.com

–Sea-Fire Marine

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WITH THE NEW PRESSURE-TRU SERIES FROM WILKINS

Time is precious, especially in fire prevention. Why waste even a moment cutting a valve out of line? The ZW4000 and the ZW4004 are fully servicable in-line and made in the USA. Factory set to your specifications, rated up to 400 psi inlet pressure and available in 2 1/2″ size. Service your valves in-line to save time and money with the new Pressure-Tru Series. Only from Wilkins.

Call for more information. Customer Service Representatives are available Monday - Friday 6:00 am to 5:00 pm PST at 877-222-5356 or 805-226-6297

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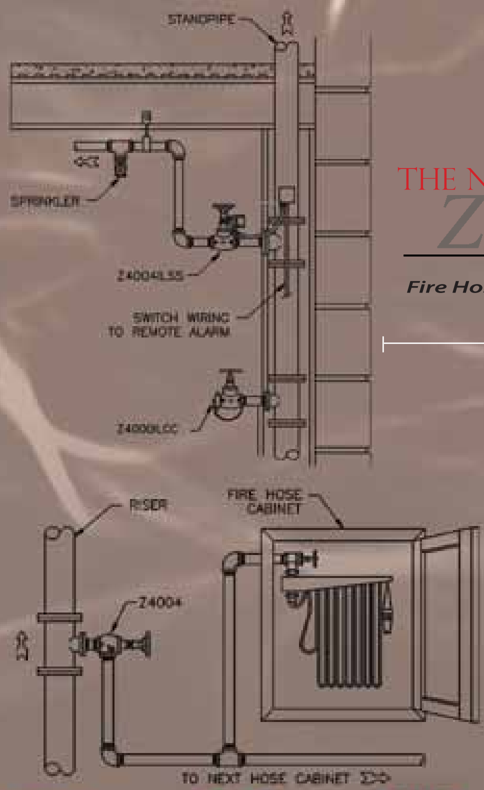

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- Features female NPT grooved inlet x male hose thread outlet
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- In-line serviceable
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FIRE PROTECTION Engineering

Fire Protection Engineering (ISSN 1524-900X) is published quarterly by the Society of Fire Protection Engineers (SFPE). The mission of *Fire Protection Engineering* is to advance the practice of fire protection engineering and to raise its visibility by providing information to fire protection engineers and allied professionals. The opinions and positions stated are the authors' and do not necessarily reflect those of SFPE.

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