

Thermal Measurements

The foundation of
Fire Standards

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Editors



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Thermal Measurements: The Foundation of Fire Standards

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Foreword

This publication, *Thermal Measurements: The Foundation of Fire Standards*, contains papers presented at the symposium of the same name held in Dallas, Texas on 3 December 2001. The symposium was sponsored by ASTM International Committee E05 on Fire Standards. The symposium co-chairmen were Louis A. Gritz, Sandia National Laboratories and Norm Alvares, Fire Science Applications.

Overview

This book represents the work of presenters at the *Symposium Thermal Measurements: The Foundation of Fire Standards* held on December 3, 2001, as part of the E-5 Fire Standards Committee meeting in Dallas, Texas. Presentations provided information on recent advances in measurements and addressed several significant challenges associated with performing thermal measurements as part of fire standards development, testing and analysis of test results. The testing environment and the results of fire standards tests are almost always based on one or more thermal measurements. Measurements of importance include temperature, heat flux, calorimetry, and gas species concentrations. These measurements are also of primary importance to the experimental validation of computer models of fire and material response.

The widespread application of thermal measurements, their importance to fire standards, and recent technical advances in diagnostic development motivated the organization of this ASTM symposium. The papers contained in this publication represent the commitment of the ASTM E-5.32 Subcommittee of Fire Standards Research to addressing key issues affecting the evolution of fire standards.

Despite frequent and numerous thermal measurements performed in fire standards testing, advances in thermal measurements have been slow to materialize. The most notable advances in measurements are associated with the development of optical diagnostics and techniques and the ability to collect and store large amounts of data. As highlighted in this publication, useful advances are often focused in scope and occur as the result of progress made by individual researchers and fire standard practitioners with specific missions, interests or needs. The ability to present and discuss these accomplishments at the symposium and through this publication broadens the impact of these contributions to fire standards.

Among the significant themes emerging from the presentations at the symposium, and reflected in the papers included herein, are efforts to better characterize the uncertainty associated with using established techniques to perform measurements of primary interest such as temperature, heat flux and calorimetry. In all of these areas, variation in uncertainty resulting from different environments, implementation, and techniques has yet to be fully characterized. Significant contributions in each of the areas, have been realized and are included in this publication.

Temperature

Despite the frequency of temperature measurement to characterize test environments and material response, challenges remain in consistently performing measurements with quantified uncertainty. Six papers addressed temperature measurement over conditions ranging from thermal fields in furnace environments to thermal response of engulfed objects in large pool fires and measurements of firefighter's clothing. Thermocouples, while straightforward in use and operation, are illustrated as deserving consideration of measurements uncertainty for each specific application.

Heat Flux

Measurements of heat flux are useful for defining the fire thermal field to evaluate material thermal response. Several established gauges have been extensively in fire standards. As with temperature measurements, the resulting uncertainty varies with the gauge design and the environment. The magnitude of this uncertainty, and the need to perform cost-effective experiments and tests, has yielded some new designs and application techniques. No new techniques have been developed recently that have gained widespread acceptance. Significant progress associated with existing methods is highlighted in papers addressing calibration, angular sensitivity, and uncertainty quantification.

Calorimetry and Ignition Energy

Included in the publication are papers on oxygen consumption calorimetry and measurements of ignition energy. Although not as common as heat flux and temperature measurements, these parameters often are very important in fire standards, for the role they play in the initiation, growth, and spread of fire environments.

Although widely acknowledged as central to fire development and growth, heat release rate measurements are often taken as having low uncertainties as compared to other measured values. Evaluation of oxygen consumption is therefore a timely topic for consideration.

Uncertainty in the measurements of ignition energy is also explored in this publication. Modern diagnostics and tools allow a closer look at legacy methods and techniques for performing these measurements.

Summary

The papers included in this publication represent progress on a range of thermal measurement topics the scope of material is indicative of the challenge to perform high quality measurements for every fire standards application. Specifically, improvements in the quantification of measurement uncertainty for these environments is promising and holds the key for advancing the thermal measurements that serve as the foundation of fire standards.