# Chapter 9

# Moving Forward

## Chapter Contents

# MOVING FORWARD 9

## 9.1 INTRODUCTION

Fire protection and life safety design methods, practices, and tools can be categorized in the following dimensions:

1st Dimension — Prescriptive codes and standards primarily based on past loss experience.

2nd Dimension — Performance-based codes and engineering practices primarily based on deterministic fire or explosion modeling.

3rd Dimension — Risk-informed, performance-based methods that involve risk (likelihood and consequences) analysis, risk tolerance benchmarks, and cost/benefit analysis of risk reduction alternatives.

Traditional prescriptive codes and standards provide specific requirements that must be applied over a wide range of applications. They are generally straightforward; however, in many building and industrial applications, their feasibility, cost-effectiveness, and actual risk reduction benefit can be questionable.

Performance-based codes and fire safety engineering methods generally provide qualitative fire safety performance goals and objectives (requirements are usually related to means of escape, fire growth and spread, and structural stability) and deterministic performance criteria. For example, limits are established for life safety exposure factors such as temperature, radiant heat, smoke visibility, and toxic combustion products. Such codes and methods are hazard driven and do not incorporate risk-informed elements.

Third dimension, risk-informed, performance-based approaches provide:

1. Quantitative fire safety performance goals and objectives in terms of a *risk tolerance profile*. The risk tolerance profile is an indication of tolerable fire event likelihoods and consequences such as life safety, property damage, and business interruption.
2. Probabilistic performance criteria in terms of the conditional probability of fire protection system success given a defined scenario, a time-line, target threshold damage limits, and risk tolerance benchmarks.
3. A method to verify the risk and safety levels of existing or proposed fire protection design options in a quantitative manner and a method to evaluate the cost-effectiveness of multiple design alternatives.

Having the third “Risk-Informed” dimension provides a path forward for situations where the application of prescriptive codes may not be feasible or cost-effective, where the application of performance-based deterministic modeling to meet code equivalency has many uncertainties, or where there is a desire to conduct cost/benefit analysis of numerous fire protection alternatives.

The steps described in this book combine probabilistic and deterministic methods for risk-informed decision making. The approach provides validation of prescriptive code and

performance-based code or design applications by objective risk-based comparison with company, industry, or code required risk tolerance benchmarks.

As Ken Dungan states:[1]

> *In fire safety, code requirements have evolved largely by trial and error, or more accurately, error then trial remedy. In response to consequences which society deems unacceptable, something must be done. So our codes are peppered with anecdotal driven requirements. All usually agree on the consequences to be prevented or mitigated, but far fewer agree on the likelihood of our success, which provides the basis for cost-benefit. These comments are not intended to criticize current codes and standards, but rather to emphasize that using risk (likelihood x consequence) as opposed to hazard (consequence) is necessary for the success of performance-based fire safety.*

Without risk tolerance criteria or benchmarks, decision makers cannot make rational risk-based decisions concerning fire safe design strategies. Without risk tolerability criteria, it is very difficult to obtain an optimal level of fire safe design, which can be quantitatively validated. Once criteria are developed, they provide designers and fire protection engineers the opportunity to develop cost-effective options and alternatives to meet agreed-upon fire risk tolerance profiles and benchmarks.

Risk-informed approaches will be adopted at various levels by review and approval groups including building code officials, fire marshals, insurance companies, and regulatory agencies.

The following is extracted from a white paper on risk-informed and performance-based regulation issued by the Nuclear Regulatory Commission (NRC) in 1998:

> *A "risk-informed" approach to regulatory decision-making represents a philosophy whereby risk insights are considered together with other factors to establish requirements that better focus licensee and regulatory attention on design and operational issues commensurate with their importance to health and safety. A "risk-informed" approach enhances the traditional approach by: (a) allowing explicit consideration of a broader set of potential challenges to safety, (b) providing a logical means for prioritizing these challenges based on risk significance, operating experience, and/or engineering judgment, (c) facilitating consideration of a broader set of resources to defend against these challenges, (d) explicitly identifying and quantifying sources of uncertainty in the analysis, and (e) leading to better decision-making by providing a means to test the sensitivity of the results to key assumptions. Where appropriate, a risk-informed regulatory approach can also be used to reduce unnecessary conservatism in deterministic approaches, or can be used to identify areas with insufficient conservatism and provide the bases for additional requirements or regulatory actions.*

## 9.2 TAKING ACTION

An old Chinese proverb states:

***I hear, and I forget***
***I see, and I remember***
***I do, and I understand***

The best way to learn, apply, and enhance the information, steps, and tools presented in this book is to take action and "learn-by-doing." The best feature about the steps in this book is that you can take action by applying one step, multiple steps, or all the steps in various levels of detail depending on the specific focus of the risk-informed project. Project focus generally stems from the particular motivation behind management's decision to perform a risk-informed, performance-based study.

Typical motivating factors can involve:

- New construction projects where code requirements are hampering the design of innovative process facilities, structures, or new technology operations.
- The need to develop fire risk reduction alternatives to comply with recommendations (which may not be feasible or cost effective) made by fire inspectors, insurance companies, or regulatory authorities.
- Risk management concerns such as, "what are my biggest fire and explosion risks?" (risk-informed information); given a fire, how well will the fire protection systems perform?" (performance-based information); how do I optimize the available fire risk reduction budget?" (cost-benefit analysis).
- Third-party liability potential such as off-site risk to the public from a large fire or explosion incident.
- Supplementing plant programs and assessments such as:[2]
  - capital improvement planning
  - management of change
  - fire system impairments or modifications
  - risk-based inspection or maintenance
  - risk-based operator training
  - emergency response planning
  - facility siting risks
  - decommissioning projects
  - loss incident investigations

As stated in reference [2], getting started may first require an examination of your company's philosophy concerning "risk-based" decision-making, including:

- Are your company's values and beliefs compatible with an objective risk management strategy?
- Does your company have an effective process safety management system to help control risk?

- Are there policies and standards that support the reduction of fire and explosion risk to protect assets, productive capacity, and public trust?
- Will your company's senior management and attorneys agree to a written risk tolerance criteria?
- Will the company really try to reduce risk if judged excessive?
- Does the risk management staff have the total support of upper management?
- Does plant management support this initiative?

Risk-informed, performance-based assessments are a powerful tool to minimize and control fire or explosion risk; however, these assessments may be difficult to implement if your company or organization does not provide an effective support structure. In some cases, full support will follow the completion of a pilot-project that proves some positive benefits resulting from the assessment. Therefore, find a pilot-project, take action, and learn by doing.

## 9.3 FIRE RISK FORUM

Fire Risk Forum (FRF) is an online internet resource providing a continuing education platform and informational tool for those interested in risk-informed, performance-based fire safety and risk-based decision making.

The web site address is:

**www.fireriskforum.com**

Figure 9.3.1 presents the FRF homepage. The overall objectives of this web site include:

1. Promoting interest in Risk-Informed, Performance-Based Fire Safety.
2. Encouraging an exchange of ideas and information via an online forum.
3. Sponsoring books, publications, and seminars.

FRF provides an extension of this book by providing a forum to ask questions, share information, and discuss risk-informed applications and projects.

Through your participation and input, FRF intends to develop seminars and publications that will focus on project examples and computer modeling tools.

**Fig. 9.3.1: Homepage of Fire Risk Forum (www.fireriskforum.com)**

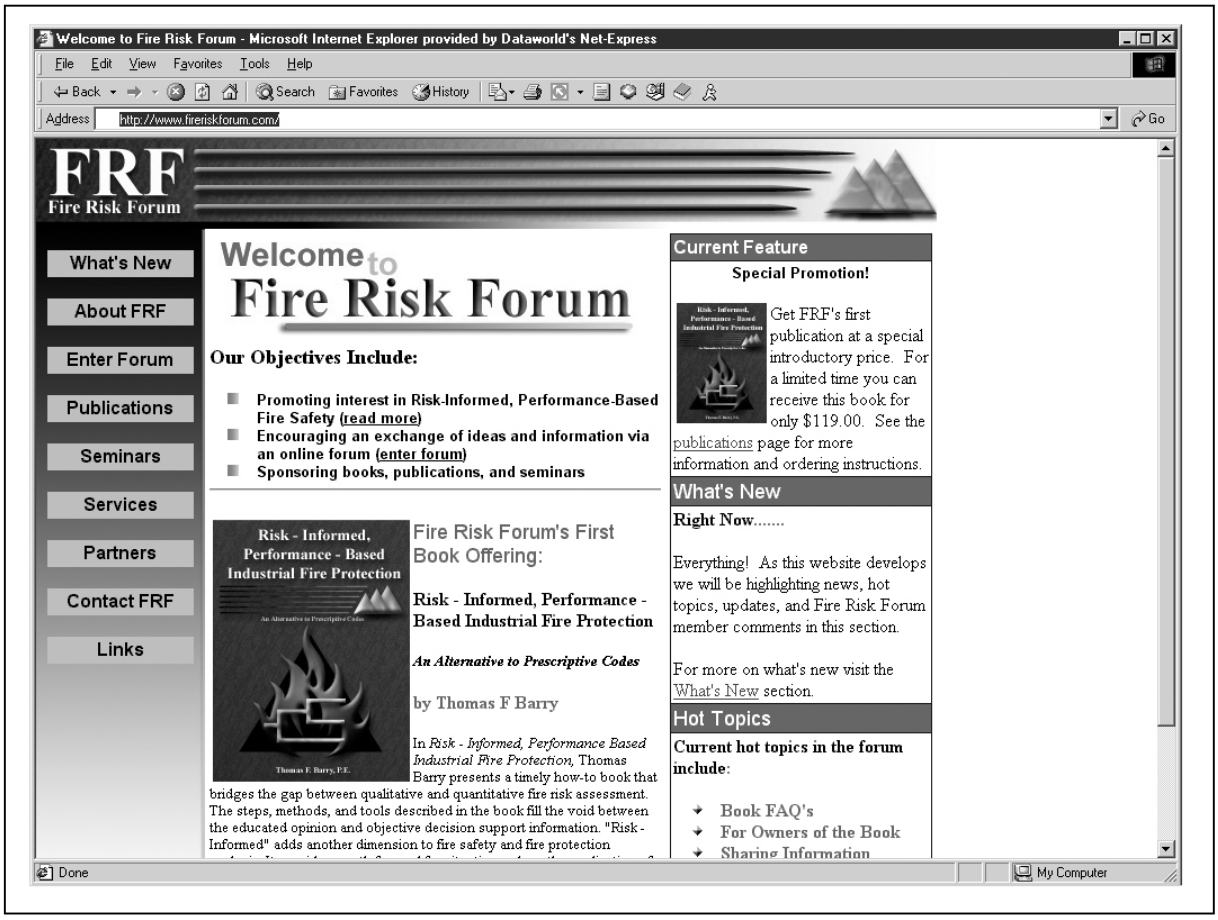


Figure 9.3.2 presents the FRF forum page, which presently includes the following topics:

**FRF Information Exchange:**

**News and Events** – Help keep Fire Risk Forum members up-to-date on latest news related to risk and performance-based fire protection, new software, products or services, and upcoming seminars or workshops.

**Software Talk** – Share information and voice your opinion on various zone and field fire models; risk and decision analysis programs including fault tree, event tree, and reliability software. Various special purpose and explosion models are also open for discussion.

**Sharing Information** – Questions on fire and explosion risk or performance? Add information, references, seminars, books, services, or internet links that may be of benefit to Fire Risk Forum members.

**Book Questions & Answers:**

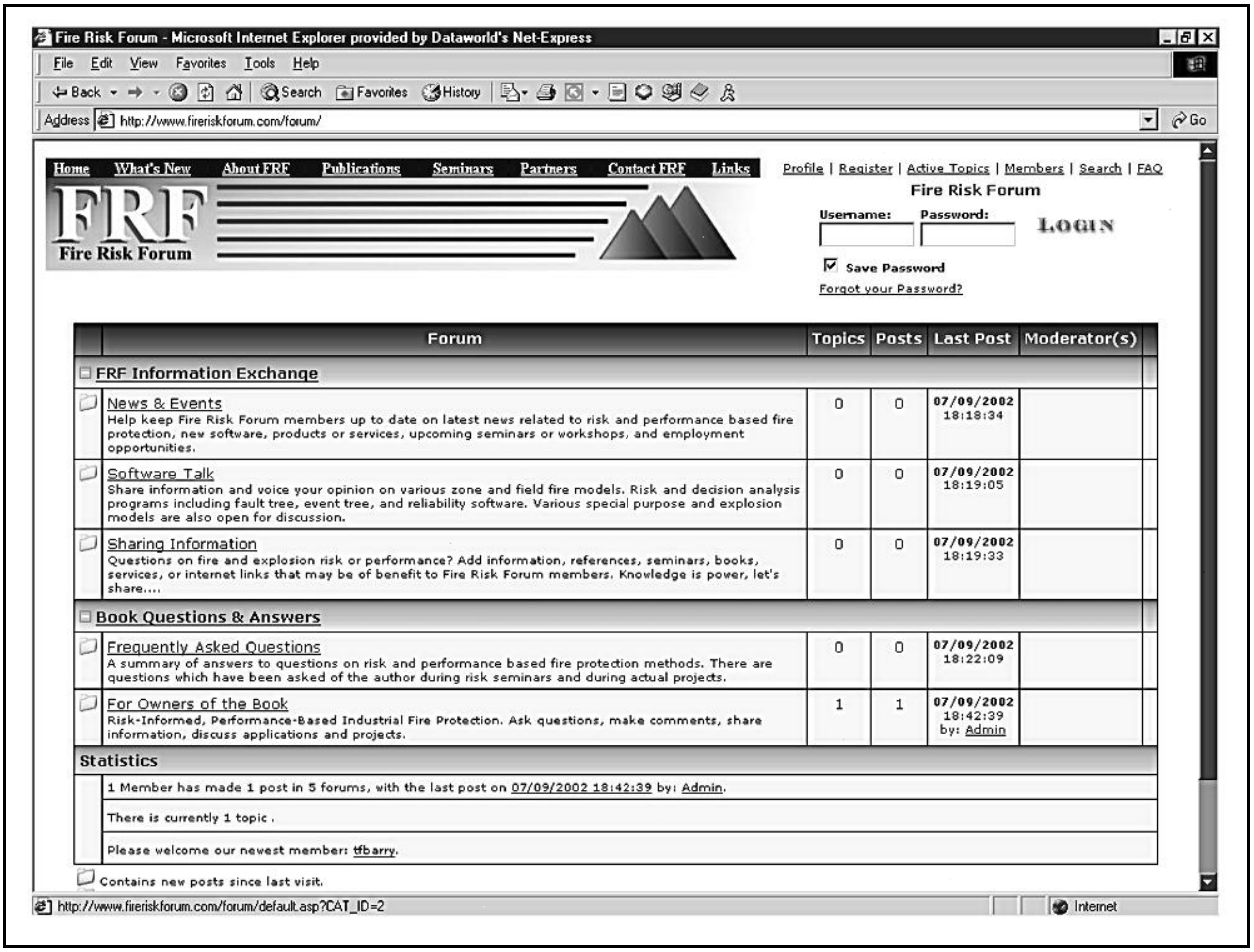
Book: *Risk-Informed, Performance-Based, Industrial Fire Protection*

**Frequently Asked Questions** – A summary of answers to questions on risk and performance-based fire protection methods. There are questions that have been asked of the author during risk seminars and during actual projects.

**For Owners of the Book** – Ask questions, make comments, share information, and discuss applications and projects.

Please join us on the internet and participate in the Fire Risk Forum. Knowledge is power, let's share it and use it to support the progression of risk-informed, performance-based fire safety applications.

**Fig. 9.3.2: FRF Forum Topics Page**



## 9.4 REFERENCES

1. Dungan, Ken W., *Practical Application of Risk-Based Methodologies, Fire Protection Engineering*, Spring 2001, Issue No. 10, published by the Society of Fire Protection Engineers (SFPE), Bethesda, MD.

2. *Center for Chemical Process Safety (CCPS), Layers of Protection Analysis: Simplified Process Risk Assessment.* American Institute of Chemical Engineers, New York, NY 2001.