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Standard Guide for Room Fire Experiments[1]

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INTRODUCTION

This guide has been written to assist those planning to conduct full-scale compartment fire experiments. There are many issues that should be resolved before such an experimental program is initiated, and this guide is written with the objective of identifying some of these issues and presenting considerations that will affect each choice of procedure.

This guide deals with any or all stages of fire growth in a compartment. Whether it is a single- or multi-room experiment, observations can be made from ignition to flashover or beyond full-room involvement.

One major reason for conducting research on room fires is to learn about the room fire buildup process so the results of standard fire test methods can be related to performance in full-scale room fires, allowing the further refinement of these test methods or development of new ones.

Another reason concerns computer fire modeling. Full-scale tests can generate data needed for modeling. Comparisons of modeling with full-scale test results can serve to validate the model.

The various results among room fire tests reflect different experimental conditions. The intent of this guide is to identify these conditions and discuss their effects so meaningful comparisons can be made among the room fire experiments conducted by various organizations.

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1. Scope

1.1 This guide addresses means of conducting full-scale fire experiments that evaluate the fire-test-response characteristics of materials, products, or assemblies under actual fire conditions.

1.2 It is intended as a guide for the design of the experiment and for the use and interpretation of its results. The guide is also useful for establishing laboratory conditions that simulate a given set of fire conditions to the greatest extent possible.

1.3 This guide allows users to obtain fire-test-response characteristics of materials, products, or assemblies, which are useful data for describing or appraising their fire performance under actual fire conditions.

1.3.1 The results of experiments conducted in accordance with this guide are also useful elements for making regulatory decisions regarding fire safety requirements. The use for regulatory purposes of data obtained from experiments conducted using this guide requires that certain conditions and criteria be specified by the regulating authority.

1.4 The rationale for conducting room fire experiments according to this guide is shown in 1.5-1.8

1.5 Room fire experiments are a means of generating input data for computer fire models and for providing output data with which to compare modeling results.

1.6 One of the major reasons for conducting room fire experiments is as an experimental means of assessing the potential fire hazard associated with the use of a material or product in a particular application. This should be borne in mind when designing nonstandard experiments.

1.7 A rationale for conducting room fire experiments is the case when smaller-scale fire tests inadequately represent end-use applications.

1.8 A further rationale for conducting room fire experiments is to verify the results obtained with smaller scale tests, to understand the scaling parameters for such tests.

1.9 *This standard is used to measure and describe the response of materials, products, or assemblies to heat and flame under controlled conditions, but does not by itself incorporate all factors required for fire hazard or fire risk assessment of the materials, products, or assemblies under actual fire conditions*

[1] This guide is under the jurisdiction of ASTM Committee E05 on Fire Standards and is the direct responsibility of Subcommittee E05.13 on Large Scale Fire Tests.

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1.10 *This standard does not purport to address all of the safety concerns, if any, associated with its use. It is the responsibility of the user of this standard to establish appropriate safety and health practices and determine the applicability of regulatory limitations prior to use.*

2. Referenced Documents

2.1 *ASTM Standards:* [2]

D 4442 Test Methods for Direct Moisture Content Measurement of Wood and Wood-Base Materials

D 4444 Test Methods for Use and Calibration of Hand-Held Moisture Meters

D 5424 Test Method for Smoke Obscuration of Insulating Materials Contained in Electrical or Optical Fiber Cables When Burning in a Vertical Cable Tray Configuration

D 5537 Test Method for Heat Release, Flame Spread and Mass Loss Testing of Insulating Materials Contained in Electrical or Optical Fiber Cables When Burning in a Vertical Cable Tray Configuration

E 176 Terminology of Fire Standards

E 800 Guide for Measurement of Gases Present or Generated During Fires

E 906 Test Method for Heat and Visible Smoke Release Rates for Materials and Products

E 1321 Test Method for Determining Material Ignition and Flame Spread Properties

E 1354 Test Method for Heat and Visible Smoke Release Rates for Materials and Products Using an Oxygen Consumption Calorimeter

E 1355 Guide for Evaluating the Predictive Capability of Deterministic Fire Models

E 1537 Test Method for Fire Testing of Real Scale Upholstered Furniture

E 1590 Test Method for Fire Testing of Mattresses

E 1822 Test Method for Fire Testing of Stacked Chairs

E 2067 Practice for Full-Scale Oxygen Consumption Calorimetry Fire Tests

E 2257 Test Method for Room Fire Test of Wall and Ceiling Materials and Assemblies

2.2 *UL Standards:*

UL 1715 Room Corner Test[3]

UL Subject 1040 Large Scale Open Corner Test[3]

2.3 *ICBO Standards:*

Uniform Building Code Standard UBC 8-2 Standard Test Method for Evaluating Room Fire Growth Contribution of Textile Wallcoverings[4]

Uniform Building Code Standard UBC 26-3 Room Fire Test Standard for Interior of Foam Plastic Systems[4]

2.4 *FM Standard:*

FM 4880 Large Scale Open Building Corner Test[5]

2.5 *ISO Standards:*

ISO 9705 Fire Tests—Full Scale Room Fire Tests for Surface Products[6]

ISO 13943 Fire Safety—Vocabulary[6]

2.6 *NFPA Standard:*

NFPA 265 Methods of Fire Tests for Evaluating Room Fire Growth Contribution of Textile Wall Coverings[7]

NFPA 286 Standard Method of Tests for Evaluating Contribution of Wall and Ceiling Interior Finish to Room Fire Growth[7]

3. Terminology

3.1 *Definitions*—For definitions of terms used in this guide and associated with fire issues, refer to the terminology contained in Terminology E 176 and ISO 13943. In case of conflict, the terminology in Terminology E 176 shall prevail.

3.1.1 *heat release rate*, *n*—the heat evolved from the specimen, per unit of time.

3.1.2 *oxygen consumption principle*, *n*—the expression of the relationship between the mass of oxygen consumed during combustion and the heat released.

3.1.3 *smoke obscuration*, *n*—reduction of light transmission by smoke, as measured by light attenuation.

3.2 *Definitions of Terms Specific to This Standard:*

3.2.1 *full-scale test*, *n*—a test in which the product(s) to be tested is utilized in the same size as in its end use.

3.2.1.1 *Discussion*—In practical applications, this term is usually applied to tests where the item to be tested is larger than would fit in a bench-scale test.

3.2.2 *total heat released*, *n*—integrated value of the rate of heat release, for a specified time period.

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4. Summary of Guide

4.1 This guide does not define a standard room fire test. It does, however, set down many of the considerations for such a test, for example, room size and shape, ventilation, specimen description, ignition source, instrumentation, and safety considerations that must be decided on in the design of a room fire experiment. It discusses performance criteria for the particular array of finishing and furnishing products that comprise the room. The behavior of any particular product in the room depends on the other products and materials present and how they are arranged in relation to one another.

4.2 Whether a particular arrangement simulates the evaluation desired depends on the size and location of the ignition source. It is therefore important that the ignition source simulate, insofar as possible, an initiating fire for the desired scenario.

4.3 The main criterion suggested in this guide for evaluating fire performance is based on the time to flashover as indicated by the time at which the radiation flux at the center of the floor

[2] For referenced ASTM standards, visit the ASTM website, www.astm.org, or contact ASTM Customer Service at service@astm.org. For Annual Book of ASTM Standards volume information, refer to the standard's Document Summary page on the ASTM website.

[3] Available from Underwriters Laboratories, Inc., 333 Pfingsten Rd., Northbrook, IL 60062.

[4] Available from International Conference of Building Officials, 5360 Workman Mill Rd. Whittier, CA 90601.

[5] Available from Factory Mutual Research Corporation, 1151 Boston-Providence Turnpike, P.O. Box 9102, Norwood, MA 02662.

[6] Available from International Organization for Standardization, P.O. Box 56, CH-1211, Geneva 20, Switzerland.

[7] Available from National Fire Protection Association, Batterymarch Park, Quincy, MA 02269.

exceeds 20 kW/m^2. Other suggested indicators of flashover include an average upper air temperature in excess of 600°C and the ignition of a cotton indicator. Other possible performance criteria include the total amount or rate of smoke and heat production, extent of the flame spread for a low-energy ignition source, and size of the primary ignition source required to produce flashover.

4.3.1 Where multi-room experiments are being conducted, flashover may not be an appropriate performance criteria. In fact, the experiments may have to be conducted beyond flashover. Post-flashover is usually required in the test room in order to observe high levels of toxic gases and smoke in remote rooms or flame spread in adjoining surface areas. Other performance criteria could be the levels of combustion products that impair visibility and cause incapacitation or lethality in remote rooms.

4.4 Primary ignition sources include gas burners, wood cribs, waste containers, and pools of liquid fuel. Waste containers and wood cribs have the advantage of presenting a solid fuel fire with some feedback effects and a luminous flame that appears to simulate the burning of furniture. However, the gas burner is the best choice for most fire experiments because of its reproducibility. The placement of the ignition source depends on the desired effect on the target material.

4.5 The instrumentation for measuring burning rate, heat release rate, heat flux, temperature, upper layer depth, air velocity, flame spread, smoke, and gas concentration is discussed, along with suggested locations. A minimum level of instrumentation is also suggested.

4.6 A typical compartment size is 2.4 by 3.7 m (8 by 12 ft), with a 2.4-m (8-ft) high ceiling. A standard-size doorway (0.80 by 2.0-m high) should be located in one wall, probably in one of the shorter ones. The top of the doorway should be at least 0.4 m (16 in.) down from the ceiling to partially contain smoke and hot gases.

4.7 Insofar as possible, the construction details of the wall and ceiling, as well as any enclosed insulation, should duplicate the room being simulated. Boundary surfaces that do not form the specimen should also be constructed of materials consistent with the room being simulated (see 6.2.3).

4.8 The safety of observers and the crew extinguishing the fire is emphasized strongly in this guide.

4.9 The analysis of data should include a comparison of the critical times, heat fluxes, temperatures, heat release rate, and smoke generation in the room with ignition, flame spread, and smoke properties of the specimen materials. This would aid in the development or modification of small-scale tests and would provide useful information for assisting in the development of analytical room fire models.

5. Significance and Use

5.1 This guide provides assistance for planning room fire tests. The object of each experiment is to evaluate the role of a material, product, or system in the fire growth within one or more compartments.

5.2 The relationship between laboratory fire test methods and actual room fires can be investigated by the use of full-scale and reduced-scale experiments. This guide is aimed at establishing a basis for conducting full-scale experiments for the study of room fire growth.

6. Experimental Choices

6.1 *General*—The complete program for any series of full-scale compartment fire experiments usually involves many different considerations and possible simulations. This guide reflects the current state of knowledge and suggests choices for geometry, ignition sources, and instrumentation.

6.2 *Compartment Design*:

6.2.1 *Ventilation*:

6.2.1.1 Experiments with ventilation-controlled fires in model rooms **(1)**,[8] where the fire has become large or reaches the point of flashover, show that the compartment geometry and dimension influence the burning rate. An important relationship is the following:

$$\dot{m} = kA\sqrt{H} \quad (1)$$

where:

$\dot{m}$ = mass loss rate (kg/s),
A = area of the ventilation opening (m^2),
H = height of the ventilation opening (m), and
k = a proportionality constant, the value of which is approximately 0.09 kg/m$^{5/2}$ s.

This equation is an empirical relationship resulting from the classic ventilation-controlled wood crib fires that Kawagoe **(2)** studied. Other experiments by Hagglund **(3)** reveal that flashover was not observed for $A\sqrt{H}$ below 0.8 m$^{5/2}$. Hagglund conducted experiments on wood cribs in a compartment measuring 2.9 by 3.75 by 3.7-m high. These studies suggest that a limiting burning rate that depends on the ventilation must be exceeded before flashover occurs. The correlation is useful as a guideline for the occurrence of flashover.

6.2.1.2 However, later studies show that the rate of burning becomes independent of ventilation at flashover. Also, a single item with a large enough burning rate can induce flashover. Among other parameters, ventilation plays an important role in fire severity. Drysdale **(4)** explores many of these parameters in detail.

6.2.1.3 Ventilation should be continuous in a multi-room test facility. The doors may be either open or partially closed. One can install a typical heating ventilation and air conditioning (HVAC) duct system if the compartments are closed.

6.2.2 *Size and Shape of Compartment*:

6.2.2.1 The geometry of the compartment in conjunction with the thermal properties of the wall and ceiling materials has substantial influence on the behavior of a confined fire, particularly by affecting flow patterns, and hence the mixing and combustion characteristics of the fire. Thus, the compartment size, shape, and openings should be chosen to simulate the nature or type of compartment or facility in which the subject material, product, or system is expected to be used in actual service. If there is a range of sizes, account should be taken of the fact that for a given ignition exposure, the smaller

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ASTM E603-03

[8] The boldface numbers in parentheses refer to the list of references at the end of this guide.

compartment sizes will usually provide the most severe fire development conditions. However, it has been found that room size (if the floor area lies between 8.7 and 11.4 m^2 and one of the room floor dimensions is between 2.4 and 3.7 m) has little effect on heat development if the heat release rate is below 600 kW **(5)**. The compartment should preferably be designed to be symmetrical and as simple as possible for ease of analysis. The proposed ASTM Room Fire Test for Interior Finish Materials is based on a 2.4 by 3.7-m (8 by 12-ft) room with a 2.4-m (8-ft) high ceiling. It has one standard-size doorway left fully open. The space between the top of the door and the ceiling is critical because of the trapping of smoke and hot gases. It is 0.4 m (16 in.) in the proposed ASTM room. The room dimensions may be chosen to simulate some particular applications. However, if there are no constraints, it would probably be better to remain within the dimensions of the proposed ASTM room for possible comparison with other single compartment tests. Also, the proposed ASTM room is already setup and instrumented in many commercial testing laboratories. The room should be located inside a larger, carefully ventilated enclosure to ensure minimum interference from drafts or wind currents. Ref **(6)** shows how doorway size and room geometry affect fire growth. In order to measure many of the properties that are required from room-sized tests, a canopy hood and exhaust duct are required. These are usually placed either in the room itself, or more commonly, just outside the doorway (see Fig. 1).

6.2.2.2 The following standards involve the use of full rooms: Test Methods D 5424, D 5537, E 1537, E 1590, E 1822 and E 2257, NFPA 265, NFPA 286, UL 1715, UBC 8-2(no longer in use), UBC 26–3 (no longer in use), and ISO 9705, as well as Practice E 2067. This list may not be complete.

6.2.2.3 In a multi-room test, it is critical to duplicate the size and location of corridors and remote rooms. If flame spread along walls is being observed, it may not matter if the corridor has a closed end; it does matter when the flame spread on the floor is important. It has been shown that closing the corridor has very important effects on gas flow and decay of gases **(7, 8)**.

6.2.3 *Thermal and Radiative Properties of Compartment Linings*:

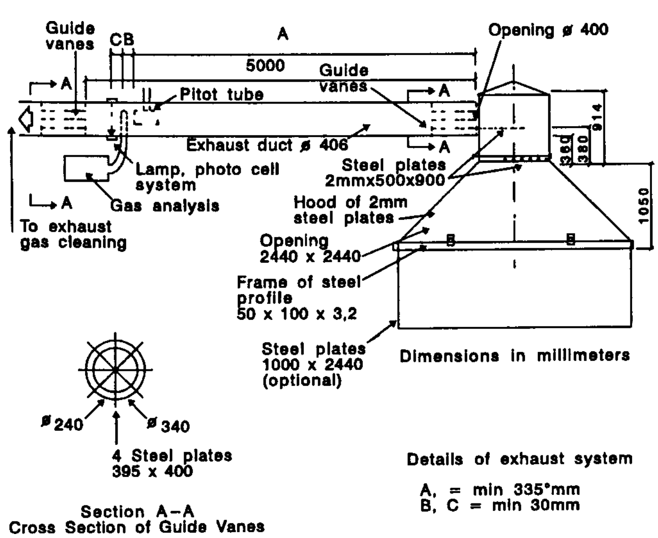

FIG. 1 Canopy Hood and Exhaust Duct

6.2.3.1 The fire gas temperature and heat flux levels in the fire compartment depend on the heat balance of the compartment (heat released during the combustion process and heat lost to the bounding surfaces and transfer of thermal energy due to the net flow of hot gas from the room through natural ventilation or forced ventilation systems. Heat transfer to a bounding surface in the presence of flames occurs mainly by radiation and convection. The amount of radiant energy impinging on a surface depends on the radiative properties of the exposure fire and of the surrounding surfaces. The convective heat transfer rate is determined by the geometry of the bounding surface and the magnitude and turbulence associated with the gas flow in the compartment. Heat transfer, which affects the magnitude of heat flux acting on the bounding surface, is related directly or indirectly to both the size and shape of the compartment involved even though radiative properties of the materials contained in bounding surfaces are unrelated to geometrical issues. Consequently, the geometry, thermal and radiative properties, and degradation characteristics of the compartment surfaces should be considered carefully when conducting compartment fire experiments.

6.2.3.2 The thermal inertia (product of thermal conductivity, density, and heat capacity, kρc) of the materials forming the linings of a fire compartment (bounding materials) directly affects their surface temperature, and its corresponding rise, the rate of heat dissipated into the internal surface, and the room gas temperature. The influence of the wall materials on the temperature distribution in the gas is also a function of the radiative properties of the gas and the gas velocity. Relevant nondimensional parameters which account for this coupled interaction have been published **(9)**. If the thermal inertia is low (good insulation), the surface temperature rises more rapidly, the rate of heat transfer decreases, and the radiation emitted from the upper walls and ceiling to both the fire itself and the lower part of the compartment increases. The emissive power of surfaces and their temperatures are coupled through the radiative transfer equation. Bounding surfaces consisting of materials with good insulating properties will produce substantially higher gas temperatures in the room than when poor insulators are used for lining the enclosed space. The effect of compartment thermal properties on the time-temperature curve has been analyzed mathematically in the post-flashover regime with numerical methods **(10-12)**. Full-scale studies demonstrate the effect of compartment wall properties on the fire intensity **(13-15)**. Typical thermal property values of some samples of common materials are given in Table 1 **(16)** as guidance.

6.2.3.3 The radiative characteristics of the bounding surfaces influence the compartment gas temperatures, particularly during the pre-flashover stages of compartment fires, but this effect decreases with time **(10)**. Bounding surfaces having a greater absorptivity result in a lower gas temperature in the fire compartment. However, the surface absorptivity effect is pronounced when good thermal conducting materials are used on the walls, ceiling, and floor and is of minor practical importance for the compartment lined with high-insulation materials.

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6.2.3.4 Since the severity of a fire in its early stages will depend on the heat exchange with the bounding surfaces of the room, it is important that construction details, such as the wallboard thickness, type, size, and spacing of the studs and joists, and insulation, if any, in the wall and ceiling cavities, be representative of the construction that is being simulated. For those areas of the interior surface not being tested, a suitable inert material may be a ceramic fiberboard that has thermal properties similar to those of gypsum board. (Tran and Janssens **(15)** have demonstrated that ceramic fiberboard is a very good insulator and can increase the severity of the test.) Gypsum and ceramic fiberboard give different results, and the results must not be intermixed. Gypsum is the material of choice for normal tests.

6.2.3.5 During the course of a compartment fire experiment, the disintegration or cracking, if any, of the materials lining the compartment will affect the behavior of the confined fire. Vertical pressure gradients developed in the presence of the fire will cause smoke and hot gases to leak to the outside and cool air to be drawn into the compartment through the cracks in the compartment walls or specimens.

6.3 *Specimens*:

6.3.1 *General*:

6.3.1.1 In the room fire experiment, all of the combustible products in the room can be considered to be part of the specimen. When some of these products are combined to form an item of furnishing or a wall, the combination becomes the specimen. In fact, the walls, ceiling, floor, and all of the furnishings constitute a configured specimen whose properties include the physical and chemical properties of the items and their location.

6.3.1.2 The following paragraphs deal with recommendations for the description and selection of specimens for the room fire experiments to ensure that the important variables will be considered, and to provide a basis of comparison between experiments conducted at different laboratories.

6.3.2 *Description*—As much information as possible should be secured and reported for the materials, products, and assemblies in order to provide the necessary information on the room fire specimen. Along with a description of the ventilation conditions and ignition source, the data are intended to provide the input necessary to estimate the degree of involvement of the various combustibles and the maximum rise in the upper air temperature that could potentially be attained.

6.3.2.1 The specimen should be divided into components classified either as finishing materials, wall and floor coverings, or furniture.

6.3.2.2 The location of the material, product, or assembly to be tested as a lining should be specified as in one or more of the following zones: (*1*) ceiling, (*2*) upper half of wall, (*3*) lower half of wall, (*4*) floor, or (*5*) fraction of a zone, for screening purposes. Both combustible and noncombustible components are to be taken into account. The test standards addressing specific items, such as Test Method E 2257, NFPA 265, or NFPA 286, give details of the locations to be used.

6.3.2.3 The chemical composition, generic or brand name of the lining material, and any involved adhesive interfaces, description of exposed area, thickness, density, moisture content, and fire properties of each component should be detailed. If possible, the thermal conductivity and specific heat should also be listed. Some fundamental fire properties of the material as determined by accepted test methods such as the cone calorimeter, Test Method E 1354, the OSU calorimeter, Test Method E 906, or the LIFT apparatus, Test Method E 1321, reflect various aspects of the fire performance in a room fire. Data such as heat release, smoke release, ignitability, flame spread, etc. may assist in interpretation of the results of the room fire experiment. The ignition times, flame spread distance and rate, and heat release rates depend on many factors, such as the incident heat flux on the specimen and the type of flame. Hence, the exposure conditions during the room fire experiments should be described. If possible, the bench-scale fire tests should be performed on specimens that have the same thickness as the material used in the room temperature for thicknesses up to 50 mm (2 in.).

6.3.2.4 The location of items of furniture in terms of their distance from the wall, corner, and other furniture items should be identified in terms of their distance from the different walls, corners, and any other furniture items specified. For each furniture item to be tested, the horizontal and vertical exposed areas, total weight, and moisture content should also be described. It would also be helpful to indicate the material composition, if known. The test standards addressing specific items, such as Test Method E 1537, for upholstered furniture or Test Method E 1590, for mattresses, give details of the locations to be used.

6.3.2.5 The ambient temperature and humidity of the room and the time these conditions have been maintained prior to the experiment should be recorded.

6.3.3 *Selection*—The choice of the specimen is based on the objective of the room fire experiment, which may be one of three types: (*1*) a demonstration experiment, (*2*) a comparison of theory and experiment, or (*3*) a determination of the fire performance of a particular product.

6.3.3.1 In the demonstration experiment, the room should be finished and furnished in the most realistic way possible. Observations and measurements should be aimed at uncovering the important phenomena involved in the simulated room fire and at establishing possible levels of temperature, gas concentration, and times of occurrence, etc.

6.3.3.2 In the second type of room fire experiment, the emphasis is on the ease of description so that calculated values can be checked against the experimental results. The number of products in any given experiment should be minimized for simplicity of description. However, products covering a large range of properties should be selected for the tests so that the prediction formulas developed do not have limited applicability.

6.3.3.3 In the third type of experiment, to evaluate fire performance, the location of the comparison product in the room should be based on its intended use (that is, a ceiling, wall, floor, wall covering, or item of furniture). Because of heat-trapping effects, the ceiling material should cover the complete room ceiling. While it may not be necessary to cover the entire wall area with the wall product, the area covered by a wall product must be large enough to contain all wall areas

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exposed during the experiment and extend beyond the end of any expected flame spread. In general, other materials in the room should be noncombustible, or at least of low heat release, and should remain the same from experiment to experiment. Because of its widespread use and low heat release, gypsum board is often used, but the board must be replaced between experiments in those areas in which it was exposed to fire. An alternative is ceramic fiberboard.

6.3.3.4 The experimenter may occasionally want to evaluate the outcome of the most severe ignition source and product orientations. It would be prudent for a caveat to be added to the conclusions of the experimental report stating that other ignition source strengths and material orientations were not considered and therefore could not be evaluated on the basis of the subject experiments.

6.3.3.5 Unless special considerations apply, the relative sizes of the product to be tested and of the ignition source should be such that only a fraction of the product to be tested should be consumed, if the product to be tested has good enough fire performance.

6.3.4 *General Considerations*:

6.3.4.1 The distinction between materials located on the upper and lower walls is made because heat conduction losses occur primarily through the upper walls and ceiling. Increasing the insulation in these areas increases the rate of temperature rise in the room and the maximum temperature that will be reached.

6.3.4.2 The spacings between the items of furniture, along with the ignitability of the furniture, determine the probability and time of flame spread between them. When two or more items of furniture are burning, their separation distance determines whether the flames will merge. Furthermore, the heat transfer between them will enhance their separate burning rates so that larger flames will result. The proximity of the burning item of furniture to the wall and corner causes an increase in flame height with an attendant increase in air temperature and the probability of the flame jumping between the item and the wall.

6.3.4.3 In addition to its toxic effect and visibility problems, smoke is a factor in the heat radiative exchange between the upper and lower portions of the room. The height of the furniture items or wall covering material will determine the probability of their ignition by the hot air layer in the upper part of the room. Horizontal and vertical surface areas are therefore specified separately because of the difference in heat transfer from flames to surfaces with these orientations. These differences lead to different heat release rates and flame spread characteristics.

6.4 *Ignition Sources*:

6.4.1 *General*—The choice of a primary ignition source in a compartment fire experiment is a critical item. This guide presents a list of the important considerations for the choice. There will always be compromises on the size, location, type of fuel, time of burning, type of burning, and other factors. This discussion will present some of the important considerations and various choices that can be made.

6.4.2 *Type and Size*—The complete character of the ignition source should be determined, including weight, material identification, morphology, dimensions, and all other physical and chemical characteristics that are necessary to repeat each ignition scenario. Typical ignition sources may be solid, liquid, or gaseous fuels and include wastebaskets, furniture items, wood cribs, gas burners, liquid pool fires, and liquid fuels poured onto items of furnishings. The size is strongly dependent on the degree of fire buildup required for the experiment and the combustibility of the materials used in the experiment. When choosing an ignition source for a particular experiment, the characteristics of the product to be tested (size and heat production capability) should be taken into account, so as to make a reasonable selection.

6.4.2.1 Gas burner flames have the following characteristics: (*1*) they are reproducible; (*2*) they are well-defined (that is, their heat production rate is determined readily from the gas flow rates); (*3*) they can be varied with time to represent the burning of different items of furniture or be maintained constant to facilitate analytical studies; (*4*) their burning rates are not influenced by heat feedback (unless controlled artificially); (*5*) the radiation properties of the flames are different than those of the product simulated; and (*6*) gas flames do not resemble what is seen in real fires.

6.4.2.2 Differences between diffusion and premixed burners should be recognized. For example, the flames from a premixed burner will be shorter and have lower emissivities. In order to avoid locally high velocities, the gas can be delivered through a large-area diffusing surface, such as a porous plate or a layer of sand.

6.4.2.3 Liquid fuel pool fires have the following characteristics: (*1*) their rate of fuel production is determined readily from their rate of mass loss or the flow rate necessary to maintain a constant depth in the pool; (*2*) they have an interaction with the fire environment that can be quantified by their change in heat production rate; (*3*) they are reproducible under the same exposure conditions; (*4*) their radiation characteristics can be controlled by the choice of fuel; (*5*) the effect of feedback is not quantitatively the same as that for furnishings; and (*6*) they lack visual realism unless they are intended to represent liquid fuel spills. A variation of the liquid pool fire is obtained by supplying the liquid fuel in a matrix of sand in order to vary its burning rate.

6.4.2.4 The solid fuels that have been used as ignition sources for room fire experiments have included primarily waste containers and wood cribs, with the latter having the longest history. Stick size, type of wood and spacing, as well as total mass have a large effect on the burning rate of the wood cribs. The use of the above two types of solid fuels is emphasized in this guide because they have been used the most up to the present time. However, the reproducibility and precisely known heat output of a gas burner makes it a likely candidate for replacement of the cribs and waste containers for standard room fire experiments when detailed heat balances must be obtained from the experiments. Waste container and wood crib fires have the following advantages: (*1*) they provide the best visual simulation of the burning of furniture; (*2*) their interaction with the environment of the fire room is perhaps closer to, though not the same as, that of the burning furniture; and (*3*) their radiation characteristics more nearly match those

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