

Summary

The symposium on Fire Safety: Science and Engineering was organized with the intent of offering an up-to-date review of the results of fire research. The papers presented at the symposium cover a gamut of topics: fire risk, performance standards, fire modeling, fire safety of structures, flame spread, the smoke problem, sprinkler, and human aspects of fires.

The keynote paper by H. E. Nelson deals with a newly emerged branch of engineering: fire protection, the teachings of which are available now to all who care to use them. Not too long ago codes and standards were based largely on experience and judgment and allowed little flexibility in accommodating new designs. Basic research has yielded a pool of information sufficient to allow many important decisions on fire safety to be made on solid scientific grounds. The key to the success of this new branch lies in the bridging of the communication gap between the researcher and the user of his information.

E. W. Marchant lists 14 aspects of building performance. The fire safety performance interacts with all other aspects. There is a trend in building regulations whereby the conventional prescriptive approach is giving way to the performance concept, which allows flexibility in complex situations. The movement toward that approach is almost complete in England and Wales.

J. R. Beyreis and G. T. Castino argue that fire test methods and building codes and standards have been based mainly on experience. They claim that fire risk assessment is an orderly process relying on the integration of fire test methods and building codes and standards as a means of responding to experience.

The next five papers deal with preflashover fires. B. T. Lee presents experimental results on various interior finish materials obtained by using the proposed ASTM standard room fire test, entitled, "Proposed Standard Method for Room Fire Test of Wall and Ceiling Materials." Employing three different fire scenarios, he finds that, although all three are satisfactory for differentiating between the finishes, one allows a very comprehensive evaluation. The heat flux incident on the floor and the doorway air temperature appear to be the most consistent parameters for evaluating fire buildup and flashover.

S. E. Magnusson and B. Sundström present a computational technique for predicting, from the results of small-scale experiments, fire growth in a room

lined with combustible materials. The model regards the fire process essentially as a concurrent flame spread phenomenon. The results of seven full-scale tests are used to define some undetermined parameters. Further experimentation is needed to assess the validity of the technique.

The problem of fire development in a room and the subsequent spread of smoke and toxic gases is discussed by W. W. Jones. An improved numerical scheme is presented which is considerably faster and more "rugged" than previous techniques used to follow up the process.

A. M. Kanury presents a preliminary study on the scaling of compartment flashover. It provides a framework for synthesizing experimental observations on flashover.

A stochastic model of fire growth, developed by G. Ramachandran, regards the growth of fire as consisting of various states. The model, based on data furnished by fire brigades in the United Kingdom, is capable of predicting the probability distribution of fire duration in each of the various states and the probability of transition from one state to another.

Two papers deal with postflashover fires. That by U. Wickström proves that all fires can be described by a single characteristic curve, which takes account of the influence of ventilation and wall properties in terms of a modified time. This curve is considered an improvement over standard temperature-time curves, such as that of ISO 834.

T. Z. Harmathy and J. R. Mehaffey discuss the normalized heat load concept of calculating the destructive potential of postflashover fires with the aid of six input variables, two of which are random. The authors outline two methods of designing building elements for prescribed levels of fire safety. Using these methods, decisions on fire safety can be based on economic considerations: balancing the cost of fire protection against the value at risk.

The calculation of the fire resistance of building elements is discussed in three papers. T. T. Lie and T. D. Lin present a numerical scheme for determining the fire resistance of reinforced concrete columns. The calculation scheme has been based on a series of experiments in which the effect of load, column size, and type of aggregate proved to be the variables having the largest influence on the column performance.

The structural response and fireproofing requirements for steel frame structures under different fire exposures are discussed by B. Bresler and R. H. Iding. Using analytical techniques, they show that some realistic fires, such as long-duration, low-intensity fires or short-duration, high-intensity fires, may produce lower thermal and structural distress in steel beams than a standard fire exposure of ASTM Method for Fire Tests of Building Construction and Materials (E-119-83). They suggest that the fireproofing requirements be developed using appropriate fire categories.

D. C. Jeanes claims that the structural performance of steel-framed floor systems can be predicted more accurately with the FASBUS II computer than

with the traditional ASTM E 119 method. The computer code can simulate the fire conditions more realistically and will provide the designer with more information.

An experimental procedure for measuring some material properties related to ignition and flame spread is described by J. G. Quintiere and M. Harkleroad. The apparatus uses a radiant heat source. The results appear to yield phenomenological constants on the ignition and flame spread characteristics of the materials, rather than factors dependent on the apparatus.

V. Babrauskas and J. F. Krasny show that it is now possible to predict, from simple bench-scale tests, whether the ignition of a single upholstered item can lead to flashover. Experiments using the cone calorimeter can supply the information needed in the prediction.

The smoke problem is discussed from three different points of view. D. D. Drysdale and F. F. Abdul-Rahim show that the quantity of smoke released in a compartment fire depends not only on the nature of the material but also on the conditions of burning. The yield of "cold" smoke appears to be greater than the quantity predicted from the dynamic measurement of hot combustion products issuing from a test rig.

Talking about heating, ventilating, and air-conditioning (HVAC) smoke management systems, L. Milewski points out that today's HVAC systems have been optimized to do their specific tasks. If intended to play a role in smoke management, their design should reflect that added role.

L. Y. Cooper introduces the concept of smoke compartmentation and discusses the importance of cross-door pressure differential in the spread of smoke. He reviews existing and potential test methods for measuring the leakage characteristics of doors.

The toxic hazards from fires in furnished rooms are analyzed by A. F. Grand et al, based on the results of full-scale experiments. The toxic hazard appears to increase drastically a few minutes before flashover. The authors believe that fast-acting sprinklers would prevent any significant toxic threat.

The development of the early-suppression, fast-response sprinkler is dealt with in C. Yao's paper. In the design of sprinkler systems, a balance has to be struck between three important parameters: convective heat release rate, actual water delivery density, and required water delivery density. In an extensive program initiated in the author's laboratory, the criteria of early suppression will be defined and used in the development of fast-response sprinkler systems.

Some aspects of the flammability of liquids are discussed by R. Munoz-Candelario and N. J. Alvares. They present experimental data on vapor concentration gradients above liquids. They show that such information is necessary for defining safe separation between liquid spills and ignition sources.

Based on studies conducted in the United Kingdom, G. Ramachandran discusses some human aspects of fires in buildings. These aspects fall into

seven areas, covering, among others, such dissimilar factors as perception of risk and weather conditions.

It is hoped that the designers of fire safety features of buildings will find this volume beneficial in their work.

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