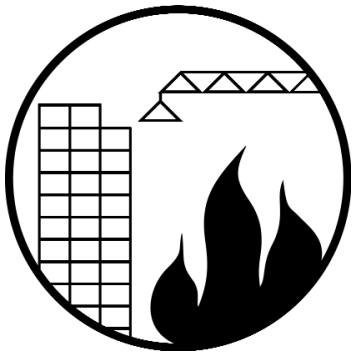
Building and Fire Research at



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ABSTRACT

In the last quarter of the 20th Century, building and fire research programs at the National Institute of Standards and Technology, formerly the National Bureau of Standards, provided one of the most significant sources of technology, measurements and standards for the construction and fire safety communities of the world. These communities are of great social and economic importance. The built environment shelters and supports most human activities. Its functionality, safety, environmental quality, aesthetics, and economy are important to everyone's quality of life and productivity. In the United States, new construction, renovation, operation and maintenance of constructed facilities amount to over 1/8 of the Gross Domestic Product, and the costs of fire protection and losses to unwanted fires exceed $200 billion, annually. This history summarizes the technical accomplishments of these programs and their impacts, the existential and management challenges faced by the programs, and the visions and efforts of the staff.

KEY WORDS: Building and fire research, built environment, codes, earthquakes, economics research, environmental systems, fire-hazard assessment, fire simulations and suppressants, life-cycle cost methods, materials, measurements, refrigerants, smoke detectors, standards, structures, test methods, wind.

FOREWORD

In April of 2000 Richard Wright suggested that his colleagues on the staff of the Building and Fire Research Laboratory, current and retired, update the history of the Laboratory. The history of building research would be from 1974 when the last history was produced to 2000. The history of fire research would be from 1968 to 2000. The date 1968 is that of the first of a flurry of legislative actions that ultimately established a separate Fire Research Center (this was the title in the law; NBS always called it CFR) at the National Bureau of Standards. Until 1968 fire research for buildings had been part of the broader program in the Building Research Division. Here we have the result of the efforts of a great many people. Read and enjoy it.

The years 1968 to 1977 or so encompassed the formation and maturation of the independent fire research effort at the Bureau. This was also the time when the consumer movement in the Nation peaked and began to decline, most notably, for CBT and CFR, in terms of appropriated budgets. This lack of budget support was odd in that whenever management needed examples of NBS work done with an impact on society the examples were very often drawn from the building and fire programs.

The budget difficulty became worse for both centers during the Reagan Administration when, at one period of several cycles, the budgets were zeroed out by the Administration. The Congress restored the funds but each time we lost a little more so that at this writing the staff level of the programs is way below what it was in the 1960s.

(However, the Congress is injecting large sums into BFRL, as this is being written, for investigation of the collapse of the World Trade Center in 2001. The nature of this work is not new for the BFRL, only the magnitude of the collapse, and the losses involved.)

Much of the work of the two programs was and is hands-on engineering whether in drafting proposed design standards, developing and proposing methods of test,

and, often, investigating disasters. In investigations the centers have been expected to analyze their findings and to draw conclusions as to likely causes and to recommend improved practices. These activities placed the two programs in the thick of controversy over the proper design of structures and the best use of materials and systems. Some of the investigations were done in the spotlight of the news media and under the control of the court system. Examples include the, collapse of the Skyline Plaza complex during construction in 1973, the 1975 study of fire safety in the D.C. metropolitan buses and subway cars, the Harbour Cay condominium (Cocoa Beach) collapse during construction in 1981, and the walkway failure in the Hyatt Regency Hotel at Kansas City in 1981. This building was in service at the time of the failure.

NBS through CBT has responsibilities for earthquake hazard mitigation working with three other Federal agencies and the states. The reports of findings from studies of several major quakes brought CBT and NBS before the Congress and into the media frequently and in a very positive light. CBT also has played a significant role in wind hazard studies; e.g., Hurricanes Hugo and Andrew. These activities are primarily the exercise of professional skills and responsibilities and are not primarily research. NBS has been asked to do this work because of its reputation for even-handed, unbiased work.

A particularly interesting project was the study in 1986-87 of the structural integrity of the newly built and unfinished Moscow chancery building of the United States Embassy complex. A team of specialists went to the USSR in the dead of winter at a time when tensions were high between the two countries. The team climbed all over the structure, both inside and out, and concluded that the structural problems could be repaired for a reasonable sum of money. However there were issues with respect to security that held up the repairs.

The work in standards and codes is less dramatic and garners little publicity outside the trade press. But it is this work that ultimately produces changes in design practices and leads to safer more durable structures, products and systems. Sometimes it will take years or even decades to effect a major change and only an organization with the characteristics of NIST has the funding and the patience to follow through on a proposal. Examples in both fire and building work will be found throughout this history. The fire program, for example, struggled for years to limit the use of a horizontal tunnel test to specific constructions. The test had been incorporated by reference into the building codes throughout the country. It took many years of presentations and argument to make the change. Similarly CBT had studied energy use in buildings before the 1973 oil crisis but many years went by before CBT's conclusions were adopted in the appropriate model codes and standards.

Underlying this work has been a solid program of scientific research. The fire program benefited a very great deal by the Congress' transfer of the package of National Science Foundation grants in the fire area. These were mostly at universities and the transfer brought to CFR a group of distinguished academics. The best-known fire researcher was Professor Howard Emmons of Harvard whose work on modeling fire in enclosures was seminal. The studies of fire deaths and injuries carried out at Johns Hopkins Applied Physics Laboratory provided the basis for NBS' program on the toxicity of fire gases. The fire program had lacked sufficient research; the transfer from NSF at a stroke provided this necessary ingredient.

A second transforming event was the establishment by management and Congress of what we came to call the "NBS Competence Fund." In this effort the Bureau was allowed to invest a few millions of dollars a year in projects of scientific research not specified in the appropriation request but decided upon internally. This program was especially beneficial to CBT, which had a small fraction of direct appropriations. Both CBT and CFR benefited. Pay-off from many fundamental programs often takes years. Examples are the fire modeling from first principles by Howard Baum and Ron Rehm; work that was supported early on by the Competence Fund and later was continued by regular funding. This work began in the 1970s and con-

tinues to this day. Studies of wind damages and earthquake phenomena have had the same long lives. NBS work on polymer structure vs. thermal stability, originally started in the 1960s in the NBS polymer program, has been extended elegantly in the fire program. CBT carried out fundamental work on details of Portland cement hydration for high-performance concrete. Bruce Ellingwood led a program to introduce into building codes and standards probability-based load criteria for use in structural design. This new concept is now broadly accepted. One last example is Emil Simiu's studies of chaotic dynamics, work supported in part by Competence funding. This phenomenon is best exemplified by the galloping failure of the Tacoma, Washington Narrows Bridge many years ago. The work indicates the conditions under which this phenomenon is likely to occur and guides the designer away from the danger zone.

The reader who was there during these times will enjoy the refreshing of his or her memories; for those who were not there, this history is full of interesting stories that will increase their appreciation of the role these two programs play in our National life.

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Many persons contributed to the preparation of this history. Without them, this account could not have been possible. The following persons made substantial contributions to this history.

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Chapter 14	James Gross, James Pielert, Robert Dikkers, and Richard Wright
Chapter 15	Bruce Ellingwood, Nicholas Carino, Emil Simiu, John Gross, and Richard Wright

As with all histories, important facts and key people are inadvertently omitted from the account. For the missing content and failure to recognize human resources during this 25-year History, the author regrets the omissions.

Noel Raufaste edited and formatted the History for publication, and worked with contributors to identify text and to prepare the many illustrations. In addition, he made great career contributions to the History. For example, the general interest documents, Project Summaries, and Publications reports that he prepared over the years of the History were vital sources of information for its preparation.

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