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Standard Guide for Fire Hazard Assessment of Rail Transportation Vehicles[1]

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INTRODUCTION

The traditional approach to codes and standards is the specification of individual fire-test-response requirements for each material, component, or product that is found in a given environment and is deemed important to maintain satisfactory levels of fire safety. This practice has been in place for so long that it gives a significant level of comfort; manufacturers know what is required to comply with the specifications and specifiers simply apply the requirements. The implicit assumptions are not stated, but they are that the use of the prescribed requirements ensures an adequate level of safety. There is no need to impose any change on those manufacturers who supply safe systems meeting existing prescriptive requirements; however, as new materials, components, and products are developed, manufacturers, designers, and specifiers often desire the flexibility to choose how overall safety requirements are to be met. It is the responsibility of developers of alternative approaches to state explicitly the assumptions being made which result in a design having an equivalent level of safety. One way to generate explicit and valid assumptions is to use a performance-based approach, based on test methods that provide data in engineering units, suitable for use in fire safety engineering calculations, as this guide provides.

This fire hazard assessment guide focuses on rail transportation vehicles. Such a fire hazard assessment requires developing all crucial fire scenarios that must be considered and consideration of the effect of all contents and designs within the rail transportation vehicle, which will potentially affect the resulting fire hazard. The intention of this guide is that rail transportation vehicles be designed either by meeting all the requirements of the traditional prescriptive approach or by conducting a fire hazard assessment, that needs to provide adequate margins of error, in which a level of safety is obtained that is equal to or greater than the level of safety resulting from the traditional approach.

1. Scope

1.1 This is a guide to developing fire hazard assessments for rail transportation vehicles. It has been written to assist professionals, including fire safety engineers, who wish to assess the fire safety of rail transportation vehicles, during or after their design (see also 1.6). This guide is not in itself a fire hazard assessment nor does it provide acceptance criteria; thus, it cannot be used for regulation.

1.2 Hazard assessment is a process that results in an estimate of the potential severity of the fires that can develop under defined scenarios, once defined incidents have occurred. Hazard assessment does not address the likelihood of a fire occurring. Hazard assessment is based on the premise that an ignition has occurred, consistent with a specified scenario, and that potential outcomes of the scenario can be reliably estimated.

1.3 Consistent with 1.2, this guide provides methods to evaluate whether particular rail passenger designs provide an equal or greater level of fire safety when compared to designs developed based on the traditional applicable fire-test-response characteristic approaches currently widely used in this industry. Such approaches have typically been based on prescriptive test methodologies. The following are examples of such lists of prescriptive tests: the requirements by the Federal Railroad Administration (FRA) (Table X1.1), the former guidelines of the FRA, the requirements of NFPA 130 (Table X3.1), and the recommended practices of the Federal Transit Administration (FTA). Selective use of parts of the methodology in this guide and of individual fire-test-response characteristics from Table X1.1 (or any other set of tests) does not satisfy the fire safety objectives of this guide or of the table. This guide shall be used in its entirety to develop a fire hazard assessment for rail transportation vehicles or to aid in the design of such vehicles.

[1] This guide is under the jurisdiction of ASTM Committee E05 on Fire Standards and is the direct responsibility of Subcommittee E05.17 on Transportation.

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1.4 This guide includes and applies accepted and clearly defined fire safety engineering techniques and methods consistent with both existing, traditional prescriptive codes and standards and performance based fire codes and standards under development throughout the world.

1.5 This guide provides recommended methods to mitigate potential damage from fires in rail transportation vehicles, by assessing the comparative fire hazard of particular products, assemblies, systems or overall designs intended for use in rail transportation vehicles. Such methods could include changes to the materials, components, products, assemblies, or systems involved in the construction of the rail transportation vehicle or changes in the design features of the vehicle, including the number and location of automatically activated fire safety devices present (see 4.4.4 for further details).

1.6 This guide is intended, among other things, to be of assistance to personnel addressing issues associated with the following areas.

1.6.1 Design and specification of rail transportation vehicles.

1.6.2 Fabrication of rail transportation vehicles.

1.6.3 Supply of assemblies, subassemblies, and component materials, for use in rail transportation vehicles.

1.6.4 Operation of rail transportation vehicles.

1.6.5 Provision of a safe environment for all occupants of a rail transportation vehicle.

1.7 The techniques provided in this guide are based on specific assumptions in terms of rail transportation vehicle designs, construction and fire scenarios. These techniques can be used to provide a quantitative measure of the fire hazards from a specified set of fire conditions, involving specific materials, products, or assemblies. Such an assessment cannot be relied upon to predict the hazard of actual fires, which involve conditions, or vehicle designs, other than those assumed in the analysis. In particular, the fire hazard may be affected by the anticipated use pattern of the vehicle.

1.8 This guide can be used to analyze the estimated fire performance of the vehicle specified under defined specific fire scenarios. Under such scenarios, incidents will begin either inside or outside a vehicle, and ignition sources can involve vehicle equipment as well as other sources. The fire scenarios to be used are described in detail in Section 5.3.

1.8.1 Fires with more severe initiating conditions than those assumed in an analysis may pose more severe fire hazard than that calculated using the techniques provided in this guide. For this reason severe fire conditions must be considered as part of an array of fire scenarios.

1.9 This fire standard cannot be used to provide quantitative measures.

1.10 *This international standard was developed in accordance with internationally recognized principles on standardization established in the Decision on Principles for the Development of International Standards, Guides and Recommendations issued by the World Trade Organization Technical Barriers to Trade (TBT) Committee.*

2. Referenced Documents

2.1 *ASTM Standards:*[2]

C1166 Test Method for Flame Propagation of Dense and Cellular Elastomeric Gaskets and Accessories

D123 Terminology Relating to Textiles

D2724 Test Method for Bond Strength of Bonded, Fused, and Laminated Apparel Fabrics

D3574 Test Methods for Flexible Cellular Materials—Slab, Bonded, and Molded Urethane Foams

D3675 Test Method for Surface Flammability of Flexible Cellular Materials Using a Radiant Heat Energy Source

D5424 Test Method for Smoke Obscuration of Insulating Materials Contained in Electrical or Optical Fiber Cables When Burning in a Vertical Cable Tray Configuration

D5537 Test Method for Heat Release, Flame Spread, Smoke Obscuration, and Mass Loss Testing of Insulating Materials Contained in Electrical or Optical Fiber Cables When Burning in a Vertical Cable Tray Configuration

D6113 Test Method for Using a Cone Calorimeter to Determine Fire-Test-Response Characteristics of Insulating Materials Contained in Electrical or Optical Fiber Cables

E119 Test Methods for Fire Tests of Building Construction and Materials

E162 Test Method for Surface Flammability of Materials Using a Radiant Heat Energy Source

E176 Terminology of Fire Standards

E603 Guide for Room Fire Experiments

E648 Test Method for Critical Radiant Flux of Floor-Covering Systems Using a Radiant Heat Energy Source

E662 Test Method for Specific Optical Density of Smoke Generated by Solid Materials

E906 Test Method for Heat and Visible Smoke Release Rates for Materials and Products Using a Thermopile Method

E1321 Test Method for Determining Material Ignition and Flame Spread Properties

E1354 Test Method for Heat and Visible Smoke Release Rates for Materials and Products Using an Oxygen Consumption Calorimeter

E1355 Guide for Evaluating the Predictive Capability of Deterministic Fire Models

E1472 Guide for Documenting Computer Software for Fire Models (Withdrawn 2011)[3]

E1474 Test Method for Determining the Heat Release Rate of Upholstered Furniture and Mattress Components or Composites Using a Bench Scale Oxygen Consumption Calorimeter

E1537 Test Method for Fire Testing of Upholstered Furniture

E1546 Guide for Development of Fire-Hazard-Assessment Standards

E1590 Test Method for Fire Testing of Mattresses

[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] The last approved version of this historical standard is referenced on www.astm.org.

E1591 Guide for Obtaining Data for Fire Growth Models
E1623 Test Method for Determination of Fire and Thermal Parameters of Materials, Products, and Systems Using an Intermediate Scale Calorimeter (ICAL)
E1740 Test Method for Determining the Heat Release Rate and Other Fire-Test-Response Characteristics of Wall Covering or Ceiling Covering Composites Using a Cone Calorimeter
F1534 Test Method for Determining Changes in Fire-Test-Response Characteristics of Cushioning Materials After Water Leaching

2.2 *NFPA Standards:*[4]
NFPA 70 National Electrical Code
NFPA 130 Standard for Fixed Guideway Transit Systems
NFPA 262 Standard Method of Test for Flame Travel and Smoke of Wires and Cables for Use in Air-Handling Spaces
NFPA 265 Standard Methods of Fire Tests for Evaluating Room Fire Growth Contribution of Textile Wall Coverings
NFPA 901 Uniform Coding for Fire Protection

2.3 *ISO Standards:*[5]
ISO 13943 Fire Safety: Vocabulary
ISO 4880 Burning Behaviour of Textiles and Textile Products
ISO 9705 Full Scale Room Fire Test for Surface Products

2.4 *Federal Aviation Administration Standards:*[6]
FAR 25.1359 Federal Aviation Administration 60° Bunsen Burner Test for Electric Wire
FAR 25.853 (a) Federal Aviation Administration Vertical Bunsen Burner Test
FAR 25.853 (c) Federal Aviation Administration Oil Burner Test for Seat Cushions

2.5 *Other Federal Standards:*[7]
Americans with Disabilities Act
FED STD 191A Textile Test Method 5830

2.6 *Underwriters Laboratories Standards:*[8]
UL 44: Standard for Safety for Thermoset-Insulated Wires and Cables
UL 83: Standard for Safety for Thermoplastic-Insulated Wires and Cables
UL 1581: Reference Standard for Electrical Wires, Cables, and Flexible Cords, 1080 (VW-1 (Vertical Wire) Flame Test)
UL 1581: Reference Standard for Electrical Wires, Cables, and Flexible Cords, 1160 Vertical Tray Flame Test
UL 1685: Standard Vertical Tray Fire Propagation and Smoke Release Test for Electrical and Optical Fiber Cables
UL 1975: Standard Fire Tests for Foamed Plastics Used for Decorative Purposes

2.7 *Canadian Standards Association Standards:*[9]
CSA Standard C22.2 No. 3, Test Methods for Electrical Wires and Cables, Vertical Flame Test—Cables in Cable Trays/FT4

2.8 *Institute of Electrical and Electronic Engineers Standards:*[10]
IEEE Standard 383, Standard for Type Tests of Class 1E Electric Cables, Field Splices, and Connections for Nuclear Power Generating Stations

2.9 *National Electrical Manufacturing Association Standards:*[11]
NEMA WC 3/ICEA S-19, Rubber-Insulated Wire and Cable for the Transmission and Distribution of Electrical Energy
ICEA S-73–532/NEMA WC-57 Standard for Control, Thermocouple Extension, and Instrumentation Cables
ICEA S-95–658/NEMA WC-70 Nonshielded Power Cables Rated 2000 Volts or Less for the Distribution of Electrical Energy

2.10 *CA Standards:*[12]
CA Technical Bulletin 129, Flammability Test Procedure for Mattresses for Use in Public Buildings
CA Technical Bulletin 133, Flammability Test Procedure for Seating Furniture for Use in Public Occupancies

2.11 *AATCC Standards:*[13]
Test Method 86 - 2005 Drycleaning: Durability of Applied Designs and Finishes
Test Method 124 - 2006 Appearance of Fabrics after Repeated Home Laundering

2.12 *IEC Standards:*[14]
IEC 60331-11 Tests for electric cables under fire conditions – Circuit integrity – Part 11: Apparatus – Fire alone at a test temperature of at least 750°C

3. Terminology

3.1 *Definitions*— For terms related to fire used in this guide, refer to Terminology E176 and ISO 13943. In case of conflict, the terminology in Terminology E176 shall prevail. For terms relating to textiles used in this guide, refer to Terminology D123 or to ISO 4880. In case of conflict, the terminology in Terminology D123 shall prevail.

[4] Available from the National Fire Protection Association (NFPA), 1 Batterymarch Park, Quincy, MA, 02269–9101.
[5] Available from International Organization for Standardization (ISO), 1 rue de Varembé, Case postale 56, CH-1211, Geneva 20, Switzerland or American National Standards Institute (ANSI), 25 W. 43rd St., 4th Floor, New York, NY 10036.
[6] Available from the Federal Aviation Administration, Technical Center, Atlantic City International Airport, Atlantic City, NJ 08405.
[7] Available from General Services Administration, Specifications Activity, Printed Materials Supply Division, Building 197, Naval Weapons Plant, Washington, DC 20407.
[8] Available from Underwriters Laboratories, Inc., 333 Pfingsten Rd., Northbrook, IL 60062.
[9] Available from the Canadian Standards Associations, 178 Rexdale Blvd., Rexdale, Ontario, Canada M9W 1R3.
[10] Available from the Institute of Electrical and Electronic Engineers, Inc., 345 East 47th Street, New York, NY 10017.
[11] Available from National Electrical Manufacturers Association, 1300 North 17th St., Ste 1847, Rosslyn, VA 22209.
[12] Available from California Bureau of Home Furnishings and Thermal Insulation, State of California, Department of Consumer Affairs, 3485 Orange Grove Avenue, North Highlands, CA 95660–5595.
[13] Available from American Association of Textile Chemists and Colorists (AATCC), One Davis Dr., P.O. Box 12215, Research Triangle Park, NC 27709-2215.
[14] Available from International Electrotechnical Commission (IEC), 3, rue de Varembé, 1st Floor, P.O. Box 131, CH-1211, Geneva 20, Switzerland, http://www.iec.ch.