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NFPA 50A Gaseous Hydrogen Systems 1984

National Fire Protection Association Batterymarch Park, Quincy, MA 02269

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Policy Adopted by NFPA Board of Directors on December 3, 1982

The Board of Directors reaffirms that the National Fire Protection Association recognizes that the toxicity of the products of combustion is an important factor in the loss of life from fire. NFPA has dealt with that subject in its technical committee documents for many years.

There is a concern that the growing use of synthetic materials may produce more or additional toxic products of combustion in a fire environment. The Board has, therefore, asked all NFPA technical committees to review the documents for which they are responsible to be sure that the documents respond to this current concern. To assist the committees in meeting this request, the Board has appointed an advisory committee to provide specific guidance to the technical committees on questions relating to assessing the hazards of the products of combustion.

Statement on NFPA Procedures

This material has been developed under the published procedures of the National Fire Protection Association, which are designed to assure the appointment of technically competent Committees having balanced representation. While these procedures assure the highest degree of care, neither the National Fire Protection Association, its members, nor those participating in its activities accepts any liability resulting from compliance or noncompliance with the provisions given herein, for any restrictions imposed on materials or processes, or for the completeness of the text.

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Standard for
Gaseous Hydrogen Systems
at Consumer Sites

NFPA 50A-1984

1984 Edition of NFPA 50A

This edition of NFPA 50A, *Standard for Gaseous Hydrogen Systems at Consumer Sites*, was prepared by the Technical Committee on Industrial and Medical Gases, and acted on by the National Fire Protection Association, Inc. at its Fall Meeting held November 14-17, 1983 in Orlando, Florida. It was issued by the Standards Council on December 8, 1983, with an effective date of December 28, 1983, and supersedes all previous editions.

This 1984 edition of this standard has been submitted to the American National Standards Institute for approval as an American National Standard.

Changes other than editorial are indicated by a vertical rule in the margin of the pages on which they appear. These lines are included as an aid to the user in identifying changes from the previous edition.

Origin and Development of NFPA 50A

Development of NFPA 50A was initiated by the Compressed Gas Association, Inc., who submitted a complete text to the NFPA Committee on Gases in 1959. Working responsibility for the project was assigned to the Sectional Committee on Industrial Gases, and the standard tentatively adopted at the 1961 Annual Meeting. Official Adoption, as NFPA 567, followed at the 1963 Annual Meeting as recommended by the Committee on Gases.

In June, 1966, responsibility for NFPA 567 was reassigned to the Committee on Industrial and Medical Gases. With the 1969 edition, which superseded the 1963 edition, the standard was redesignated as NFPA 50A. Subsequent editions were adopted in 1973 and 1978.

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This list represents the membership at the time the Committee was balloted on the text of this edition. Since that time, changes in the membership may have occurred.

NOTE: Membership on a Committee shall not in and of itself constitute an endorsement of the Association or any document developed by the Committee on which the member serves.

Contents

Standard for Gaseous Hydrogen Systems at Consumer Sites

NFPA 50A-1984

Chapter 1 General Information

1-1 Introduction.

1-1.1 Hydrogen is a flammable gas. It is colorless, odorless, tasteless and nontoxic. It is the lightest gas known, having a specific gravity of 0.0695 (air = 1.0). Hydrogen diffuses rapidly in air and through porous materials.

1-1.2 Hydrogen burns in air with a pale blue, almost invisible flame. At atmospheric pressure the ignition temperature of hydrogen-air mixtures has been reported by the US Bureau of Mines to be as low as 932°F (500°C). The flammable limits of hydrogen-air mixtures depend upon pressure, temperature and water vapor content. At atmospheric pressure the flammable range is approximately 4 percent to 74 percent by volume of hydrogen in air.

1-1.3 Hydrogen is nontoxic, but can cause anoxia (asphyxiation) when it displaces the normal 21 percent oxygen in a confined area without adequate ventilation. Because hydrogen is colorless, odorless and tasteless, its presence cannot be detected by the human senses.

1-1.4 Since the control of the hydrogen system may remain with the supplier, compliance with this standard will minimize the possibility of a consumer fire involving the hydrogen system, as well as the possibility of a hydrogen fire involving the consumer's premises.

1-2 Application of Standard.

1-2.1 This standard covers the general principles recommended for the installation of gaseous hydrogen systems on consumer premises where the hydrogen supply to the consumer premises originates outside the consumer premises and is delivered by mobile equipment.

1-2.2 This standard covers requirements for gaseous hydrogen systems. Systems are classified according to the total volume of hydrogen including unconnected reserves, as follows:

(a) Less than 3,000 CF (85 m^3), except as covered in 1-2.3.

(b) From 3,000 (85m^3) to 15,000 CF (255 m^3).

(c) In excess of 15,000 CF (255 m^3).

1-2.3 The application of this standard at places of public assembly is subject to approval of the authority having jurisdiction.

1-2.4 An existing system which is not in strict compliance with the provisions of this standard may be continued in use when such use does not constitute a distinct hazard to life or adjoining property.

1-2.5 This standard does not apply to single systems using containers having a total hydrogen content of less than 400 CF (11 m^3). Where individual systems, each having a total hydrogen content of less than 400 CF (11 m^3), are located less than 5 ft (1.5 m) from each other, this standard shall apply.

1-2.6 This standard does not apply to hydrogen manufacturing plants or other establishments operated by the hydrogen supplier or his agent for the purpose of storing hydrogen and refilling portable containers, trailers, mobile supply trucks or tank cars.

1-3 Definitions.

Approved. Acceptable to the "authority having jurisdiction."

NOTE: The National Fire Protection Association does not approve, inspect or certify any installations, procedures, equipment, or materials nor does it approve or evaluate testing laboratories. In determining the acceptability of installations or procedures, equipment or materials, the authority having jurisdiction may base acceptance on compliance with NFPA or other appropriate standards. In the absence of such standards, said authority may require evidence of proper installation, procedure or use. The authority having jurisdiction may also refer to the listings or labeling practices of an organization concerned with product evaluations which is in a position to determine compliance with appropriate standards for the current production of listed items.

Authority Having Jurisdiction. The "authority having jurisdiction" is the organization, office or individual responsible for "approving" equipment, an installation or a procedure.

NOTE: The phrase "authority having jurisdiction" is used in NFPA documents in a broad manner since jurisdictions and "approval" agencies vary as do their responsibilities. Where public safety is primary, the "authority having jurisdiction" may be a federal, state, local or other regional department or individual such as a fire chief, fire marshal, chief of a fire prevention bureau, labor department, health department, building official, electrical inspector, or others having statutory authority. For insurance purposes, an insurance inspection department, rating bureau, or other insurance company representative may be the "authority having jurisdiction." In many circumstances the property owner or his designated agent assumes the role of the "authority having jurisdiction"; at government installations, the commanding officer or departmental official may be the "authority having jurisdiction."

CF. Cubic feet of gas at 14.7 psia (101 kPa) and 70°F (21.1°C).

Combustible Liquid. A liquid having a closed cup flash point at or above 100°F (37.8°C) and subdivided as follows:

Class II liquids shall include those having a flash point at or above 100°F (37.8°C) and below 140°F (60°C).

Class IIIA liquids shall include those having a flash point at or above 140°F (60°C) and below 200°F (93.4°C).

Class IIIB liquids shall include those having flash points at or above 200°F (93.4°C).

Flammable Liquid (Class I). Any liquid having a closed cup flash point below 100°F (37.8°C) and having a vapor pressure not exceeding 40 psia absolute (276 kPa) at 100°F (37.8°C).

Gallon. A standard US gallon.

Gaseous Hydrogen System. One in which the hydrogen is delivered, stored and discharged in the gaseous form to consumer's piping. The system includes stationary or movable containers, pressure regulators, pressure relief devices, manifolds, interconnecting piping and controls. The system terminates at the point where hydrogen at service pressure first enters the consumer's distribution piping.

Labeled. Equipment or materials to which has been attached a label, symbol or other identifying mark of an organization acceptable to the "authority having jurisdiction" and concerned with product evaluation, that maintains periodic inspection of production of labeled equipment or materials and by whose labeling the manufacturer indicates compliance with appropriate standards or performance in a specified manner.

Limited-Combustible Material. A type of building construction material as defined in NFPA 220, *Standard on Types of Building Construction*.

Listed. Equipment or materials included in a list published by an organization acceptable to the "authority having jurisdiction" and concerned with product evaluation, that maintains periodic inspection of production of listed equipment or materials and whose listing states either that the equipment or material meets appropriate standards or has been tested and found suitable for use in a specified manner.

NOTE: The means for identifying listed equipment may vary for each organization concerned with product evaluation, some of which do not recognize equipment as listed unless it is also labeled. The "authority having jurisdiction" should utilize the system employed by the listing organization to identify a listed product.

Noncombustible Material (as defined in NFPA 220, *Standard on Types of Building Construction*). A material which, in the form in which it is used and under the conditions anticipated, will not ignite, burn, support combustion, or release flammable vapors when subjected to fire or heat. Materials reported as noncombustible, when tested in accordance with the *Standard Method of Test for Behavior of Materials in a Vertical Tube Furnace at 750°C*, ASTM E-136 shall be considered noncombustible materials.

Outdoors. Location outside of any building or structure. Outdoors shall also mean locations under a weather shelter or canopy provided this area is not enclosed on more than two sides.

Separate Building. A detached building used exclusively to house a hydrogen system.

Shall. Indicates a mandatory requirement.

Special Room. A separate enclosed area which is part of or attached to another building and is used exclusively for a hydrogen system.

Chapter 2 Design of Hydrogen Systems

2-1 Containers.

2-1.1 Hydrogen containers shall comply with one of the following:

(a) Designed, constructed, and tested in accordance with appropriate requirements of ASME *Boiler and Pressure Vessel Code*, Section VIII — Unifired Pressure Vessels.

(b) Designed, constructed, tested and maintained in accordance with US Department of Transportation (formerly Interstate Commerce Commission) Specifications and Regulations.

2-1.2 Permanently installed containers shall be provided with substantial supports of noncombustible material on firm foundations of noncombustible material.

2-1.3 Each portable container shall be legibly marked with the name "Hydrogen" in accordance with ANSI Z48.1, *American Standard Method of Marking Portable Compressed Gas Containers to Identify the Material Contained*. Each manifold hydrogen supply unit shall be legibly marked with the name HYDROGEN or a legend such as "This unit contains hydrogen."

2-2 Pressure Relief Devices.

2-2.1 Hydrogen containers shall be equipped with pressure relief devices as required by the ASME Code or the DOT Specifications and Regulations under which the container is fabricated.

2-2.2 Pressure relief devices shall be arranged to discharge upward and unobstructed to the open air in such a manner as to prevent any impingement of escaping gas upon the container, adjacent structures or personnel. This requirement does not apply to DOT Specification containers having an internal volume of 2.0 cu ft (0.057 m^3) or less.

2-2.3 Pressure relief devices or vent piping shall be designed or located so that moisture cannot collect and freeze in a manner which would interfere with proper operation of the device.

2-3 Piping, Tubing and Fittings.

2-3.1 Piping, tubing and fittings shall be suitable for hydrogen service and for the pressures and temperatures involved. Cast-iron pipe and fittings shall not be used.

2-3.2 Material specifications and thickness requirements for piping and tubing shall conform to the American National Standard *Code for Chemical Plant and Petroleum Refinery Piping*, ANSI B31.3.

2-3.3 Joints in piping and tubing shall be made by welding or brazing or by use of flanged, threaded, socket, slip or compression fittings. Gaskets and thread sealants shall be suitable for hydrogen service. Brazing materials shall have a melting point above 1000°F (538°C).

2-4 Equipment Assembly.

2-4.1 Valves, gauges, regulators and other accessories shall be suitable for hydrogen service.

2-4.2 Installation of hydrogen systems shall be supervised by personnel familiar with proper practices with reference to their construction and use.

2-4.3 Storage containers, piping, valves, regulating equipment and other accessories shall be readily accessible, and shall be protected against physical damage and against tampering by the general public.

2-4.4 Cabinets or housings containing hydrogen control or operating equipment shall be adequately ventilated.

2-4.5 Each mobile hydrogen supply unit used as part of a hydrogen system shall be adequately secured to prevent movement.

2-4.6 Mobile hydrogen supply units shall be electrically bonded to the system before discharging hydrogen.

2-5 Marking.

2-5.1 The hydrogen storage location shall be permanently placarded as follows: "HYDROGEN – FLAMMABLE GAS – NO SMOKING – NO OPEN FLAMES," or equivalent.

2-6 Testing.

2-6.1 After installation, all piping, tubing and fittings shall be tested and proved hydrogen gastight at maximum operating pressure.

Chapter 3 Location of Gaseous Hydrogen Systems

3-1 General.

3-1.1 The system shall be located so that it is readily accessible to delivery equipment and to authorized personnel. Suitable roadways or other means of access for emergency equipment, such as fire department apparatus, shall be provided.

3-1.2 Systems shall be located aboveground.

3-1.3 Systems shall not be located beneath or where exposed by failure of electric power lines, piping containing all classes of flammable or combustible liquids (*see definition*), piping containing other flammable gases, or piping containing oxidizing materials.

3-1.4 Systems near aboveground storage of all classes of flammable and combustible liquids shall be located on ground higher than such storage, except when dikes, diversion curbs, grading or separating solid walls are used to prevent accumulation of these liquids under the system.

3-2 Specific Requirements.

3-2.1 The location of a system, as determined by the maximum total contained volume of hydrogen, shall be in the order of preference as indicated by Roman numerals in Table 3-2.1.

Table 3-2.1

Nature of Location	Size of Hydrogen System: Less than 3,000 CF (85m³)	3,000 CF (85m³) to 15,000 CF (255m³)	In Excess of 15,000 CF (255m³)
Outdoors	I	I	I
In a separate building	II	II	II
In a special room	III	III	Not Permitted
Inside buildings not in a special room and exposed to other occupancies	IV	Not Permitted	Not Permitted

3-2.2 The minimum distance in feet from a hydrogen system of indicated capacity located outdoors, in separate buildings or in special rooms to any specified outdoor exposure shall be in accordance with Table 3-2.2. The distances in Items 1, 14 and 3 to 10 inclusive in Table 3-2.2 do not apply where protective structures, having a minimum fire-resistance rating of two hours, are located between the system and the exposure.

(a) Unloading connections on delivery equipment shall not be positioned closer to any of the exposures cited in Table 3-2.2 than the distances given for the storage system.

3-2.3 Hydrogen systems of less than 3,000 CF (85 m³) when located inside buildings and exposed to other occupancies shall be situated in the building so that the system will be as follows:

(a) In an adequately ventilated area as in 4-2.2.

(b) 20 ft (6 m) from all classes of flammable and combustible liquids, oxidizing gases and readily combustible materials, such as excelsior and paper.

(c) 25 ft (7.6 m) from open flames, ordinary electrical equipment or other sources of ignition.

(d) 50 ft (15 m) from intakes of ventilation or air conditioning equipment and air compressors.

(e) 50 ft (15 m) from other flammable gas storage.

(f) Protected against damage or injury due to falling objects or working activity in the area.

(g) More than one system of 3,000 CF (85 m³) or less may be installed in the same room, provided the systems are separated by at least 50 ft (15 m). Each such system shall meet all of the requirements of this section.

Table 3-2.2

Type of Outdoor Exposure		Size of Hydrogen System: Less than 3,000 CF (85 m³)	3,000 CF (85 m³) to 15,000 CF (255 m³)	In Excess of 15,000 CF (255 m³)
1. Building or Structure	a) Wall(s) adjacent to system constructed of noncombustible or limited-combustible materials.			
	1) Sprinklered building or structure, or contents noncombustible	0[1]	5[1]	5[1]
	2) Unsprinklered building or structure with combustible contents.			
	Adjacent wall(s) with fire-resistance rating less than 2 hours.[2]	0[3]	10	25[4]
	Adjacent wall(s) with fire-resistance rating of 2 hours or greater.[2]	0	5	5
	b) Wall(s) adjacent to system constructed of other than noncombustible or limited combustible materials.	10	25	50[4]
2. Wall Openings	Not above any part of a system	10 ft (3 m)	10 ft (3 m)	10 ft (3 m)
	Above any part of a system	25 ft (7.6 m)	25 ft (7.6 m)	25 ft (7.6 m)
3. All classes of flammable and combustible liquids above ground*	0-1,000 gallons	10 ft (3 m)	25 ft (7.6 m)	25 ft (7.6 m)
	In excess of 1,000 gallons	25 ft (7.6 m)	50 ft (15 m)	50 ft (15 m)
4. All classes of flammable and combustible liquids below ground — 0-1,000 gallons*	Tank	10 ft (3 m)	10 ft (3 m)	10 ft (3 m)
	Vent or fill opening of tank	25 ft (7.6 m)	25 ft (7.6 m)	25 ft (7.6 m)
5. All classes of flammable and combustible liquids below ground — in excess of 1,000 gallons*	Tank	20 ft (6 m)	20 ft (6 m)	20 ft (6 m)
	Vent or fill opening of tank	25 ft (7.6 m)	25 ft (7.6 m)	25 ft (7.6 m)
6. Flammable gas storage (other than hydrogen), either high pressure or low pressure	0-15,000 CF (255 m³) capacity	10 ft (3 m)	25 ft (7.6 m)	25 ft (7.6 m)
	In excess of 15,000 CF (255 m³) capacity	25 ft (7.6 m)	50 ft (15 m)	50 ft (15 m)
7. Oxygen Storage	20,000 CF (566 m³) or less	Refer to NFPA 51, Gas Systems for Welding and Cutting		
	More than 20,000 CF (566 m³)	Refer to NFPA 50, Bulk Oxygen Systems at Consumer Sites		
8. Fast burning solids such as ordinary lumber, excelsior or paper		50 ft (15 m)	50 ft (15 m)	50 ft (15 m)
9. Slow burning solids such as heavy timber or coal		25 ft (7.6 m)	25 ft (7.6 m)	25 ft (7.6 m)
10. Open flames and welding		25 ft (7.6 m)	25 ft (7.6 m)	25 ft (7.6 m)
11. Air compressor intakes or inlets to ventilating or air-conditioning equipment		50 ft (15 m)	50 ft (15 m)	50 ft (15 m)
12. Places of public assembly		25 ft (7.6 m)	50 ft (15 m)	50 ft (15 m)
13. Public sidewalks		15 ft (4.6 m)	15 ft (4.6 m)	15 ft (4.6 m)
14. Line of adjoining property which may be built upon		5 ft (1.5 m)	5 ft (1.5 m)	5 ft (1.5 m)

Notes to Item 1 of Table 3-2.2

1. Portions of wall less than 10 ft (3 m) (measured horizontally) from any part of a system shall have a fire-resistance rating of at least ½ hour.

2. Exclusive of windows and doors (see Item 2 of Table 3-2.2).

3. Portions of wall less than 10 ft (3 m) (measured horizontally) from any part of a system shall have a fire-resistance rating of at least 1 hour.

4. But not less than one-half the height of adjacent wall of building or structure.

*Distances may be reduced to 15 ft (4.6 m) for Class IIIB combustible liquids.

Chapter 4 Design Considerations at Specific Locations

4-1 Outdoor Locations.

4-1.1 Where protective walls or roofs are provided, they shall be constructed of noncombustible or limited-combustible materials.

4-1.2 Where the enclosing sides adjoin each other, the area shall be properly ventilated.

4-1.3 Electrical equipment within 15 ft (4.6 m) shall be in accordance with Article 501 of the *National Electrical Code®* for Class I, Division 2 locations.

4-2 Separate Buildings.

4-2.1 Separate buildings shall be constructed of noncombustible or limited-combustible materials. Windows and doors shall be located so as to be readily accessible in case of emergency.

Exception: Window glazing may be plastic.

4-2.2 Adequate ventilation to the outdoors shall be provided. Inlet openings shall be located near the floor in exterior walls only. Outlet openings shall be located at the high point of the room in exterior walls or roof. Inlet and outlet openings shall each have a minimum total area of one (1) sq ft per 1,000 cu ft (1 sq m per 305 cu m) of room volume. Discharge from outlet openings shall be directed or conducted to a safe location.

4-2.3 Explosion venting shall be provided in exterior walls or roof only. Vents may consist of any one or any combination of the following designed to relieve at a maximum internal pressure of 25 lb per sq ft (13.3 kPa per sq m):

(1) Walls of light material.
(2) Lightly fastened hatch covers.
(3) Lightly fastened, outward-opening swinging doors in exterior walls.
(4) Lightly fastened walls or roof.

(a) Where applicable, snow loads shall be considered.

(b) For buildings or rooms housing hydrogen systems of 15,000 CF (255 m^3) or less, the venting area shall be equal to not less than 1 sq ft per 30 cu ft (1 sq m per 9 cu m) of room volume.

(c) For buildings housing hydrogen systems larger than 15,000 CF (255 m^3), see NFPA 68, *Guide for Explosion Venting*.

4-2.4 There shall be no sources of ignition from open flames, electrical equipment, or heating equipment.

4-2.5 Electrical equipment shall be in accordance with Article 501 of the *National Electrical Code* for Class I, Division 2 locations.

4-2.6 Heating, if provided, shall be by steam, hot water, or other indirect means except that electrical heating may be used if in compliance with 4-2.5

4-3 Special Rooms.

4-3.1 Floor, walls and ceiling shall be constructed of noncombustible or limited-combustible materials. Interior walls or partitions shall have a fire-resistance rating of at least 2 hours, be continuous from floor to ceiling and shall be securely anchored. At least one wall shall be an exterior wall. Openings to other parts of the building shall not be permitted. Windows and doors shall be in exterior walls and shall be located so as to be readily accessible in case of emergency.

Exception: Window glazing may be plastic.

4-3.2 Ventilation shall be as provided in 4-2.2.

4-3.3 Explosion venting shall be as provided in 4-2.3.

4-3.4 There shall be no sources of ignition from open flames, electrical equipment, or heating equipment.

4-3.5 Electrical equipment shall be in accordance with Article 501 of the *National Electrical Code* for Class I, Division 2 locations.

4-3.6 Heating, if provided, shall be by steam, hot water, or indirect means except that electrical heating may be used if in compliance with 4-3.5.

Chapter 5 Operation and Maintenance

5-1 Operating Instructions. For installations which require any operation of equipment by the user, legible instructions shall be maintained at operating locations.

5-2 Maintenance. Each hydrogen system installed on consumer premises shall be inspected annually and maintained by a qualified representative of the equipment owner.

5-3 The area within 15 ft (4.6 m) of any hydrogen container shall be kept free of dry vegetation and combustible material.

Chapter 6 Fire Protection

Hydrogen fires are not normally extinguished until the supply of hydrogen has been shut off because of the danger of reignition or explosion. In the event of fire, large quantities of water have been sprayed on adjacent equipment to cool the equipment and prevent involvement in the fire. Combination fog and solid stream nozzles have been preferred to permit widest adaptability

in fire control. Small hydrogen fires have been extinguished by dry chemical extinguishers or with carbon dioxide, nitrogen and steam. Reignition may occur if a metal surface adjacent to the flame is not cooled with water or other means.

6-1 The fire protection provided shall be determined by an analysis of local conditions of hazard, within the plant, exposure to other properties, water supplies, the probable effectiveness of plant fire brigades, and the time of response and probable effectiveness of fire departments.

6-2 Personnel shall be cautioned that hydrogen flames are practically invisible.

Chapter 7 Mandatory Referenced Publications

7-1 This chapter lists publications referenced within this document which, in whole or in part, are part of the requirements of this document.

7-1.1 NFPA Publications. The following publications are available from the National Fire Protection Association, Batterymarch Park, Quincy, MA 02269.

NFPA 68-1978, *Guide for Explosion Venting*

NFPA 70-1984, *National Electrical Code*

NFPA 220-1979, *Standard on Types of Building Construction*

7-1.2 ANSI Publications. The following publications are available from the American National Standards Institute, 1430 Broadway, New York, NY 10018.

ANSI B31.3-1980, *Code for Chemical Plant and Petroleum Refinery Piping*.

ANSI Z48.1-1978, *Method of Marking Portable Gas Containers to Identify the Material Contained.*

7-1.3 ASME Publication. The following publication is available from the American Society for Mechanical Engineers, 345 East 47th St., New York, NY 10017.

Rules for the Construction of Unfired Pressure Vessels, Section VIII, ASME *Boiler and Pressure Vessel Code*-1980.

7-1.4 ASTM Publication. The following publication is available from the American Society for Testing and Materials, 1916 Race St., Philadelphia, PA 19103.

ASTM E-136-1979, *Standard Method of Test for Behavior of Materials in a Vertical Tube Furnace at 750°C.*

7-1.5 Federal Regulations. The following publication is available from the US Government Printing Office, Washington, DC 20401.

Code of Federal Regulations, Title 49, Parts 171-190.