This standard shall apply to Class A, Class B, Class C, and Class D ovens, dryers, and furnaces; thermal oxidizers; and any other heated enclosure systems and related equipment used for processing of materials and related equipment.

Supplemental Information

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Submitter Information Verification

Submitter Full Name: Eric Nette
Organization: National Fire Protection Assoc
Street Address:
City:
State:
Zip:
Submittal Date: Wed Nov 30 11:39:30 EST 2016

Committee Statement

Committee Statement: The term heated enclosures was too broad and could be interpreted to mean the building that the process equipment is located in.
Response Message:

Public Input No. 23-NFPA 86-2016 [Section No. 1.1 [Excluding any Sub-Sections]]
Public Input No. 24-NFPA 86-2016 [Section No. A.1.1]
A.1.1

The use of the term **heated systems** is intended to apply to all guidance contained within this standard to the extent that it is applicable to the safe design, operation, and maintenance of heat utilization equipment as addressed within the provisions of this standard. Explosions and fires in fuel-fired and electric heat utilization equipment constitute a loss potential in life, property, and production. This standard is a compilation of guidelines, rules, and methods applicable to the safe operation of this type of equipment.

Conditions and regulations that are not covered in this standard — such as toxic vapors, hazardous materials, noise levels, heat stress, and local, state, and federal regulations (EPA and OSHA) — should be considered in the design and operation of furnaces.

Most failures can be traced to human error. The most significant failures include inadequate training of operators, lack of proper maintenance, and improper application of equipment. Users and designers must utilize engineering skill to bring together that proper combination of controls and training necessary for the safe operation of equipment. This standard classifies furnaces as follows:

1. **Class A ovens and furnaces** are heat utilization equipment operating at approximately atmospheric pressure wherein there is a potential explosion or fire hazard that could be occasioned by the presence of flammable volatiles or combustible materials processed or heated in the furnace. Such flammable volatiles or combustible materials can originate from any of the following:
   a) Paints, powders, inks, and adhesives from finishing processes, such as dipped, coated, sprayed, and impregnated materials
   b) Substrate material
   c) Wood, paper, and plastic pallets, spacers, or packaging materials
   d) Polymerization or other molecular rearrangements

   Potentially flammable materials, such as quench oil, water-borne finishes, cooling oil, and cooking oils, that present a hazard are ventilated according to Class A standards.

2. **Class B ovens and furnaces** are heat utilization equipment operating at approximately atmospheric pressure wherein no flammable volatiles or combustible materials are being heated.

3. **Class C ovens and furnaces** are those in which there is a potential hazard due to a flammable or other special atmosphere being used for treatment of material in process. This type of furnace can use any type of heating system and includes a special atmosphere supply system(s). Also included in the Class C classification are integral quench furnaces and molten salt bath furnaces.

4. **Class D furnaces** are vacuum furnaces that operate at temperatures that exceed ambient to over 5000°F (2760°C) and at pressures from vacuum to several atmospheres during heating using any type of heating system. These furnaces can include the use of special processing atmospheres. During gas quenching, these furnaces can operate at pressures from below atmospheric to over a gauge pressure of 100 psi (690 kPa).
1.4.1
Unless otherwise specified to be retroactive, the provisions of this standard shall not apply to facilities, equipment, structures, or installations that existed or were approved for construction or installation prior to the effective date of the standard. Where specified, the provisions of this standard shall be retroactive.

Submitter Information Verification

Submitter Full Name: Eric Nette
Organization: National Fire Protection Assoc
Street Address: 
City: 
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Submittal Date: Tue Nov 29 09:14:42 EST 2016

Committee Statement

Committee Statement: The language has been updated to remove redundancy.
Response Message:
Public Input No. 47-NFPA 86-2016 [Section No. 1.4.1]
1.4.2*

In those cases where the authority having jurisdiction determines that the existing situation presents an unacceptable degree of risk, the authority having jurisdiction shall be permitted to apply retroactively any portions of this standard deemed appropriate.

Supplemental Information

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Submitter Information Verification

Submitter Full Name: Eric Nette
Organization: National Fire Protection Assoc
Street Address:
City:
State:
Zip:
Submittal Date: Wed Nov 30 10:33:09 EST 2016

Committee Statement

Committee Statement: This provides guidance to address the ambiguity of this requirement.
Response Message:

Public Input No. 48-NFPA 86-2016 [Section No. 1.4.2]
A.1.4.2
Retroactive application of a current requirement is not intended to be triggered for equipment by the performance of routine maintenance or replacement in kind (defined by OSHA in 29 CFR 1910.119(b) as “a replacement which satisfies the design specification”). When equipment is modified to such an extent that new hazards are introduced or existing hazards are subject to increased risk, such modifications should be analyzed by the owner/user to determine if the current published requirements apply to the modification.

If the equipment is moved to a different location within the same building/site, it would be the decision of the AHJ whether or not to apply retroactivity (see Section 1.4), provided safety features (e.g., explosion relief) are not incidentally altered. However, the same building would normally be the same site/location. When equipment is moved to a new site/location, retroactivity should be considered.
Chapter 2  Referenced Publications

2.1 General.

The documents or portions thereof listed in this chapter are referenced within this standard and shall be considered part of the requirements of this document.

2.2 NFPA Publications.

National Fire Protection Association, 1 Batterymarch Park, Quincy, MA 02169-7471.


2.3 Other Publications.

2.3.1 ANSI Publications.

American National Standards Institute, Inc., 25 West 43rd Street, 4th Floor, New York, NY 10036.

2.3.2 API Publications.

American Petroleum Institute, 1220 L Street, NW, Washington, DC 20005-4070.
2.3.3 ASME Publications.

2.3.4 ASTM Publications.
ASTM International, 100 Barr Harbor Drive, P.O. Box C700, West Conshohocken, PA 19428-2959.

2.3.5 CGA Publications.
Compressed Gas Association, 4221 Walney Road, 5th Floor 14501 George Carter Way, Suite 103, Chantilly, VA 20151-2923.

2.3.6 IEC Publications.
International Electrical Electrotechnical Commission, 3, rue de Varembé, P.O. Box 131, CH - 1211, Geneva 20, Switzerland.

2.3.7 Other Publications.

2.4 References for Extracts in Mandatory Sections.

Submitter Information Verification
Submitter Full Name: Eric Nette
Organization: National Fire Protection Assoc
Street Address:
City:
State:
Zip:
Submittal Date: Tue Nov 29 09:40:30 EST 2016

Committee Statement
Committee Statement: Referenced current SDO names, addresses, standard names, numbers, and editions. Staff is instructed to verify updated references.
Response
Message:

Public Input No. 8-NFPA 86-2015 [Chapter 2]
3.3.13 Cooling Systems.

3.3.13.1 Closed Cooling Systems.
A cooling system that does not utilize unrestricted sight drain(s) observable by the operator(s).

3.3.13.2 Open Cooling Systems.
A cooling system that utilizes unrestricted sight drain(s) observable by the operator(s).

Submitter Information Verification

Submitter Full Name: Eric Nette
Organization: National Fire Protection Assoc
Street Address:
City:
State:
Zip:
Submittal Date: Wed Nov 30 11:41:16 EST 2016

Committee Statement

Committee Statement: Since “closed loop” and “open loop” are used in multiple places in the standard (i.e. Chapters 5, 13, and 14), “closed loop” and “open loop” should be defined.

Response Message: Public Input No. 75-NFPA 86-2016 [New Section after 3.3.10]
3.3.38 Impulse Pipe.

A pipe or tube used to connect an instrument to a point in the system at which a process variable is to be measured.

Submitter Information Verification

Submitter Full Name: Eric Nette
Organization: National Fire Protection Assoc
Street Address: 
City: 
State: 
Zip: 
Submittal Date: Wed Nov 30 11:41:50 EST 2016

Committee Statement

Committee Statement: Adding definition to a term that is currently used in annex material and will be used in proposed mandatory language (new 7.4.4.1).
Response Message:

Public Input No. 142-NFPA 86-2016 [New Section after 3.3.35]
Public Input No. 165-NFPA 86-2016 [New Section after 3.3.35]
3.3.38.3 Proved Low-Fire Start Interlock.

A burner start interlock in which a control sequence ensures that a high–low or modulated burner is at a reduced firing rate for reliable ignition before the burner can be ignited.

Submitter Information Verification

Submitter Full Name: Eric Nette
Organization: National Fire Protection Assoc
Street Address:
City:
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Submittal Date: Wed Nov 30 13:34:25 EST 2016

Committee Statement

Committee Statement: The definition has only been used once in the text, and will now be addressed where used.
Response Message: Public Input No. 95-NFPA 86-2016 [Section No. 3.3.36.3]
### 3.3.43.1 Air–Fuel Gas Mixer.

A mixer that combines air and fuel gas in the proper specific proportions for use in combustion.

### Submitter Information Verification

**Submitter Full Name:** Eric Nette  
**Organization:** National Fire Protection Assoc  
**Street Address:**  
**City:**  
**State:**  
**Zip:**  
**Submittal Date:** Wed Nov 30 11:42:36 EST 2016

### Committee Statement

**Committee Statement:** Existing text implies a flammable mixture, but mixers could also make mixtures for fuel equivalency that are not in the flammable range.

**Response Message:**

Public Input No. 79-NFPA 86-2016 [Section No. 3.3.40.1]
3.3.44 Mixing Blower.
A motor-driven blower to supply air–fuel gas mixtures for combustion through one or more fuel burners or nozzles on a single-zone industrial heating appliance or on each control zone of a multizone installation. Mixing machines operated at 10 in. w.c. (2.49 kPa) or less static pressure are considered mixing blowers.

Submitter Information Verification
Submitter Full Name: Eric Nette
Organization: National Fire Protection Assoc
Street Address:
City:
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Submittal Date: Wed Nov 30 11:43:05 EST 2016

Committee Statement
Committee Statement: This creates confusion in proposal for 6.2.9.2(B) and its annex. Deleting it here and adding it under requirements in 6.2.9.3 provides clarity.
Response Message:

Public Input No. 81-NFPA 86-2016 [Section No. 3.3.41]
3.3.66 Safety Blowout

A device or combination of devices that quench a flame, relieve pressure, and provide a means for automatic shut-off of the air–gas mixture flow in the event of a flashback in air–fuel gas mixture piping.

Submitter Information Verification

Submitter Full Name: Eric Nette
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Street Address:
City:
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Submittal Date: Wed Nov 30 11:43:38 EST 2016

Committee Statement

Committee Statement: New definition, used in 6.2.9.3(E).
Response Message:

Public Input No. 80-NFPA 86-2016 [New Section after 3.3.65]
### 3.3.19* Flame Curtain

A type of line burner used to provide an ignition source of flammable gases exiting a furnace or to reduce the ingress of air into a furnace.

### Supplemental Information

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### Submitter Information Verification

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<th>Submitter Full Name:</th>
<th>Eric Nette</th>
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<td>Organization:</td>
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<tr>
<td>Submittal Date:</td>
<td>Tue Nov 29 11:25:43 EST 2016</td>
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</tbody>
</table>

### Committee Statement

Committee Statement: Flame Curtain is lacking a definition in NFPA 86. Chapter 13 eliminates at the double SSOV requirement for Flame Curtains.

Response Message:

Public Input No. 143-NFPA 86-2016 [New Section after 3.3.82]
A.3.3.19 Flame Curtain.
Flame curtains are typically located at operating doors or open ends of furnaces.
5.1.3.2*
Unrelated stock and combustible materials shall be located at a distance from a furnace, a furnace heater, or ductwork so that the combustible materials will not be ignited, with a minimum separation distance of 2.5 ft (0.8 m).

Supplemental Information

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Submitter Information Verification

Submitter Full Name: Eric Nette
Organization: National Fire Protection Assoc
Street Address:
City:
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Zip:
Submittal Date: Tue Dec 06 11:27:29 EST 2016

Committee Statement

Annex directs the reader to relevant NFPA documents regarding clearance to combustibles.

Response Message:

Public Input No. 163-NFPA 86-2016 [New Section after A.5.1.1.4]
A.5.1.3.2
See NFPA 5000 and NFPA 101 for information on clearance to combustibles.
5.2.10*

Each portion of a closed cooling system shall be equipped with the following:

1. Pressure relief

2. Flow switches equipped with an audible and visual alarm upon loss of coolant flow

Submitter Information Verification

Submitter Full Name: Eric Nette
Organization: National Fire Protection Assoc
Street Address:
City:
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Submittal Date: Wed Nov 30 11:44:45 EST 2016

Committee Statement

Committee Statement: The existing wording (i.e. “Each portion…” and “switches”) implies that multiple pressure reliefs and flow switches are a requirement of the standard. Common (i.e. non-isolated) piping portions of a cooling system only require a single point of pressure relief and a single flow switch for alarming.

Response Message:

Public Input No. 76-NFPA 86-2016 [Section No. 5.2.10]
5.2.11
Open cooling systems utilizing unrestricted sight drains observable by the operator shall not require pressure relief or loss of flow switches alarming.

Submitter Information Verification

Submitter Full Name: Eric Nette
Organization: National Fire Protection Assoc
Street Address:
City:
State:
Zip:
Submittal Date: Wed Nov 30 11:45:08 EST 2016

Committee Statement

Committee Statement:
1. Since "open cooling systems" has been defined, no further clarification is required (i.e. "utilizing unrestricted ….").

2. The addition of "pressure relief or" in paragraph 5.2.11 clarifies that for pressure relief is not required for open cooling systems.

3. Paragraph 5.2.11 is more an exception to paragraph 5.2.10 than an actual requirement.

Response Message:

Public Input No. 77-NFPA 86-2016 [Section No. 5.2.11]
5.2.12 Where a cooling system is critical to continued safe operation of a furnace, the following shall be required:

1. The cooling system shall continue to operate after a safety shutdown or power failure.

2. The furnace manufacturer’s operating instructions shall state, in effect, that the cooling system is critical for safe operation.

Submitter Information Verification

Submitter Full Name: Eric Nette
Organization: National Fire Protection Assoc
Street Address: 
City: 
State: 
Zip: 
Submittal Date: Wed Nov 30 11:45:42 EST 2016

Committee Statement

Committee Statement: It is the responsibility of the furnace manufacturer to inform the end user that the cooling system (typically the water supply) is critical to the safe operation of the furnace.

Response Message: 

Public Input No. 78-NFPA 86-2016 [Section No. 5.2.12]
5.2.14

Furnace hydraulic systems shall utilize either of the following:

(1) Fire-resistant fluids or flammable.
(2) Other hydraulic fluids where approved and failure of hydraulic system components cannot result in a fire hazard.

Submitter Information Verification

Submitter Full Name: Eric Nette
Organization: National Fire Protection Assoc
Street Address: 
City: 
State: 
Zip: 
Submittal Date: Wed Nov 30 13:56:19 EST 2016

Committee Statement

Committee Statement: Clarification of verbiage on flammable hydraulic fluids and those that do not need to be approved.

Response Message:

Public Input No. 115-NFPA 86-2016 [Section No. 5.2.14]
5.3.1*

Fuel-fired furnaces and furnaces that contain flammable liquids, gases, or combustible dusts shall be equipped with unobstructed explosion relief for freely relieving internal explosion pressures except in the following cases:

(1) Explosion relief shall not be required on furnaces with a shell construction having a minimum \(3\,\text{\(\frac{3}{16}\)}\text{ in.} \) (4.8 mm) or heavier steel plate shells or equivalent strength construction reinforced with structural steel beams and buckstays that support and retain refractory or insulating materials that are required for temperature endurance, which makes them unsuitable for the installation of explosion relief.

(2) Explosion relief panels shall not be required for low-oxygen atmosphere ovens designed and protected in accordance with 13.5.12 Section 11.7.

(3) The requirements for explosion relief shall not apply to thermal oxidizers.

(4) The requirements for explosion relief shall not apply to Class D furnaces.

(5) Explosion relief panels shall not be required in the work chamber of indirect-fired ovens where it is demonstrated by calculation that the combustible concentration in the work chamber cannot exceed 25 percent of the lower flammable limit (LFL) under any operating conditions.

(6)* Explosion relief shall not be required in the work chamber of direct-fired ovens where all of the following conditions are met:

(a) It is demonstrated by calculation that the combustible concentration in the work chamber cannot exceed 25 percent of the LFL under any operating conditions.

(b) LFL aspirating detection is provided to monitor flammable concentrations in each direct-fired combustion chamber and interlocked to prevent start-up or initiate a safety shutdown upon detecting a concentration greater than 10 percent of the LFL.

(c) Where recirculating direct-fired systems are implemented, the LFL aspirating detection system is calibrated for all possible flammable gases that could be present as a result of the process or incomplete combustion.

(d) LFL aspirating detection sensing intake ports are located in the region of each combustion chamber that is most likely to accumulate flammable gases as a result of a gas leak or incomplete combustion.

(e) Documentation of LFL aspirating detection system calibration is maintained and posted at each system.

(f) LFL aspirating detection systems are calibrated at least annually or more often if recommended by the manufacturer for intended service.

(7)* Explosion relief shall not be required for the combustion chamber of an indirect-fired oven that incorporates a single combustion airflow path through the heat exchanger and does not recirculate the products of combustion.

Supplemental Information

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Submitter Information Verification

Submitter Full Name: Eric Nette
Organization: National Fire Protection Assoc
A.5.3.1(6)
For reliable operation, the LFL detection sensing location(s) should be located in the region of the combustion chamber most likely to accumulate flammable gases as a result of a gas leak or incomplete combustion. This should be determined by a qualified engineer because numerous factors need to be taken into account (properties of gases, source, expected airflows, etc.). In some cases, it might be necessary to provide multiple ports in a single combustion chamber to reliably monitor potential flammable gas accumulations.

In addition, the detection sensing system should be selected to detect all potential explosive gases that could be developed as a result of the process and burner systems. This could require multiple sensing systems as LFL calibration for different gases might not be the same. Alternatively, the calibration should be such that no potential flammable gas could exceed a concentration of 10 percent LFL without tripping the sensor (with the side effect that some gases might trip the sensor at much lower LFL percentage concentrations).
Committee Statement

<table>
<thead>
<tr>
<th>Committee Statement</th>
<th>For Item 1: Different construction shells are available for this application and should be allowed by the standard if determined to be equivalent.</th>
</tr>
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<tbody>
<tr>
<td></td>
<td>For Item 2: The wrong section is referenced. The correct section to reference is 11.7 &quot;Low-Oxygen Atmosphere Class A Ovens with Solvent Recovery&quot;.</td>
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<td>For Oven/Furnace &quot;5.3 Explosion Relief&quot;, some users use aspirating LFL detection in the combustion chamber of oven heater boxes. The main reason for excluding direct fired ovens from the &quot;exception language&quot; in 5.3.1(6) is that direct fired ovens can introduce an explosive atmosphere into the work chamber due to incomplete combustion and gas leaks. With LFL detection implemented to trip at a level well below 25% LFL and interlocked to interrupt start-up and running permissives.</td>
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<td>Annex materiel related to new 5.3.1(6) changes this item to 5.3.1(7).</td>
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Response Message:

- Public Input No. 103-NFPA 86-2016 [Section No. 5.3.1]
- Public Input No. 104-NFPA 86-2016 [Section No. A.5.3.1(6)]
- Public Input No. 65-NFPA 86-2016 [Section No. 5.3.1]
- Public Input No. 13-NFPA 86-2015 [Section No. 5.3.1]
### 6.2.2.4*

Where primary or secondary combustion air is provided mechanically, combustion airflow or pressure shall be proven and interlocked with the safety shutoff valves so that fuel gas cannot be admitted prior to establishment of combustion air and so that the gas is shut off in the event of combustion air failure. *(See 8.5.1.2 and 8.7.4.)*

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<td>Wed Nov 30 11:47:24 EST 2016</td>
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**Committee Statement**

- **Committee Statement:** Reference needed as part of related FR's.
- **Response Message:**

  *Public Input No. 152-NFPA 86-2016 [Section No. 6.2.2.4]*
6.2.6* Pressure Regulators, Pressure Relief Valves, and Pressure Switches.

6.2.6.1
A pressure regulator shall be furnished wherever the plant supply pressure exceeds the burner operating or design parameters or wherever the plant supply pressure is subject to fluctuations, unless otherwise permitted by 6.2.6.2.

6.2.6.2
An automatic flow control valve shall be permitted to meet the requirement of 6.2.6.1, provided it can compensate for the full range of expected source pressure variations.

6.2.6.3*
Regulators, relief valves, and switches shall be vented to an approved location, and the following criteria also shall be met:

1. Heavier-than-air flammable gases shall be vented outside the building to a location where the gas is diluted below its LFL before coming in contact with sources of ignition or re-entering the building.

2. Vents shall be designed to prevent the entry of water and insects without restricting the flow capacity of the vent.

6.2.6.4*
Fuel gas regulators, ratio regulators, and zero governors shall not be required to be vented to an approved location in the following situations:

1. Where backloaded from combustion air lines, air–gas mixture lines, or combustion chambers, provided that gas leakage through the backload connection does not create a hazard

2. Where a listed regulator–vent limiter combination is used

3. Where a regulator system is listed for use without vent piping

4. A regulator incorporating a leak limiting system, which prevents or restricts the escape of gas into a space large enough and with sufficient natural ventilation so that the escaping gas does not present a hazard

6.2.6.5*
A pressure switch shall not be required to be vented if it employs a vent limiter rated for the service intended, that has been listed for ventless operation shall not be required to be vented.

6.2.6.6
Fuel gas regulators and zero governors shall not be backloaded from oxygen or oxygen-enriched air lines.

6.2.6.7
Vent lines from multiple furnaces shall not be manifoded together.

6.2.6.8
Vents from systems operating at different pressure control levels shall not be manifoded together.

6.2.6.9
Vents from systems served from different pressure-reducing stations shall not be manifoded together.

6.2.6.10
Vents from systems using different fuel sources shall not be manifoded together.
6.2.6.11
Vent lines from multiple regulators and switches of a single furnace, where manifolded together, shall be piped in such a manner that any gas being vented from one ruptured diaphragm does not backload the other devices.

6.2.6.12
The cross-sectional area of the manifold line shall not be less than the greater of the following:

(1) The cross-sectional area of the largest vent plus 50 percent of the sum of the cross-sectional areas of the additional vent lines

(2) The sum of the cross-sectional areas of the two largest vent lines.

6.2.6.13*
A vent between safety shutoff valves, where installed, shall comply with the following:

(1) Shall It shall not be combined with other vents.

(2) Shall It shall terminate to an approved location.

Supplemental Information

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Submitter Information Verification

Submitter Full Name: Eric Nette
Organization: National Fire Protection Assoc
Street Address:
City:
State:
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Submittal Date: Tue Nov 29 14:47:41 EST 2016

Committee Statement

Committee Statement: Explanatory text is being added to provide examples of various regulators that would fall under the requirements of this section. Allowances for the installation of listed devices that do not require a vent were added.

Response Message:

Public Input No. 37-NFPA 86-2016 [Section No. 6.2.6]
A.6.2.6
Regulators could be, but are not limited to, fuel gas appliance (equipment) pressure regulators, ratio regulators, and zero governors.
6.2.7.3
When a relief valve is used to comply with 6.2.7.1, the relief valve shall be a full-capacity relief type.

Submitter Information Verification

Submitter Full Name: Eric Nette
Organization: National Fire Protection Assoc
Street Address:
City:
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Submittal Date: Wed Nov 30 11:49:58 EST 2016

Committee Statement

Committee Statement: Deleted paragraph 6.2.7.3 is repeats the same information in paragraph 6.2.7.2 (3).
Response Message:

Public Input No. 91-NFPA 86-2016 [Section No. 6.2.7.3]
6.2.7.3

Token relief valves and internal token relief valves shall not be permitted to be used as the only overpressure protection devices.

Submitter Information Verification

Submitter Full Name: Eric Nette
Organization: National Fire Protection Assoc
Street Address:
City:
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Submittal Date: Wed Nov 30 11:52:37 EST 2016

Committee Statement

Committee Statement:
Deleted paragraph 6.2.7.4 is not necessary, the requirement in paragraph 6.2.7.2 (3) already prohibits the use of “token” pressure relief valves.

Response Message:

Public Input No. 92-NFPA 86-2016 [Section No. 6.2.7.4]
Valves or other obstructions shall not be installed between a
air jet mixer, gas jet mixer, proportional mixer, or a mixing blower and burners, unless otherwise permitted by 6.2.9.2(C).

Submitter Information Verification

Submitter Full Name: Eric Nette
Organization: National Fire Protection Assoc
Street Address:
City:
State:
Zip:
Submittal Date: Wed Nov 30 11:53:55 EST 2016

Committee Statement

Committee Statement: Clarifies specific defined mixer types; these were not previously used except in Chap 3.
Response Message:

Public Input No. 82-NFPA 86-2016 [Section No. 6.2.9.2(B)]
Mixing blowers having a static discharge pressure of more than 10 in. w.c. (2.49 kPa) shall be considered mixing machines.

Committee Statement

Committee Statement: The term discharge is a more accurate term than delivery.
Response Message:

Submitter Information Verification

Submitter Full Name: Eric Nette
Organization: National Fire Protection Assoc
Street Address: 
City: 
State: 
Zip: 
Submittal Date: Tue Nov 29 15:43:41 EST 2016
(A)*
Automatic fire checks shall be provided in piping systems that distribute flammable air–fuel gas mixtures from a mixing machine at a pressure greater than 10 in. w.c. (2.49 kPa).

Submitter Information Verification

Submitter Full Name: Eric Nette
Organization: National Fire Protection Assoc
Street Address:
City:
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Submittal Date: Wed Nov 30 11:53:29 EST 2016

Committee Statement

Committee Statement: Adds back the requirement only for pressure >10"wc with proposal to remove it from the definition.
Response Message:
Public Input No. 83-NFPA 86-2016 [Section No. 6.2.9.3(A)]
A backfire arrester with a safety blowout device shall be installed in accordance with the manufacturer’s instructions near the outlet of each mixing machine that produces a flammable air–fuel gas mixture at a pressure greater than 10 in. w.c. (2.49 kPa).

Submitter Information Verification

Submitter Full Name: Eric Nette
Organization: National Fire Protection Assoc
Street Address: City: State: Zip: Submittal Date: Wed Nov 30 14:06:38 EST 2016

Committee Statement

Committee Statement: Adds back the requirement only for pressure >10"wc in combination with the removal of it from definition. The safety blowout definition and annex eliminates the need for this annex.

Response Message:

Public Input No. 87-NFPA 86-2016 [Section No. A.6.2.9.3(E)]
Public Input No. 84-NFPA 86-2016 [Section No. 6.2.9.3(E)]
Where a mixing machine is used, safety shutoff valves shall be installed in the fuel gas supply and shall interrupt the fuel gas supply automatically when the mixing machine is not in operation or in the event of an air or fuel gas supply failure.

Submitter Information Verification

Submitter Full Name: Eric Nette
Organization: National Fire Protection Assoc
Street Address:
City:
State:
Zip:
Submittal Date: Wed Nov 30 11:55:54 EST 2016

Committee Statement

Committee Statement: (F) is redundant to 8.14.
Response Message:

Public Input No. 85-NFPA 86-2016 [Section No. 6.2.9.3(F)]
### 6.2.10.6

Radiant tube heating systems using metallic tubes fully open at one or both ends shall not require explosion resistance validation.

### 6.2.10.7*

A manufacturer’s claim of explosion-resistant radiant tube heating systems using nonmetallic tubes or metallic tubes sealed in at both ends shall be validated.

### Submitter Information Verification

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<th>Submitter Full Name:</th>
<th>Eric Nette</th>
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<td>National Fire Protection Assoc</td>
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<td>Submittal Date:</td>
<td>Wed Nov 30 08:35:38 EST 2016</td>
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### Committee Statement

| Committee Statement: | These requirements should be based on performance and not specifically on the type of material utilized. |

### Response Message:

Public Input No. 171-NFPA 86-2016 [Sections 6.2.10.6, 6.2.10.7]
6.2.11.3*
Handheld igniters that generate electric sparks shall be listed.

Supplemental Information

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Submitter Information Verification

Submitter Full Name: Eric Nette
Organization: National Fire Protection Assoc
Street Address: 
City: 
State: 
Zip: 
Submittal Date: Tue Nov 29 13:41:53 EST 2016

Committee Statement

Committee Statement: Fixed igniters that utilize high voltage to generate electric sparks have been proven safe in vast numbers of systems. However, handheld sparking igniters utilizing high voltage transformers (especially homemade igniters not constructed with suitable electrical insulation and safety guards) pose a severe electrocution hazard and should not be used to light gas-fired burners in ovens or furnaces. Sparking igniters that rely on piezoelectric energy to generate a spark are not intended to be precluded by this prescriptive requirement.

Response Message:

Public Input No. 30-NFPA 86-2016 [New Section after 6.2.11.2]
A.6.2.11.3
Igniters not constructed with suitable electrical insulation and/or safety guards pose a severe electrocution hazard.
7.4.1*
Safety devices shall be maintained in accordance with the manufacturer's instructions.

Supplemental Information

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Submitter Information Verification

Submitter Full Name: Eric Nette
Organization: National Fire Protection Assoc
Street Address:
City:
State:
Zip:
Submittal Date: Wed Nov 30 14:39:38 EST 2016

Committee Statement

Committee Statement:
The committee recommend that actions to be taken if devices are exposed to conditions outside their ratings. E.g. too high of pressure can also permanently damage safety devices, and if this occurs, the devices may not properly operate.

Response Message:

Public Input No. 67-NFPA 86-2016 [Section No. A.8.2.3]
A.7.4.1
A safety device should be tested for proper function, or replaced, if exposed to conditions (e.g., pressure, temperature, corrosive gases) outside of manufacturer’s specifications.
7.4.4.1*

Where an impulse pipe is used to connect a safety device, the impulse pipe shall be inspected for leaks at least annually.

Supplemental Information

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Submitter Information Verification

Submitter Full Name: Eric Nette
Organization: National Fire Protection Assoc
Street Address:
City:
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Submittal Date: Wed Nov 30 11:54:45 EST 2016

Committee Statement

Committee Statement: Changes the suggestion to inspect the impulse line found in current annex material to a requirement to test the functionality of the impulse line. The change also establishes a time frequency that is consistent with the current frequency required for the safety device it is connected to. Annex material for new 7.4.4.1 to list the inspections that should be performed.

Response Message:
- Public Input No. 140-NFPA 86-2016 [New Section after 7.4.4]
- Public Input No. 141-NFPA 86-2016 [New Section after A.7.3.8]
- Public Input No. 166-NFPA 86-2016 [New Section after 7.4.4]
- Public Input No. 167-NFPA 86-2016 [New Section after A.7.3.8]
A.7.4.4.1
The following inspections should be performed:

1. Ensure that the pressure connection is correct.
2. Check for entrapped gas in liquid lines or entrapped liquid in gas lines.
3. Check for leaks.
**First Revision No. 17-NFPA 86-2016 [ New Section after 7.4.9 ]**

**7.4.10**
The set point of the pressure relief valve, where installed, shall be verified at least annually.

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**Supplemental Information**

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**Submitter Information Verification**

- **Submitter Full Name:** Eric Nette
- **Organization:** National Fire Protection Assoc

**Committee Statement**

NFPA 86 needed guidance on how relief valves can be inspected in the field since they provide a layer of safety to the gas train.

**Response Message:**

Public Input No. 36-NFPA 86-2016 [New Section after 7.4.9]
A.7.4.10
Recommended checks in the field should include the following:

1. Inspection of the physical condition
2. Inspection for dirt, liquids, or other conditions that might prevent proper operation
3. Inspection to determine that the point of termination is still vented to an approved location and that the vent line is protected from the entry of water and insects without restricting the flow capacity of the vent
7.4.11 Safety Shutoff Valve Replacement. Replacement of Safety Shutoff Valves for Open-Close Cycling Applications.

7.4.11.1 Safety shutoff valves that are used to comply with 8.5.1.8 (4) 8.8.1.6 and are not proved closed shall be replaced before they exceed their maximum allowable number of lifetime open-close cycles.

7.4.11.2* The number of safety shutoff valve cycles shall be determined by one of the following ways:

1. Counting of actual safety shutoff valve open-close cycles
2. Estimated time to reach 90 percent of lifetime total cycles based on normal cycling rates

Submitter Information Verification

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Submittal Date: Wed Nov 30 10:54:31 EST 2016

Committee Statement

Committee Statement: Title was changed to distinguish replacement of the safety shutoff valve applicability to only open-close cycling applications. The requirements in 7.4.10.1 were not clear in terms of referring to 8.5.1.8 (4). See related 8.8.1.6.

Response Message:

Public Input No. 22-NFPA 86-2016 [Section No. 7.4.10]
Public Input No. 107-NFPA 86-2016 [Section No. 7.4.10.1]
Public Input No. 164-NFPA 86-2016 [Section No. 7.4.10.1]
### 8.2.6

_Safety devices shall be installed, used, and maintained in accordance with the manufacturer's instructions._

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**Submitter Information Verification**

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<th>Submitter Full Name</th>
<th>Eric Nette</th>
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**Committee Statement**

- **Committee Statement:** 8.2.6 is redundant as these requirements are already in 8.2.3 and 7.4.1.
- **Response Message:**

  **Public Input No. 43-NFPA 86-2016 [Section No. 8.2.6]**
8.2.9.1*
If the mushroom-type emergency fuel stop is wired to the inputs of a safety programmable logic controller (PLC) per Section 8.4, the emergency fuel stop shall use redundant contacts to redundant safety inputs per the manufacturer's safety manual for implementing an emergency stop to safety integrity level (SIL) 3/PL e.

8.2.9.2*
Ancillary furnace functions not related to fuel shall be evaluated using the appropriate standards for their inherent hazard, and the appropriate action shall be taken to mitigate that hazard when the emergency fuel stop is activated.

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Submitter Information Verification

Submitter Full Name: Eric Nette
Organization: National Fire Protection Assoc
Street Address: 
City: 
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Submittal Date: Wed Nov 30 11:57:22 EST 2016

Committee Statement

Committee Statement: Some furnaces include complex control of motion, hydraulics, and special atmospheres that can't be immediately depowered without creating additional hazards when the fuel stop button is depressed.

Response Message:

Public Input No. 101-NFPA 86-2016 [New Section after 8.2.9]
Public Input No. 102-NFPA 86-2016 [New Section after A.8.2.9]
A.8.2.9.1
This requirement permits the mushroom-style switch to act as a hardwired fuel stop by directly de-energizing the safety shutoff valves, or it can be used as an input to a safety programmable logic controller (PLC) when more complicated stop sequences are required. If the safety PLC is used to sequence the stop, dual contacts are required to dual safety inputs per the manufacturer’s safety manual to ensure control reliability. If the single mushroom-style fuel stop eliminates all hazards associated with the furnace or machine, the mushroom-style button can display the yellow ring at its base and it can be labeled an emergency stop per NFPA 79.

A.8.2.9.2
Some furnaces include complex control of motion, hydraulics, and special atmospheres that cannot be immediately depowered without creating additional hazards when the fuel stop button is depressed. For that reason, the fuel stop button can be wired to a safety PLC so that a shutdown sequence is initiated to bring the furnace and ancillary equipment to a safe state. This controlled stop is consistent with a Category 1 or 2 stop function defined in NFPA 79.

It is the designer’s responsibility to analyze each of the ancillary function’s hazards against the appropriate standards to ensure the entire furnace or machine is brought to a safe state when commanded to do so.
First Revision No. 77-NFPA 86-2016 [Section No. 8.4.4(B)]

(B)
Safety PLCs shall not implement replace the following devices:

1. Manual emergency switches
2. Continuous vapor concentration high-limit controllers

Submitter Information Verification

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Street Address:
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Submittal Date: Wed Nov 30 16:38:40 EST 2016

Committee Statement

Committee Statement: Clarifying the language that prohibits the use of a PLC to replace the manual emergency switch and Continuous vapor concentration high-limit controllers.

Response Message:

Public Input No. 62-NFPA 86-2016 [Section No. 8.4.4(B)]
First Revision No. 112-NFPA 86-2016 [Section No. 8.5.1.2(D)]

(D)*
The minimum required pre-ignition airflow shall be proved and maintained throughout the timed pre-ignition purge interval.

Supplemental Information

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Submitter Information Verification

Submitter Full Name: Eric Nette  
Organization: National Fire Protection Assoc  
Street Address:  
City:  
State:  
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Submittal Date: Tue Dec 06 12:48:26 EST 2016

Committee Statement

Committee Statement: Annex material adds guidance for various methods to implement an air flow interlock.  
Response Message:  
Public Input No. 156-NFPA 86-2016 [New Section after A.8.5.1.2(C)(2)]
A.8.5.1.2(D)

A pre-ignition airflow interlock can be provided by a variety of devices. Most commonly, a fixed orifice plate is used to generate a differential pressure at the desired (calculated) pre-ignition airflow rate. A differential pressure switch, used in conjunction with the fixed orifice, provides the electrical permissive to verify the presence of air movement at the required flow rate.

Similarly, a differential pressure switch can be used as an airflow interlock by monitoring the differential pressure across a burner, either in single or multiburner systems. Single burner applications would include package burner assemblies. Burners provide a fixed airflow rate at a known pressure; therefore, a burner can be utilized as the flow element. Burner manufacturer’s literature will typically provide the pressure-flow data for each specific burner size available. Valves that can restrict airflow below the minimum required pre-ignition airflow rate should not be installed downstream of the pressure switch location. (See Figure A.8.7.4.) If the furnace internal pressure is operated above atmospheric pressure, the reference connection on the pressure switch should be connected to the furnace heating chamber in lieu of an atmospheric pressure reference.

A vane- or paddle-type flow switch is another example of a device that can be used to provide the required pre-ignition airflow interlock. When utilizing a vane flow switch, the purge time should be calculated based on the minimum airflow for the particular vane size being used. Manufacturer’s literature will typically specify the airflow range for each size vane available.
Air pressure switches shall not be used to prove airflow where valves downstream of the pressure switch can be closed to the point of reducing airflow below the minimum required.

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Submitter Information Verification

Submitter Full Name: Eric Nette
Organization: National Fire Protection Assoc

Committee Statement

Committee Statement: Provides another method of implementing an air flow interlock which is based on the burner system's defined pressure drop versus air flow.

Annex Item: In some applications, the airflow is so low that it is impractical to prove at each individual burner. However, if the airflow is proven at the main header and then flows through a fixed orifice, this meets the intent of NFPA 86.

Response Message:

Public Input No. 136-NFPA 86-2016 [New Section after A.8.5.1.8(4)(d)]
Public Input No. 153-NFPA 86-2016 [New Section after 8.5.1.2(E)]
A.8.5.1.2(F)
A system that has no valve(s) in the flow path(s) downstream of the air pressure proving interlock and a constant airflow is considered to have proven airflow.

If the furnace internal pressure is operated above atmospheric pressure, the reference connection on the pressure switch should be connected to the furnace heating chamber in lieu of an atmospheric pressure reference.
8.5.1.5

Burner ignition sequence shall be started at the completion of the pre-ignition purge unless one safety shutoff valve required by 8.5.1.2(C) is proved closed and one of the following conditions is satisfied:

(A) The purge airflow rate is maintained and proved without interruption following the completion of the pre-ignition purge.

(B)* It is demonstrated that the flammable vapor and gas concentrations within the system volume described in 8.5.1.2(B) will not exceed 25 percent of LFL at the time of ignition.

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Submitter Information Verification

Submitter Full Name: Eric Nette
Organization: National Fire Protection Assoc
Street Address:
City:
State:
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Submittal Date: Wed Nov 30 17:06:54 EST 2016

Committee Statement

Committee Statement: To introduce requirements to the standard that limits the time frame between completing purge and lighting burners.
Response Message:

Public Input No. 138-NFPA 86-2016 [Section No. 8.5.1]
A.8.5.1.5(B)
See A.8.5.1.9(3)(c) for an example method to calculate LFL.
8.5.1.6
Pre-ignition purging of radiant tube–type heating systems shall be provided, unless otherwise permitted by 8.5.1.7.

8.5.1.7
Pre-ignition purging of radiant tube–type heating systems shall not be required where the systems are arranged and designed such that either of the following conditions is satisfied:

1. The tubes are of metal construction and open at one or both ends. If heat recovery systems are used, they shall be of explosion-resistant construction. The system is fully open at one or both ends, or
2. The entire radiant tube heating system, including any associated heat recovery system, is of explosion-resistant construction. The system is of explosion-resistant construction.

Submitter Information Verification

Submitter Full Name: Eric Nette
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Street Address:  
City:  
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Submittal Date: Wed Nov 30 09:12:22 EST 2016

Committee Statement

Committee Statement: These requirements should be based on performance and not specifically on the type of material utilized.

Response Message:

Public Input No. 170-NFPA 86-2016 [Sections 8.5.1.5, 8.5.1.6]
8.5.1.9*
Repeating the pre-ignition purge shall not be required where any one of the following conditions is satisfied:

1. The heating chamber temperature is proved to be above 1400°F (760°C).

2.* For a multiburner fuel-fired system not proved to be above 1400°F (760°C) and with each burner system equipped with two safety shutoff valves that close between each burner that is not operating and all of the following conditions are satisfied: the fuel supply, at least one burner remains operating in the common combustion chamber of the burner to be re-ignited.

   At least one burner remains operating in the common combustion chamber of the burner to be re-ignited.

   The burner(s) remaining in operation shall provide ignition without explosion of any unintended release of fuel through other burners that are not in operation.

3. For a multiburner fuel-fired system not proved to be above 1400°F (760°C) and with each burner equipped with one safety shutoff valve, all of the following conditions are satisfied (does not apply to fuel oil systems):
   a. The number of safety shutoff valves required to close in 8.8.1.3 and 8.8.2.1 will close between the burner system and the fuel gas supply when that burner system is off.

   Safety shutoff valve seat leak testing is performed on at least a semiannual basis.

   b. The burner system uses natural gas, butane, or propane fuel gas.

   c.* It can be demonstrated based on the leakage rate, that the combustible concentration in the heating chamber and all other passages that handle the recirculation and exhaust of products of combustion cannot exceed 25 percent of the LFL.

   d. The minimum airflow used in the LFL calculation in 8.5.1.9(3)(c) is proved and maintained during the period the burner(s) are off.

4.* For fuel gas–fired burner systems and assuming that all safety shutoff valves fail in the full open position, it can be demonstrated that the combustible concentration in the heating chamber and all other passages that handle the recirculation and exhaust of products of combustion cannot exceed 25 percent of the LFL.

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Submitter Information Verification

Submitter Full Name: Eric Nette
Organization: National Fire Protection Assoc
Street Address:
City:
State:
Zip:
Submittal Date: Thu Dec 01 08:59:00 EST 2016
8.5.1.8 *
Repeating the pre-ignition purge shall not be required where any one of the following conditions is satisfied:

(1) The heating chamber temperature is proved to be above 1400°F (760°C).

(2) For a multi-burner fuel-fired system not proved to be above 1400°F (760°C) and with each burner system equipped with two safety shutoff valves that close between each burner that is not operating and the fuel supply, all of the following conditions are satisfied: and at least one burner remains operating in the common combustion chamber of the burner to be re-ignited.
   (a) At least one burner remains operating in the common combustion chamber of the burner to be re-ignited.
   (b) The burner(s) remaining in operation shall provide ignition without explosion of any unintended release of fuel through other burners that are not in operation.

(3)* For a multi-burner fuel-fired system not proved to be above 1400°F (760°C) and with each burner equipped with one safety shutoff valve, all of the following conditions are satisfied (does not apply to fuel oil systems):
   (a) The number of safety shutoff valves required to close in 8.8.1.3 and 8.8.2.1 will close between the burner system and the fuel gas supply when that burner system is off.
   (b) If a gas filter is not installed upstream of each individual burner safety shutoff valve(s), seat leak testing is performed on at least a semiannual basis.
   (c) The burner system uses natural gas, butane, or propane fuel gas.
   (d)* It can be demonstrated based on the leakage rate, that the combustible concentration in the heating chamber and all other passages that handle the recirculation and exhaust of products of combustion cannot exceed 25 percent of the LFL.
   (e) The minimum airflow used in the LFL calculation in 8.5.1.8 (4)(d) is proved and maintained during the period the burner(s) are off.

(4)* For fuel gas–fired burner systems and assuming that all safety shutoff valves fail in the full open position, it can be demonstrated that the combustible concentration in the heating chamber and all other passages that handle the recirculation and exhaust of products of combustion cannot exceed 25 percent of the LFL.
Committee Statement

Committee Statement: The change recognizes the integrity of using 2 safety shutoff valves in series for burners that are not operating in a multi-burner system to be an indication that the potential leakage through any safety shutoff valve is much less than the 1 SCFH recognized in the annex. The added requirement of 1 burner operating in the common combustion chamber with the burner(s) that are not operating proves that the overall burner management system is functional and the equipment is in a normal operating state.

The requirement for semiannual testing of safety shutoff valves was deleted because of requirements elsewhere in the standard that specify the replacement of safety shutoff valves before they reach their allowable number of lifetime open-close cycles.

Response Message:

Public Input No. 93-NFPA 86-2016 [Section No. 8.5.1.8]
First Revision No. 67-NFPA 86-2016 [Section No. 8.5.3]

8.5.3* Ignition of Main Burners — Fuel Gas or Oil.

Where a reduced firing rate is required for ignition of the burner, an interlock shall be provided to prove that the control valve has moved to the design position specified firing condition is required for ignition of the burner or equipment, the control element(s) shall be proved at the specified condition(s) prior to each attempt at ignition.

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Submitter Information Verification

Submitter Full Name: Eric Nette
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Street Address: 
City: 
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Submittal Date: Wed Nov 30 13:35:46 EST 2016

Committee Statement

Committee Statement: Revisions made in the mandatory text to eliminate the need for a definition. Explanatory material to identify various means to provide the proving for ignition was added.

Response Message:

Public Input No. 96-NFPA 86-2016 [Section No. 8.5.3]
Public Input No. 97-NFPA 86-2016 [New Section after A.8.5.2]
A.8.5.3
A specified firing condition can be proved by:

1. Feedback sensor in the actuator of a flow control valve
2. Feedback sensor on the flow control valve such that it is actuated by the valve handle
3. Pressure sensor located downstream of the combustion airflow control valve
4. Combustion airflow below a determined rate for burner ignition
8.7.4*
Combustion air minimum pressure or flow shall be interlocked into the burner management system by any of the following methods:

(1) A low pressure switch that senses and monitors the combustion air source pressure
(2) A differential pressure switch that senses the differential pressure across a fixed orifice in the combustion air system
(3) An airflow switch

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Submitter Information Verification

Submitter Full Name: Eric Nette
Organization: National Fire Protection Assoc
Street Address:
City:
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Zip:
Submittal Date: Wed Nov 30 11:59:37 EST 2016

Committee Statement

Committee Statement: Fixed typos.
Annex materials adds implementation examples.

Response Message:
Public Input No. 157-NFPA 86-2016 [Section No. A.8.7.4]
Public Input No. 154-NFPA 86-2016 [Section No. 8.7.4]
A.8.7.4
In industrial combustion applications with modulating flow control valves downstream of the combustion air blower, it is most common to interlock the constant combustion air source pressure on single and multiburner systems to meet the requirements of 8.7.2 and 8.7.4.

Because the combustion airflow is proved during each purge cycle along with the combustion air source pressure, the most common convention is to prove the combustion air source pressure during burner operation following purge. In a multiburner system, the proof of combustion airflow during purge proves that any manual valves in the combustion air system are in an adequately open position. These manual air valves are provided for maintenance and combustion airflow balancing among burners in a temperature control zone. In combustion air supply systems that use either an inlet damper or a speed control, the combustion air pressure can fall below reliably repeatable levels with listed pressure switch interlocks at low fire. For these systems, the proof of minimum airflow can be a more reliable interlock.

A pressure switch on the inlet (suction) side of an induced draft (ID) fan can be used to prove that the minimum required suction pressure is available.

For combustion systems that use high pressure gas–air to induce (inspirate) air locally at each burner, it is impractical to monitor and prove the availability of combustion air.

For combustion systems that use natural (stack) draft to induce air into the burners or combustion chamber, it is impractical to monitor and prove the availability of combustion air.

Figure A.8.7.4 shows examples of air proving devices that might be used in multiburner systems.

Figure A.8.7.4 Examples of Air Proving Devices Used in Multiburner Systems (fuel piping not shown for clarity).
### First Revision No. 63-NFPA 86-2016 [Section No. 8.7.6]

**8.7.6**

In any combustion system where the combustion air supply can be diverted to an alternate flow path other than to a burner (e.g., to a regenerative burner system's exhaust path), that burner's associated combustion airflow path valve(s) shall be proved open, and its alternate airflow path valve(s) shall be proved closed, before that burner's fuel safety shutoff valve(s) are energized.

#### Submitter Information Verification

- **Submitter Full Name:** Eric Nette
- **Organization:** National Fire Protection Assoc
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- **Submittal Date:** Wed Nov 30 12:05:18 EST 2016

#### Committee Statement

- **Committee Statement:** The use of term “airflow” and “air flow” should be used consistently throughout the Standard.

#### Response Message:

Public Input No. 25-NFPA 86-2016 [Section No. 8.7.6]
8.8.1.6* Safety shutoff valves shall not be open-close cycled at a rate that exceeds that specified by its manufacturer, operated open-close more than 10 cycles per hour shall be permitted where all of the following requirements are met:

1. Safety shutoff valves shall not be open-close cycled at a rate that exceeds that specified by the manufacturer.
2. Safety shutoff valves shall have a published designed open-close cycle rate.
3. Control logic shall not result in exceeding the published open-close cycle rate of the safety shutoff valves.
4. Safety shutoff valves shall have a published designed lifetime number of cycles and/or time intervals.
5. Safety shutoff valves shall be replaced prior to exceeding the lesser of the published designed lifetime number of cycles and/or time intervals unless equipped with a proof of closure switch incorporating change-of-state logic in the burner management system.
6. Safety shutoff valves shall be tested in accordance with the manufacturer’s requirements for high cycle rate valves.

Supplemental Information

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Submitter Information Verification

Submitter Full Name: Eric Nette
Organization: National Fire Protection Assoc
Street Address:
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Submittal Date: Thu Dec 01 09:21:00 EST 2016

Committee Statement

Committee Statement: The existing requirement in 7.4.10 is not clear in terms of its reference to 8.5.1.8 (4). Annex material is added for additional information. The requirements differentiate open-close cycle duty between pulse firing and non-pulse firing systems. The 10 cycles per hour were chosen as a distinct benchmark to differentiate these systems and is explained further in annex material.

Response Message:

Public Input No. 20-NFPA 86-2016 [Section No. 8.8.1.6]
A.8.8.1.6
The open-close safety shutoff valve cycle limit of 10 cycles per hour is intended to differentiate safety shutoff valve requirements for high cycling operation (e.g., pulse firing) from traditional operation, where safety shutoff valves cycle only a few times per day.

Further, the 10 cycles per hour threshold is based on the following:

1. The safety shutoff valves are certified to UL 429, *Standard for Electrically Operated Valves for Gas Appliances*, or ANSI Z21.21/CSA 6.5, *Automatic Valves for Gas Appliances*, which requires demonstration that a safety shutoff valve is still fully functional and able to pass leak testing after a testing interval of 100,000 cycles.
2. At least once per year as required by this standard, the minimum required safety shutoff valve leak tightness is tested.
3. Additionally, 100,000 cycles per year divided by 8,760 hours per year equals 11.4 cycles per hour, which is greater than, and the basis for, the 10 cycles per hour threshold.

The requirements of 8.8.1.6 apply to all safety shutoff valves, including three-position safety shutoff valves and those rated for concurrent modulating service.
8.8.2.1 Each main and pilot fuel gas burner system shall be separately equipped with either of the following:

1. Two safety shutoff valves piped in series

2. For radiant tube–fired burner systems only, a single safety shutoff valve where either of the following conditions is satisfied:
   
   (a) The tubes are of metal construction and the system is fully open at one or both ends. If heat recovery systems are used, they shall be of explosion-resistant construction; or
   
   (b) The entire radiant tube heating system, including any associated heat recovery system is of explosion-resistant construction.

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Submittal Date: Wed Nov 30 09:27:01 EST 2016

Committee Statement

Committee Statement: These requirements should be based on performance and not specifically on the type of material utilized.

Response Message:
Public Input No. 172-NFPA 86-2016 [Section No. 8.8.2.1]
First Revision No. 113-NFPA 86-2016 [Section No. 8.8.2.3]

8.8.2.3*
Means for testing all fuel gas safety shutoff valves for valve seat leakage shall be installed.

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Submitter Information Verification

Submitter Full Name: Eric Nette
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Submittal Date: Tue Dec 06 13:03:48 EST 2016

Committee Statement

Committee Statement: Adds back a useful Figure that was lost between the 2011 and 2015 editions.
Response Message:
Public Input No. 161-NFPA 86-2016 [New Section after A.8.8.2.2]
A.8.8.2.3
There are other acceptable piping arrangements. For example, the pilot take-off can also be downstream of the main pressure regulator. (See Figure A.8.8.2.3 for an example.)

Figure A.8.8.2.3 One Example of a Leak Testing Arrangement.
8.10.2
The following shall not require a supervised flame:

(1) Burner flames for radiant tube–type heating systems where a means of ignition is provided and the systems are arranged and designed such that either of the following conditions is satisfied:
   
   (a) The tubes are of metal construction and the system is full open at one or both ends. If heat recovery systems are used, they shall be of explosion-resistant construction; or
   
   (b) The entire radiant tube heating system, including any associated heat recovery system, is of The system is explosion-resistant construction.

(2) Burner flames at burners interlocked with a 1400°F (760°C) bypass interlock that prevents burner operation when the temperature in the zone where the burner is located is less than 1400°F (760°C).

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Committee Statement

Committee Statement: These requirements should be based on performance and not specifically on the type of material utilized.

Response Message:

Public Input No. 173-NFPA 86-2016 [Section No. 8.10.2]
8.10.5 Where a supervised flame is required for a burner, each pilot and main burner flame shall be equipped with flame supervision in one of the following ways:

1) Main and pilot flames supervised with independent flame sensors
2) Main and interrupted pilot flames supervised with a single flame sensor
3) Self-piloted burner supervised with a single flame sensor

Committee Statement
Annex is intended to help the user understand what to be cautious of when employing 2 flame detectors.

1) NFPA85 requires (2) sensors, one for pilot and the other for main, if the pilot is continuous.

2) Because of the difficulty of sensing the pilot and main flames independently with (2) UV scanners, other parts of the world (Australia as an example), require the pilot to be supervised by a flame rod and the main flame by a UV scanner.
A.8.10.5(1)
Where independent flame sensors are used for detecting pilot and main flames, ensure the pilot and the main flame are each sensed independently. Due to the difficulty of sensing the pilot and main flames independently with two UV scanners, sensing the pilot by a flame rod and the main flame by a UV scanner is acceptable.
8.10.6

Line burners, A line burner, pipe burners, and burner, or radiant burners, where installed adjacent to one another or connected burner with flames propagating devices, shall be considered to be a single burner and 3 ft (1 m) or longer shall have at least one flame detector installed to sense burner flame at the end of the assembly farthest from the source of ignition.

8.10.6.1

A line burner, pipe burner, or radiant burner with a pilot shall have one flame detector installed to sense pilot burner flame at the source of ignition.

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Submitter Information Verification

Submitter Full Name: Eric Nette
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Submittal Date: Wed Nov 30 12:01:44 EST 2016

Committee Statement

Committee Statement: Adjacent is relative. Unburned fuel in the firing chamber or direct-fired heating duct is a primary combustion system hazard. Lineburners and such that operate without fully propagated flames can produce significant amounts of unburned fuel. Lack of flame development across the entire lineburner length may be caused by uneven process air flow distribution through the burner, burner damage, or debris accumulation.

Previous wording is subject to interpretation and does not exclude very short line burner lengths that have low risk for flame propagation failure.

Annex to help identify requirements when trying to independently monitor the pilot and main flame.

Response Message:

Public Input No. 63-NFPA 86-2016 [Section No. 8.10.6]
Public Input No. 151-NFPA 86-2016 [Section No. A.8.10.6]
Public Input No. 147-NFPA 86-2016 [Section No. 8.10.6]
A.8.10.6

A line burner, pipe burner, or radiant burner with flames propagating 3 ft (1 m) or shorter are only required to have one flame sensor for pilot and main flame detection. A line burner, pipe burner, or radiant burner with flames propagating 3 ft (1 m) or longer are required to have two flame sensors, one for pilot and one to sense main burner flame at the end of the assembly farthest from the source of ignition.

Two examples of burner arrangements considered to be a single burner with one flame safeguard installed at the end of the assembly are shown in Figure A.8.10.6(a) and Figure A.8.10.6(b).

**Figure A.8.10.6(a) Example of a Combustion Safeguard Supervising a Pilot for a Continuous Line Burner During Light-Off and the Main Flame Alone During Firing.**

**Figure A.8.10.6(b) Example of a Combustion Safeguard Supervising a Group of Radiant Cup Burners Having Reliable Flame-Propagation Characteristics from One to the Other by Means of Flame-Propagation Devices.**
First Revision No. 84-NFPA 86-2016 [Section No. 9.3.3]

9.3.3
Where sprinklers are selected for the protection of ovens, furnaces, or related equipment, the use of closed-head sprinkler systems shall be prohibited, and only deluge sprinkler systems shall be used systems with only open sprinklers shall be installed where the following conditions exist:

(1) In equipment where temperatures can exceed 625°F (329°C)
(2) Where flash fire conditions can occur

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Submittal Date: Thu Dec 01 10:14:57 EST 2016

Committee Statement

Committee Statement: Open sprinkler is defined so that term was used in the above revision. The submitter pointed out that the term “closed head” is not used in NFPA 13.
Response Message:

Public Input No. 14-NFPA 86-2015 [Section No. 9.3.3]
10.6.2 Purging

Equipment shall not be purged into a running thermal oxidizer unless one of the following conditions is met:

1. It shall be demonstrated that the flammable vapor concentration entering the thermal oxidizer cannot exceed 50 percent of the LFL under all anticipated normal and abnormal operating conditions.

2. Where it is not permitted to discharge the air mixture being purged directly to atmosphere, the source equipment, connecting ductwork, and thermal oxidizers used to oxidize the purge discharge shall have explosion prevention and protection systems designed and installed in accordance with the requirements of NFPA 69.

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Submittal Date: Thu Dec 01 10:18:01 EST 2016

Committee Statement

Currently the introductory chapters only preclude purging ovens and furnaces into running incinerators (as referenced in 8.5.1.3 and 8.5.1.4). However, thermal oxidizers may process fumes that are sourced from equipment other than ovens and furnaces.

Restricting concentrations to a maximum of 50% LFL, regardless of flammable gas/vapor source, the likelihood of the mixture being ignited and flashing back into the source equipment is reduced.

Alternatively NFPA 69, which requires redundant methods of explosion prevention and protection, may provide an effective approach for processes where the equipment exhaust is toxic and must be oxidized at all times (discharge to atmosphere is not acceptable).

Response Message:

Public Input No. 149-NFPA 86-2016 [New Section after 10.6.1]
Public Input No. 155-NFPA 86-2016 [New Section after A.10.6.1]
A.10.6.2
The introductory chapters only preclude purging ovens and furnaces into running incinerators (as referenced in 8.5.1.3 and 8.5.1.4). However, thermal oxidizers can process fumes that are sourced from equipment other than ovens and furnaces.

Restricting concentrations to a maximum of 50 percent LFL, regardless of flammable gas or vapor source, reduces the likelihood of the mixture being ignited and flashing back into the source equipment.

Alternatively, NFPA 69, which offers a variety of methods of explosion prevention and protection, might provide an effective approach for processes where the equipment exhaust is toxic and must be oxidized at all times (discharge to atmosphere is not acceptable).
11.6.1.10*

Safety ventilation shall be proved by one of the following:

1. A dedicated exhaust fan proved in accordance with Section 8.6

2. The presence of at least the required fresh airflow into the system proven in accordance with 11.6.1.11

3. The presence of at least the required exhaust flow out of the system proven in accordance with 11.6.1.11

4. A continuous vapor concentration high-limit controller in accordance with 11.6.10

Supplemental Information

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Submitter Information Verification

Submitter Full Name: Eric Nette
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Street Address:
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Submittal Date: Wed Nov 30 12:00:43 EST 2016

Committee Statement

Committee Statement: The use of term "airflow" and "air flow" should be used consistently throughout the Standard.

Response Message:

Public Input No. 29-NFPA 86-2016 [Section No. A.11.6.1.10]
Public Input No. 26-NFPA 86-2016 [Section No. 11.6.1.10]
A.11.6.1.10
In the past, NFPA 86 prohibited ovens using a single fan for both recirculation and exhaust. These dual-purpose fan installations have a long history of fire and explosion incidents. The primary cause of these incidents was short-circuiting of safety ventilation resulting in pockets or zones in which flammable vapors can concentrate.

The current text for 11.6.1.10 now permits alternative means to dedicated exhaust fans for proving safety ventilation. Accordingly, the user, oven designer, and the AHJ are cautioned to carefully examine airflow of both incoming and exhaust with respect to operating pressures, circulating methodology, and proof of the air flow design.

Figure A.11.6.1.10 illustrates an example that is unacceptable because short-circuiting is possible as well as an example that is potentially acceptable. The key in most cases is locating the fresh air intake(s) in relation to the exhaust appropriately to ensure that fresh air passes throughout the volume.

These drawings best pertain to batch ovens, as the openings in a continuous oven alter pressure differentials creating additional flow paths which must be taken into consideration.

Figure A.11.6.1.10 Unacceptable Safety Ventilation Systems Using a Single Fan (Recirculation Combined with Spill Exhaust).
UNACCEPTABLE EXAMPLE

Note that the fresh air passes through the heater and out the exhaust without recirculating, allowing localized concentrations in excess of 25% LFL.

POTENTIALLY ACCEPTABLE EXAMPLE

Note that the recirculation and flow path forces the fresh air into the oven to travel throughout the volume and mix with the oven atmosphere before exiting via the exhaust. Other features, such as proving airflow through the exhaust, are required.
11.6.1.11 Safety ventilation shall be arranged to meet the following design characteristics:

(1) The reduction of airflow below the minimum required by 11.6.1 shall activate the ventilation safety devices provided in accordance with Section 8.6.

(2) The physical arrangement of dampers, fans, ducts, chambers, and passages shall ensure that a short-circuited airflow cannot occur without activating the ventilation safety devices provided in accordance with Section 8.6.

Submitter Information Verification

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Submittal Date: Wed Nov 30 11:38:36 EST 2016

Committee Statement

Committee Statement: The use of term "airflow" and "air flow" should be used consistently throughout the Standard.

Response Message:

Public Input No. 27-NFPA 86-2016 [Section No. 11.6.1.11]
11.6.8.5
The required minimum rate of exhaust airflow, at standard atmosphere and temperature, shall be determined by multiplying the cubic feet of diluted mixture at 25 percent LFL per gallon of solvent evaporated in the process by the maximum allowable gallons per minute of solvent entering the process oven, as follows:

\[
\text{ft}^3 \text{ or } \text{m}^3 \text{ of exhaust to prove safety ventilation} = \left( \frac{\text{gal or L of solvent entering the oven}}{\text{min}} \right) \left( \frac{\text{ft}^3 \text{ or } \text{m}^3 \text{ diluted mixture at 25\% LFL}}{\text{gal or L of solvent evaporated}} \right)
\]

[11.6.8.5]

Submitter Information Verification

Submitter Full Name: Eric Nette
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Street Address:
City:
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Submittal Date: Wed Nov 30 11:38:59 EST 2016

Committee Statement

Committee Statement: The use of term "airflow" and "air flow" should be used consistently throughout the Standard.
11.6.9.3 Methods for Determining Solvent Safety Ventilation Rate.

In batch process ovens, the rate of safety ventilation air shall be either calculated or estimated using 11.6.9.3(A) or 11.6.9.3(B).

(A) Method for Calculating Modulating Safety Ventilation Rate to Control Vapor Concentration.

The minimum following safety ventilation rate equipment and controls shall be one of the following:

1. Calculated using 11.6.9.3(A):

   - 440 scfm of air per gal (3.29 standard m³/min of air per L) of solvent

   (1) Other than 440 scfm (3.29 standard m³/min) where ventilation is provided, with exhaust fans and other devices designed to prevent average concentration in the oven from exceeding 25 percent of the LFL.

   (2) A continuous vapor concentration high limit controller meeting one both of the following criteria:

      (a) The controller is arranged to alarm and shut down the oven heating system if the vapor concentration exceeds 50 percent of the LFL.

      (b) The controller is arranged to operate additional exhaust fans at a predetermined vapor concentration not exceeding 50 percent of the LFL.

(B) Method for Estimating Rate of Ventilation Safety Ventilation Rate.

Batch ovens shall have a minimum safety ventilation rate either of that given in 11.6.9.3(A) or as follows:

1. The safety ventilation rate of batch ovens shall be designed and maintained to provide 440 scfm of air per gal (3.29 standard m³/min of air per L) of flammable volatiles in each batch.

2. Where the solvent used requires a volume of air greater than 2640 standard ft³ to dilute vapor from 1 gal of solvent to the LFL (19.75 standard m³/L), safety ventilation shall be adjusted in proportion to the ratio of the actual volume of air necessary to render 2640 ft³/gal (19.75 m³/L) barely explosive.

CAUTION: Caution shall be used where applying this method to products of low mass that can heat up quickly (such as paper or textiles) or materials coated with very highly volatile solvents. Either condition can produce too high a peak evaporation rate for this method to be used.

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Submittal Date: Thu Dec 01 10:42:44 EST 2016

Committee Statement

Committee Method A was revised to clarify that it is not a calculation but a method for controlling vapor
Statement: concentration.
Response Message: Public Input No. 162-NFPA 86-2016 [Section No. 11.6.9.3]
13.5.5.1 General.

(A) Piping and piping components shall be in accordance with ASME B31.3, *Process Piping*.

(B) Locations for tanks and cylinders containing flammable or toxic fluids shall comply with the applicable NFPA standards.

(C) Storage tanks and their associated piping and controls shall comply with the following standards:
   
   (1) Liquefied petroleum gas systems shall be in accordance with NFPA 58, *Liquefied Petroleum Gas Code*.

   (2) Fuel gas systems shall be in accordance with NFPA 54, *National Fuel Gas Code*.

   (3) Hydrogen storage systems shall be in accordance with NFPA 55, *Compressed Gases and Cryogenic Fluids Code*.

   (4)* Flammable or combustible liquid systems shall be in accordance with NFPA 30, *Flammable and Combustible Liquids Code*.

(D) Where inert purge gas is required by this standard or used as a safety purge media, the following shall apply:

   (1) It shall be available at all times and be sufficient for five volume changes of all connected atmosphere furnaces.

   (2) If the inert gas has a flammable gas component, it shall be analyzed on a continuous basis to verify that the oxygen content is less than 1 percent and the combined combustible gas concentration remains less than 25 percent of the LFL.

(E) Bulk storage systems shall be rated and installed to provide the required flow of special atmospheres to the user equipment if an interruption of the flow can create an explosion hazard.

(F) Where inert gases are used as safety purge media, the minimum volume stored shall be the amount required to purge all connected special atmosphere furnaces with at least five furnace volume changes wherever the flammable atmospheres are being used.
Committee Statement: 3.5.5.1(F) is already covered in paragraph 3.5.5.1(D)(1).

Response Message:

Public Input No. 117-NFPA 86-2016 [Section No. 13.5.5.1(F)]
13.5.7.2

The flow rates used shall restore positive internal pressure without infiltration of air during atmosphere contractions when furnace chamber doors close or workloads are quenched. When furnace chamber door operation or workload quenching causes atmosphere contractions, the flow rates used shall restore positive internal pressure before air infiltration would cause a transition into the flammability range.

Submitter Information Verification

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Submittal Date: Thu Dec 01 11:30:52 EST 2016

Committee Statement

Committee Statement: During workload cycling (e.g. movement into and out of the furnace and quenching) air infiltration occurs. Flow rates should safely limit this air infiltration until positive pressure is restored.

Response Message:

Public Input No. 118-NFPA 86-2016 [Section No. 13.5.7.2]
Synthetic atmosphere flow control units shall have the additional capabilities specified in 13.5.8.1 through 13.5.8.12.

Submitter Information Verification

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Submittal Date: Thu Dec 01 11:33:48 EST 2016

Committee Statement

Committee Statement: Corrects editorial error (i.e. all of the following sections/paragraphs apply).

Response Message:

Public Input No. 119-NFPA 86-2016 [Section No. 13.5.8 [Excluding any Sub-Sections]]
13.5.11.1 General.

(A) Flammable and indeterminate atmosphere gases shall be introduced, used, and removed from furnaces without creating an uncontrolled fire, deflagration, or explosion.

(B)* Special atmosphere furnaces that use flammable or indeterminate special atmospheres shall be designed and maintained to minimize the unintended infiltration of air into the furnace.

(C)* Operating instructions for introducing, using, and removing flammable special atmosphere gases shall comply with Chapter 13 and Section 7.3.

(D)* Where present, the liquid level in manometers or bubbler bottles on vent lines shall be checked and maintained at the required operating range as necessary.

(E)* Discharge from effluent vents of furnaces using special atmospheres shall be piped or captured by hoods and discharged to an approved location.

(F)* Process control air or burnout air shall be supplied from an air blower.

(G)* Where a furnace uses an atmosphere oil seal, means shall be provided so that furnace pressure is maintained below the static head pressure of the seal oil.

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Submitter Information Verification

Submitter Full Name: Eric Nette
Organization: National Fire Protection Assoc
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Submittal Date: Thu Dec 01 11:35:45 EST 2016

Committee Statement

Committee Statement: 1. In the 2015 edition paragraph 13.5.11.7.8(C) is the only place that lists requirements for "oil seals". This paragraph is specific to burn-in requirements for Type VIII and IX furnaces only.

2. The above public comment moves the requirement to the "general" where it would apply to any atmosphere oil seal that is used by a Class C furnace and for any type of introduction of
A.13.5.11.1(G)
The means to maintain furnace pressure below the static head pressure of the seal oil include the use of bubblers or manometers on vent lines. Other means might be possible. (*Also see A.13.5.11.1(D).*)
Response
Message:

Public Input No. 120-NFPA 86-2016 [New Section after 13.5.11.1(F)]
Public Input No. 121-NFPA 86-2016 [New Section after A.13.5.11.1(F)]
**13.5.11.3** Flame Curtains.

Where a flame curtain is used, the following features shall be provided and in service:

1. One or more flame curtain pilots shall be positioned to reliably ignite the flame curtain.

2. At least one flame curtain pilot at a flame curtain shall have flame supervision interlocked to prevent the opening of a closed door served and interlocked to prevent initial operation of the flame curtain at the door served.

3. At least one safety shutoff valve upstream of all flame curtains on a furnace shall be interlocked to close upon the following conditions:
   - Low fuel gas pressure on the flame curtain fuel gas supply
   - High fuel gas pressure on the flame curtain fuel gas supply where a high gas pressure issue would create a safety concern

4. For flame curtains equipped with flame supervision independent of the flame curtain pilot flame supervision, it shall be permissible to bypass the safety shutoff valve interlocks in 13.5.11.3(3)(a) and 13.5.11.3(3)(b) once the door served is open provided that flame curtain flame is sensed by the flame curtain flame supervision system.

5. An automatic control valve shall be provided ahead of each flame curtain arranged to open when the door served is not closed.

6. When the safety shutoff valve in item 13.5.11.3(3) is closed, any doors served by that safety shutoff valve shall be interlocked so they cannot open.

7. A manual means of overriding the door interlock in 13.5.11.3(6) shall be provided.

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<td>FR-100_A.13.5.11.3_A.13.5.11.3_2_.docx</td>
<td>Annex text</td>
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</table>

**Submitter Information Verification**

- **Submitter Full Name:** Eric Nette
- **Organization:** National Fire Protection Assoc
- **Street Address:**
- **City:**
- **State:**
- **Zip:**
- **Submittal Date:** Thu Dec 01 12:45:01 EST 2016

**Committee Statement**

- **Committee Statement:** Improves on the overall safety of the flame curtain operation. The statement added to the Annex provides additional guidance on the use of flame curtains.

**Response Message:**

Public Input No. 145-NFPA 86-2016 [Section No. A.13.5.11.3]
A.13.5.11.3
Regarding items (2) and (5), once a door begins to open, it is intended that the door will be permitted to open completely. The interlock is only intended to prevent a closed door from opening. Flame curtains are often used to minimize the ingress of air into a furnace through an open furnace door to prevent process upset and not for the purpose of providing the ignition source for flammable atmosphere exiting from the door.

A.13.5.11.3(2)
It is recognized that maintaining a reliable source of ignition is critical to avoid explosion at an open door from which flammable atmosphere gas is flowing. Once a door begins to open or is full open, the flame curtain pilot flame supervision and flame curtain low and high gas interlocks can be ignored provided that flame curtain flame is sensed by an independent flame supervision system.
Public Input No. 144-NFPA 86-2016 [Section No. 13.5.11.3]
Public Input No. 146-NFPA 86-2016 [New Section after A.13.5.11.3]
13.5.11.4 Flammable Special Atmosphere Introduction.
Flammable special atmospheres shall be introduced into a furnace using one of the following methods:

1. Purge-in
2. Burn-in [With the exception of Type VIII furnaces, burn-in]

13.5.11.5 Flammable Special Atmosphere Removal.
Flammable special atmospheres shall be removed from a furnace using one of the following methods:

1. Purge-out
2. Burn-out [With the exception of Type VIII furnaces, burn-out]

13.5.11.6 Purge-in Requirements.

13.5.11.6.1 Written purge-in instructions shall be provided for each furnace.

(A)* Purge effectiveness shall not be compromised during the purge process.

(B) Furnace doors and covers shall be positioned in accordance with the operating instructions before purge-in begins. The inner and outer covers of Type VIII and Type IX furnaces shall not be placed in position onto the furnace base unless the workload and base are at least 50°F (28°C) below the auto-ignition temperature of any flammable gas mixture that can be present in the cover.

13.5.11.6.2 Purge-in shall reduce the oxygen content of the furnace to less than 1 percent by displacement with an inert gas or before introduction of the flammable special atmosphere gas.

13.5.11.6.3 Positive Furnace Pressure.

(A) A positive furnace pressure shall be maintained during the purge-in process and continue through the transition from the inert gas purge to the introduction of special atmosphere gas.

(B) Positive pressure for Type VIII or Type IX heating-cover (retort) type furnaces shall be indicated by a bubbler, vent manometer, or similar device.

13.5.11.6.4* During the inert gas purge, flammable special atmosphere safety shutoff valves shall remain closed.

13.5.11.6.5 Purging of the furnace shall continue until the purge has been verified as complete using one of the following methods:

1. Time-flow purge method in accordance with 13.5.12.
2. Two consecutive analyses of all chambers indicating that the oxygen content is less than 1 percent

13.5.11.6.6 Furnaces shall not be required to be at any specific temperature when the inert gas is displaced by the flammable special atmosphere gases.
13.5.11.6.7*
Active sources of ignition shall be provided at interfaces between air and flammable or indeterminate special atmosphere gases at furnace openings and doors. Effluent vents terminating inside a building shall also be provided with an active source of ignition.

13.5.11.6.8*
All furnace and vestibule volumes that will contain a flammable special atmosphere gas shall be purged with inert gas prior to the special atmosphere gas being admitted.

13.5.11.6.9
During the inert gas purge, all flame curtain fuel gas valves shall be closed.

13.5.11.6.10
During the inert gas purge, all circulating and recirculating fans shall be operating as required by the operating instructions.

13.5.11.6.11
Flammable special atmosphere gases shall not be introduced unless the following conditions exist:

1. Burn-off pilots at open ends, doors, and effluent lines are ignited.
2. All manual valves to flame curtains (where provided) are open.
3. All automatic valves to flame curtain are in service.
4. All required quench fluid levels are at the correct level.
5. Purging of the furnace has been completed as defined by 13.5.11.6.5.
6. Operation of flame curtains (where provided) is verified.

13.5.11.6.12*
After the introduction of the flammable special atmosphere, the purge-in atmosphere introduction process is considered complete when flame appears at furnace doors, open ends, or effluent lines in accordance with the specific design features and operating instructions for the furnace.

13.5.11.7 Burn-in Requirements.

13.5.11.7.1
For Type VIII furnaces, burn-in procedures shall not be used.

13.5.11.7.2
Written burn-in instructions shall be provided for each furnace.

(A)*
Burn-in effectiveness shall not be compromised by taking any action that deviates from the written operating instructions for burn-in.

(B)
The position of inner and outer furnace doors and the placement of manual torches shall be as directed in the operating instructions during each stage of the burn-in procedure.

13.5.11.7.3*
Burn-in shall reduce the oxygen content of the furnace by consuming the oxygen in the air through combustion with a flammable atmosphere gas that will reliably ignite at the gas–air interfaces.

13.5.11.7.4*
To begin the burn-in process, the flammable special atmosphere gas shall be introduced at a location in the furnace that is at or above 1400°F (760°C).

13.5.11.7.5*
Where a stable flame front propagating through a chamber under 1400°F (760°C) cannot be maintained, the burn-in process shall not be used.
13.5.11.7.6*
For zones under 1400°F (760°C), stable flames of burning gas shall be maintained in the zones as the special atmosphere gas is burned-in.

13.5.11.7.7*
For a Type II furnace (batch integral quench furnace) with heating chamber fan, the fan shall not be operating during burn-in while the inner heating chamber door is open.

13.5.11.7.8*
For Types I through VII furnaces, recirculating fans in cooling zones shall be turned off during burn-in.

13.5.11.7.9 Special Requirements for Type VIII and IX Furnaces.

(A) Circulating base fans, where provided, shall be turned on.

(B)* The cover shall be sealed to the furnace base before flammable or indeterminate special atmospheres are introduced.

(C) Where a furnace uses an oil seal between a cover and a base, means shall be provided so that furnace pressure is maintained below the static head pressure of the seal oil.

13.5.11.7.10
Flammable special atmosphere gases shall not be introduced unless the following conditions exist:

(1) Burn-off pilots at open ends, doors, and effluent lines are ignited.

(2) All required quench fluid levels are at the correct level.

(3) Operation of flame curtains (where provided) is verified.

13.5.11.7.11*
After the introduction of the flammable special atmosphere, the burn-in atmosphere introduction process shall be considered complete when flame appears at the furnace doors, open ends, or effluent lines, where present, in accordance with the specific design features and operating instructions for the furnace.

13.5.11.8 Purge-out Requirements.

13.5.11.8.1 Written purge-out instructions shall be provided for each furnace.

(A)* Purge effectiveness shall not be compromised during the purge process.

(B) Furnace doors and covers shall be positioned in accordance with the manufacturer’s instructions before purge-out begins.

13.5.11.8.2 Positive Furnace Pressure.

(A) A positive furnace pressure shall be maintained at all times during purge-out, including the transition from the special atmosphere gas operation to the inert gas purge.

(B) For Types VIII and IX furnaces, an indication of positive furnace pressure shall be provided by an indicating manometer or similar device.
13.5.11.8.3*  
Once the inert purge gas flow has been established for purge-out, the flow of all flammable special atmosphere gases shall be stopped.

13.5.11.8.4*  
Purging shall include all of the furnace volume that contains a flammable or indeterminate special atmosphere gas.

13.5.11.8.5*  
Purge-out shall be considered complete when all chambers that would create a hazard are below 50 percent of LFL and shall be determined by one of the following two methods:

1. Time-flow purge method in accordance with 13.5.12 as it applies to the purge-out process
2. Two consecutive analyses of all chambers indicating that the flammable level within the furnace is below 50 percent of LFL

13.5.11.8.6  
When purge-out is complete, the following shall be permitted to be turned off:

1. Burn-off pilots
2. Circulation and recirculation fans required for purge-out
3. Inert purge gas supply to the furnace
4. Flame curtains

13.5.11.9  
Burn-Out Requirements.

13.5.11.9.1  
For Type VIII furnaces, burn-out procedures shall not be used.

13.5.11.9.2  
Written burn-out instructions shall be provided for each furnace.

(A)*  
Burn-out effectiveness shall not be compromised by taking any action that deviates from the written operating instructions for burn-out.

(B)*  
Inner and outer furnace doors, where provided, shall be placed in the appropriate position as directed in the operating instructions during each stage of the burn-out procedure.

13.5.11.9.3*  
Through the controlled admission of air to a furnace, burn-out shall reduce the flammable content within all heating chambers and vestibules through combustion with the oxygen in the air.

13.5.11.9.4*  
To initiate the burn-out process, one of the following conditions shall be met:

1. Air is introduced into the furnace at a point that is at or above 1400°F (760°C).
2. Where air is introduced into a furnace at a point below 1400°F (760°C), the following shall apply:
   (a)*  The furnace is under positive pressure.
   (b)  A source of ignition is provided at the interface between the flammable atmosphere and the point of air introduction.

13.5.11.9.5  
Burn-out shall include turning off all special atmosphere gases and admitting air in a sequence outlined in the written burn-out instructions.
13.5.11.9.6
Burnout air shall be admitted by any of the following arrangements:

(1) Through furnace doors
(2) Through independent piping and furnace gas inlets
(3) Through sections of piping and furnace inlets that are common to both flammable special atmosphere and burnout air when the systems are designed to prevent the flow of air and flammable special atmosphere at the same time

13.5.11.9.7*
During burn-out, recirculating fans shall be turned off in furnace zones under 1400°F (760°C) and in zones at or above 1400°F (760°C) that can cause turbulence in zones under 1400°F (760°C).

13.5.11.9.8
Burn-out shall be considered complete when one of the following conditions is satisfied:

(1) For furnaces that do not contain soot, all visible flame in the furnace and at all effluents are observed to be extinguished.
(2) For furnaces that contain soot that cannot re-form a flammable atmosphere gas, all visible flames in the furnace and at all effluents are observed to be extinguished.
(3) For furnaces that contain soot that re-form flammable atmosphere gas, all visible flames in the furnace and at effluents are observed to be extinguished after burn-out procedures are performed that include the introduction of additional air to effect the burn-out of the re-formed flammable atmosphere gas.

13.5.11.9.9
When burn-out is complete, the following shall be permitted to be turned off:

(1) Burn-off pilots
(2) Circulation and recirculation fans required for burn-out
(3) Flame curtains

Supplemental Information

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Submitter Information Verification

Submitter Full Name: Eric Nette
Organization: National Fire Protection Assoc
Street Address:
City:
State:
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Submittal Date: Thu Dec 01 11:43:42 EST 2016

Committee Statement

Committee Statement: Type VIII purge-in and purge-out only requirements should not be “buried” in the text. Oil seal design requirements should be located to “13.5.11.1 General” not “13.5.11.7 Burn-in Requirements”. Burn-off pilots lit and correct oil levels requirements should be included for “burn-in” the same as they are required for “purge-in”.

Annex:
13.5.11.4 Flammable Special Atmosphere Introduction. Flammable special atmospheres shall be introduced into a furnace using one of the following methods:

(1) Purge-in

(2) Burn-in with the exception of Type VIII furnaces burn-in

13.5.11.5 Flammable Special Atmosphere Removal.

Flammable special atmospheres shall be removed from a furnace using one of the following methods:

(1) Purge-out

(2) Burn-out With the exception of Type VIII furnaces burn-out

13.5.11.6 Purge-in Requirements.

13.5.11.6.1 Written purge-in instructions shall be provided for each furnace.

(A)* Purge effectiveness shall not be compromised during the purge process.

(B) Furnace doors and covers shall be positioned in accordance with the operating instructions before purge-in begins. The inner and outer covers of Type VIII and Type IX furnaces shall not be placed in position onto the furnace base unless the workload and base are at least 50°F (28°C) below the autoignition temperature of any flammable gas mixture that can be present in the cover.

13.5.11.6.2 Purge-in shall reduce the oxygen content of the furnace to less than 1 percent by displacement with an inert gas or before introduction of the flammable special atmosphere gas.

13.5.11.6.3 Positive Furnace Pressure.

(A) A positive furnace pressure shall be maintained during the purge-in process and continue through the transition from the inert gas purge to the introduction of special atmosphere gas.

(B) Positive pressure for Type VIII or Type IX heating-cover (retort) type furnaces shall be indicated by a bubbler, vent manometer, or similar device.

13.5.11.6.4* During the inert gas purge, flammable special atmosphere safety shutoff valves shall remain closed.

13.5.11.6.5 Purging of the furnace shall continue until the purge has been verified as complete using one of the following methods:

(1) Time-flow purge method in accordance with 13.5.12.

(2) Two consecutive analyses of all chambers indicating that the oxygen content is less than 1 percent
13.5.11.6.6 Furnaces shall not be required to be at any specific temperature when the inert gas is displaced by the flammable special atmosphere gases.

13.5.11.6.7* Active sources of ignition shall be provided at interfaces between air and flammable or indeterminate special atmosphere gases at furnace openings and doors. Effluent vents terminating inside a building shall also be provided with an active source of ignition.

13.5.11.6.8* All furnace and vestibule volumes that will contain a flammable special atmosphere gas shall be purged with inert gas prior to the special atmosphere gas being admitted.

13.5.11.6.9 During the inert gas purge, all flame curtain fuel gas valves shall be closed.

13.5.11.6.10 During the inert gas purge, all circulating and recirculating fans shall be operating as required by the operating instructions.

13.5.11.6.11 Flammable special atmosphere gases shall not be introduced unless the following conditions exist:

   (1) Burn-off pilots at open ends, doors, and effluent lines are ignited.

   (2) All manual valves to flame curtains (where provided) are open.

   (3) All automatic valves to flame curtain are in service.

   (4)* All required quench fluid levels are at the correct level.

   (5) Purging of the furnace has been completed as defined by 13.5.11.6.5.

   (6) Operation of flame curtains (where provided) is verified.

13.5.11.6.12* After the introduction of the flammable special atmosphere, the purge-in atmosphere introduction process is considered complete when flame appears at furnace doors, open ends, or effluent lines in accordance with the specific design features and operating instructions for the furnace.

13.5.11.7 Burn-in Requirements.

13.5.11.7.1 For Type VIII furnaces, burn-in procedures shall not be used

13.5.11.7.1.2 Written burn-in instructions shall be provided for each furnace.

(A)* Burn-in effectiveness shall not be compromised by taking any action that deviates from the written operating instructions for burn-in.

(B) The position of inner and outer furnace doors and the placement of manual torches shall be as directed in the operating instructions during each stage of the burn-in procedure.
13.5.11.7.23* Burn-in shall reduce the oxygen content of the furnace by consuming the oxygen in the air through combustion with a flammable atmosphere gas that will reliably ignite at the gas–air interfaces.

13.5.11.7.34* To begin the burn-in process, the flammable special atmosphere gas shall be introduced at a location in the furnace that is at or above 1400°F (760°C).

13.5.11.7.45* Where a stable flame front propagating through a chamber under 1400°F (760°C) cannot be maintained, the burn-in process shall not be used.

13.5.11.7.56* For zones under 1400°F (760°C), stable flames of burning gas shall be maintained in the zones as the special atmosphere gas is burned-in.

13.5.11.7.67* For a Type II furnace (batch integral quench furnace) with heating chamber fan, the fan shall not be operating during burn-in while the inner heating chamber door is open.

13.5.11.7.78* For Types I through VII furnaces, recirculating fans in cooling zones shall be turned off during burn-in.

13.5.11.7.8-9 Special Requirements for Type VIII and IX Furnaces.

(A) Circulating base fans, where provided, shall be turned on.

(B)* The cover shall be sealed to the furnace base before flammable or indeterminate special atmospheres are introduced.

(C)* Where a furnace uses an oil seal between a cover and a base, means shall be provided so that furnace pressure is maintained below the static head pressure of the seal oil.

13.5.11.7.9 For Type VIII furnaces, atmosphere introduction shall be by purge-in, and atmosphere removal shall be by purge-out; burn-in and burn-out procedures shall not be used.

13.5.11.7.10 Flammable special atmosphere gases shall not be introduced unless the following conditions exist:

(1) Burn-off pilots at open ends, doors, and effluent lines are ignited.

(2)* All required quench fluid levels are at the correct level.

(3) Operation of flame curtains (where provided) is verified.

13.5.11.7.101* After the introduction of the flammable special atmosphere, the burn-in atmosphere introduction process shall be considered complete when flame appears at the furnace doors, open ends, or effluent lines, where present, in accordance with the specific design features and operating instructions for the furnace.

13.5.11.8 Purge-out Requirements.
13.5.11.8.1 Written purge-out instructions shall be provided for each furnace.

(A)* Purge effectiveness shall not be compromised during the purge process.

(B) Furnace doors and covers shall be positioned in accordance with the manufacturer’s instructions before purge-out begins.

13.5.11.8.2 Positive Furnace Pressure.

(A) A positive furnace pressure shall be maintained at all times during purge-out, including the transition from the special atmosphere gas operation to the inert gas purge.

(B) For Types VIII and IX furnaces, an indication of positive furnace pressure shall be provided by an indicating manometer or similar device.

13.5.11.8.3* Once the inert purge gas flow has been established for purge-out, the flow of all flammable special atmosphere gases shall be stopped.

13.5.11.8.4* Purging shall include all of the furnace volume that contains a flammable or indeterminate special atmosphere gas.

13.5.11.8.5* Purge-out shall be considered complete when all chambers that would create a hazard are below 50 percent of LFL and shall be determined by one of the following two methods:

(1) Time-flow purge method in accordance with 13.5.12 as it applies to the purge-out process

(2) Two consecutive analyses of all chambers indicating that the flammable level within the furnace is below 50 percent of LFL

13.5.11.8.6 When purge-out is complete, the following shall be permitted to be turned off:

(1) Burn-off pilots

(2) Circulation and recirculation fans required for purge-out

(3) Inert purge gas supply to the furnace

(4) Flame curtains

13.5.11.9 Burn-Out Requirements.

13.5.11.9.1 For Type VIII furnaces, burn-out procedures shall not be used.

13.5.11.9.4-2 Written burn-out instructions shall be provided for each furnace.
(A)* Burn-out effectiveness shall not be compromised by taking any action that deviates from the written operating instructions for burn-out.

(B)* Inner and outer furnace doors, where provided, shall be placed in the appropriate position as directed in the operating instructions during each stage of the burn-out procedure.

13.5.11.9.23* Through the controlled admission of air to a furnace, burn-out shall reduce the flammable content within all heating chambers and vestibules through combustion with the oxygen in the air.

13.5.11.9.34* To initiate the burn-out process, one of the following conditions shall be met:

(1) Air is introduced into the furnace at a point that is at or above 1400°F (760°C).

(2) Where air is introduced into a furnace at a point below 1400°F (760°C), the following shall apply:

(a)* The furnace is under positive pressure.

(b) A source of ignition is provided at the interface between the flammable atmosphere and the point of air introduction.

13.5.11.9.45 Burn-out shall include turning off all special atmosphere gases and admitting air in a sequence outlined in the written burn-out instructions.

13.5.11.9.56 Burnout air shall be admitted by any of the following arrangements:

(1) Through furnace doors

(2) Through independent piping and furnace gas inlets

(3) Through sections of piping and furnace inlets that are common to both flammable special atmosphere and burnout air when the systems are designed to prevent the flow of air and flammable special atmosphere at the same time

13.5.11.9.67* During burn-out, recirculating fans shall be turned off in furnace zones under 1400°F (760°C) and in zones at or above 1400°F (760°C) that can cause turbulence in zones under 1400°F (760°C).

13.5.11.9.78 Burn-out shall be considered complete when one of the following conditions is satisfied:
(1) For furnaces that do not contain soot, all visible flame in the furnace and at all effluents are observed to be extinguished.

(2) For furnaces that contain soot that cannot re-form a flammable atmosphere gas, all visible flames in the furnace and at all effluents are observed to be extinguished.

(3) For furnaces that contain soot that re-form flammable atmosphere gas, all visible flames in the furnace and at effluents are observed to be extinguished after burn-out procedures are performed that include the introduction of additional air to effect the burn-out of the re-formed flammable atmosphere gas.

13.5.11.9.8 When burn-out is complete, the following shall be permitted to be turned off:

(1) Burn-off pilots

(2) Circulation and recirculation fans required for burn-out

(3) Flame curtains
1. Existing paragraph 13.5.11.7.9 prohibits using burn-in for Type VIII furnaces, so any special requirements of Type VIII is a moot point.

2. As for Type IX furnaces, the Table 13.5.10.3 states that the furnace may or may not have a cover therefore references to covers is inappropriate.

Response Message:
Public Input No. 129-NFPA 86-2016 [Section No. 13.5.11.9.1]
Public Input No. 128-NFPA 86-2016 [New Section after 13.5.11.7.10]
Public Input No. 125-NFPA 86-2016 [Section No. 13.5.11.7.8]
Public Input No. 126-NFPA 86-2016 [Sections A.13.5.11.7.8(B), A.13.5.11.7.8(C)]
Public Input No. 123-NFPA 86-2016 [Section No. 13.5.11.4]
Public Input No. 124-NFPA 86-2016 [Section No. 13.5.11.5]
Public Input No. 127-NFPA 86-2016 [Section No. 13.5.11.7.9]
13.5.13.6.3 External Air-Cooled Heat Exchanger.  

If the air-cooled heat exchanger is installed in a rooftop location, it shall be installed in a curbed or diked area and drained to an approved location outside the building.

Submitter Information Verification

Submitter Full Name: Eric Nette
Organization: National Fire Protection Assoc
Street Address:
City:
State:
Zip:
Submittal Date: Thu Dec 01 11:52:58 EST 2016

Committee Statement

Committee Statement: This requirement is not limited to air cooled heat exchangers.
Response Message: 

Public Input No. 130-NFPA 86-2016 [Section No. 13.5.13.6.3]
13.5.13.7* Quench Tank Protective Features.

13.5.13.7.1 The quench reservoir shall be equipped with a quench medium level indicator.

13.5.13.7.2 If of the sight-glass type, the level indicator shall be of heavy-duty construction and protected from mechanical damage.

13.5.13.7.3 The quench tank shall be equipped with a low-level device that is arranged to sound an alarm, actuates a visual and audible alarm, prevents the start of quenching, and that shuts off the heating medium in case of a low-level condition.

13.5.13.7.4 Where agitation of the quench medium is required to prevent overheating, the agitation shall be interlocked to prevent quenching until the agitator has been started.

13.5.13.7.5 The quench oil shall be analyzed for water contamination.

(A)* The existence of water in quench oil shall be determined by laboratory testing or by other means.

(B)* A representative sample of quench oil shall be obtained.

(C)* Quench oil shall be tested for water content whenever there is a possibility that water has contaminated the quench oil system.

(D) Quenching operations shall be prohibited until the water contamination is corrected and confirmed by test.

13.5.13.7.6 Heated quench tanks shall have an over temperature visual and audible alarm interlocked with the oil heating system.

(A) The over temperature controller shall be independent of the quench tank's temperature controller.

(B) The over temperature controller setting shall be at least 50°F (28°C) below the flash point of the oil.

13.5.13.7.7 A maximum starting quenchant temperature shall be calculated to maintain a temperature at least 50°F (28°C) below the flash point of the oil and interlocked.

13.5.13.8* Quench Tank Heating Controls.

13.5.13.8.1 Fuel-Fired Immersion Heaters.

(A) Burner control systems shall be interlocked with the quench medium agitation system, the recirculating system, or both to prevent localized overheating of the quench medium.
The immersion tubes shall be installed so that the entire tube within the quench tank is covered with quench medium at all times.

A quench medium level control and excess temperature supervision shall be interlocked to shut off fuel-fired immersion heating when low quench level or overtemperature is detected.

13.5.13.8.2 Electric Immersion Heaters.

(A) Electric immersion heaters shall be of sheath-type construction.

(B) Heaters shall be installed so that the hot sheath is fully submerged in the quench medium at all times.

(C) The quench medium shall be supervised by both of the following:
   - Temperature controller that maintains the quench medium at the intended temperature
   - Quench medium level control and excess temperature supervision that are interlocked to shut off the electric immersion heating when low quench level or overtemperature is detected

(D) The electrical heating system shall be interlocked with the quench medium agitation system to prevent localized overheating of the quench medium.

13.5.13.8 Quench Tank Heating Controls and Design.

13.5.13.8.1 The quench tank shall be equipped with a temperature controller that maintains the quench medium at the intended temperature.

13.5.13.8.2 Heating control systems shall be interlocked with the quench medium agitation system, the recirculating system, or both to prevent localized overheating of the quench medium.

13.5.13.8.3 Fuel-fired immersion tubes shall be installed so that the entire tube within the quench tank is covered with quench medium at all times.

13.5.13.8.4 Electric immersion heaters shall be of sheath-type construction and installed so that the hot sheath is fully submerged in the quench medium at all times.

Supplemental Information

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Submitter Information Verification

Submitter Full Name: Eric Nette
Organization: National Fire Protection Assoc
Street Address:
City:
State:
13.5.13.7* Quench Tank Protective Features.

13.5.13.7.1 The quench reservoir shall be equipped with a quench medium level indicator.

13.5.13.7.2 If of the sight-glass type, the level indicator shall be of heavy-duty construction and protected from mechanical damage.

13.5.13.7.3 The quench tank shall be equipped with a low-level device that is arranged to sound an alarm to shall actuate a visual and audible alarm, prevent the start of quenching and that shuts off the heating medium in case of a low-level condition.

13.5.13.7.4 Where agitation of the quench medium is required to prevent overheating, the agitation shall be interlocked to prevent quenching until the agitator has been started.

13.5.13.7.5 The quench oil shall be analyzed for water contamination.

(A)* The existence of water in quench oil shall be determined by laboratory testing or by other means.

(B)* A representative sample of quench oil shall be obtained.

(C)* Quench oil shall be tested for water content whenever there is a possibility that water has contaminated the quench oil system.

(D) Quenching operations shall be prohibited until the water contamination is corrected and confirmed by test.

13.5.13.7.6 Heated quench tanks shall have an over temperature visual and audible alarm interlocked with the oil heating system.

(A) The over temperature controller shall be independent of the quench tank's temperature controller

(B) The over temperature controller setting shall be at least 50°F (28°C) below the flash point of the oil.

13.5.13.7.7 A maximum starting quenchant temperature shall be calculated to maintain a temperature at least 50°F (28°C) below the flash point of the oil and interlocked.
13.5.13.8 Quench Tank Heating Controls.

13.5.13.8.1 Fuel-Fired Immersion Heaters.

(A) Burner control systems shall be interlocked with the quench medium agitation system, the recirculating system, or both to prevent localized overheating of the quench medium.

(B) The immersion tubes shall be installed so that the entire tube within the quench tank is covered with quench medium at all times.

(C) A quench medium level control and excess temperature supervision shall be interlocked to shut off fuel-fired immersion heating when low quench level or overtemperature is detected.

13.5.13.8.2 Electric Immersion Heaters.

(A) Electric immersion heaters shall be of sheath-type construction.

(B) Heaters shall be installed so that the hot sheath is fully submerged in the quench medium at all times.

(C) The quench medium shall be supervised by both of the following:

(1) Temperature controller that maintains the quench medium at the intended temperature

(2) Quench medium level control and excess temperature supervision that are interlocked to shut off the electric immersion heating when low quench level or overtemperature is detected

(D) The electrical heating system shall be interlocked with the quench medium agitation system to prevent localized overheating of the quench medium.
13.5.13.8 Quench Tank Heating Controls and Design.

13.5.13.8.1 Shall be equipped with a temperature controller that maintains the quench medium at the intended temperature.

13.5.13.8.2 Heating control systems shall be interlocked with the quench medium agitation system, the recirculating system, or both to prevent localized overheating of the quency medium.

13.5.13.8.3 Fuel-fired immersion tubes shall be installed so that the entire tube within the quency tank is covered with quench medium at all times.

13.5.13.8.4 Electric immersion heaters shall be of sheath-type construction and installed so that the hot sheath is fully submerged in the quench medium at all times.
Committee Statement

Committee Statement: The revision requires both visual and audible indication of the alarms. The revision places excess temperature limit interlock into “protective” paragraph where it belongs (versus "design"). The revision requires same temperature setting of the excess temperature limit interlock that is required for "open" quench tanks (i.e. 13.5.14.3.2(E)). The revision states that quenching should be prohibited if a workload to be quenched will raise the temperature of the quench oil to an "unsafe" temperature. This also minimizes repetitious text: Temperature controller requirement and recirculating system interlock for any heating system (i.e. fuel-fired heaters or electrical heaters).

Response Message:

Public Input No. 131-NFPA 86-2016 [Section No. 13.5.13.7.3]
Public Input No. 132-NFPA 86-2016 [New Section after 13.5.13.7.5]
Public Input No. 133-NFPA 86-2016 [New Section after 13.5.13.7.5]
Public Input No. 134-NFPA 86-2016 [Section No. 13.5.13.8]
13.5.14.3.3 Low Oil Level Sensor.

A low oil level sensor shall be provided to sound an actuate a visual and audible alarm in the event that the oil level is below the prescribed limits where any of the following conditions exist:

1. The liquid surface area exceeds 10 ft\(^2\) (1 m\(^2\)).
2. Incoming or outgoing work is handled by a conveyor.
3. The tank is equipped with a heating system.

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Committee Statement

Committee Statement: Without a visual alarm it may be difficult to ascertain which alarm is sounding at any time.

Response Message:

Public Input No. 135-NFPA 86-2016 [Section No. 13.5.14.3.3]
### A.6.2.6.13

NFPA 86 does not address vents between safety shutoff valves, but they are sometimes installed. **If installed, they should be leak tested in accordance with the manufacturer’s instructions.**

---

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- **Submittal Date:** Tue Nov 29 16:09:24 EST 2016

---

**Committee Statement**

- **Committee Statement:** If vents are installed it could be a safety hazard if they leak.
- **Response Message:**

---

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A.6.2.7.2(3)

Token relief valves only provide minimum pressure relief in cases where ambient temperatures increase the pressure inside the gas piping, which can occur during shutdown periods, or relieves small increases of pressure due to high lockup pressures that occur during a shutdown.

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Committee Statement

Committee Statement: This section was misnumbered in a previous edition.
Response Message:

Public Input No. 89-NFPA 86-2016 [Section No. A.6.2.7.3]
Public Input No. 90-NFPA 86-2016 [Section No. 6.2.7.2]
A.6.2.9.1
In the design, fabrication, and utilization of mixture piping, it should be recognized that the air–fuel gas mixture might be in the flammable range. Even with mixers that operate at or below 10 in. w.c. (2.49 kPa), there might be certain site conditions where it is advisable to install fire checks and safety blowouts. Consideration should be given to the volume, length, and location of the premix pipe. The user should consider the possibility of a backfire and subsequent rise in pressure and temperature in the mixture piping and connected systems. Some guidance for pressure calculations can be obtained from NFPA 68.

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Submittal Date: Wed Nov 30 11:53:02 EST 2016

Committee Statement
Committee Statement: Revised annex adds additional information for the user on the use of fire checks and safety blowouts.
Response Message:
Public Input No. 86-NFPA 86-2016 [Section No. A.6.2.9.1]
A.7.1.3
Typically, inspection and leak tests of furnace piping that conveys flammable liquids or flammable gases are performed at a pressure not less than their normal operating pressure. Using the test method detailed in NFPA 54.

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Submittal Date: Tue Nov 29 15:50:25 EST 2016

Committee Statement

Committee Statement: NPFA 54 has a method for leak tightness testing that is suitable for leak testing a gas train.
Response Message: 

Public Input No. 40-NFPA 86-2016 [Section No. A.7.1.3]
The following is an example of a leak test procedure for safety shutoff valves on direct gas-fired ovens with a self-piloted burner and intermittent pilot. With the oven burner(s) shut off, the main shutoff valve open, and the manual shutoff valve closed, the procedures are as follows:

1. Place the tube in test connection 1, immersed just below the surface of a container of water.
2. Open the test connection valve. If bubbles appear, the valve is leaking, and the manufacturer's instructions should be referenced for corrective action. Energize the auxiliary power supply to safety shutoff valve No. 1 and open that valve.
3. Place the tube in test connection 2, immersed just below the surface of a container of water.
4. Open the test connection valve. If bubbles appear, the valve is leaking. Reference the manufacturer's instructions for corrective action.

This procedure is predicated on the piping diagram shown in Figure A.7.4.9(a) and the wiring diagram shown in Figure A.7.4.9(b).

**Figure A.7.4.9(a) Example of a Gas Piping Diagram for Leak Test.**

**Figure A.7.4.9(b) Example of a Wiring Diagram for Leak Test.**

It is recognized that safety shutoff valves are not entirely leak free. Because valve seats can deteriorate over time, they require periodic leak testing. Many variables are associated with the valve seat leak testing process, including gas piping and valve size, gas pressure and specific gravity, size of the burner chamber, length of downtime, and the many leakage rates published by recognized laboratories and other organizations.

Leakage rates are published for new valves and vary by manufacturer and the individual listings to which the manufacturer subscribes. It is not expected that valves in service can be held to these published leakage rates, but rather that the leakage rates are comparable over a series of tests over time. Any significant deviation from the comparable leakage rates over time will indicate to the user that successive leakage tests can indicate unsafe conditions. These conditions should then be addressed by the user in a timely manner.

The location of the manual shutoff valve downstream of the safety shutoff valve affects the volume downstream of the safety shutoff valve and is an important factor in determining when to start counting bubbles during a safety shutoff valve seat leakage test. The greater the volume downstream of the safety shutoff valve, the longer it will take to fully charge the trapped volume in the pipe between the safety shutoff valve and the manual shutoff valve. This trapped volume needs to be fully charged before starting the leak test.

Care should be exercised when performing the safety shutoff valve seat leakage test, because flammable gases will be released into the local environment at some indeterminate pressure. Particular attention should be paid to lubricated plug valves used as manual shutoff valves to ensure that they have been properly serviced prior to the valve seat leakage test.

The publications listed in Annex M include examples, although not all inclusive, of acceptable leakage rate...
methodologies that the user can employ.

Figure A.7.4.9(a) through Figure A.7.4.9(c) show examples of gas piping and wiring diagrams for leak testing.

Example. The following example is predicated on the piping diagram shown in Figure A.7.4.9(a) and the wiring diagram shown in Figure A.7.4.9(b).

With the oven burner(s) shut off, the equipment isolation valve open, and the manual shutoff valve located downstream of the second safety shutoff valve closed, the procedures are as follows:

(1) Connect the tube to leak test valve No. 1.

(2) Bleed trapped gas by opening leak test valve No. 1.

(3) Immerse the tube in water as shown in Figure A.7.4.9(c). If bubbles appear, the valve is leaking. Reference the manufacturer's instructions for corrective action. Examples of acceptable leakage rates are given in Table A.7.4.9(a).

(4) Apply auxiliary power to safety shutoff valve No. 1. Close leak test valve No. 1. Connect the tube to leak test valve No. 2 and immerse it in water as shown in Figure A.7.4.9(c).

(5) Open leak test valve No. 2. If bubbles appear, the valve is leaking. Reference the manufacturer's instructions for corrective action. Examples of acceptable leakage rates are given in Table A.7.4.9(a).

Figure A.7.4.9(c) Leak Test for a Safety Shutoff Valve.

Table A.7.4.9(a) Maximum Acceptable Leakage Rates for New Production Valves

<table>
<thead>
<tr>
<th>NPT Nominal Size (in.)</th>
<th>DN Nominal Size (mm)</th>
<th>UL 429, ANSI Z21.21/CSA 6.5 ft³/hr mL/hr mL/min Bubbles/ min</th>
<th>FM Approval 7400 ft³/hr mL/hr mL/min Bubbles/ min</th>
<th>BS E ft³/hr mL/hr mL/min Bubbles/ min</th>
</tr>
</thead>
<tbody>
<tr>
<td>0.38 10</td>
<td>0.0083235 3.92</td>
<td>26 0.014 400 6.7 44</td>
<td>0.014 400 6.7 44</td>
<td>0.0014 40 0.6</td>
</tr>
<tr>
<td>0.50 15</td>
<td>0.0083235 3.92</td>
<td>26 0.014 400 6.7 44</td>
<td>0.014 400 6.7 44</td>
<td>0.014 40 0.6</td>
</tr>
<tr>
<td>0.75 20</td>
<td>0.0083235 3.92</td>
<td>26 0.014 400 6.7 44</td>
<td>0.014 400 6.7 44</td>
<td>0.0014 60 1.6</td>
</tr>
<tr>
<td>1.00 25</td>
<td>0.0083235 3.92</td>
<td>26 0.014 400 6.7 44</td>
<td>0.014 400 6.7 44</td>
<td>0.014 40 0.6</td>
</tr>
<tr>
<td>1.25 32</td>
<td>0.0083235 3.92</td>
<td>26 0.014 400 6.7 44</td>
<td>0.014 400 6.7 44</td>
<td>0.0021 60 1.6</td>
</tr>
<tr>
<td>1.50 40</td>
<td>0.0124353 5.88</td>
<td>39 0.014 400 6.7 44</td>
<td>0.014 400 6.7 44</td>
<td>0.0021 60 1.6</td>
</tr>
<tr>
<td>2.00 50</td>
<td>0.0164470 7.83</td>
<td>52 0.014 400 6.7 44</td>
<td>0.014 400 6.7 44</td>
<td>0.0021 60 1.6</td>
</tr>
<tr>
<td>2.50 65</td>
<td>0.0207588 9.79</td>
<td>65 0.014 400 6.7 44</td>
<td>0.014 400 6.7 44</td>
<td>0.0021 60 1.6</td>
</tr>
<tr>
<td>3.00 80</td>
<td>0.0249705 11.75</td>
<td>78 0.014 400 6.7 44</td>
<td>0.014 400 6.7 44</td>
<td>0.0035 100 1.6</td>
</tr>
<tr>
<td>4.00 100</td>
<td>0.0332940 15.67</td>
<td>104 0.014 400 6.7 44</td>
<td>0.014 400 6.7 44</td>
<td>0.0035 100 1.6</td>
</tr>
<tr>
<td>6.00 150</td>
<td>0.04981,410 23.50</td>
<td>157 0.014 400 6.7 44</td>
<td>0.014 400 6.7 44</td>
<td>0.0053 150 2.5</td>
</tr>
<tr>
<td>8.00 200</td>
<td>0.06641,880 31.33</td>
<td>209 0.014 400 6.7 44</td>
<td>0.014 400 6.7 44</td>
<td>0.0053 150 2.5</td>
</tr>
</tbody>
</table>

\[ L = \frac{|\Delta p| \times V_{test} \times 3600}{P_{atm} \times T_{test}} \] 

where:

NFPA 86 First Revisions Report Page 124 of 153
\[ L = \text{leakage rate (cm}^3/\text{hr}) \]
\[ |\Delta p| = \text{absolute value of initial test pressure (mbar) — final test pressure (mbar)} \]
\[ V_{\text{test}} = \text{total volume of the test (cm}^3) \]
\[ P_{\text{atm}} = \text{atmospheric pressure (atmospheres)} \]
\[ T_{\text{test}} = \text{test time (seconds)} \]

Conversion factors
1 in. water col. = 2.44 mbar
1 psi = 27.7 in. water col.
1 atmosphere = 14.7 psi

This test method can be done by tapping into the following ports and performing the test method in Table A.7.4.9(b).

**Table A.7.4.9(b) Test Methods.**

<table>
<thead>
<tr>
<th>Test Port Location</th>
<th>Test Method</th>
</tr>
</thead>
<tbody>
<tr>
<td>A test port between both safety shutoff valves</td>
<td>Pressure decay on ( V_2 )</td>
</tr>
<tr>
<td></td>
<td>Pressure rise on ( V_1 )</td>
</tr>
<tr>
<td>A test port downstream of both safety shutoff valves</td>
<td>Pressure rise on ( V_1 ) and ( V_2 ) (requires manual shutoff valve downstream both safety shutoff valves and that it be leak tightness tested).</td>
</tr>
<tr>
<td>A test port upstream of both valves</td>
<td>Pressure decay on ( V_1 ) and ( V_2 ) (requires a leak tightness test on the upstream, manual isolation valve)</td>
</tr>
</tbody>
</table>

**Other Methods for Leak Testing Safety Shutoff Valves.**

Other methods for leak testing safety shutoff valves follow:

1. Another method to leak test safety shutoff valves — and without energizing any of the valves — is bubble tightness testing. With leak test valve No. 1 upstream of \( V_1 \), leak test valve No. 2 between \( V_1 \) and \( V_2 \), and leak test valve No. 3 downstream of \( V_2 \), proceed as follows:

   a. The procedure for leak testing of \( V_1 \) is as follows:

      i. Ready a tube that connects to leak test valve No. 2. *(see Figure A.7.4.9(c) for tube dimensions)*

      ii. Ready a glass of water as shown in Figure A.7.4.9(c).

      iii. Open leak test valve No. 2, and bleed any trapped gas.

      iv. Immerse the tube on leak test valve No. 2 in water as shown in Figure A.7.4.9(c).

      v. If bubbles appear, the valve is leaking. Reference the manufacturer’s instructions for corrective action. Examples of acceptable leakage rates are given in Table A.7.4.9(a).

      vi. Remove all tubes, and close the test valves.

   b. The procedure for leak testing of \( V_2 \) is as follows:

      i. Ready a tube of sufficient length that will connect leak test valve No. 1 to leak test valve No. 2.

      ii. Ready another tube that connects to leak test valve No. 3. *(see Figure A.7.4.9(c) for tube dimensions)*

      iii. Ready a glass of water as shown in Figure A.7.4.9(c).

      iv. Install a tube of sufficient length that will connect leak test valve No. 1 to leak test valve No. 2 without crimping or kinking the tubing.

      v. Install another tube that connects to leak test valve No. 3. *(see Figure A.7.4.9(c) for tube dimensions)*

      vi. Open leak test valve No. 2, and bleed any trapped gas.
vii. Close the manual shutoff valve downstream of \( V_2 \).
viii. Connect the tube to leak test valve No. 2.
ix. Open leak test valve No. 1, and immediately connect the tube on leak test valve No. 2 to leak test valve No. 1. This will change the volume between \( V_1 \) and \( V_2 \) with gas pressure.
x. Immerse the tube on leak test valve No. 3 in water as shown in Figure A.7.4.9(c).
xii. If bubbles appear, the valve is leaking. Reference the manufacturer’s instructions for corrective action. Examples of acceptable leakage rates are given in Table A.7.4.9(a).

After any test method is complete, close the test valves, remove all tubing, and restore the system to its original pretest condition.

(2) A combination of pressure decay testing and bubble tightness testing can be done to leak test safety shutoff valves. Depending on the fuel gas train arrangement, the leak test valves and pressure port available, and the availability of manual valves on the fuel gas train, a pressure decay test on valve No. 2, followed by bubble tightness testing on valve No. 1, might be desirable.

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Committee Statement

Committee Statement: Title of table was changed to reflect original material.
Response Message:

Public Input No. 10-NFPA 86-2015 [Section No. A.7.4.9]
Public Input No. 66-NFPA 86-2016 [Section No. A.7.4.9]
A.8.4
The PLC approach to combustion interlocks—multiburner a burner management system (BMS) is as follows:

1. Interlocks relating to purge are done via PLC.
2. The purge timer is implemented in the PLC.
3. Interlocks relating to combustion air and gas pressure are done via PLC.
4. Gas valves for pilots and burners directly connected to flame safeguards must the PLC should conform to the requirements of 8.8.2.
5. Operation of pilot and burner gas valves must should be confirmed by the PLC.
6. A PLC can be set up as intermittent, interrupted, or constant pilot operation. With an appropriate flame safeguard, it would be possible to provide an interrupted pilot with one flame sensor and one flame safeguard. The PLC should perform the safe start check.
7. The PLC should perform the trial of ignition per 8.5.2.
8. The PLC should monitor all limits and all permissives and close the safety shutoff valves when appropriate.

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Committee Statement

Committee Statement: Section 8.4 of the standard deals with using a PLC as the BMS logic solver yet A.8.4 (4) referenced a combustion safeguard which didn’t belong in the reference. Additional PLC recommendations were added to A.8.4 for completeness. Item (6) was reworded for clarity.

Response Message:

Public Input No. 73-NFPA 86-2016 [Section No. A.8.4]
Compliance with the manufacturer’s safety manual would achieve actions such as, but not limited to, the PLC detecting the following:

1. Failure to execute any program or task containing safety logic
2. Failure to communicate with any safety I/O
3. Changes in software set points of safety functions
4. Failure of outputs related to safety functions
5. Failure of timing related to safety functions

A SIL 3–capable PLC includes third-party certification, the actions above, and partitioning to separate safety logic from process logic.

The requirements for SIL capability in 8.4.2 pertain only to the PLC and its I/O and not to the implementation of the burner management system (BMS). The purpose of the SIL capability requirement is to provide control reliability.

A SIL 3–capable PLC includes third-party certification, the actions above, and partitioning to separate safety logic from process logic. SIL 3–capable PLCs automate many of the complexities of designing a safety system, namely, the PLCs have separate safe and nonsafe program and memory areas and the safe areas can be locked with a signature. The inputs and outputs are monitored for stuck bits and loss of control. The firmware, application code, and timing are continually checked for faults. The outputs are internally redundant to ensure they will open even with a hardware failure. By contrast, SIL 2–capable PLCs require that many of these functions be implemented by the application code developer.

Codes have traditionally relied on independent third-party companies to test and approve safety devices suitable for use in the specific application. In the United States, companies like FM and UL develop design standards and test safety equipment to those standards to ensure the devices will operate properly when used correctly. Safety shutoff valves, scanners, combustion safeguards, and pressure switches are some of the items that need to be approved for their intended service. Combustion systems have become far more complex, requiring greater computing power and greater flexibility, so the industry has turned to PLCs to address the increased complexity. Using a PLC as the BMS makes the PLC a safety device. Just like every other safety component, the PLC must be held to a minimum standard to ensure that it performs predictably and reliably and that its failure modes are well understood.

When assessing a PLC’s ability to perform safety functions, the internationally recognized standard is IEC 61508, *Functional Safety of Electrical/Electronic/Programmable Electronic Safety-Related Systems*. IEC 61508 is a detailed quantitative guideline for designing and testing electronic safety systems. By following the directives in this standard, a piece of equipment can be certified by an independent body as capable of meeting a SIL.

The goal of IEC 61508 is to quantify the probability that the safety device will fail in an unsafe fashion when commanded to act. The term used is *probability of failure on demand* (PFD). The data required and the circuit and software expertise needed to get to the PFD can be quite overwhelming, but once calculated they are categorized as shown in Table A.8.4.2.

**Table A.8.4.2 SIL Level Calculated Values**

<table>
<thead>
<tr>
<th>Safety Integrity Level (SIL)</th>
<th>Probability of Failure on Demand (PFD)</th>
<th>Risk Reduction Factor (1/PFD)</th>
<th>Safety Availability (1 – PFD)</th>
</tr>
</thead>
<tbody>
<tr>
<td>44</td>
<td>&gt; 0.00001 to &lt; 0.001</td>
<td>&gt; 10,000 to &lt; 100,000</td>
<td>&gt; 99.99 to &lt; 99.999</td>
</tr>
<tr>
<td>33</td>
<td>&gt; 0.0001 to &lt; 0.001</td>
<td>&gt; 1,000 to &lt; 10,000</td>
<td>&gt; 99.9 to &lt; 99.99</td>
</tr>
<tr>
<td>22</td>
<td>&gt; 0.01 to &lt; 0.1</td>
<td>&gt; 100 to &lt;1,000</td>
<td>&gt; 99 to &lt; 99.9</td>
</tr>
<tr>
<td>11</td>
<td>&gt; 0.1 to &lt; 0.1</td>
<td>&lt; 10 to &lt; 100</td>
<td>&gt; 90 to &lt; 99</td>
</tr>
</tbody>
</table>

One can quickly see that the SIL number is a power of 10 change in PFD. The PFD for SIL 1 states that the probability of an unsafe failure in any year is 1 percent to 10 percent, and SIL 3 has the probability of an unsafe failure in any year of 0.01 percent to 0.1 percent. Stated otherwise, a SIL 1 system has the probability of an unsafe failure every 10 to 100 years, and a SIL 3 system has the probability of an unsafe failure, when demanded, once every 1,000 to 10,000 years.

When the PLC, sensor, or final element is certified to SIL 2, it carries the language “SIL 2–capable.” This is done because the device in question is capable of performing at that level only when the...
manufacturer’s safety manual has been followed, and the installation is correct per the manufacturer’s safety manual.

Stipulating that the PLC and its associated I/O should be SIL 2–capable is only setting the floor for performance and helping to ensure that the hardware selected is suitable for use as a safety device — nothing else is implied.

Confusion might occur when users assume that because the hardware has been certified to IEC 61508 and is SIL-capable, the system must be designed according to IEC 61511 or ANSI/ISA-84.00.01. *Functional Safety: Safety Instrumented Systems for the Process Industry Sector*. That is not the intent. IEC 61511 is a performance-based standard that offers advice and guidance to quantify, analyze, and subsequently mitigate risks associated with hazards in safety instrumented systems (SIS). When following IEC 61511, each safety function (e.g., flame failure, emergency stop, high gas pressure) is analyzed. A systematic approach is taken to determine the severity of the failure of that safety function and then the appropriate SIL is assigned to that safety function. Once assigned, the appropriate sensors, logic solvers, and final elements are chosen so that three or more of them working together can achieve the required SIL. Placing a sensor in series with a logic solver in series with a final element lowers the SIL and increases the PFD, because their individual unsafe failures are cumulative. Therefore, it is possible to start with all SIL 2–capable components and end up with a SIL 1 safety function due to the cumulative failures of the individual devices.

Offered here is an extremely brief and simple overview of SIS; however, its proper application is extremely complicated and requires expertise. NFPA 87 requirements do not specify or imply that SIS must be implemented, nor that a safety function meet a specified SIL target.

An extremely effective risk-reducing technique is the use of layers of protection. Analyzing the layers is called *layer-of-protection-analysis* (LOPA). This technique applies safeties that are independent of other safeties and therefore cannot fall victim to common mode errors or failures. As an example, picture a storage tank being filled by a pump that is controlled by a level sensor. It is important to contain the liquid but also not overpressurize the tank. A layer of protection could be a pressure relief valve because that is independent of the pump control and the level sensor. Another layer could be a dike around the tank in case the pressure relief valve relieves or the tank fails. Again, the dike is completely independent of the other safeties and should not suffer failures that might attack the other safeties.

Common mode failures can be insidious. Think about this example of independent safeties and then think about a massive earthquake and tsunami hitting the dike, tanks, and controls — all destroyed by a common mode disturbance (e.g., Fukushima). This technique can be effective in providing independent layers of protection that can reduce the risk by a factor of 10 — or an entire SIL. Modern combustion systems take advantage of layers of protection, thus reducing the SIL of each individual safety function. Following are some examples: burner flows set up with mechanical locking devices to stay within the burner’s stable operating range, gas pressures monitored for variances, combustion air pressure monitored, and the flame scanned.

ISA prepared IEC 61511 calculations and scenarios on boiler systems and did not identify any functions above SIL 2, with the majority being SIL 1 or less.

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**Submittal Date:** Wed Nov 30 15:21:28 EST 2016

**Committee Statement**

**Committee Statement:** The proposed revision to A.8.4.2 adds expanded information on the related subject matter so as to help the user understand more about the intent of the safety PLC requirements in the mandatory text.
Response
Message:
Public Input No. 74-NFPA 86-2016 [Section No. A.8.4.2]
A.8.5.1.2(C)(2)

See Figure A.8.5.1.2(C)(2) Example for Multiple Burner System with Independently Operated Burners Using a Common SSOV with Single Proved Closed Interlock for Pre-purge.

Submitted Information Verification

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Submittal Date: Wed Nov 30 11:58:28 EST 2016
Committee Statement

Committee Statement: Add legend for symbols used in current Annex Figure.

Response Message:

Public Input No. 159-NFPA 86-2016 [Section No. A.8.5.1.2(C)(2)]
A.8.5.1.9(3)(c)
In accordance with 8.5.1.9(3)(c), fuels other than natural gas, butane, or propane might require additional consideration. These additional considerations would be addressed using Section 1.5. The concern with other fuel gases is the variability of fuel gas content being delivered over time. Specific examples include landfill gas and bio gas.

The following sample calculation illustrating the use of 8.5.1.9(3)(c) is provided to demonstrate a method of determining the 25 percent LFL requirement.

The sample calculation is based upon the following assumptions:

1. The fuel is methane gas.
2. All burners are turned off for control purposes. All safety shutoff valves are de-energized.
3. At each burner, two safety shutoff valves are closed, or a single shutoff valve is proven closed.
4. All safety shutoff valves are tested for seat leakage at least semiannually.
5. Safety shutoff valve seat leakage is assumed to be 1 scfh (0.0283 m$^3$/hr @ 21°C).

The following thoughts are offered regarding the selection of the 1 scfh (0.0283 m$^3$/hr @ 21°C) safety shutoff valve seat leakage rate.

Limited data reviewed by the committee indicate that valve seat leakage rates over 1 scfh (0.0283 m$^3$/hr @ 21°C) are not anticipated unless the safety shutoff valve seats are exposed to extremely unusual conditions such as corrosives in the fuel gas or furnace heat allowed to back up the fuel line and burn the safety shutoff valve seat. The former condition is the basis for limiting the use of 8.5.1.9(3) to furnaces using natural gas, butane, or propane fuel gases. The latter condition occurred in a case where a fuel line was inappropriately opened by maintenance staff while the furnace was in operation. The furnace was promptly shut down, and the safety shutoff valves were replaced.

Under operating conditions expected by this standard, it is anticipated that debris from internal fuel gas line oxidation (rust), pipe thread shavings not removed before fuel line assembly, or similar exposures can subject one safety shutoff valve to seat damage that can lead to seat leakage of one safety shutoff valve; however, it is not expected that both safety shutoff valves would experience similar seat leakage. The selected safety shutoff valve seat leakage rate of 1 scfh (0.0283 m$^3$/hr @ 21°C) is considered conservative.

Overall, this sample calculation is based upon the following conservative conditions:

1. Using a safety shutoff valve seat leakage rate of 1 scfh (0.0283 m$^3$/hr @ 21°C)
2. Providing two safety shutoff valves for each fuel path
3. Closing two valves or using proof of closure if closing one valve
4. Assuming safety shutoff valve leakage at each burner fuel path
5. Using a design limit of 25 percent of LFL
6. Including the effects of elevated furnace temperature on the LFL
7. Assuming no fuel exits the furnace

The effects of temperature on fuel gas LFL were obtained from Bureau of Mines Bulletin 680, "Investigation of Fire and Explosion Accidents in the Chemical, Mining, and Fuel-Related Industries — A Manual." Figure 34 in that bulletin, "Temperature effect on lower limits of flammability of 10 normal paraffins in air at atmospheric pressure," shows temperature (°C) versus combustibles (volume percent) and includes curves for methane, butane, and propane. It also includes a formula for computing LFL at elevated temperature. That formula, based on Bureau of Mines Bulletin 627, "Flammability Characteristics of Combustible Gases and Vapors," is as follows:

\[
L_T = L_{25} \left[ 1 - 0.000721(T - 25°C) \right]
\]

where:

\(L_T\) = LFL at the desired elevated temperature, \(T\) (°C)
\(L_{25}\) = LFL at 25°C
\(T\) = Desired elevated temperature (°C)
Sample Problem — U. S. Customary Units

Objective. Calculate the amount of time that all burners can be turned off before the furnace atmosphere will reach 25 percent LFL.

Assumptions. Furnace contains no combustibles when the burners are turned off. Furnace is under positive pressure with no air infiltration.

Given the following information:

Furnace type: Batch
Furnace size: 8 ft wide × 6 ft deep × 8 ft tall
Number of burners: 5
Burner design rate: 0.8 MM Btu/hr
Burner design excess air: 10.0% 0%
Burner design air capacity: 8800 scfh
Burner air minimum design flow: 100 scfh
Maximum leak rate each flow path*: 1 scfh
Number of burner flow paths**: 5
Furnace temperature: 900°F (482°C)
Oxygen in furnace atmosphere: 18%
Fuel: Methane

*The flow path is across one set of closed safety shutoff valves.
**The number of flow paths is the number of sets of safety shutoff valves that are closed that can leak into the furnace enclosure.

Step 1. Determine LFL at 900°F using the formula from above:

\[ L_{900°F} = L_{25°C} \left[ 1 - 0.000721(T - 25°C) \right] \]
\[ = 5.3 \left[ 1 - 0.000721(482°C - 25°C) \right] \]
\[ = 3.6\% \text{ by volume} \]

Step 2. Determine the furnace volume:

\[ V_{FCE} = L \times W \times H = 8 \text{ ft} \times 6 \text{ ft} \times 8 \text{ ft} = 384 \text{ ft}^3 \]

Step 3. Determine the methane leak rate into the furnace with all burners off:

\[ Q_{LEAK} = \text{# flow paths} \times \text{leak rate per path} \]
\[ = 5 \text{ paths} \times 1 \text{ scfh/path} \]
\[ = 5 \text{ scfh} \]

Step 4. Determine the airflow into the furnace with all burners off:

\[ Q_{AIR} = \text{# burners} \times \text{airflow rate per idle burner} \]
\[ = 5 \text{ burners} \times 100 \text{ scfh/burner} \]
\[ = 500 \text{ scfh} \]

Step 5. Determine the percent volume methane to air through all burners:

\[ \% \text{ volume methane to air} = \left( \frac{Q_{LEAK}}{Q_{AIR}} \right) \times 100\% \]
\[ = \left( \frac{5 \text{ scfh}}{500 \text{ scfh}} \right) \times 100\% \]
\[ = 1\% \]

Step 6. Determine the percent LFL resulting from the methane flow through all burner fuel paths at 900°F:
Step 7. Determine the time in minutes to reach 25 percent LFL with all burners off:

$$t_{\text{FCE} \ 25\% \ LFL} = \left[ \left( \frac{L_{900\degree F}}{0.25} \right) / \left( \frac{Q_{\text{LEAK}}}{V_{\text{FCE}}} \right) \right] (60 \text{ min/hr})$$

$$= \left[ \left( 0.036 \right) / \left( 5 \text{ ft}^3/\text{hr} / 384 \text{ ft}^3 \right) \right] (60 \text{ min/hr})$$

$$= 41.5 \text{ minutes}$$

Conclusions. Where the value of percent $LFL_{900\degree F}$ exceeds 25 percent, the burner safety shutoff valves can remain closed and burners be reignited without a repurge within a period of time not exceeding $t_{\text{FCE} \ 25\% \ LFL}$. After $t_{\text{FCE} \ 25\% \ LFL}$ is exceeded, a repurge of the furnace is required.

Where the value of percent $LFL_{900\degree F}$ equals or is less than 25 percent, burners can be reignited at any time as long as the airflow rate $Q_{\text{AIR}}$ is proven and interlocked in the burner management system such that loss of this proven airflow rate will require a repurge of the furnace before burner reignition is permitted.

Sample Problem — SI Units

Objective. Calculate the amount of time that all burners can be turned off before the furnace atmosphere will reach 25 percent LFL.

Assumptions. Furnace contains no combustibles when the burners are turned off. Furnace is under positive pressure with no air infiltration.

Given the following information:

- Furnace type: Batch
- Furnace size: 2.438 m wide × 1.828 m deep × 2.428 m tall
- Number of burners: 5
- Burner design rate: 234.2 kW
- Burner design excess air: 10.0 percent
- Burner design air capacity: 249.2 m$^3$/hr @ 21°C
- Burner air minimum design flow: 2.83 m$^3$/hr @ 21°C
- Maximum leak rate each flow path*: 0.0283 m$^3$/hr @ 21°C
- Number of burner flow paths**: 5
- Furnace temperature: 482°C (900°F)
- Oxygen in furnace atmosphere: 18 percent
- Fuel: Methane

*The flow path is across one set of closed safety shutoff valves.

**The number of flow paths is the number of sets of safety shutoff valves that are closed that can leak into the furnace enclosure.

Step 1. Determine LFL at 482°C using the formula from above:
Step 2. Determine the furnace volume:

\[ V_{FCE} = L \times W \times H = 2.438 \, m \times 1.828 \, m \times 2.428 \, m = 10.87 \, m^3 \]

Step 3. Determine the methane leak rate into the furnace with all burners off:

\[ Q_{LEAK} = \text{# flow paths} \times \text{leak rate per path} \]
\[ = 5 \, \text{paths} \times 0.0283 \, m^3/hr \, @ \, 21^\circ C / \text{path} \]
\[ = 0.142 \, m^3/hr \, @ \, 21^\circ C \]

Step 4. Determine the airflow into the furnace with all burners off:

\[ Q_{AIR} = \text{# burners} \times \text{airflow rate per idle burner} \]
\[ = 5 \, \text{burners} \times 2.83 \, m^3/hr \, @ \, 21^\circ C / \text{burner} \]
\[ = 14.2 \, m^3/hr \, @ \, 21^\circ C \]

Step 5. Determine the percent volume methane to air through all burners:

\[ \% \text{vol. methane to air} = \left( \frac{Q_{LEAK}}{Q_{AIR}} \right) (100\%) \]
\[ = \left( \frac{0.142 \, m^3/hr \, @ \, 21^\circ C}{14.2 \, m^3/hr \, @ \, 21^\circ C} \right) (100\%) \]
\[ = 1\% \]

Step 6. Determine the percent LFL resulting from the methane flow through all burner fuel paths at 482°C:

\[ \% LFL_{482^\circ C} = \left( \% \text{volume methane to air} / LFL_{482^\circ C} \right) (100\%) \]
\[ = \left( 1\% / 3.5\% \right) (100\%) \]
\[ = 28.57\% \]

\[ \% LFL_{482^\circ C} = \left( \% \text{volume methane to air} / LFL_{482^\circ C} \right) (100\%) \]
\[ = \left( 1\% / 3.6\% \right) (100\%) \]
\[ = 27.78\% \]

Step 7. Determine the time in minutes to reach 25 percent LFL with all burners off:

\[ t_{FCE \, 25\% \, LFL} = \left[ \left( L_{482^\circ C} \right) (0.25) \right] / \left[ \left( Q_{LEAK} / V_{FCE} \right) \right] (60 \, \text{min/hr}) \]
\[ = \left[ (0.036)(0.25) / (0.142 \, m^3/hr)(10.87 \, m^3) \right] (60 \, \text{min/hr}) \]
\[ = 41.3 \, \text{minutes} \]

Conclusions. Where the value of percent \( LFL_{482^\circ C} \) exceeds 25 percent, the burner safety shutoff valves can remain closed and burners be reignited without a repurge within a period of time not exceeding \( t_{FCE \, 25\% \, LFL} \). After \( t_{FCE \, 25\% \, LFL} \) is exceeded, a repurge of the furnace is required.

Where the value of percent \( LFL_{482^\circ C} \) equals or is less than 25 percent, burners can be reignited at any time as long as the airflow rate \( Q_{AIR} \) is proven and interlocked in the burner management system such that loss of this proven airflow rate will require a repurge of the furnace before burner reignition is permitted.

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104 of 117 1/27/2017 7:20 AM 1/27/2017 7:20 AM
Committee Statement

Committee Statement: In the sample problems (both U.S. Customary Units and SI units), remove the given information "Oxygen in furnace atmosphere: 10 percent" as this information is not a factor in the sample problem. Also, make corrections in Step 6 of the sample problem calculations for both the U.S. Customary Units and SI units. Calculations are being clarified for accuracy and usability.

Response Message:

Public Input No. 137-NFPA 86-2016 [Section No. A.8.5.1.8(4)(d)]
First Revision No. 83-NFPA 86-2016 [Section No. A.9.1]

A.9.1

This standard addresses the protection needs of ovens, furnaces, and related equipment. Fire protection needs external to this equipment are beyond the scope of this standard. The determination and extent of required fixed protection depends on the following:

1. The construction and arrangement of the oven, furnace, or related equipment
2. The materials being processed
3. Whether fixtures or racks are combustible or are subject to loading with excess combustible finishing materials, or if an appreciable amount of combustible drippings from finishing materials accumulates in the oven or ductwork, protection should also be provided.

Fixed fire protection for the equipment can consist of sprinklers, water spray, carbon dioxide, foam, dry chemical, water mist, or steam extinguishing systems. The extent of protection required depends upon the construction and arrangement of the oven, furnace, or related equipment as well as the materials being processed. Fixed protection should extend as far as necessary in the enclosure and ductwork if combustible material is processed or combustible buildup is likely to occur. If the fixtures or racks are combustible or are subject to loading with excess combustible finishing materials, or if an appreciable amount of combustible drippings from finishing materials accumulates in the oven or ductwork, protection should also be provided.

Fixed protection should extend as far as necessary in the enclosure and ductwork if combustible material is processed or combustible buildup is likely to occur. This includes the potential for solvent condensation in ductwork as well as particle build-up.

Fixed fire protection for the equipment can consist of sprinklers, water spray, carbon dioxide, foam, dry chemical, water mist, or steam extinguishing systems.

Steam inerting extinguishing (inerting) systems can be used to protect ovens where steam flooding is the only means available. Otherwise, the use of steam in ovens is not recommended.

Hydrogen and other flammable gas fires are not normally extinguished until the supply of gas has been shut off because of the danger of re-ignition or explosion. Personnel should be cautioned that hydrogen flames are invisible and do not radiate heat. In the event of fire, large quantities of water should be sprayed on adjacent equipment to cool the equipment and prevent its involvement in the fire. Combination fog and solid stream nozzles should be used to allow the widest adaptability in fire control.

Small flammable gas fires can be extinguished by dry chemical extinguishers or with carbon dioxide, nitrogen, or steam. Re-ignition can occur if a metal surface adjacent to the flame is not cooled with water or by other means.

Dip tanks and drain boards included in oven enclosures should be protected by an automatic fire suppression system if flammable or combustible liquids are involved. NFPA 34 provides guidance for the design of fire suppression systems for dip tanks and drain boards.

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Submittal Date: Thu Dec 01 10:12:21 EST 2016
<table>
<thead>
<tr>
<th>Committee Statement</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Committee Statement:</strong> The existing language, while accurate, does not clearly identify the conditions that result in a need for installation of fixed fire protection within an oven enclosure and associated ductwork.</td>
</tr>
<tr>
<td><strong>Response Message:</strong> The explanatory material is made clearer by rephrasing the first paragraph as an explanation of how to determine when protection is required, and then listing the conditions.</td>
</tr>
</tbody>
</table>

Public Input No. 158-NFPA 86-2016 [Section No. A.9.1]
A.11.6.5
The processes of determining the minimum safety ventilation for continuous ovens and for batch ovens are shown in Figure A.11.6.5(a) and Figure A.11.6.5(b).

**Figure A.11.6.5(a) Calculation of Required Safety Ventilation for Continuous Process Ovens.**

**Figure A.11.6.5(b) Calculation of Required Safety Ventilation for Batch Process Ovens.**
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Submittal Date: Thu Dec 01 11:16:05 EST 2016

Committee Statement
Committee Statement: Body titles were changed and the figure A.11.6.5(b) must be updated with those title changes.

Response Message:
Annex M  Informational References

M.1  Referenced Publications.

The documents or portions thereof listed in this annex are referenced within the informational sections of this standard and are not part of the requirements of this document unless also listed in Chapter 2 for other reasons.

M.1.1  NFPA Publications.

National Fire Protection Association, 1 Batterymarch Park, Quincy, MA 02169-7471.


M.1.2  Other Publications.
M.1.2.1 ANSI Publications.
American National Standards Institute, Inc., 25 West 43rd Street, 4th Floor, New York, NY 10036.
ANSI B16.24, Cast Copper Alloy Pipe Flanges and Flanged Fittings Class 150, 300, 400, 600, 900, 1500, and 2500, 2001.
ANSI Z117.1, Safety Requirements for Confined Spaces, 2009.

M.1.2.2 API Publications.
American Petroleum Institute, 1220 L Street, N.W., Washington, DC 20005-4070.

M.1.2.3 ASME Publications.
American Society of Mechanical Engineers, Two Park Avenue, New York, NY 10016-5990.
ASME B16.24, Cast Copper Alloy Pipe Flanges and Flanged Fittings Class 150, 300, 400, 600, 900, 1500, and 2500, 2011.

M.1.2.4 ASTM Publications.
ASTM International, 100 Barr Harbor Drive, P.O. Box C700, West Conshohocken, PA 19428–2959.

M.1.2.5 AVS Publications.
American Vacuum Society, 125 Maiden Lane, 15th Floor, New York, NY 10038.
M.1.2.6 CENELEC Publications.

CENELEC, European Committee for Electrotechnical Standardization, CEN-CENELEC Management Centre, Avenue Marnix 17, 4th floor, B-1000, Brussels.


M.1.2.7 CGA Publications.

Compressed Gas Association, 4221 Walney Road, 5th Floor, Chantilly, VA 20151-2923, 14501 George Carter Way, Suite 103, Chantilly, VA 20151-1788.


CGA G-6, Carbon Dioxide, 2006 2009.


CGA P-1, Safe Handling of Compressed Gases in Containers, 2008 2012.

M.1.2.8 CSA America Publications.

Canadian Standards Association, 8501 East Pleasant Valley Road, Cleveland, OH 44131–5575.

CSA B149.6, Code for Digester Gas and Landfill Gas Installations, and Biogas Generation and Utilization, 2011.

M.1.2.9 EN Publications.

European Committee for Standardization, 36, rue de Stassart, B-1050, Brussels, Belgium.


M.1.2.9 FM Publications.

FM Global, 1301 Atwood 270 Central Avenue, P.O. Box 7500, Johnston, RI 02919-4923.


M.1.2.10 IEC Publications.

International Electrical Electrotechnical Commission, 3 rue de Varembé, P.O. Box 131, CH - 1211, Geneva 20, Switzerland.


M.1.2.11 JIC Publications.

Joint Industrial Council, 7901 West Park Drive, McLean, VA 22101.

Hydraulic Standards for Industrial Equipment.
M.1.2.12 NEMA Publications.

National Electrical Manufacturers Association, 1300 North 17th Street, Suite 1847, Rosslyn 900, Arlington, VA 22209.

NEMA TR 27, Commercial, Institutional and Industrial Dry-Type Transformers, 1976.

M.1.2.13 NIOSH Publications.

National Institute for Occupational Safety and Health, Centers for Disease Control and Prevention, 1600 Clifton Road, Atlanta, GA 30333 30329-4027.


M.1.2.14 PCI Publications.

The Powder Coating Institute, 2170 Buckthorne Place, Suite 250, The Woodlands, TX 77380, 5040 Old Taylor Mill Road, PMB 13, Taylor Mill, KY 41015.

Recommended Procedure No. 9, “Volatile Content.”

M.1.2.15 UL Publications.

Underwriters Laboratories Inc., 333 Pfingsten Road, Northbrook, IL 60062-2096.


M.1.2.16 U.S. Government Publications.


M.1.2.17 Other Publications.


M.2 Informational References.

The following documents or portions thereof are listed here as informational resources only. They are not a part of the requirements of this document.

M.2.1 NFPA Publications.

National Fire Protection Association. 1 Batterymarch Park, Quincy, MA 02169–7471.

M.2.2 ASME Publications.
American Society of Mechanical Engineers ASME International, Two Park Avenue, New York, NY 10016-5990.

M.3 References for Extracts in Informational Sections. (Reserved)

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Committee Statement

Committee Statement: Updated references.
Response Message:
Public Input No. 139-NFPA 86-2016 [Section No. M.1.2.15]
Public Input No. 9-NFPA 86-2015 [Chapter M]