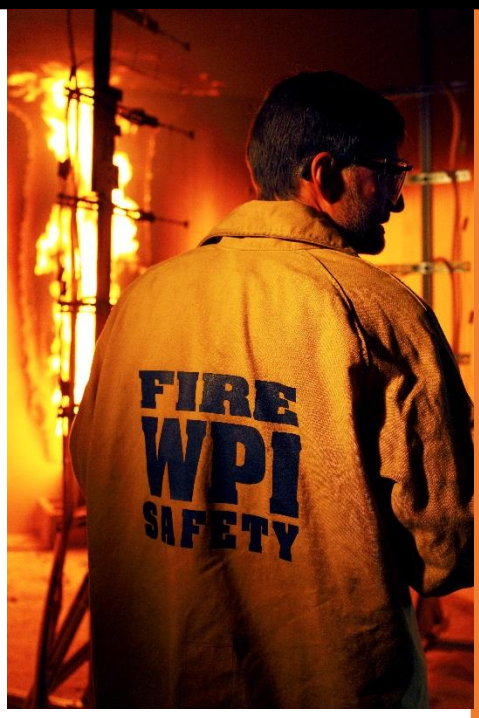
Avoiding Costly Losses Due to Fire:
Who's Engineering the Solutions? What Are Their Qualifications?



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Objective

This paper serves two purposes. First, it provides an introduction on how decision makers can help their organizations avoid costly losses due to fire and explosions, while addressing certain misconceptions about good fire safety practices. Second, it introduces the profession of fire protection engineering and the important roles these specially educated and trained engineers take on. The paper is designed to educate readers on how they can put their organizations in more advantageous positions with respect to fire and explosion threats that put people, property, business continuity, the environment and our cultural heritage at risk.

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Decisions & Misconceptions about Fire Safety

Are you responsible for ensuring that your organization's fire and life safety obligations and needs are satisfied? Are you concerned about the liabilities and costs that can result when a catastrophic fire occurs? Do you know the true impact of your decisions? How confident are you in your decisions? Who influences your decisions?

Industries and organizations across the globe make critical decisions about fire and life safety on a daily basis – either implicitly or explicitly. These decisions impact not only the safety and wellbeing of people internal and external to the organization, but also directly affect the ability of an organization to continue functioning and successfully fulfilling its mission regardless of whether it does so as a for-profit, a not-for-profit or a governmental entity. Interconnected decisions span the planning and operational phases, and overlap with fire response and recovery measures. The missions of organizations vary, but common fire and life safety themes exist. Acknowledging and understanding the associated issues is paramount. Executive leadership must give these concerns the proper priority and attention.

A common approach for addressing the relevant concerns is to rely solely on compliance with regulations, laws, and insurance recommendations, assuming of course, that all the applicable requirements are identified, understood and correctly applied. As will be later described, regulations and insurance company policies tend to provide "prescribed" solutions to generic problems that may not completely or effectively address all the relevant concerns. Most regulations acknowledge this to some degree by allowing for alternative approaches.

Furthermore, most regulations focus largely on life safety and do not specifically address property protection, business continuity, or historic preservation among other concerns. Insurance company recommendations on the other hand, tend to focus more on property protection and business continuity to keep the policy owner in line with underwriting protocols. It needs to be verified that the fire safety objectives among the numerous stakeholders including, regulators, insurers, business owners, and management are properly aligned and acted upon.

So in light of these facts, who in your organization is responsible for the following?

- Accurately identifying and quantifying the potential operational fire and explosions hazards that can put people, property, the environment and business continuity at risk.
- Hiring those qualified, credentialed and capable of understanding the relevant ongoing fire safety issues and their impact both internally and externally.
- Developing appropriate multi-disciplined strategies to mitigate and respond to potential fires and explosions.
- Understanding the impact of applicable regulations and their limitations with respect to achieving desired outcomes.
- Continuing professional educational development and training of key personnel responsible for fire safety decision-making.

Gauging the Impact of Fire

While the economic impact of fire safety is just one measure of the magnitude and importance of the associated decision-making process, it underscores the attention that needs to be given to the subject. For 2011, the latest figures available, the total cost of fire in the United States was estimated at $329 billion, or roughly 2.1% of U.S. gross domestic product[i]. This figure is reported as a combination of the losses caused by fire and the money spent on fire prevention, protection and mitigation to prevent worse losses, by preventing them, containing them, detecting them quickly, and suppressing them effectively.

The study of the financial consequences of catastrophes, such as fires and explosions, presents an unpleasant subject; however, these events provide a unique opportunity to evaluate how financial markets respond when major risks become a reality. A study funded by the Sedgwick Group examined the impact of catastrophes on shareholder value[ii]. Selected case studies focusing on major fire events are summarized below.

Chemical Plant Explosion
On May 5, 1988, the Norco refinery and chemical plant exploded after hydrogen gas escaped from a corroded pipe and was ignited. 2800 residents from nearby neighborhoods were evacuated. Seven workers were killed and 42 injured. The total cost of the vent was estimated at $706 million comprising of $409 million to replace equipment and $216 million in liability claims.

Oil Platform Fire
On July 6, 1988, one of two condensate injection pumps on the Piper Alpha oil platform in the North Sea failed. This resulted in a leak of condensate,

causing a small explosion, which knocked out safety equipment, and initiated a series of major blasts and a fire ball. Shortly thereafter the gas pipeline riser fractured, leading to a massive explosion and the collapse of the drilling rig—167 workers died. The principle cause of death was smoke inhalation and a few died of burns. The total final cost of the disaster was estimated at $1.4 billion.

Devastation of Semiconductor Supply Chain
The potential impact of relatively small fire events can also be catastrophic. A rather minor fire from a fire fighting perspective resulted in an estimated $2.4 billion loss due to a supply chain disruption[iii]. On March 17, 2000, a fabricator furnace at a semiconductor plant in New Mexico caught fire. The good news was that alarms sounded, the sprinkler system activated, emergency responders acted promptly and the fire was extinguished in less than 10 minutes. The fire event did not make headlines; however, the impact of the extinguished fire had global implications well beyond those of the plant owner.

Semiconductor fabrication must be completely clean. The actual fire damaged electronics that affected thousands cellphones worth of production. The real impact was the spread of smoke, soot and contaminates to all cleanrooms by responding personnel. These actions unintentionally destroyed millions of cellphones worth of microchips in a matter of minutes. Even worse than the damage to the microchips was the loss of production facilities and the extended downtime needed to return the cleanrooms to a pristine functional state.

Although precise figures are not readily obtainable, the worldwide cost of fire is much greater than that estimated for the U.S. Even though financial resources directed at achieving a desired level of fire safety are significant and noteworthy, the overwhelming concerns pertain to loss of life and permanent injury to our fellow humans such as occurred in fairly recent devastating fires in a nightclub, textile factory and metal production facility [iv,v,vi], the long-term damage to our environment such as from the Gulf Oil Spill[vii], and the unrecoverable losses associated with critical information such as in hospital archive facilities and a stock exchange data center[viii,ix], and the devastation of historic structures and our cultural heritage such as the loss of an entire historic Norwegian community consisting of wooden buildings [x].

Decisions prior to and during a fire event have a direct impact on the outcome.

Making Sense of Fire-Related Regulations

As previously noted, solutions to many common fire and life safety concerns are embodied in regulatory documents such as building and fire codes, system design and installation standards, and product safety standards. While often mandated by law, these documents are largely prescriptive in nature and usually provide an unspecified level of safety to a loosely described fire threat. Even so, it is critical that organizations understand and obtain agreement and approval on the intent and impact of the regulations, which are often subject to interpretation by the associated stakeholders, i.e. business owners and their agents, insurance company representatives, building and fire officials, regulatory agencies, etc. For certain industries such as Nuclear Power Production and Health Care Institutions, entire comprehensive sets of federally mandated regulations addressing a broad range of fire and life safety concerns among other subjects must be applied and firmly adhered to throughout the life of the facility.

In many situations, strict compliance with the prescriptive mandate of regulations is not a straightforward process. Perhaps more importantly, the regulations may not adequately address an organization's specific concerns associated with fire, explosion and life safety. To account for this, many regulations normally allow for an "equivalent" or "alternative" means of protection. Some regulations also formally allow for a "performance-based approach" during which solutions are developed using calculation and engineering techniques to demonstrate that the agreed upon and quantified fire safety goals can be achieved for a specified set of fire scenarios. In either case, a sufficient understanding of the technical and historic basis of the regulatory requirements and their intent is crucial.

While compliance with the applicable regulations usually ensures that appropriate permits and licenses for occupying and operating a facility or process system can be obtained, these regulations might not provide the desired outcomes for the range of fire events and explosions that pose a threat. For example, regulatory documents do not typically address property protection, business continuity, or preservation of cultural heritage. As such an analysis of the fire safety goals and objectives of the organization needs to be quantified and contrasted against those implied by the applicable regulations. In other cases, a higher or different level of life safety than that mandated by the applicable regulations might be desired.

While regulatory codes and standards form the cornerstone to many fire and life safety solutions, it is important to recognize that these documents usually serve as a starting point. Furthermore, they do not function as design guides or how-to-books. This is evidenced through the many

seminars and continuing education programs offered by code writing bodies and other groups. It needs to be further recognized that these regulatory documents need to be correctly interpreted and applied not only during the design and installation phase of a given project, but continually throughout the life of the given business venture as the protective systems put in place need to be properly maintained and updated to reflect the changing operations and associated fire risks of the organization.

Recognizing Ever-Changing Challenges

The changing landscape of our human existence continues to bring forth new fire and life safety challenges. Emerging technologies and societal preferences prompt an ever-increasing spectrum of issues, choices and decisions. In response, organizations need to be adept at properly addressing these challenges, and make well informed decisions.

Society continues to build taller, larger, more complex and visually iconic buildings, structures and transportation facilities[xi]. This trend translates to larger numbers of people exposed to more traditional and newer types of fire threats. The likelihood for greater economic loss also exists[xii]. The associated design and construction relies upon the use of a widening range of developing building materials, products, features and systems, all of which need to be considered and properly evaluated with respect to their risk to fire and life safety. This translates to the need for more sophisticated fire safety strategies, and the use of integrated systems and features to mitigate the associated risks.

Media reports bring to light some of the more recent noteworthy areas of interest with respect to fire safety. Such subjects include the push for unconventional means of oil and gas drilling, production and transport; the broadening use of green technologies for building design and construction; the use, transport and storage of high-energy batteries; oil spills in the artic; and firefighting tactics and equipment among others. Recent headlines and publications as noted below serve to capture the public's attention:

> "Oil From U.S. Fracking is More Volatile than Expected – High Gas Content Extends Beyond North Dakota's Bakken Shale to Colorado and Texas"[xiii]
>
> "Crude on Derailed Train Contained High Level of Gas – Cargo would have violated new vapor-pressure cap that goes into effect in April"[xiv]

"NTSB Sees Flawed Oversight of Gas Pipelines – Investigators Issue More Than Two-Dozen Recommendations"[xv]

"Fire Safety Challenges of Green Buildings"[xvi]

"Air-Safety Board Cites Failures Before Dreamliner's Battery Fire – FAA, Boing and Yuasa All Faulted Over Fire That Led to Fleet's Grounding"[xvii]

"Fire Hose Failure Uncovered; Researcher Sounds the Alarm – Boston Fire Fuels Study of Attack Lines Nationwide"[xviii]

"New Fires, New Tactics – As modern furnishings and construction methods lead to bigger, more aggressive fires, a wealth of new research is leading the fire service to reexamine fundamental practices for fighting residential fires"[xix]

A sufficient technical understanding of the physical phenomena associated with the newly developing fire and explosion threats is likely to be lacking, prompting the need for research, the creation of new products and systems, as well as the development or revision of regulatory documents and standards of practice.

Who's Influencing the Decision Making?

Decisions at the executive level include asset allocations to effectively manage an organization's risks from fires and explosions. Ideally, these decisions are informed through a fire risk assessment and the development of a comprehensive fire and life safety strategy that clearly articulates the agreed upon long-term goals of all stakeholders, which includes government officials who represent the public interest. As previously noted, validating the necessary choices is not always a straightforward matter, and developing an appropriate strategy requires much more than reading the applicable regulations.

Fire protection engineers (FPE's), who might also be referred to as fire engineers or fire safety engineers, are specially trained to deal with these matters, and serve many roles and functions for an organization whether as full time employees or contracted specialists. The FPE possess an in-depth grasp of the available fire risk and hazard evaluation techniques; mandated rules and regulations including insurance company recommendations; available technologies, products and systems; associated design principles, calculation techniques and testing protocols; as well as a thorough

understanding of the operations of the organization and the desired fire safety goals and objectives of all stakeholders.

The FPE is skilled in fire risk assessment and management, and can develop effective loss prevention strategies addressing the control of ignition sources and explosive atmospheres. FPEs are expert in the principles of combustion and explosions, the dynamics of fire growth and spread, and the production of smoke and harmful combustion by-products. While well versed with the applicable laws and regulations, they also possess a sound understanding of the techniques used to mathematically model fire behavior, fire safety system response and occupant movement. The FPE understands the application, limits and necessary coordination of the active and passive systems that serve to satisfy the overall fire and life safety goals. The FPE comprehends first responder protocols and manual firefighting operations, so that these procedures and activities can be integrated into the overall fire safety strategy. Additionally, the FPE needs to be prepared to conduct or manage fire investigations and forensic analysis, should an undesired outcome occur.

In the end, FPEs are relied upon for their recommendations. They need to confidently confirm that all applicable regulations are complied with, and that the proposed systems and features will satisfy the stated goals under the conditions specified, i.e. validation that the expected outcomes can be achieved for the fire scenarios to be considered.

Core Educational Criteria and Credentials for FPE's

No matter the profession, no one graduates from an institution of higher learning as an expert in his or her chosen field. Wisdom is gained from experience, skills are refined through repetition, and knowledge is best obtained through a sound and robust educational experience. Completion of such an educational and training program provides for a well-rooted foundation, and enables one to hit the ground running and make better choices sooner. It also better enables the continued life-long learning process, and the on-the-job mentoring process that is fundamental to many successful organizations.

Because many who desire to achieve a formal degree in FPE are currently working full time, those institutions that offer an advanced degree do so in a manner that allows the degree to be earned on part-time basis remote from the physical campus, i.e., the student can engage the curriculum through on-line networks from their present locations across the globe. This also allows for practicing engineers to apply their new skills on a real-time basis.

To establish a consistent and uniform educational baseline that a degreed fire protection engineer should possess, the Society of Fire Protection Engineers (SFPE) has developed a recommended model curriculum for both Undergraduate and Master's Degrees in Fire Protection Engineering[xx,xxi]. The model curriculum includes core as well as application and design courses. Certain core courses such as fire dynamics, introduction to combustion, fire safe building design including egress analysis, fire protection systems including hydraulic analysis, fire risk assessment, and performance-based design ensure that a fundamental understanding of fire, and what influences its behavior and effects are obtained.

Application and design courses provide for a more focused study of the subject matter and require students to apply basic engineering concepts to solve more detailed fire related problems. Courses in this category can include fire modeling; fire testing; detection and alarm systems; special-hazard fire suppression systems; smoke management systems; industrial fire protection; failure analysis and forensics; and business practices in fire safety among others. Depending upon the institution, the student would have the flexibility to choose their area of specialty or interest. In some cases a thesis project could be pursued to establish a more focused course of study.

Ultimately, FPE's should hold licenses, credentials or other designations that establish them as recognized and qualified professionals in their field, and hold them accountable for conducting themselves in accordance with an established code of ethics. Formal degrees in the Fire Protection Engineering establish the foundation for this credentialing, and best prepare the engineer for subsequent evaluations of their knowledge, skill and experience. In the United States, individual states recognize the professional engineer (PE) designation for fire protection following the successful completion of examinations, peer references and documented experience. Efforts are underway outside the US to establish similar rigorous credentialing and licensing programs.

Closing Remarks

Accidental fires are bound to happen even with the best thought out plans. Life in a world of zero risk is not possible, and peoples' sometimes-unpredictable behavior or unprepared responses at key decision points compound the negative effects of an undesirable situation. The intent, however, is to enable the best response by both people and systems to an incident so that successful predetermined outcomes are much more likely to

be achieved. Key decision points occur during the planning, design and approval stages of a given enterprise, and not just during the operational and reaction phases. Involvement by properly educated, trained and credentialed engineers in the field of fire safety greatly increases the odds for success.

So in closing, how confident are you that your fire and life safety decision makers have put your organization in the best position with respect to a potential fire or explosion event? What qualifications do they possess to give you assurance? Do you know your options for improving your odds?

About the Author

Milosh is the first Professor of Practice, and Director of Corporate and Professional Education in the Department of Fire Protection Engineering at Worcester Polytechnic Institute where he specializes in (a) fire protection and suppression systems; (b) fire hazard analysis and fire behavior; (c) means of egress and occupant movement; (d) building construction; (e) design and installation practices; and (f) building and fire regulations.

Milosh was previously Assistant Vice President at the National Fire Protection Association (NFPA) where he served as Secretary to the Standards Council overseeing the technical and regulatory development of all NFPA codes and standards. While at NFPA, Milosh also served as Principal Engineer holding responsibility for key technical projects including those on NFPA 13 - *Sprinkler Systems*, NFPA 14 – *Standpipe Systems*, NFPA 20 - *Fire Pumps*, NFPA 92 – *Smoke Control Systems*, NFPA 101 - *Life Safety Code*, NFPA 5000 - *Building Code* and the *Fire Test Standards,* among others.

As a practicing consulting engineer, and loss control specialist for the insurance industry, Milosh designed, specified and evaluated various types of active and passive fire and life safety systems, and led building and infrastructure projects across the globe.

Milosh remains active with fire protection engineering by: (a) developing and teaching graduate engineering courses and technical seminars; (b) evaluating building fire and life safety system performance; (c) conducting research in support of engineering practices and regulations; (d) authoring, editing and reviewing books and technical publications; and (e) serving on industry committees and panels, including those of the NFPA, the Society of Fire Protection Engineers (SFPE), and Underwriter's Laboratories.

Milosh is President-Elect and a Fellow of the SFPE, and is a member of the Society's Engineering Licensing Committee. Milosh holds two engineering degrees, is a registered professional engineer and routinely speaks at conferences and technical programs internationally.

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