# Fire Incident Documentation for the Twenty-First Century

A System for Post-Incident Documentation of Building Performance

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ABSTRACT

The BPRI and its research partners have been developing the methodology for a Building Performance Database to address the information deficiency that exists relative to accurate "real" fire data. The origins of this project can be traced to the concern that there is currently no broad-scale method of collecting, recording, and analyzing the performance of building components and systems when subjected to the effects of a structure fire.

In addition to providing an organized means of analyzing building performance for building/fire prevention code development and validation, this project encourages collaboration and cooperation between the fire service and building design professions, thereby fostering a better understanding of each others role in fire safety. The result and overriding goal of this project is to reduce the loss of life and property from fires, while creating realistic cost-effective solutions for occupant and firefighter fire-safety in buildings.

This paper will present an overview of the project methodology, a history of the research endeavor as well as a summary of current progress.

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# PART I –FIRE AND CODE HISTORY IN THE UNITED STATES

### A NEW CENTURY, THE SAME CONCERNS

As we enter the 21st Century, the United States finds itself facing many of the same problems it has during the past century. According to US Fire Administration data, the number of fires and number of fire-related deaths has not decreased significantly over the past 10 years. This appears to indicate that while we are making technological progress in some areas, we have still not truly addressed our “fire problem”.

Advances in fireground tactics, and improvements in firefighter protective equipment have allowed our fire service to become more aggressive in suppression and rescue activities. Additionally new technology in automated detection and suppression systems have allowed for safer buildings.

Yet we still have a problem.

### A CHANGE IN BUILDING DESIGN

As our nation's building stock ages we are faced with the need to renovate significant older structures and design new ones to provide us with the facilities in which to live and conduct business. The renovation of "historically significant" structures as well as the design and construction of new technically advanced building types is the current mainstay of the building design/construction community.

This provides a challenge to the building design industry: How to improve the aesthetics, functionality, and integrity of a space while maintaining fire and life-safety. To make these criteria possible, they must be achieved without incurring significant additional cost. An answer to these needs lies in the development of Performance-Based code methodology.

Performance-based design (PBD) is characterized by the elimination of specific code requirements, and the creation of language describing the *intent* of the code requirements.

To understand the importance of developing a performance-based building design system and why the, one must first briefly evaluate the history and evolution of our building codes.

### EXISTING BUILDING AND FIRE CODES

The current code language in the United States is primarily comprised of what is classified as Prescriptive Based language. This approach is often referred to as the "Cook Book" approach, as the requirements for a specific building type or occupancy are listed in a lengthy standardized fashion. With this approach, as designer will look through the code manuals to determine what "ingredients" are required for his/her building, and then create the building around those required dimensions, ratings, equipment types, etc. While these requirements have provided us with a presumably acceptable level of safety, the code language is often the result of outdated information. Historically, building codes have been developed without adequate scientific or statistical information. As subsequent editions of codes have been authored, often addendum and requirements have been added without reviewing the history of the existing language. While not common, this has resulted in the misinterpretation of previous information and even the incorrect transcription of data. This has lead to the inclusion of many non-validated stipulations that are based merely on negotiated values.

Additionally, in the aftermath of a significant incident, code requirements are often created or refined. While there is merit to this approach, the resulting provisions may be hasty, piece-meal, and lacking in actual quantitative analysis. Given the knowledge and scientific examination that is available today, the non-evaluative approach is no longer the *optimal* approach. Moreover, the current level of safety provided by the prescriptive codes has not been thoroughly evaluated or quantified.

## THE HISTORY OF CODE DEVELOPMENT

The current methodology can be attributed to our nation's (and the world's) experience with fire. In the aftermath of a significant fire incident, a new code requirement was typically an expected result.

For example, Fires such as that in the Asch Building in 1911 (better known as the Triangle Shirtwaist Factory Fire) had been the turning point for many factory and group occupancy building code changes. New York City officials were forced to face the inadequacies of their fire safety requirements and enforcement policies following the loss of over 140 lives on Saturday, March 25, 1911.

The Triangle fire also highlights the arbitrary nature of prescriptive building codes. At 135 feet, the Asch Building was just below the 150 foot limit for that construction type[1] which allowed the floor structure and interior/exterior trim to be built of combustible construction. The somewhat arbitrary height/material requirement clouded the true intent of the code, and thus allowed an inherently dangerous condition to exist, merely because it complied with the letter of the law. A building of 148 feet can be expected to present the same emergency egress and fire suppression difficulties as a similar building of 150 feet, yet the negligibly taller building is held to a higher level of safety. A simply stated performance objective would lead to an appropriate level of safety in either building.

This procedure of *reacting* to an event is still commonplace in code development. In 1998 two residential high-rise fire incidents occurred in New York City. These disasters resulted in the city’s residential sprinkler ordinance. The December 23 fire in a 51 story “non-combustible” luxury building resulted in four civilian deaths. A week prior, three New York City Firefighters were killed in a board-and-care facility fire. Despite New York City's infamous Local Law 5, the need for improved fire safety education and protection in multi-unit housing was again in the limelight. In March of 1999, the City Council passed legislation requiring sprinklers in residential structures of more than four units. The requirement of suppression systems was an admirable decision, however it falls short of addressing the larger problem of inadequate building maintenance and smoke/heat migration in high-rise fires.[2]

These incidents did contribute to "improvements" in the codes, however, the hasty response to a catastrophe usually does little more that further complicating and diluting the existing codes.  A performance-based modification is one attempt at distilling the many prescriptive requirements down to more simplified objective-based requirements.

### PERFORMANCE-BASED DESIGN: A VERY BRIEF OVERVIEW

The building design and construction community has recognized these shortcomings and has ventured into the realm of performance-based fire and life-safety design of buildings.

This new code methodology is defined by the conservative design of life-safety systems based on scientific engineering analysis of realistic, expected fire scenarios. The analysis relies on using experience, professional judgment, and statistical data to quantify the anticipated actual level of building safety. While this approach to fire and life safety is seen as somewhat new, it has been practiced in the field of structural engineering for several decades.

There are many tools available to the designer when performing a performance-based design. Recent developments in fire incident modeling, calculation methods, and building components and systems allow designers to offer unique progressive solutions to fire safety in buildings. [3] Much of this information is the result of the improved evaluation of test fires on both a large and small scale. Although performance-based design is rapidly gaining acceptance and is being implemented for selected complex projects, there are still many roadblocks to overcome before it will be more uniformly accepted.

## PART II – FIRE AND FIRE DATA

### THE FIRE PROBLEM

The total cost of fire in the United States exceeds $60 billion annually.[4] On average, each year there is a fire in a mid-rise building (three to seven stories) every six minutes and in a high rise every two hours.[5] Additionally, once every eighty-two minutes an occupant of a multi-story building dies or is injured during a fire event.[6]

Despite some minimal improvements in these statistics, the United States still has the second highest per capita death rate due to fire in the industrialized world.[7] Although there is good data with regard to the frequency of these fire incidents, the causes of such are still not adequately tracked. The FEMA/United States Fire Administration's National Fire Incident Reporting System (NFIRS), National Fire Protection Association's Annual Survey of Fire Departments, and NFPA’s Fire Incident Data Organization (FIDO) have been implemented to address these needs. While each of the databases provides substantial data and analysis of fire incidents, in-depth information regarding the actual performance of the building, the building’s systems, or the human response to fire is still a deficiency.

The need for this type of data has been identified many times by various groups of experts assembled to review our nation's fire dilemma. As performance-based design and alternative fire-safety methodologies gained exposure in the United States in 1991, the need for more detailed fire incident data was highlighted during the Conference on Firesafety Design in the 21st Century held at Worcester Polytechnic Institute.[8]

Eight years later, at the Second Conference on Fire Safety Design in the 21st Century, the "Lack of an incident reporting system that can be directly compared to performance-based design goals and can be used to directly measure the adequacy of performance-based codes"[9] was identified as one of the remaining "barriers" to widespread acceptance, implementation and enforcement of performance-based design.

In early 2000, the *America Burning, Recommissioned* Panel identified a similar concern in their *Principal Findings and Recommendations* Report[10]. In Finding #4, the committee reiterated that "After-action data, which is not currently collated should be collected and analyzed by the center. Such data should identify the pre-event activities, (e.g., preventive actions, codes or standards, training) and response activities (including equipment, techniques, etc.) proved most effective."

## AN ANSWER TO THE PROBLEM

In an attempt to address this information deficiency, the Building Performance Research Institute, an Idaho 501(3)(c) non-profit research entity has accepted project management and administration responsibilities for the development and implementation of a Building Performance Module Adjunct to the National Fire Incident Reporting System (NFIRS). The project has been titled **postFIRE™**: Performance Observations of Structures/Fire Incident Research and Evaluation.

This project was initiated in 1997 under the guidance of the American Institute of Architects (AIA) Center for Building Performance (CBP) Fire and Life Safety Task Force. Through the support of the AIA, the project was able to make significant progress during 1999-2000. However, due to corporate restructuring, the CBP was no longer able to facilitate this project, and has ceded management responsibilities to the BPRI.

Throughout this process, members of the American Institute of Architects (AIA), in cooperation with staff from the National Fire Protection Association (NFPA) and members of the Society of Fire Protection Engineers (SFPE) have been developing the methodology for a Building Performance Database to address the information deficiency that exists relative to accurate “real” fire data.

The London Fire Brigade, Copenhagen Fire Brigade and the fire service in New South Wales Australia have initiated similar efforts in their own jurisdictions. While the level of performance-based design varies in each of these nations, the data collected is an invaluable resource by which existing buildings and codes can be analyzed.

## A TEAM EFFORT

A Project Advisory Board consisting of architects, fire protection engineers, fire service officials, and building code administrators has been assembled to support and advise the project direction and implementation. The Advisory Board will coordinate meetings, reviews, and other discussions as necessary during the development of the project.

The Fire Prevention Bureau of the Boston Fire Department has eagerly adopted this project and assisted in the establishment of a Pilot Program in the City of Boston, MA. In October, 2000 an orientation program for members of the Boston Fire Department Fire Investigation Unit, members of the Boston Society of Architects (BSA) and members of the New England Chapter of the SFPE. In future months, this workshop will ideally be supplemented through additional classroom and field training exercises. The actual data collection process will include the evaluation of fire scenes by an Architect and a Fire Protection Engineer in conjunction with fire department Fire Investigation and/or Fire Protection Engineering personnel.

**PROJECT METHODOLOGY**

In addition to providing an organized means of analyzing building performance for building/fire prevention code development and validation, this project encourages collaboration and cooperation between the fire service and building design professions, thereby fostering a better understanding of each others role in fire safety. The result and overriding goal of this project is to reduce the loss of life and property from fires, while creating realistic cost-effective solutions for occupant and firefighter fire-safety in buildings.

Accurate data is needed to determine the effectiveness of various types of building components and systems, thereby providing useful feedback for prescriptive code developments. The data will also establish realistic performance requirements within the constructed environment. Initial research will focus on commercial, institutional, multiunit housing and mid/hi-rise structures. The data collected will be beneficial to all building types regardless of use classifications. The result of this effort will be an improvement in the availability of information needed to economically design and construct buildings that can be effectively protected from fire.

The core of the project consists of the evaluation of actual fire incidents. Both large and small fires will be investigated as there is as much potentially viable information that can be recorded from fire protection “successes” as from disasters. This perishable data will be evaluated and recorded at the fire scene. Additionally, design and code reviews can be conducted at a later date if conditions warrant.

Once the data elements and recording methodology have been fine-tuned, a technology-transfer program will be established to train individuals in the data collection nation-wide. The intent is to provide for the effective collection of data in any jurisdiction regardless of their access to full-time design professionals such as architects and fire protection engineers.

## CONCLUSION

As our built environment rapidly changes, so are the ways that we are addressing fire and life-safety issues. To meet these needs, we must complete the "paradigm shift" as related to the need for accurate, usable fire data and its applicability to both prescriptive and performance-based code reforms.

The occupants of our nation's buildings and the rescuers who are called upon when fires occur in these structures are deserving of an increased, more uniform level of safety. The cooperation of the design community, the fire service and code officials will be critical for this improvement. With the participation of the BPRI and its collaborators, we anticipate the ability to facilitate this progress through the use of the postFIRE system.

Only together can we work to achieve a more fire safe future.

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