ANSI/NFPA 423 An American National Standard August 7, 1989

# NFPA 423
# Aircraft Engine Test Facilities
## 1989 Edition

NFPA

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.

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NATIONAL FIRE PROTECTION ASSOCIATION

**NFPA 423**

**Standard for Construction and Protection of**

# Aircraft Engine Test Facilities

**1989 Edition**

This edition of NFPA 423, *Standard for Construction and Protection of Aircraft Engine Test Facilities*, was prepared by the Technical Committee on Airport Facilities, released by the Correlating Committee on Aviation, and acted on by the National Fire Protection Association, Inc. at its Annual Meeting held May 15-18, 1989 in Washington, DC. It was issued by the Standards Council on July 14, 1989, with an effective date of August 7, 1989, and supersedes all previous editions.

The 1989 edition of this document has been approved by the American National Standards Institute.

## Origin and Development of NFPA 423

The Sectional Committee started work on this standard in 1972. It was first submitted to the association at the 1975 Fall Meeting but was returned to committee for coordination with the NFPA Committee on Fire Tests. The 1977 edition contains the results of that coordination effort. The standard was reconfirmed in 1983.

The 1989 edition is a complete revision of the 1983 edition.

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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.

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NFPA 423

Standard for Construction and Protection of

# Aircraft Engine Test Facilities

1989 Edition

NOTICE: An asterisk (*) following the number or letter designating a paragraph indicates explanatory material on that paragraph in Appendix A.

Information on referenced publications can be found in Chapter 7 and Appendix B.

## Chapter 1 Administration

### 1-1 Scope.

**1-1.1** This standard establishes the minimum firesafety practices regarding location, construction, services, utilities, fire protection, operation, and maintenance of aircraft engine test facilities. These facilities include test cells and test stands.

**1-1.2** This standard does not apply to engines and engine accessories, nor to engine test facilities where other than hydrocarbon fuels are used.

**1-2 Purpose.** The purpose of this standard is to provide a reasonable degree of protection, for life and property from fire, for aircraft engine test facilities, based upon sound engineering principles, test data, and field experience.

### 1-3 Definitions.

**Approved.*** Acceptable to the "authority having jurisdiction."

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

**Control Room.** A room with instrumentation and devices to control, measure, record, or observe test cell and engine operation and performance.

**Detection System.** A system consisting of detectors, controls, control panels, automatic and manual actuating mechanisms, all wiring, and all associated equipment.

**Engine Rundown Time.** The time required for the engine under test to have reduced its rotational speed to 10 percent of that at full power (100 percent).

**Engine Test Cell.** The space in which the test engine is installed on a thrust stand during a test. This space is totally enclosed by permanent building components except where the enclosure is breached by air ducts, services, access ports, or doors.

**Engine Test Facility.** An integrated system of building(s), structure(s), space, and services used to test aircraft engines contained within a test cell or on a test stand.

**Engine Test Stand.** An integrated system for testing an aircraft engine, as in a test cell, except that the engine test space is not totally enclosed within a permanent building.

**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.

**May.** This term is used to state a permissive use, or an alternative method to a specified requirement.

**Shall.** Indicates a mandatory requirement.

**Should.** Indicates a recommendation or that which is advised but not required.

**Support Room.** An enclosure or area, excluding the test cell or control room, that is an integral part of engine testing, including fuel handling rooms, hydraulic rooms, preparation areas, mechanical/electrical rooms, etc.

**Test Cell.** See Engine Test Cell.

## Chapter 2 Construction and Internal Subdivisions

### 2-1 Construction of Aircraft Engine Test Facilities.

**2-1.1** Test cell walls, ceilings, and floor assemblies shall be at least Type II (222) construction as defined in NFPA 220, *Standard on Types of Building Construction.*

**2-1.2** Materials of construction such as thermal or acoustic insulation used within the test cell shall be noncombustible as defined in Section 2-6 of NFPA 220, *Standard on Types of Building Construction.*

**2-1.3** Engine test facilities shall be constructed without basements or below grade areas other than those recesses in the floor necessary to accommodate sump pumps, drainage facilities, or lifting platforms.

**2-1.3.1** In existing facilities, all basement areas, tunnels, or other below grade spaces shall be eliminated; or the fuel handling system shall be segregated, drainage shall be provided, and the basement area cut off so as to eliminate the possibility of flammable vapors collecting in the basement area or a spill of flammable or combustible liquids discharging into a basement area.

**2-1.4*** An explosion hazard analysis of the engine test cell shall be performed to determine if an explosion hazard exists capable of compromising the integrity of the structure. If the analysis indicates such a hazard exists, one of the following shall be incorporated:

(a) Explosion venting;

(b) Explosion suppression system;

(c) Explosion limiting construction.

**2-2 Internal Subdivisions of Aircraft Engine Test Facilities.**

**2-2.1*** Engine test cells, fuel handling areas, and hydraulic rooms shall be separated from adjacent areas by construction having a minimum fire rating of 2 hours.

## Chapter 3 Service and Utilities

**3-1 General Safeguards.**

**3-1.1*** All objects, such as supports, nuts, and bolts, located where they might be ingested into an aircraft turbine engine shall be positively secured by safety wires, tack welding, suitable adhesive, or approved aircraft-type locking devices; or an inlet screen of proper design shall be used to protect an engine from foreign object damage.

**3-1.2** All materials likely to become exposed to fuels, oils, or hydraulic fluids shall be resistant to deterioration from the fuels being used.

**3-2 Drainage Systems.**

**3-2.1*** Drainage systems shall be provided for engine test cells and support rooms containing flammable or combustible liquid handling systems to reduce the fire and explosion hazards.

**3-2.2** Floors subject to possible spillage of flammable or combustible liquids shall be pitched a minimum of one percent toward the drain(s). Drain(s) shall be located to minimize fuel spread and exposure to equipment.

**3-2.3** Curbs, ramps, or drain trenches shall be installed to prevent the flow of flammable or combustible liquids into adjacent rooms or buildings.

**3-2.4*** Drainage systems shall be designed and installed to provide sufficient capacity to prevent buildup of flammable or combustible liquids and water over the drain inlet under maximum possible water discharge rate.

**3-2.5*** Drain traps shall have a trap seal water head. In test cells, the seal water head shall be greater than the expected difference between the test cell operating pressure and atmospheric pressure.

**3-2.6** Drain piping and joints shall be resistant to deterioration from fuels, engine oil, and aircraft hydraulic system fluids.

**3-2.7** Common or separate oil separator(s) shall be provided in drains from the engine area, the exhaust plenum area, and support rooms. Separator systems shall discharge flammable or combustible liquid product to an approved, safely located tank, cistern, sump, or pond away from or cut off from the engine test facility. In aircraft engine test facilities protected by a fire protection system utilizing water, a bypass shall be provided around the separator to allow for emergency direct disposal of water and flammable liquids to an approved location.

**3-2.8** Maintenance checks and flushing shall be conducted on all drains and oil separators at least annually to assure that they are clear of obstructions.

**3-3 Electrical.**

**3-3.1** Any pit, depression, or other below floor level locations of engine test cells, fuel handling areas, and hydraulic rooms shall be classified as a Class I, Division 1 Hazardous Location as defined in Article 500, Chapter 5, of NFPA 70, *National Electrical Code®*. This classification shall extend up to floor level.

**3-3.2** Engine test cell including intake and exhaust plenums, fuel handling areas, and hydraulic rooms shall be classified as a Class I, Division 2 Hazardous Location as defined in Article 500, Chapter 5, of NFPA 70, *National Electrical Code*. This classification shall extend up to a level 18 inches (0.46 m) above the floor.

**3-3.3*** All wiring and equipment that is installed or operated within any of the hazardous locations specified in this section shall comply with applicable provisions of Article 501, Chapter 5, of NFPA 70, *National Electrical Code.*

**3-3.4** When wiring is located in vaults, pits, or ducts below the test cell floor, drainage shall be provided.

**3-3.5** All wiring in the exhaust plenum not within the hazardous location as specified in 3-3.2 of this section shall be installed in rigid conduit.

**3-3.6** All other test facility wiring not within a hazardous location shall meet the requirements of Chapter 3 of NFPA 70, *National Electrical Code.*

**3-3.7** All wiring not enclosed in raceways, such as harness wires connecting to the engine, shall be adequately supported, laced, or banded to minimize wear from air velocity and vibration.

**3-3.8*** A means shall be provided at the control console to shut off all electric power other than emergency circuits to the test cell in the event that the engine disintegrates or fuel leaks develop during operation.

**3-4 Heating and Cooling.**

**3-4.1*** Heating and cooling systems shall be arranged to:

(a) Reduce exposure of their vital elements to fire, explosion, and damage by metal;

(b) Eliminate introduction of ignition sources by components of heating systems;

(c) Minimize passage of fire through ductwork; and

(d) Eliminate pockets in which flammable vapors can accumulate.

3-4.2* Steam, hot water, or indirect warm-air heating systems shall be used for general room or building heating in areas where flammable or combustible liquids or flammable gases are handled. Where flammable or combustible liquids or heavier-than-air flammable gases are used, return openings in hot air systems shall be located a minimum of ten (10) feet (3 m) above the floor. A conveniently located remote control station shall be provided to shut down the warm-air heating system.

3-4.3* Cooling systems utilizing flammable refrigerants shall not be installed nor used within the test cell.

3-4.4* When direct-fired inlet air preheaters are essential to simulate hot inlet air conditions, fuel safety controls as specified in NFPA 86, *Standard for Ovens and Furnaces*, shall be provided. Interlocks shall be provided to prevent ignition of a direct-fired system until adequate airflow has been established within the test cell or the engine is running.

3-4.5 Direct-fired or indirect-fired heaters for heating test cell inlet air shall be designed in accordance with applicable sections of NFPA 31, *Standard for the Installation of Oil Burning Equipment*; NFPA 54, *National Fuel Gas Code*; and NFPA 58, *Standard for the Storage and Handling of Liquefied Petroleum Gases*.

## 3-5 Ventilation.

3-5.1* Continuous forced ventilation using fresh air at the rate of at least 2 cu ft per minute per sq ft (0.01 cubic meter per second per square meter) of floor area shall be provided in all support rooms handling flammable or combustible liquids.

3-5.2 Ventilation systems shall be arranged to draw heavier-than-air vapors or gases from near the floor level and discharge to a safe location. Where lighter-than-air gases are used, similar ventilation shall be provided but arranged to exhaust from ceiling level and with calculations based on the ceiling area. Ventilation for lighter-than-air gases shall be designed to prevent pocketing of such gases at ceiling level. Rotating elements of fans shall be of nonferrous or nonsparking materials, or the casing shall consist of or be lined with such material.

3-5.3 Where ventilation is provided, each cell or room handling flammable or combustible liquids or flammable gases shall have its own ventilation system in order to avoid interconnecting multiple hazards.

## 3-6 Fuel Systems and Lubricating Oil Systems.

3-6.1 Fuel systems and lubricating oil systems shall meet the requirements of NFPA 30, *Flammable and Combustible Liquids Code*. Plastic, aluminum, or cast iron shall not be permitted to be used aboveground for pipe, valve bodies, and fittings in test facilities.

3-6.2* Fuel systems shall be equipped with manually operated control valves located at strategic points both outside and inside the engine test facility so that the main fuel supplies can be shut down quickly in the event of an emergency.

3-6.3* Emergency safety shutoff valve(s) shall be installed in the fuel supply line(s) to each test cell and shall be located outside each test cell. These valves shall close on operation of a readily accessible and placarded emergency control device.

3-6.4 Fuel lines from main fuel headers shall enter fuel handling areas and run to test cells without passing through the control room. Relief valves arranged to discharge into collection tanks or fuel return lines, or other suitable devices, shall be installed in the piping system to protect the piping and equipment against overpressure due to thermal expansion of liquid in valved off sections.

3-6.5 Glass fuel flow measuring devices shall not be used.

3-6.6 Flexible sections in the fuel and lubricating oil systems shall be suitable for the fluid and for the temperature and pressure to be expected.

3-6.7 Fuel and lubricant piping within the test cell shall be located as to minimize exposure from physical damage.

## 3-7 Compressed Air.

3-7.1 Compressed air piping systems shall conform to requirements of ANSI B31.1, *Code for Power Piping*.

3-7.2 Materials in compressed air piping systems shall be rated for the conditions of pressure and temperature expected. They shall be resistant to the fuels, oils, or hydraulic fluids to which they could be exposed.

3-7.3 Hose bands and joint couplings shall be of an approved type, and shall be safety wired.

## 3-8 Hydraulic Fluids.

3-8.1* Hydraulic systems shall be designed in accordance with ANSI B31.1, *Code for Power Piping*. Piping and fittings shall be designed to withstand maximum surge pressures in the system. Piping shall be securely mounted to prevent failure due to vibration or mechanical damage. Gasket materials and seals shall be suitable for the fluid used.

3-8.2* Properly identified, manually actuated devices shall be provided in a readily accessible location to shut off hydraulic pumps in the event of leakage, pipe or hose failure, or fire. These devices shall shut off the hydraulic pump drive system.

## 3-9* Instrumentation.

3-9.1 Computer rooms and electronic data processing equipment shall meet the requirements of NFPA 75, *Standard for the Protection of Electronic Computer/Data Processing Equipment*, and the protection requirements specified in Chapter 4 of this standard.

3-9.2* Signal and control wiring or tubing shall be installed to minimize exposure from fuel hazards or physical damage from engine disintegration.

3-9.3 Flow meters or sensing lines containing fuel or oil shall not be located in the control room.

## Chapter 4 Fire Protection Requirements

### 4-1 Engine Test Facility.

**4-1.1** Portable fire extinguishers shall be provided throughout the engine test facility. Portable fire extinguishers and their distribution shall meet the requirements of NFPA 10, *Standard for Portable Fire Extinguishers*.

**4-1.2** Portable fire extinguishers shall not be located within the engine test cell.

**4-1.3** Class B hazards shall be classified as an Extra Hazard in accordance with NFPA 10, *Standard for Portable Fire Extinguishers*.

**4-1.4** Class A hazards shall be classified as at least an Ordinary Hazard in accordance with NFPA 10, *Standard for Portable Fire Extinguishers*.

**4-1.5** As an alternative to the requirements of 4-1.1 of this section, hand hose lines of one or more of the following types shall be permitted in place of 50 percent of the required portable fire extinguishers:

(a) Water, meeting the requirements of NFPA 14, *Standard for the Installation of Standpipe and Hose Systems*;

(b) Carbon dioxide, meeting the requirements of Chapter 4 of NFPA 12, *Standard on Carbon Dioxide Extinguishing Systems*;

(c) Foam, meeting the requirements of NFPA 11, *Standard for Low Expansion Foam and Combined Agent Systems*;

(d) Dry chemical, meeting the requirements of Chapter 5 of NFPA 17, *Standard for Dry Chemical Extinguishing Systems*.

**4-1.5.1** Where hand hose lines are provided, each hose line station shall be located so it is easily accessible.

**4-1.6** The engine test facility shall be provided with an alarm and communications system meeting the requirements of 30-3.4 and Section 7-6 of NFPA *101*®, *Life Safety Code*®. In addition, the alarm system shall notify personnel in the control room and engine test cell.

**4-1.7*** Where provided, fire detection systems shall meet the requirements of NFPA 72E, *Standard on Automatic Fire Detectors*.

### 4-2* Engine Test Cell.

**4-2.1*** At least one of the following fire protection systems shall be provided to protect each engine test cell.

(a) Carbon dioxide system, meeting the requirements of Sections 5-1 and 5-2 of this standard;

(b) Halon system, meeting the requirements of Sections 5-1 and 5-3 of this standard;

(c) Foam system, meeting the requirements of Sections 5-1 and 5-5 of this standard;

(d) Water spray system, meeting the requirements of Sections 5-1 and 5-6 of this standard;

(e) Water deluge system, meeting the requirements of Sections 5-1 and 5-6 of this standard;

(f) Automatic sprinkler system, meeting the requirements of Sections 5-1 and 5-6 of this standard.

**4-2.1.1** Systems (a) through (e) shall have a manual release located within the control room.

**4-2.1.2** Systems (a) through (e) shall not be required to be automatically actuated.

**4-2.2** Where provided, automatic actuation may be bypassed during engine operation provided the control room is continuously attended. Detection and alarms shall remain in service at all times. Any such bypass function shall be electrically supervised.

**4-2.3** A separate fire protection system control valve shall be provided for each engine test cell.

**4-2.4** Extinguishing systems for engine test cells shall be designed to compensate for the high airflows encountered during operation and engine rundown time.

**4-2.5** When provided, time delay for system discharge shall not be less than that required for safe egress of personnel, but shall be permitted to be extended to compensate for engine rundown time.

**4-2.6** Piping, nozzles, and actuation systems shall be located to minimize the extent of physical damage in the event of engine disintegration.

### 4-3 Control Rooms.

**4-3.1** Control rooms constructed of materials that are other than noncombustible or limited combustible as defined in Sections 2-3 and 2-6 of NFPA 220, *Standard on Types of Building Construction*, shall be protected by an automatic sprinkler system meeting the requirements of Sections 5-1 and 5-6 of this standard.

**4-3.2*** Control rooms constructed of either noncombustible or limited combustible materials as defined in Sections 2-3 and 2-6 of NFPA 220, *Standards on Types of Building Construction*, shall be provided with at least one of the following automatic fire protection systems:

(a) Halon 1301 total flooding system, meeting the requirements of Sections 5-1 and 5-3 of this standard;

(b) Automatic sprinkler system, meeting the requirements of Sections 5-1 and 5-6 of this standard.

### 4-4 Support Rooms.

**4-4.1*** All support rooms shall be provided with at least one of the following automatic fire protection systems:

(a) Carbon dioxide system, meeting the requirements of Sections 5-1 and 5-2 of this standard;

(b) Halon 1301 system, meeting the requirements of Sections 5-1 and 5-3 of this standard;

(c) Dry chemical system, meeting the requirements of Sections 5-1 and 5-4 of this standard;

(d) Foam system, meeting the requirements of Sections 5-1 and 5-5 of this standard;

(e) Water spray system, meeting the requirements of Sections 5-1 and 5-6 of this standard;

(f) Water deluge system, meeting the requirements of Sections 5-1 and 5-6 of this standard;

(g) Automatic sprinkler system, meeting the requirements of Sections 5-1 and 5-6 of this standard.

## Chapter 5 Fixed Fire Protection Systems

### 5-1 General Design Requirements.

**5-1.1** Fire protection system control equipment shall be located outside of the hazard area.

**5-1.2** All fire protection system control equipment shall be identified as to the hazard protected, the function performed, and the method of operation for manual controls.

**5-1.3** Manual fire protection system controls shall be conveniently located and accessible at all times, including the time of fire.

### 5-2 Carbon Dioxide Systems.

**5-2.1** Carbon dioxide systems shall meet the requirements of NFPA 12, *Standard on Carbon Dioxide Extinguishing Systems.*

**5-2.2** The system shall have a connected reserve supply not less than 100 percent of the primary supply arranged for immediate manual discharge.

**5-2.3** The actuation of the system shall:

(a) Close fuel valves supplying fuel to the protected area; and

(b) Activate alarm devices to warn personnel to evacuate the protected area.

**5-2.4** The actuation of a total flooding system shall do the following in addition to the requirements of 5-2.3 of this section:

(a) Provide sufficient time to allow personnel to egress before the extinguishing agent is discharged; and

(b) Shut off ventilating fans and close doors and other openings to minimize the leakage of the extinguishing agent from the protected area.

**5-2.5** Closing of doors shall not prevent the safe egress of personnel from the protected area.

### 5-3 Halon Systems.

**5-3.1** Halon systems shall meet the requirements of NFPA 12A, *Standard on Halon 1301 Fire Extinguishing Systems*, or NFPA 12B, *Standard on Halon 1211 Fire Extinguishing Systems.*

**5-3.2** Halon systems shall have a connected reserve supply not less than 100 percent of the primary supply arranged for immediate manual discharge.

**5-3.3** The actuation of the system shall:

(a) Close fuel valves supplying fuel to the protected area; and

(b) Activate alarm devices to warn personnel to evacuate the protected area.

**5-3.4** The actuation of a total flooding system shall do the following in addition to the requirements of 5-3.3 of this section:

(a) Provide sufficient time to allow personnel to egress before the extinguishing agent is discharged; and

(b) Shut off ventilating fans and close doors and other openings to minimize the leakage of the extinguishing agent from the protected area.

**5-3.5** Closing of doors shall not prevent the safe egress of personnel from the protected area.

### 5-4 Dry Chemical Systems.

**5-4.1** Dry chemical systems shall meet the requirements of NFPA 17, *Standard for Dry Chemical Extinguishing Systems.*

**5-4.2** The actuation of the system shall:

(a) Close fuel valves supplying fuel to the protected area;

(b) Activate alarm devices to warn personnel to evacuate the protected area;

(c) Provide sufficient time to allow personnel to egress before the extinguishing agent is discharged; and

(d) Cause ventilating fans to shut down.

### 5-5 Foam, High Expansion Foam, Foam-Water Sprinkler, and Foam-Water Spray Systems.

**5-5.1** Low expansion foam extinguishing systems shall meet the requirements of NFPA 11, *Standard for Low Expansion Foam and Combined Agent Systems.*

**5-5.2** High expansion foam systems shall meet the requirements of NFPA 11A, *Standard for Medium and High Expansion Foam Systems.*

**5-5.3** Foam-water sprinkler systems and foam-water spray systems shall meet the requirements of NFPA 16, *Standard on Deluge Foam-Water Sprinkler and Foam-Water Spray Systems.*

**5-5.4** The actuation of a foam, high expansion foam, foam-water sprinkler, or foam-water spray system shall:

(a) Close fuel valves supplying fuel to the protected area;

(b) Activate alarm devices to warn personnel to evacuate the protected area;

(c) Provide sufficient time to allow personnel to egress before the extinguishing agent is discharged; and

(d) Cause ventilating fans to shut down and doors to close automatically.

**5-5.5** In engine test cells only, the total discharge rate shall be calculated on the required density over the total floor area.

**5-5.6** In engine test cells only, discharge devices shall be arranged to provide coverage of the hazard area. Discharge devices located at the ceiling shall provide complete coverage over the floor area. Directional discharge devices shall project the foam onto the thrust stand regardless of the discharge device location.

**5-6 Water Spray Systems, Water Deluge Systems, and Automatic Sprinkler Systems.**

**5-6.1** Water spray systems shall meet the requirements of NFPA 15, *Standard for Water Spray Fixed Systems for Fire Protection.*

**5-6.2** Water deluge systems and other automatic sprinkler systems shall meet the requirements of NFPA 13, *Standard for the Installation of Sprinkler Systems.*

**5-6.3*** In engine test cells, the minimum design discharge density shall be 0.50 gallons per minute per sq ft (0.34 liters per second per square meter) of protected area.

**5-6.4** In engine test cells, water supplies shall be capable of meeting the largest demand at the design rate plus hose stream demand for a period of 30 minutes. Hose stream demand shall be a minimum of 250 gallons per minute (16 liters per second). The hydraulic calculation and the water supply shall be based on the assumption that all sprinklers in the test cell are operating simultaneously.

## Chapter 6 Employee Organization for Firesafety

**6-1 General.**

**6-1.1** All personnel engaged in aircraft engine testing operations and all other persons regularly employed and working around engine test facilities shall be instructed in fire prevention practices as part of their regular training. These personnel shall also be trained in the operation of all portable fire extinguishers and hose line systems provided in the area in which they work.

**6-1.2** Selected personnel on each operational shift shall be trained in operation of the fixed fire protection systems provided in the test facility. This training shall be accompanied by a comprehensive explanation of all features of such systems and the area they protect.

**6-1.3** Responsibility for fire protection equipment, inspection, and maintenance shall be assigned to key personnel.

## Chapter 7 Referenced Publications

**7-1** The following documents or portions thereof are referenced within this standard and shall be considered part of the requirements of this document. The edition indicated for each reference is the current edition as of the date of the NFPA issuance of this document.

**7-1.1 NFPA Publications.** National Fire Protection Association, Batterymarch Park, Quincy, MA 02269.

NFPA 10-1988, *Standard for Portable Fire Extinguishers*

NFPA 11-1988, *Standard for Low Expansion Foam and Combined Agent Systems*

NFPA 11A-1988, *Standard for Medium and High Expansion Foam Systems*

NFPA 12-1989, *Standard on Carbon Dioxide Extinguishing Systems*

NFPA 12A-1989, *Standard on Halon 1301 Fire Extinguishing Systems*

NFPA 12B-1989, *Standard on Halon 1211 Fire Extinguishing Systems*

NFPA 13-1989, *Standard for the Installation of Sprinkler Systems*

NFPA 14-1986, *Standard for the Installation of Standpipe and Hose Systems*

NFPA 15-1985, *Standard for Water Spray Fixed Systems for Fire Protection*

NFPA 16-1986, *Standard on Deluge Foam-Water Sprinkler and Foam-Water Spray Systems*

NFPA 17-1985, *Standard for Dry Chemical Extinguishing Systems*

NFPA 30-1987, *Flammable and Combustible Liquids Code*

NFPA 31-1987, *Standard for the Installation of Oil Burning Equipment*

NFPA 54-1988, *National Fuel Gas Code*

NFPA 58-1989, *Standard for the Storage and Handling of Liquefied Petroleum Gases*

NFPA 70-1990, *National Electrical Code*

NFPA 72E-1987, *Standard on Automatic Fire Detectors*

NFPA 75-1989, *Standard for the Protection of Electronic Computer/Data Processing Equipment*

NFPA 86-1985, *Standard for Ovens and Furnaces*

NFPA 101-1988, *Code for Safety to Life from Fire in Buildings and Structures*

NFPA 220-1985, *Standard on Types of Building Construction.*

**7-1.2 ANSI Publication.** American National Standards Institute, 1430 Broadway, New York, NY 10018.

ANSI B31.1-1983, *Code for Power Piping.*

## Appendix A

*This Appendix is not a part of the requirements of this NFPA document, but is included for information purposes only.*

**A-1-3 Approved.** 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.

**A-1-3 Authority Having Jurisdiction.** 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."

**A-1-3 Listed.** 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.

**A-2-1.4** Analysis should include, but not be limited to:

(a) The type of testing to be done (e.g., production, endurance, development/research);

(b) Characteristics of the fuel (e.g., flash point, vapor density, autoignition temperature);

(c) Amount of airflow and whether it is ducted to the engine;

(d) Presence of continuous ventilation;

(e) Fuel quantity in relation to volume of the enclosure;

(f) Maximum fuel pressure, temperature, flow, and delivery system;

(g) Life safety considerations.

Test cells can be subject to an explosion hazard because of the presence of flammable vapors and the confinement of same within the test cell. The potential damage from an explosion will depend on numerous factors including:

(a) The designed pressure resistance of the structure;

(b) The amount of area utilized for inlet and exhaust air;

(c) The amount of explosion venting provided;

(d) The amount of continuous ventilation provided;

(e) The presence of explosion suppression equipment.

Explosion venting, continuous ventilation, and/or explosion suppression should be considered in the design of test cells. The planned use of the cell, the supporting equipment, the type of construction, and the configuration of the cell are some factors to be considered. (*See A-3-5.1.*) The net unobstructed area of engine test cell inlet and exhaust passages can be included in the venting area. Explosion venting could be effected in the cells proper by the use of lightweight roof or wall panels or outward opening doors equipped with resisting devices to prevent the venting device from being projected with chance of injury to personnel or damage to equipment in the event of operation. Guidance for explosion venting is provided in NFPA 68, *Guide for Venting of Deflagrations*. Where the specific design or configuration of a test facility does not allow the use of explosion venting, or very minimal explosion venting, consideration should be given to the protection of the structure or specialized equipment by the use of explosion suppression systems. Requirements for explosion suppressions are provided in NFPA 69, *Standard on Explosion Prevention Systems*.

**A-2-2.1** Test cell walls should not form common walls with main manufacturing buildings. Test cells should be located to minimize the exposure from openings such as doors, windows, inlet and exhaust stacks, ventilating ducts, explosion vents, or exhaust pipes to: (a) combustible construction or unprotected openings at the same or higher elevation, and (b) utilities such as transformers, overhead transmission lines, overhead service piping, and cooling towers. Where test cells are of light construction, important exposed buildings and utilities should be shielded from the possible disintegration of aircraft engines.

Other walls, ceilings, and floor assemblies comprising the engine test facility should be fire resistive, protected noncombustible, or noncombustible construction. The type of construction utilized in test buildings is determined to an extent by their proximity to main buildings or vital utilities.

**A-3-1.1** Parts or foreign objects that are located in front of a turbine engine or in other locations where they might be ingested into an engine are likely to cause damage to the engine or to a critcal system and cause a fire. Test cell operating procedures should therefore include a thorough inspection of the test cell and engine before engine starting to check for proper safety of parts and to eliminate foreign objects (e.g., tools, lockwire, nuts, bolts, washers, stones).

**A-3-2.1** Test cells and support rooms not containing flammable or combustible liquid handling systems might also require drainage systems to effectively dispose of water used for engine washing, exhaust gas cooling system malfunctions, rainwater, and water discharged from fire protection systems. Test cell floor drains should be located, where possible, downwind of probable fuel spill locations to minimize the pounding effect of high test cell air velocity. Requirements of federal, state, and local environmental agencies should be consulted.

**A-3-2.4** Where deluge sprinkler systems are installed, the capacity of the drainage system can be determined by the sprinkler design rate increased by an appropriate correction for maximum main pressure. Exhaust gas cooling water rates need not be included in the determination of peak drainage if an adequate emergency shutoff system or separate drainage system is provided.

**A-3-2.5** All drain traps should be provided with an automatic reseal system.

**A-3-3.3** It is common practice to locate limit switches for elevating work platforms below the floor level. An accidental shorting or grounding of these circuits should not allow the elevator to move or overrun, resulting in damage to engine fuel lines with ensuing fire.

**A-3-3.8** The failure of electric power supply to a test cell might deprive the operator of control of the engine, resulting in possible engine damage and ensuing fire. Battery power or other means should be provided in order to properly operate the engine during such failures.

**A-3-4.1** Heating and cooling systems used in conjunction with engine test facilities require careful design and installation because of the magnitude of the hazards, the complexity of the operations, and the operational importance of the facility.

**A-3-4.2** Surface temperatures of exposed heating elements should not equal or exceed the minimum auto-ignition temperature of the most hazardous flammable liquid or gas used.

**A-3-4.3** Direct cooling systems are preferred to systems that utilize extensive ductwork that penetrates cell walls.

**A-3-4.4** Test cell inlet preheaters used to simulate hot inlet air conditions should preferably use steam or a liquid heat exchange medium. Auxiliary fans to allow pre- and post-operation purging prior to lightoff and after running might be needed. Four complete cell air changes should be made before purging is considered complete. Preheaters utilizing gaseous fuel should have continuous gas detectors sampling all areas subject to flammable vapor accumulation. Gas detection systems should be interlocked to shut off gas and sound an alarm at 25 percent of the lower flammable limit.

**A-3-5.1** Forced air ventilation at the rate of one cubic foot per minute per square foot (0.005 cubic meters per second per square meter) of floor area should be provided in engine test areas when engines are not running.

**A-3-6.2** An additional fuel shutoff valve should be located before any flexible connection to the engine to isolate fuel inside the test cell if the quantity contained between the test cell wall and the engine is significant.

**A-3-6.3** Consideration should be given to the automatic operation of the emergency fuel safety shutoff valve by one or more of the following methods:

(a) Operation of the fire protection system;

(b) On actuation of heat sensing devices;

(c) Excess fuel flow.

**A-3-8.1** Many hydraulic systems utilize combustible oil under high pressure to transmit power or motion. The use of combustible hydraulic oils presents a potential fire and explosion hazard. Atomization of such fluids greatly increases the ease of ignition.

Use of hydraulic fluids with low fire hazard potential is encouraged. Such fluids include water-glycol, halogenated-hydrocarbon, phosphate-ester, or water-oil-emulsion types. When converting from one hydraulic fluid to another, the entire hydraulic system should be thoroughly cleaned, and seals, packings, valves, or pumps should be changed to prevent leakage. Equipment and fluid manufacturers should be consulted for proper conversion procedures in these nonengine related hydraulic systems.

Flexible connectors and hoses should be avoided.

**A-3-8.2** The hydraulic line should also be shut off by these devices to minimize fluid leakage.

**A-3-9** Instrumentation is an essential part of every engine testing facility and can include flow meters, pressure and temperature sensors, indicators, gauges, transducers, thrust and position indicators, vibration monitors, etc.

**A-3-9.2** Control instrumentation should be arranged so that its failure will not introduce a hazard. Where combustible pneumatic tubing is grouped in cabletrays or troughs, additional fire protection might be needed to prevent extensive damage to the tubing system.

**A-4-1.7** When a fire detection system is installed to sound an alarm or actuate a fire extinguishing system, the detection system design should consider airflows, engine location, heat sources from engine, and whether or not the engine is being continously observed. In test facilities where airflow velocities in excess of 25 ft/sec (7.6 m/sec) are expected, optical detection should be used.

**A-4-2** Where supplementary fire protection systems are provided for engine protection in addition to the required engine test cell fire protection, they should be designed and installed in an approved manner.

The following are the more common supplementary systems used for engine protection:

(a) *Carbon dioxide spurt system.*

1. A carbon dioxide spurt system is usually a manually actuated fixed-pipe system designed to locally apply carbon dioxide to an engine on an intermittent basis, or continuously by the operator. A spurt system can have its own agent supply or can be supplied from a total flooding or local application carbon dioxide system. Such a system is intended to provide a means for quick knockdown of fires in or around the engine while the engine is operating. There are usually no interlocks to shut down fuel flows, alarms, etc.

2. Pipings and fittings should conform to the applicable provisions of NFPA 12, *Standard on Carbon Dioxide Extinguishing Systems.*

3. The primary and connected reserve supply should each be designed to provide a continuous discharge for a minimum of three minutes.

(b) *Steam fire protection systems.* Steam extinguishes a fire in a manner similar to inert gases. In order to maintain steam in its true form at normal atmospheric temperatures and pressures and prevent its condensing to water vapor, very large quantities should be discharged at one time. This makes steam impractical for total flooding of a large test cell. It can be effective for engine fires when discharged within an enclosing cowl, when injected into cavities within the engine, or when injected into the main inlet air stream or into the tailpipe of an engine. Such factors as boiler maintenance, standby boilers, boiler fuel availability, normal peak steam demand, boiler feedwater availability, and availability of alternate emergency fire protection services should be considered in analyzing steam source requirements or suitability. The following guidelines are offered:

1. Steam can be used as an effective supplementary system for engine protection, provided steam is available in sufficient quantities whenever the test cell is in operation.

2. Piping for the distribution of steam from the source to the point of use should follow ANSI B31.1, *Code for Power Piping*, as applicable.

3. The steam flow rate should be sufficient to achieve a ratio of steam volume to total protected volume of 50 percent within 30 seconds. The steam supply should be capable of maintaining that concentration until the fire has been extinguished. Steam discharge to atmosphere of not less than 15 pounds per square inch (103,421 Pa) can be approximated by the formula:

$$W = 0.7A\,(P + 15)$$

where:

W = pounds of steam per minute

0.7 = constant including an orifice coefficient

A = orifice area (square inches)

P = gauge pressure at outlet (pounds per square inch)

For more precise determination of required orifice size, or when upstream and downstream pressure conditions are different from the above, consult a standard textbook on steam flow control.

4. The system should not be automatically actuated. Personnel hazards should be considered prior to manual actuation.

5. Steam condensate traps and lines should be provided to bleed off liquid and allow only vapor to be directed to the protected area.

6. The steam system should be inspected and tested at least semiannually.

**A-4-2.1** Each agent has its advantages and disadvantages and the choice of agent or combination of agents should be made only after careful consideration of the objective of the protection and the conditions of each individual installation. Some of the factors pertinent to each agent are:

(a) *Water.* Water, particularly in spray form, is an effective agent in controlling or extinguishing kerosene-grade (e.g., JET A or A-1; JP-5 or JP-8) jet fuel fires. It is not an effective extinguishing agent for fuels containing gasoline (e.g., JET B; JP-4). The principal advantage of water is its superior cooling capacity. Other advantages are: adequate supply for continuous discharge over long periods, ease of piping, and low cost. Disadvantages are: drainage requirements and possible water damage to the test engine, electrical devices, wiring, and instrumentation. Deluge systems are considered more appropriate than closed head automatic sprinklers due to their speed of operation and simultaneous discharge from all nozzles. Automatic sprinklers can be effectively used in small test cells [600 sq ft (56 $m^2$) or less] where it is likely that all sprinklers would fuse at the same time, or, as a back-up to a manual water spray or other manual system.

(b) *Carbon Dioxide.* Carbon dioxide is an effective extinguishing agent for flammable liquid fires when applied in sufficient concentration. Its principal advantage is lack of agent damage. Other advantages are no cleanup and relatively low cost for recharging the system. Disadvantages are the need to evacuate personnel from a protected area, limited supply of agent, leakage of agent from a protected space, and lack of significant cooling effect.

(c) *Foam.* Foam is an effective extinguishing agent for all aviation fuels. It is most applicable for fires involving large spills. Other advantages are: (1) the ability to cover large fuel spills before they become ignited, and (2) its insulating qualities. Disadvantages are lack of effectiveness on three-dimensional fires (e.g., fuel flowing from an elevated source), cost of agent, and cleanup. Foam systems are not effective on fires involving flammable gases.

(d) *Dry chemical.* Dry chemical extinguishing agents are effective for flammable liquid and gaseous fires. They have rapid knockdown and extinguishing capability. Dry chemical extinguishing agents are not considered desirable for test cell coverage due to extensive cleanup required and potential damage to electrical contacts and engine parts.

(e) *Halon.* Halon can be used for extinguishing fuel spill fires and engine fires and has the ability to extinguish or suppress fires in surface-burning Class A materials as well as extinguishing Class B fires and being safe to use on Class C (electrical) fires. The compatibility of the agents with engine parts should be investigated since the decomposition products might be corrosive. The only halons recommended for test facility protection are Halon 1301 and Halon 1211. Both agents require less extinguishing concentrations than carbon dioxide, resulting in smaller piping and less agent storage.

See NFPA 12A (Halon 1301) and NFPA 12B (Halon 1211) for more descriptive information.

**A-4-3.2** See A-4-2.1.

**A-4-4.1** See A-4-2.1.

**A-5-6.3** Because of the nature of the test cell fire potential, deluge systems are considered more appropriate than automatic sprinklers due to their speed of operation and simultaneous discharge of all nozzles; however, automatic sprinklers can be used:

(a) In small cells [600 sq ft (56 $m^2$) or less] where it is likely that all sprinklers would fuse at the same time; or

(b) As a backup to a manual water spray or other manual system.

## Appendix B Referenced Publications

**B-1** The following documents or portions thereof are referenced within this standard for informational purposes only and thus are not considered part of the requirements of this document. The edition indicated for each reference is the current edition as of the date of the NFPA issuance of this document.

**B-1.1 NFPA Publications.** National Fire Protection Association, Batterymarch Park, Quincy, MA 02269.

NFPA 12-1989, *Standard on Carbon Dioxide Extinguishing Systems*

NFPA 12A-1989, *Standard on Halon 1301 Fire Extinguishing Systems*

NFPA 12B-1985, *Standard on Halon 1211 Fire Extinguishing Systems*

NFPA 68-1988, *Guide for Venting of Deflagrations*

NFPA 69-1986, *Standard on Explosion Prevention Systems.*

**B-1.2 ANSI Publication.** American National Standards Institute, 1430 Broadway, New York, NY 10018.

ANSI B31.1-1983, *Code for Power Piping.*

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# SUBMITTING PROPOSALS ON NFPA TECHNICAL COMMITTEE DOCUMENTS

**Contact NFPA Standards Administration for final date for receipt of proposals on a specific document.**

## INSTRUCTIONS

**Please use the forms which follow for submitting proposed amendments. Use a separate form for each proposal.**

1. For each document on which you are proposing amendment indicate:
   (a) The number and title of the document
   (b) The specific section or paragraph.

2. Check the box indicating whether or not this proposal recommends new text, revised text, or to delete text.

3. In the space identified as "Proposal" include the wording you propose as new or revised text, or indicate if you wish to delete text.

4. In the space titled "Statement of Problem and Substantiation for Proposal" state the problem which will be resolved by your recommendation and give the specific reason for your proposal including copies of tests, research papers, fire experience, etc. If a statement is more than 200 words in length, the technical committee is authorized to abstract it for the Technical Committee Report.

5. Check the box indicating whether or not this proposal is original material, and if it is not, indicate source.

6. If supplementary material (photographs, diagrams, reports, etc.) is included, you may be required to submit sufficient copies for all members and alternates of the technical committee.

NOTE: The NFPA Regulations Governing Committee Projects in Paragraph 10-10 state: Each proposal shall be submitted to the Council Secretary and shall include:

(a) identification of the submitter and his affiliation (Committee, organization, company) where appropriate, and

(b) identification of the document, paragraph of the document to which the proposal is directed, and

(c) a statement of the problem and substantiation for the proposal, and

(d) proposed text of proposal, including the wording to be added, revised (and how revised), or deleted.

# FORM FOR PROPOSALS ON NFPA TECHNICAL COMMITTEE DOCUMENTS

Mail to: Secretary, Standards Council
National Fire Protection Association, Batterymarch Park, Quincy, Massachusetts 02269

Date 5/18/85 Name John B. Smith Tel. No. 617-555-1212

Address 9 Seattle St., Seattle, WA 02255

Representing (Please indicate organization, company or self) Fire Marshals Assn. of North America

1. a) Document Title: Protective Signaling Systems NFPA No. & Year NFPA 72D

   b) Section/Paragraph: 2-7.1 (Exception)

2. Proposal recommends: (Check one)
   - ☐ new text
   - ☐ revised text
   - ☒ deleted text.

3. Proposal (include proposed new or revised wording, or identification of wording to be deleted):

   Delete exception.



4. Statement of Problem and Substantiation for Proposal:

   A properly installed and maintained system should be free of ground faults. The occurrence of one or more ground faults should be required to cause a "trouble" signal because it indicates a condition that could contribute to future malfunction of the system. Ground fault protection has been widely available on these systems for years and its cost is negligible. Requiring it on all systems will promote better installations, maintenance and reliability.

5. ☒ This Proposal is original material.
   ☐ This Proposal is not original material; its source (if known) is as follows: ______

(Note: Original material is considered to be the submitter's own idea based on or as a result of his own experience, thought, or research and, to the best of his knowledge, is not copied from another source.)

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PLEASE USE SEPARATE FORM FOR EACH PROPOSAL

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1. a) Document Title: ________________________ NFPA No. & Year ____________

   b) Section/Paragraph: ________________________________

2. Proposal recommends: (Check one) ☐ new text
   ☐ revised text
   ☐ deleted text.

3. Proposal (include proposed new or revised wording, or identification of wording to be deleted):

4. Statement of Problem and Substantiation for Proposal:

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   ☐ This Proposal is not original material; its source (if known) is as follows: ____________

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(Note: Original material is considered to be the submitter's own idea based on or as a result of his own experience, thought, or research and, to the best of his knowledge, is not copied from another source.)

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