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Standard Test Method for Evaluating the Under-Deck Fire Test Response of Deck Materials[1]

This standard is issued under the fixed designation E2632/E2632M; the number immediately following the designation indicates the year of original adoption or, in the case of revision, the year of last revision. A number in parentheses indicates the year of last reapproval. A superscript epsilon (ε) indicates an editorial change since the last revision or reapproval.

ε[1] NOTE—The units statement and captions for figures were updated editorially in February 2013.

1. Scope

1.1 This standard prescribes a method to assess the fire-test response characteristics of deck materials when used as the walking surface of a deck. The prescribed fire exposure is intended, under test conditions, to determine the heat release rate and the thermal decomposition modes of decking materials when exposed to a burner flame simulating combustibles burning beneath a deck.[2]

1.2 The values stated in either SI units or inch-pound units are to be regarded separately as standard. The values stated in each system are not necessarily exact equivalents; therefore, each system shall be used independently of the other. Combining values from the two systems has the potential to result in non-conformance with the standard.

1.3 This standard is used to measure and describe the response of deck materials 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 deck materials under actual fire conditions.

1.4 *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.*

1.5 Fire testing is inherently hazardous. Adequate safeguards for personnel and property shall be employed in conducting these tests.

2. Referenced Documents

2.1 *ASTM Standards:*[3]

D2898 Practice for Accelerated Weathering of Fire-Retardant-Treated Wood for Fire Testing

E176 Terminology of Fire Standards

E2067 Practice for Full-Scale Oxygen Consumption Calorimetry Fire Tests

2.2 *ISO Standards:*[4]

ISO 13943 Fire Safety – Vocabulary

3. Terminology

3.1 *Definitions*—For definitions of terms used in this test method, refer to Terminology E176 or ISO 13943. When discrepancies exist, the definition in Terminology E176 shall prevail.

3.2 *Definitions of Terms Specific to This Standard:*

3.2.1 *deck surface area, n*—the test specimen area defined by the overall specimen length and width after assembly.

4. Summary of Test Method

4.1 The test method described here measures the heat release rate of deck materials subjected to a flame source located beneath a test specimen.

4.2 The test method employs a diffusion flame based fire source from a nominal 305 mm [12 in.] square burner located underneath the test specimen.

4.3 An 80 kW fire exposure shall be applied to the underside of the test specimen for a period of 3 min after which the burner is extinguished.

[1] This test method is under the jurisdiction of ASTM Committee E05 on Fire Standards and is the direct responsibility of Subcommittee E05.14 on External Fire Exposures.

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[2] Appendix X1 provides commentary on the background of this test method as well as its potential use for evaluation of coatings and surface treatments of deck products.

[3] 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.

[4] Available from International Organization for Standardization (ISO), 1, ch. de la Voie-Creuse, CP 56, CH-1211 Geneva 20, Switzerland, http://www.iso.org.

4.4 Fire test response characteristics monitored and recorded shall include heat release of the test specimen utilizing oxygen depletion methodologies as described in Practice E2067. In addition, physical changes of the test specimen during the test shall be recorded.

5. Significance and Use

5.1 This test method addresses the suitability of deck materials by assessing their response to fire hazards associated with sources of flame located beneath the deck material.

6. Deck Test Specimen

6.1 Test material shall be representative of normal daily production and shall be installed according to the manufacturer's instructions. Test material for developmental products shall be so identified.

6.2 *Pre-test Conditioning*—Prior to testing, all materials (deck boards and joist material) shall be conditioned to a constant weight or for a minimum of 30 days at 21 ± 2 ºC [70 ± 4 ºF] and 50 ± 5 % relative humidity, whichever occurs first. Constant weight shall be defined as occurring when the change in test material weight is less than or equal to 0.1 % in a 24-h period. For those materials whose fire test response is potentially affected by moisture resident within that material, the moisture content of the test material shall be measured prior to conducting the test.

6.3 *Test Specimen Size*—The overall test specimen width (i.e., direction of joists, see Fig. 1) shall be 710 ± 51 mm [28 ± 2.0 in.] to accommodate variations in individual deck board width and spacing. The length of individual deck boards shall be 610 ± 6 mm [24 ± 0.25 in.]. The deck surface area shall be the overall test specimen length and width after assembly of the test specimen. The front deck board shall be flush with the ends of the joists. The rear deck board shall overhang the end of the joists by 25 ± 6 mm [1 ± 0.25 in.] and rest on the ledger board attached to the test apparatus. Deck board profiles shall not be changed from their manufactured dimensions.

6.4 *Joists*—When constructing the test specimen, the deck materials shall be attached to two nominal 2 by 6-in. Douglas-fir joists with a 406 ± 5 mm [16 ± 0.2 in.] center-to-center spacing, creating an approximate 90 mm [approx. 3.5 in.] overhang on one side of each joist.

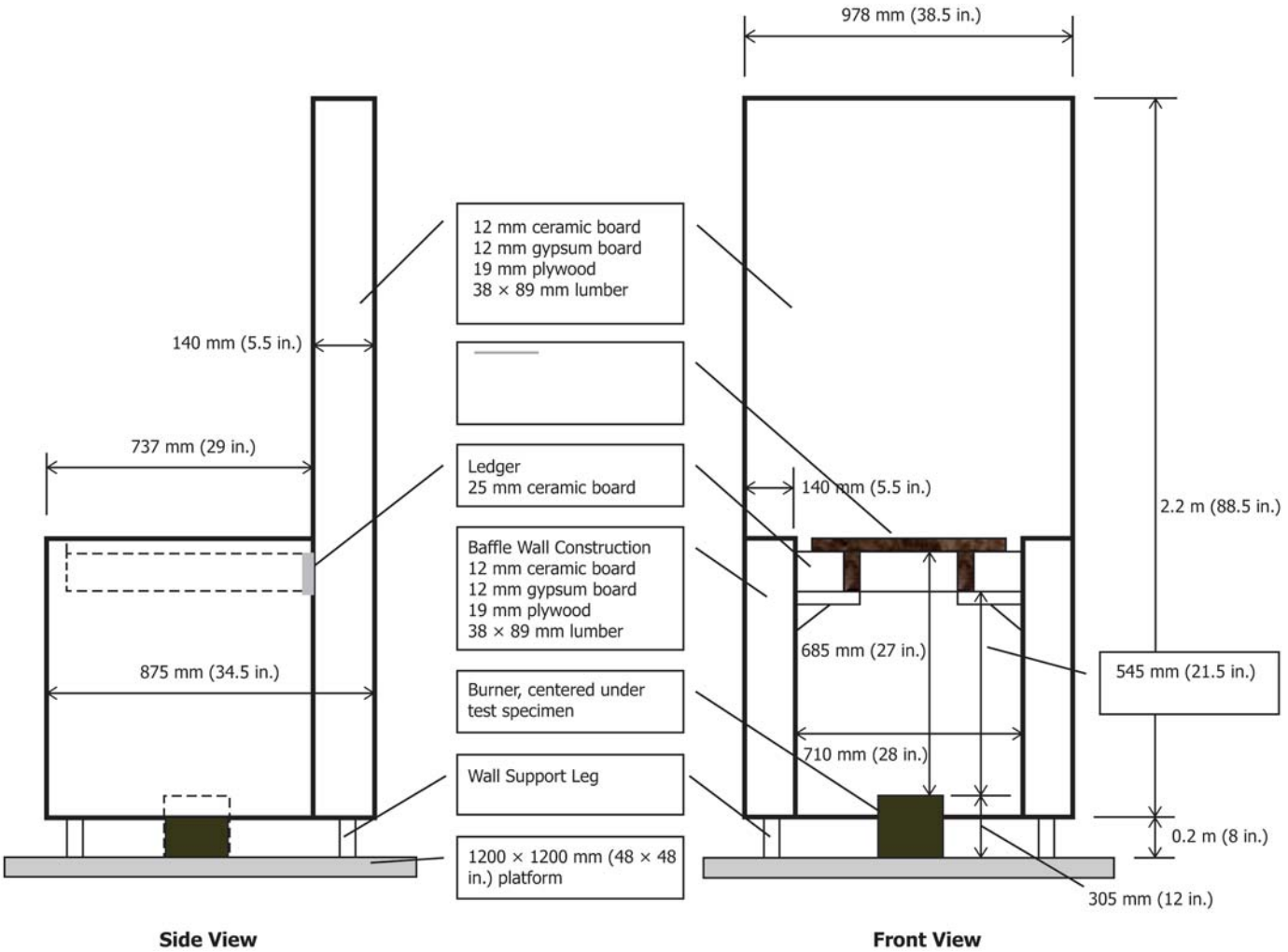

FIG. 1 Schematic Representation of the Under-Deck Test Apparatus

7. Under-Deck Test Apparatus (See Fig. 1 and Fig. 2)

7.1 *Burner*—The ignition source for the test shall be a gas burner with a nominal 305 by 305 mm [12 by 12 in.] porous top surface of a refractory material. The refractory material shall be a minimum 102-mm [4-in.] layer of white Ottawa sand used to provide the horizontal surface through which the gas is supplied. The gas supply to the burner shall provide an output of 80 ± 4 kW using a regulated CP propane gas source, and shall be metered throughout the test, with an accuracy of at least ±3 %. Heat release rates shall be calculated using propane's net heat of combustion, which is 50.0 MJ/kg.

7.2 *Oxygen Depletion Calorimeter*—The system includes a hood, associated ducting, and instrumentation to provide heat release rate data by oxygen consumption calorimetry, and is described in Sections 6.4 and 7 of Practice E2067.

7.3 The facility where the test is conducted shall be draft-protected and equipped with a system for exhausting smoke or noxious gases, or both, produced by testing. Air velocity in the vicinity of the test deck surface shall not exceed 0.5 m/s [1.64 ft/s]. This facility shall be maintained at 20 ± 10 °C [68 ± 18 °F] and at a relative humidity less than 75 % at the time the test begins. Initiation of flammability testing shall begin within 20 min after removal of the test specimen from the pre-test conditioning environment.

7.4 *Baffle Walls*—Ceramic fiber board or other non-combustible panel product shall be used for the interior surface of the baffle walls. The baffle wall shall extend 0.2 m ± 6 mm [8 ± 0.25 in.] above the floor to a total height of 0.9 m ± 6 mm [37 ± 0.25 in.] and be supported to allow unrestricted airflow.

7.5 *Joist Support*—Horizontal metal plates shall be provided to support the joists along their full length, and also to confine burner flames to the underside of the deck boards located between the support joists. The support surface of the joist support shall be 545 mm ± 6 mm [21.5 ± 0.25 in.] above the top of the burner. If gaps exist between the joists and joist support, the user shall be permitted to insert ceramic wool, of joist width and no more than 6 mm [0.25 in.] thick, along the bottom of each joist to confine burner flames to the underside of the deck boards.

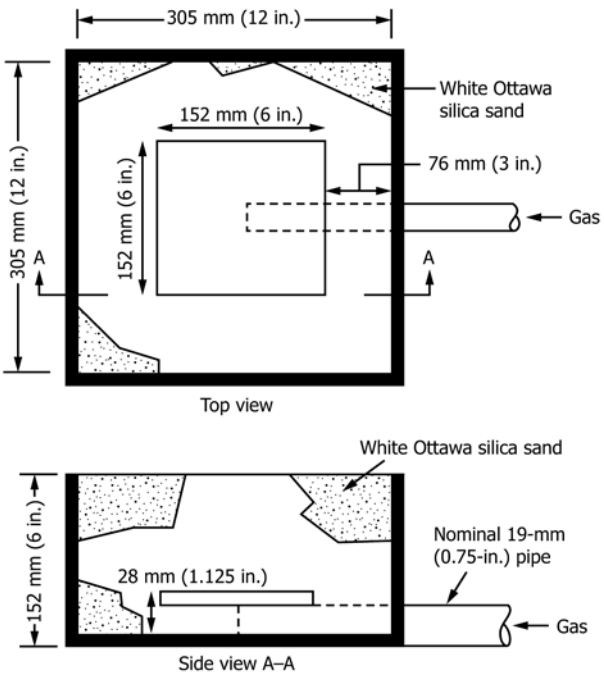

FIG. 2 Schematic Representation of the Gas Burner

7.6 *Back Wall*—Ceramic fiber board or other non-combustible panel product shall be used for the interior surface of the back wall. The back wall shall extend 0.2 m ± 6 mm [8 ± 0.25 in.] above the floor and be supported to allow unrestricted airflow. Total height of the back wall shall be 2.4 m ± 12 mm [8 ft ± 0.5 in.].

7.7 *Ledger Board*—A 0.71 m ± 5 mm [28 ± 0.25 in.] long simulated 38 by 140 mm [nominal 2 by 6- in.] ledger board shall be constructed of layers of ceramic fiber board (or other non-combustible panel product) and attached to the back wall, between the baffle walls, at a height slightly below the overhang of the rear deck board of the test specimen.

7.8 *Burner Location*—The burner shall be centered directly under the test specimen, midway between the support joists. The distance from the top of the burner to the lowest portion of the deck material shall be 690 ± 5 mm [27 ± 0.2 in.].

7.9 *Burner Output Verification*—Without a test specimen in the apparatus, the burner output shall be set to 80 ± 4 kW. At least one, 3 min verification run shall be conducted to ensure the burner heat release rate.

8. Under-Deck Test Procedure

8.1 The test shall be conducted on a minimum of two test specimens. If the difference between the peak heat release rates, determined in 10.3, for these two test specimens is greater than 20 %, a third replicate shall be required. The percent difference shall be calculated using the larger value of the two peak heat release rates in the denominator.

8.2 Ignite the burner, controlling for a constant 80 ± 4 kW output.

8.3 Continue the exposure for a 3 min [+2 s, -0 s] period. Extinguish the burner.

8.4 Continue observation for an additional 40 min or until all combustion has ceased, whichever occurs first. The test shall be terminated immediately if flaming combustion accelerates uncontrollably (runaway combustion).

8.5 Note physical changes of the deck materials during the test, including structural failure of any deck board, location of flaming and glowing ignition, and loss of material (i.e., flaming drops or particles falling from the deck). A video or photographic record of the test shall be obtained.

8.6 *Measurement of Heat Release Rate*—Heat release rate is measured during the tests using an oxygen depletion calorimeter (per 10.3). The heat release rate shall be measured throughout the test duration at a maximum of 6 s intervals.

9. Accelerated Aging/Weathering

9.1 When it is anticipated that a regulatory or other agency will require pre-test accelerated aging/weathering of the

samples, the manufacturer shall have the option to conduct such weathering. Weathering shall be conducted as specified by the regulatory agency or applicable methods as specified for the product. The process shall evaluate the potential for the fire test response characteristics as measured in this test method to deteriorate due to accelerated aging/weathering of the deck material. Details of the accelerated aging/weathering method used, or a reference to a standard test method, shall be included in the report (see Commentary X1.4).

10. Report

10.1 The report shall include a description of the test material, the accelerated aging/weathering cycle (when performed), the test specimen, and support structure.

10.2 The report shall include notation of physical changes of the test material during the test, including complete burn-through of an individual cross-section, structural failure of any test material, location of flaming and glowing combustion, and loss of material during the test including (i.e., flaming drops or particles falling from the deck). A photographic or a video record, or both, of the test shall be reported.

10.3 The report shall include complete data on the measured heat release rate (kW) versus time(s). Because the burner is ignited for the first three minutes of the test, the calculation of the peak heat release rate during that period shall be reduced by the amount of heat provided by the burner. For the first three minutes of the test, the peak heat release rate per unit area (Pk HRR) shall be reported as: Pk HRR = [maximum HRR recorded – 80 kW] / [deck surface area]. Once the burner no longer affects the heat release rate, the peak heat release rate per unit area (Pk HRR) shall be reported as: Pk HRR = [maximum HRR recorded / deck surface area].

11. Precision and Bias

11.1 Committee E05 is pursuing the development of data regarding the precision and bias of this test method. One laboratory conducted an evaluation of three products with three replicates per product. The within-laboratory coefficient of variation of peak heat release rate for the three products was 3.6 %, 4.2 %, and 2.4 % respectively.

12. Keywords

12.1 decking products; fire test response; heat release rate; under-deck fire test

APPENDIX

(Nonmandatory Information)

X1. COMMENTARY

X1.1 Scope

X1.1.1 This test method was developed in response to recommendations developed by the California Office of the State Fire Marshal (OSFM)[5] regarding the performance of decking materials in a wildland fire (exterior wildfire exposure). The wood-plastic composite lumber industry and solid lumber industry participated in the development of these recommendations. The OSFM recommendations established performance criteria for a variety of materials to be used in exterior buildings, structures, and detached accessory structures. This test method is intended to address one component of an exterior wildfire exposure, that is, the under-deck fire test. This is typically a performance test of an as-installed structure comprised of materials for which information about their performance is desired. The test is a practical attempt to simulate the case where combustible material resides beneath a structure and is capable of becoming involved in a wildland fire event. The judgment regarding the magnitude of the fire source used was the result of wildland fire studies by UC Berkeley, the OSFM, along with industry input. While this test method addresses only fire threats originating below the test specimen, a companion test method is under development within the E05 committee which addresses the impact of burning brands applied to the upper surface of decks.

[5] OSFM California Department of Forestry & Fire Prevention, *12–7A-4 Fire Resistance Standards for Decks and Other Horizontal Ancillary Structures*, Office of the State Fire Marshall, PO Box 944246, Sacramento, CA 94244-2450, 2006.

X1.2 Decking Test Method Development

X1.2.1 The major concern about the ignition of decking is the hazard that it presents to the habitable structure. For example, most decks, porches, patios, and landings are adjacent and usually attached to the structure. As such, most decking is configured so that it can be threatened by two potential sources of ignition: brands on the surface and flaming material underneath the structure. This test method addresses the case where a brand is blown or a surface fire extends under a deck and onto combustible material causing flaming combustion that may lead to penetration through the siding or some other vulnerable point of the main structure.

X1.2.2 In an attempt to better understand the effects of an under-deck fire, a preliminary test method was developed by the Forest Products Research Laboratory at UC Berkeley. Initially it was important to select a test specimen size. After under-deck fire testing various sizes from “pallet size” about 1.2 by 1.2 m [4 by 4 ft], it was found that the minimum size for reproducibility was 610 by 610 mm [2 by 2 ft], with 38 by 140 mm [nominal 2 by 6 in.] joists spaced 410 mm [16 in.] on center (a common joist spacing for decks). Deck board spacing was 5 mm [3/16 in.]. There is a key relationship between deck and burner size, in that the burner must be small enough to not impact the deck edges. The 300 by 300 mm [12 by 12 in.] burner concentrated its direct energy in an area slightly larger than the burner size. For combustible materials, there is also

horizontal flamespread on the underside that is largely confined to the space between the joists.

X1.2.3 The next step was to develop the test protocol. The under-deck fire assembly was supported over a 300 by 300 mm [12 by 12 in.] propane burner, and abutted to a 1.8 m [5.9 ft] gypsum board wall. The under-deck test was modeled after Babrauskas[6] and Lee[7] by using an 80 kW fire (equivalent to about 1 kg [2.2 lb] of paper trash). The under-deck test included a measurement of heat release rate to determine if that would be a useful criterion for determining accelerated combustion. In order to have impingement of the flame tip on the underside of the deck boards a spacing of 690 mm [27 in.] from top of burner to bottom of decking was chosen. Preliminary tests were conducted to determine the length of time of exposure to flames. A 3 min exposure was found to be consistent for the 1 kg [2.2 lb] paper scenario and produced the best sensitivity in decking performance.

X1.2.4 *Test Materials*—The deck tests included 15 commercial deck board materials (wood, wood/plastic, and all-plastic) that were chosen to be representative of the range of more than 20 products available on the market in early 2001. Selection of products was based on material composition and cross-sectional form. The deck materials were purchased from retail sources between March and May of 2001. The boards were cut into 610 mm [2 ft] lengths with five pieces taken from different full-length boards to minimize the effects of board-to-board variability.

X1.2.5 Because many decks in California are constructed with 38 mm [nominal 2 in.] heartgrade redwood, this product was also tested. The redwood material served as a benchmark for the comparison of plastic lumber and wood-plastic composite decking materials to typical decking materials used in this application. The deck materials were conditioned to 6 % equilibrium moisture content in an effort to simulate the very low equilibrium moisture content conditions of fire weather.

X1.2.6 *Test Results*—There were three major events that were observed for the wide range of deck boards tested: 1) accelerated (runaway) combustion, 2) dripping or dropping of flaming combustibles, and 3) collapse of deck boards. Since some of these events occurred long after the 3 min flame exposure, the total test time was set at 40 min to ascertain that all events had been completed.

X1.2.7 All tests were digitally recorded. Video tapes were used to verify direct observations. The assemblies were tested by the end of June 2001. Therefore, the composition of the synthetic-based materials reflected those commercially available by that date. Since the composition of most of the deck board products is proprietary, the results only apply to those formulations produced at that time. Thus, the user cannot assume that a newly purchased product would necessarily have the same performance. Most materials had some combustion that was accelerated by the open front edge of the deck assembly during the under-deck test. However, in general, this had little effect on the results, but was helpful to understand the effect of under-deck flamespread to the edge of a deck. For the most part, the ends of the deck boards were shielded by joists, however, fire occasionally spread under or around the joists. In this case, negative effects that could affect the degradation criteria were discounted. On the other hand, ends of deck boards do exist, and the exposure of core material in some products could make them more vulnerable to degradation. The common 5 mm [3/16 in.] gap spacing is used to drain standing water from decks and also permit the joist-deck board interface to properly ventilate. However, virtually all products developed their initial flaming state by burner flames that penetrated through the deck boards.

X1.3 Test Method Applicability for Surface Coatings

X1.3.1 This test method can be used to evaluate the fire-test response of materials with paints, coatings, stains, or other surface treatments used to enhance their fire performance. However, no recommendation is provided or intended relating to the efficacy of a particular coating or surface treatment in a particular end-use application.

X1.4 Accelerated Aging/Weathering of Test Material

X1.4.1 The intent of the investigation will determine whether or not some form of accelerated aging/weathering of the test material prior to conducting the fire test is warranted. For product development research it may not be important or cost effective to subject a prototype test material to a treatment cycle before conducting a fire test. That decision is afforded the product development proponent. However, it is important to alert the user of this test method that test material exposure conditions are always important to consider.

X1.4.2 It is reasonable to assume that some form of accelerated aging/weathering cycle will be required by an AHJ (authority having jurisdiction) or listing agency when it is important to evaluate the permanence of the fire retardant properties of the product. In this case the particular aging process will be defined by the intended end-use application and the materials content of the product being tested. Because this is a test method that can be used for a wide range of decking products, it is not reasonable to assume that all materials should be subjected to the same accelerated aging/weathering process, particularly when materials content can be dramatically different between product types. For example, Practice D2898 has long been used with fire retardant treated lumber products where leaching of chemicals may be an issue. For a product comprised of 100 % plastic, where leaching is not an issue, some other environmental stress may be appropriate.

X1.4.3 The language has been worded so that accelerated aging/weathering is not required in all cases, but is required where such results are a condition of acceptance for a product to be used in a code regulated application. As such, the language provides the flexibility needed for the range of materials being used for decking products.

[6] Babrauskas, V., *Heat Release Rates*, in SFPE Handbook of Fire Protection Engineering, 3rd ed., National Fire Protection Assn., Quincy, MA, 1995, pp. 3-1 to 3-37.

[7] Lee, B. T., *Heat Release Rate Characteristics of Some Combustible Fuel Sources in Nuclear Power Plants*, NBSIR 85-3195, National Bureau of Standards, Washington, DC, 1985.