Second Revision No. 51-NFPA 86-2013 [ Section No. 2.4 ]

2.4 References for Extracts in Mandatory Sections.

Submitter Information Verification

Submitter Full Name: Guy Colonna
Organization: National Fire Protection Assoc
Street Address:
City:
State:
Zip:
Submittal Date: Fri Nov 08 14:15:16 EST 2013

Committee Statement

Committee Statement: The Committee updated the edition dates for the reference sources for extracted text within the standard per the NFPA Manual of Style.
3.3.6* Burner Management System.
The field devices, logic system, and final control elements dedicated to combustion safety and operator assistance in the starting and stopping of fuel preparation and burning equipment and for preventing misoperation of and damage to fuel preparation and burning equipment. [85, 2011]

Submitter Information Verification

Submitter Full Name: [Not Specified]
Organization: [Not Specified]
Street Address:
City:
State:
Zip:
Submittal Date: Mon Sep 30 15:16:57 EDT 2013

Committee Statement

Committee Statement: This definition matches the definition of Burner Management System in NFPA 85. An extract notation should be added. The Committee agrees to show this definition as an extract from NFPA 85, but recommends that the Boiler Combustion Systems Committee consider changing the word “misoperation” which is not a word.

Response Message:
Public Comment No. 18-NFPA 86-2013 [Section No. 3.3.6]
Second Revision No. 2-NFPA 86-2013 [Section No. 3.3.11]

3.3.11 Combustion Safeguard.
A safety device directly responsive to or system that responds to the presence or absence of flame properties that senses the presence or absence of flame using flame sensors, using one or more flame detectors and provides safe start-up, safe operation, and safe shutdown of a burner under normal and abnormal conditions.

Submitter Information Verification

Submitter Full Name: [Not Specified]
Organization: [Not Specified]
Street Address:
City:
State:
Zip:
Submittal Date: Mon Sep 30 15:23:29 EDT 2013

Committee Statement

Committee Statement: This definition is based on FM's standard for these devices, FM Approval Standard 7610 1.2 Scope: 1.2.2 A combustion safeguard is a device intended to provide safe start, safe operation, and shutdown under normal and abnormal conditions. This device is used in conjunction with a flame sensing system. 1.2.3 A flame sensing system detects the presence and absence of flame. It may be of the flame rectification, infra-red, or ultra-violet type. Sensors may be capable of monitoring coal, gas, and/or oil flames, and are a primary component of a combustion control system.

Response Message:
Public Comment No. 23-NFPA 86-2013 [Section No. 3.3.11]
3.3.18 Flame Detector.
A safety device directly responsive to flame properties that senses the presence or absence of flame using flame sensors.

Submitter Information Verification

Submitter Full Name: [Not Specified]
Organization: [Not Specified]
Street Address:
City:
State:
Zip:
Submittal Date: Mon Sep 30 16:40:13 EDT 2013

Committee Statement

Committee Statement: The new term 'flame detector' is better than 'combustion safeguard' with this definition. This term and definition aligns with CSA C22.2 NO. 199 / ANSI Z21.20 / UL 372 standards as used in the industry. This new term should replace 'combustion safeguard' where used throughout the introductory chapters. See PC No. 23.

Response Message:
Public Comment No. 24-NFPA 86-2013 [New Section after 3.3.17]
3.3.19 Flame Failure Response Time (FFRT).
The period of time that starts with the loss of flame and ends with the loss of flame signal from the combustion safeguard de-energizing of the safety shutoff valve(s).

Submitter Information Verification
Submitter Full Name: Guy Colonna
Organization: National Fire Protection Assoc
Street Address:
City:
State:
Zip:
Submittal Date: Fri Nov 08 13:59:08 EST 2013

Committee Statement
Committee Statement: The Committee edited this term to be consistent with the newly added definition for combustion safeguard. To avoid confusion in the industry, follow the safety standards for burner ignition controls, CSA C22.2 NO. 199 / ANSI Z21.20 / UL 372, which uses "FLAME FAILURE RESPONSE TIME: The period of time between loss of supervised ignition source or the supervised main burner flame and the action to shut off the fuel supply.

Response Message:
3.3.21 Flame Response Time (FRT).
The period of time that starts with the loss of flame and ends with the de-energizing of the safety shutoff valve(s).

Submitter Information Verification
Submitter Full Name: Guy Colonna
Organization: National Fire Protection Assoc
Street Address:
City:
State:
Zip:
Submittal Date: Fri Nov 08 14:08:47 EST 2013

Committee Statement
Committee Statement: The term Flame Response Time defined in 3.3.21 is no longer needed as a result of action on SR no. 49 which modifies the definition of Flame Failure Response Time. This is consistent with the inclusion of a definition for the term combustion safeguards.
3.3.21* Flame Rod.

A detector sensor that employs an electrically insulated rod of temperature-resistant material that extends into the flame being supervised, with a voltage impressed between the rod and a ground connected to the nozzle or burner.

Submitter Information Verification

Submitter Full Name: [Not Specified]
Organization: [Not Specified]
Street Address: 
City: 
State: 
Zip: 
Submittal Date: Wed Oct 16 14:56:46 EDT 2013

Committee Statement

Committee Statement: This is an editorial revision, replacing "detector" with "sensor" as it is the more correct term for this application. Separately, the annex to this definition has been revised to use flame detector rather than combustion safeguard now that flame detector has been defined in the standard.

Response Message: 

3.3.51.6 Proved Pilot.
A pilot whose flame is supervised by a combustion safeguard flame detector that senses the presence of the pilot flame.

Submitter Information Verification

Submitter Full Name: [Not Specified]
Organization: [Not Specified]
Street Address:
City:
State:
Zip:

Submit Date: Mon Sep 30 16:54:07 EDT 2013

Committee Statement

Committee Statement: This change is consistent with the addition of the definition of flame detector and the modified definition for combustion safeguard.
Response Message:
3.3.53 Pilot Flame Establishing Period.

The interval of time during light-off that a safety control circuit allows the pilot fuel safety shutoff valve to remain open before the combustion safeguard proves the presence of the pilot flame.
3.3.55 Pressure Relief Valve.
A valve that automatically opens and closes a relief vent, depending on whether the pressure is above or below a predetermined value. [54, 2015]

Submitter Information Verification

Submitter Full Name: [Not Specified]
Organization: [Not Specified]
Street Address: 
City: 
State: 
Zip: 
Submit Date: Tue Oct 01 21:30:33 EDT 2013

Committee Statement

Committee Statement: This definition is the same as that used in NFPA 54. An extract notation should be added.
Response Message:
Public Comment No. 17-NFPA 86-2013 [Section No. 3.3.56]
3.3.62* Safe-Start Check.
A checking circuit test incorporated in a safety-control circuit combustion safeguard that prevents light-off start-up if the flame-sensing relay of the combustion safeguard is in the unsafe (flame-present) position a flame-detected presence condition exists due to component failure within the combustion safeguard or flame detector(s) due to the presence of actual or simulated flame.

Supplemental Information

File Name: Annex_to_SR_9_A.3.3.64_Safe-start_check.docx
Description: Annex text for proposed new annex item to definition for safe-start check.

Submitter Information Verification

Submitter Full Name: [ Not Specified ]
Organization: [ Not Specified ]
Street Address:
City:
State:
Zip:
Submittal Date: Tue Oct 01 21:38:07 EDT 2013

Committee Statement

Committee Statement: Edited for clarification based on the revision of the definition for combustion safeguard. Combustion safeguard replaced safety control circuit which is not used in the standard and "test" replaced "checking circuit" as it was deemed more clear as to the meaning. The broader terminology with "test" permits PLC logic solver action in addition to physical checking circuits. An annex was also created to remove text from the definition that supports the defined term.

Response Message:
A.3.3.64 A flame-detected condition could exist due to the presence of actual or simulated flame or due to component failure within the combustion safeguard or flame detector(s).
3.3.68 Supervised Flame. A flame whose presence or absence is detected by a combustion safeguard flame detector.

Submitter Information Verification

Submitter Full Name: [ Not Specified ]
Organization: [ Not Specified ]
Street Address:
City:
State:
Zip:
Submittal Date: Tue Oct 01 21:41:25 EDT 2013

Committee Statement

Committee Statement: With the addition of the definition for flame detector, this edit is necessary to this definition in order to use the properly defined term.
Response Message:
3.3.72 Trial-for-Ignition Period (Flame-Establishing Period).
The interval of time during light-off that a safety control circuit combustion safeguard allows the fuel safety shutoff valve to remain open before the combustion safeguard flame detector is required to supervise the flame.

Submitter Information Verification

Submitter Full Name: [ Not Specified ]
Organization: [ Not Specified ]
Street Address:
City:
State:
Zip:
Submittal Date: Tue Oct 01 21:43:07 EDT 2013

Committee Statement

Committee Statement: Due to the revision of the combustion safeguard definition and the addition of a definition for flame detector, this definition must be revised to use those terms correctly.
Any deviation from this standard shall require **approval** from the authority having jurisdiction.

Submitter Information Verification

**Submitter Full Name:** [ Not Specified ]
**Organization:** [ Not Specified ]
**Street Address:**
**City:**
**State:**
**Zip:**
**Submittal Date:** Fri Oct 25 16:37:48 EDT 2013

Committee Statement

**Committee Statement:** The Committee believes that "approval" is more clear and enforceable as opposed to the phrase "special permission."

**Response Message:**
Second Revision No. 31-NFPA 86-2013 [Section No. 6.2.6.8]

6.2.6.8 Vent lines from multiple regulators and switches of a single furnace, where manifolded together, shall be piped in such a manner that diaphragm rupture of one vent line does not backload the others. Vents from systems operating at different pressure control levels shall not be manifolded together.

6.2.6.8.1 Vents from systems operating at different pressure levels shall not be manifolded together.

6.2.6.8.2 Vents from systems served from different pressure-reducing stations shall not be manifolded together.

6.2.6.8.3 Vents from systems using different fuel sources shall not be manifolded together.

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

6.2.6.10 Vents from systems using different fuel sources shall not be manifolded 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.
Second Revision No. 12-NFPA 86-2013 [Section No. 6.2.7.1]

6.2.7.1 Overpressure protection shall be provided in either of the following cases:
   (1) When the supply pressure exceeds the pressure rating of any downstream component
   (2) When the failure of a single upstream line regulator or service pressure regulator results in a supply pressure exceeding the pressure rating of any downstream component

Submitter Information Verification

Submitter Full Name: [Not Specified]
Organization: [Not Specified]
Street Address:
City:
State:
Zip:
Submittal Date: Tue Oct 01 21:54:12 EDT 2013

Committee Statement

Committee Statement: Editorial.
Response Message:
Public Comment No. 9-NFPA 86-2013 [Section No. 6.2.7.1]
6.2.7.3*
When a relief valve is used to comply with 8.2.10 6.2.7.1, the relief valve shall be a full-capacity relief type.

Submitter Information Verification

Submitter Full Name: [ Not Specified ]
Organization: [ Not Specified ]
Street Address:
City:
State:
Zip:
Submittal Date: Fri Oct 25 15:23:56 EDT 2013

Committee Statement

Committee Statement: This is an editorial correction to the cross-sectional reference.
Response Message:
6.2.7.4
Token relief valves and internal token relief valves shall not be permitted to be used as an OPD as the only overpressure protection devices.

Submitter Information Verification

Submitter Full Name: [Not Specified]

Organization: [Not Specified]

Street Address:

City: [Not Specified]

State:

Zip:

Submittal Date: Tue Oct 01 22:03:23 EDT 2013

Committee Statement

Committee Statement: The initials OPD should be expanded to words since the initials may not be immediately clear to a user. Add the word 'only' so that a device with token relief can be combined when used with other approved OPDs, such as a monitoring regulator system.

Response Message:

Public Comment No. 29-NFPA 86-2013 [Section No. 6.2.7.4]
7.1 Commissioning.
7.1.1* Commissioning shall be required for all new installations or for any changes that affect the safety system.
7.1.2 All pertinent apparatus shall be installed and connected in accordance with the system design.
7.1.3* During commissioning, all furnace piping that conveys flammable liquids or flammable gases shall be inspected for leaks.
7.1.4 The furnace shall not be released for operation before the installation and checkout testing of the required safety systems have been successfully completed.
7.1.4.1* Burner management system logic shall be tested and verified for compliance with the design criteria when the burner management system logic is installed, replaced, repaired, or updated.
7.1.4.2 Documentation shall be provided that confirms that all related safety devices and safety logic are functional.
7.1.5 Any changes to the original design made during commissioning shall be reflected in the documentation.
7.1.6* Set points of all safety interlock settings shall be documented.
7.1.6* During commissioning, all furnace piping that conveys flammable liquids or flammable gases shall be inspected for leaks.
7.1.7* A confirmed source of combustible flammable gas shall be provided to the inlet of the equipment isolation valve(s) (see each time a flammable gas supply is placed into service or restored to service. (See 6.2.4.1 and 13.5.11.10.2.1.) each time a combustible gas supply is placed into service or restored to service.

Supplemental Information

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Submitter Information Verification

Submitter Full Name: [ Not Specified ]
Organization: [ Not Specified ]
Street Address: [ Not Specified ]
City: [ Not Specified ]
State: [ Not Specified ]
Zip: [ Not Specified ]
Submittal Date: Fri Oct 25 13:18:15 EDT 2013

Committee Statement

Committee Statement: This modification restructures the existing 7.1 for better logic in terms of the relationship between the sub-requirements, and deletes unenforceable terms. New annex material is also provided for...
the new requirement on testing and verification.

Response
Message:
Attachment to SR 39, New Annex text

Create new annex, A.7.1.4.1 as shown:

A.7.1.4.1 The testing and verification of the Burner Management System logic should be completed by a competent person other than the system designer.

Add “*” to 7.1.4.1 to indicate annex material.
7.4.10.1
Safety shutoff valves that are used to comply with 8.5.1.8 (4) that are not proved closed shall be replaced before they exceed their maximum allowable number of lifetime open–closed cycles.

Submitter Information Verification
Submitter Full Name: [Not Specified]
Organization: [Not Specified]
Street Address:
City:
State:
Zip:
Submittal Date: Tue Oct 01 22:06:49 EDT 2013

Committee Statement
Committee Statement:
Clarifies that two conditions exist when cycle counting is needed. 1) when skipping purge and 2) valves are not proved closed.

Response Message:
Public Comment No. 5-NFPA 86-2013 [Section No. 7.4.10.1]
7.4.19
Whenever combustible gas piping is placed into service or removed from service, any release of combustible gas shall be vented to an approved location.

Submitter Information Verification
Submitter Full Name: [Not Specified]
Organization: [Not Specified]
Street Address:
City:
State:
Zip:
Submittal Date: Thu Oct 24 14:40:29 EDT 2013

Committee Statement
Committee Statement: The committee clarified the application of this new provision introduced as part of the first draft; the committee did not accept the 2.5 ft³/hr as this is not as practical for large volumes, since some of the guidance for this could be based more commonly on LFL or percent of the LFL for determining the hazardous condition.

Response Message:
Public Comment No. 8-NFPA 86-2013 [Section No. 7.4.19]
Second Revision No. 20-NFPA 86-2013 [Section No. 8.2.1]

8.2.1* Combustion

Except as permitted by Section 8.4, combustion safeguards, flame detectors, excess temperature limit interlocks, and safety shutoff valves shall be listed for combustion safety service or approved if a listed device is not commercially available.

Supplemental Information

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Submitter Information Verification

Submitter Full Name: [Not Specified]
Organization: [Not Specified]
Street Address: [Not Specified]
City: [Not Specified]
State: [Not Specified]
Zip: [Not Specified]
Submittal Date: Wed Oct 16 15:46:56 EDT 2013

Committee Statement

Committee Statement: The intent for the listing of these elements has been clarified and limited as appropriate with edits to this requirement and the defined term "flame detector" has been added to the list of similar elements required to be listed for combustion safety service. In addition, an annex item has been added to clarify that a flame rod is only a flame sensor and not required to be listed.

Response Message: [Not Specified]
SR No. 20, New Annex A.8.2.1

A.8.2.1 A flame rod is not required to be listed.
Second Revision No. 15-NFPA 86-2013 [Section No. 8.2.11]

8.2.11*
Where transmitters are used in place of switches for safety functions, the following shall apply:

(1) The transmitter shall be safety integrity level (SIL) 2 capable.
(2) Transmitter failure shall be detected and initiate a safety shutdown.
(3) The transmitter shall be dedicated to safety service unless listed for simultaneous process and safety service.

Submitter Information Verification

Submitter Full Name: [Not Specified]
Organization: [Not Specified]
Street Address: [Not Specified]
City:
State:
Zip:
Submittal Date: Tue Oct 01 22:09:44 EDT 2013

Committee Statement

Committee Statement: The added condition was originally present in 8.4.4(2) before it was moved to 8.2.11 by First Revision No. 9-NFPA 86-2012. Re-inserting the missing text will keep 86 aligned with 87 and avoid confusion.

Response Message:
Public Comment No. 30-NFPA 86-2013 [Section No. 8.2.11]
8.3.1.3 Safety interlocks shall meet one or more of the following criteria:

1. Be hardwired without relays in series and ahead of the controlled device.
2. Be connected to an input of a programmable controller logic system complying with Section 8.4.
3. Be connected to a relay that represents a single safety interlock that is configured to initiate safety shutdown in the event of power loss.
4. Be connected to a listed safety relay that represents one or more safety interlocks and initiates safety shutdown upon power loss.

Submitter Information Verification

Submitter Full Name: [Not Specified]
Organization: [Not Specified]
Street Address: [Not Specified]
City: [Not Specified]
State: [Not Specified]
Zip: [Not Specified]
Submittal Date: Tue Oct 01 22:13:08 EDT 2013

Committee Statement

Committee: Clarified what initiates the lockout. The safety interlock, not the relay, initiates the shutdown.
Response Message: Public Comment No. 7-NFPA 86-2013 [Section No. 8.3.1.3]
PLCs, Where PLCs are not listed for combustion safety service or as combustion safeguard, the PLC and its associated I/O input and output (I/O) used to perform safety functions shall be certified to IEC 61508 for use in safety applications with a safety integrity level of 2 or greater, as follows:

1. Third-party certified to IEC 61508 safety integrity level (SIL) 2 or greater
2. Applied to achieve at least an SIL 2 capability per the manufacturer's safety manual

Supplemental Information

File Name  Description
Attachment_for_SR_38_A.8.4.2.1382719138317.docx  This is new annex text for A.8.4.2

Submitter Information Verification

Submitter Full Name: [Not Specified]
Organization: [Not Specified]
Street Address: [Not Specified]
City: [Not Specified]
State: [Not Specified]
Zip: [Not Specified]
Submittal Date: Fri Oct 25 12:11:30 EDT 2013

Committee Statement

Committee Statement: The modifications make it more clear the 2 provisions required for the PLC not listed for combustion safety service or as combustion safeguard and its associated I/O and also removes non-mandatory language that had been also proposed. Annex material is also provided to explain the implementation of SIL 2 capability and also the range of intended applicability for the SIL 2 requirement.

Response Message:
Public Comment No. 35-NFPA 86-2013 [Section No. 8.4.2 [Excluding any Sub-Sections]]
Attachment for SR 38-NFPA 86, A.8.4.2

Related to Public Comment No. 35

Add “*” to 8.4.2 to indicate annex text

Add new annex to 8.4.2 as shown:

A.8.4.2 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 input or output
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

An 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. The purpose of the SIL capability requirement is to provide control reliability.
8.4.2.1  The safety functions shall be implemented according to the device's safety manual requirements to achieve a safety integrity level of 2 or greater.

8.4.2.2  General.

(A) Before the PLC is placed in operation, documentation shall be provided that confirms that all related safety devices and safety logic are functional.

(B) All changes to hardware or software shall be documented and maintained in a file that is separate from the furnace programmable controller.

(C) System operation shall be tested and verified for compliance with the design criteria when the PLC is replaced, repaired, or updated.

(D) The control system shall have at least one manual emergency switch that initiates a safety shutdown.

Submitter Information Verification

Submitter Full Name:  [ Not Specified ]
Organization:  [ Not Specified ]
Street Address:
City:
State:
Zip:
Submittal Date:  Fri Oct 25 15:56:09 EDT 2013

Committee Statement

Committee Statement:  These sections are deleted as they are included in the new 8.4.2 developed in SR No. 38 and also covered by paragraph 8.2.9.
Response Message:
8.4.3

General purpose PLCs Any PLC shall be permitted to perform the purge timing function.

Submitter Information Verification

Submitter Full Name: [ Not Specified ]
Organization: [ Not Specified ]
Street Address: 
City: 
State: 
Zip: 
Submittal Date: Thu Oct 24 15:52:09 EDT 2013

Committee Statement

Committee Statement: This revision clarifies the change made during the first draft stage.
Response Message:
8.4.4* Safety PLCs.

(A) Where used for combustion safety service, safety programmable logic controllers PLCs shall have the following characteristics:

1. The processor and the input and output (I/O) shall be listed for control reliable service with an SIL rating of at least 2.

2. Access to PLC dedicated to safety functions shall be restricted separate from access to nonsafety functions.

3. Nonsafety functions, where implemented, shall be independently accessible from Access to PLC logic dedicated to safety functions shall be restricted to prevent unauthorized changes.

4. All safety function sensors and final elements shall be independent of operating sensors and final elements.

(B) Safety PLCs shall not implement the following:

1. Manual emergency switches

2. Continuous vapor concentration high-limit controllers

Supplemental Information

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Submitter Information Verification

Submitter Full Name: [Not Specified]  
Organization: [Not Specified]  
Street Address:  
City:  
State:  
Zip:  
Submittal Date: Thu Oct 24 15:46:04 EDT 2013

Committee Statement

Committee Statement: Defines the degree of restriction needed. The changes modify the requirement for separate and restricted access to safety instructions. Annex was added to clarify the requirements. This addresses Public Comments 22 and 36.

Response Message: Public Comment No. 22-NFPA 86-2013 [Section No. 8.4.4]
Attachment to SR 25, new annex to 8.4.4 addressing PC 22 and 36:

Create new Annex A.8.4.4 and add "*" to existing 8.4.4.

A.8.4.4 The burner management system (BMS) logic, memory, and I/O should be characterized by the following:

1. Independent from non-safety logic and memory
2. Protected from alteration by non-BMS logic or memory access
3. Protected from alteration by unauthorized users
8.4.5
PLCs shall not implement the following:
(1) Manual emergency switches
(2) Continuous vapor concentration high-limit controllers

Submitter Information Verification
Submitter Full Name: [ Not Specified ]
Organization: [ Not Specified ]
Street Address: [ Not Specified ]
City: [ Not Specified ]
State: [ Not Specified ]
Zip: [ Not Specified ]
Submittal Date: Thu Oct 24 16:52:42 EDT 2013

Committee Statement
Committee Statement: Delete 8.4.5 as the 1st edition does not acknowledge the use of general purpose PLC’s except for pre-purge timing.
Response Message: Public Comment No. 34-NFPA 86-2013 [Section No. 8.4.5]
Second Revision No. 28-NFPA 86-2013 [ Section No. 8.5.1.2(A) ]

(A) At least 4 four scf system volumes of fresh air or inert gas per cubic foot (4 m$^3$/m$^3$) of system volume shall be introduced during the purging cycle.

Submitter Information Verification

Submitter Full Name: [ Not Specified ]
Organization: [ Not Specified ]
Street Address:
City:
State:
Zip:
Submittal Date: Thu Oct 24 17:19:29 EDT 2013

Committee Statement

Committee Statement: The present requirement includes a contradiction in that in the requirement for 4 scf (standard cubic foot) is not on the same basis as (4 m$^3$/m$^3$). The purge requirement should be based on actual volume, not corrected for Standard or Normal conditions. This revision removes any conflict between standard volumes and actual volumes.

Response Message:

Public Comment No. 37-NFPA 86-2013 [Section No. 8.5.1.2(A)]
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 multiburner fuel-fired system not proved to be above 1400°F (760°C), all of the following conditions are satisfied:
   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 without explosion.

3. For fuel gas–fired burner systems and assuming that all safety shut-off 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.

4. All of the following conditions are satisfied (does not apply to fuel oil systems):
   a. The number of safety shut-off 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. Safety shut-off valve 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 safety shut-off valve leakage rates, 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.

Submitter Information Verification

Submitter Full Name: [Not Specified]
Organization: [Not Specified]
Street Address:
City:
State:
Zip:
Submittal Date: Thu Oct 24 17:29:17 EDT 2013

Committee Statement

Committee Statement: The critical rate is the leakage into the combustion chamber, not the leakage of an individual valve in the case when two valves in series are installed at the burner. One can imagine two valves in series, 1 leaks and the other does not. The actual leakage to the burner is then 0. The changes to 8.5.1.8 (2) (b) and (4) (d) are editorial.

Response Message:

Public Comment No. 11-NFPA 86-2013 [Section No. 8.5.1.8]
### 8.5.2.1
The trial-for-ignition period of any pilot or main gas burner shall not exceed 15 seconds, unless both of the following conditions are satisfied:

1. A written request for an extension of the trial-for-ignition period is approved by the authority having jurisdiction.
2. It is determined that 25 percent of the LFL cannot be exceeded in the extended time.

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**Submitter Information Verification**

- **Submitter Full Name**: Not Specified
- **Organization**: Not Specified
- **Street Address**: Not Specified
- **City**: Not Specified
- **State**: Not Specified
- **Zip**: Not Specified
- **Submittal Date**: Thu Oct 24 17:45:40 EDT 2013

**Committee Statement**

- **Committee Statement**: Editorial...add "of" before "any".
- **Response Message**:
  - Public Comment No. 38-NFPA 86-2013 [Section No. 8.5.2.1]
8.5.2.3
Where direct spark ignition systems cause a false flame signal in required flame detectors and combustion safeguards, the electrical spark shall be terminated after the main burner trial-for-ignition period.

Submitter Information Verification

Submitter Full Name: [ Not Specified ]
Organization: [ Not Specified ]
Street Address:
City:
State:
Zip:
Submittal Date: Wed Oct 16 15:37:39 EDT 2013

Committee Statement

Committee Statement: This modification adds the defined term "flame detector" in addition to the existing term "combustion safeguards" in this requirement in order to properly use both defined terms.
Second Revision No. 21-NFPA 86-2013 [ Section No. 8.6.1 [Excluding any Sub-Sections]

Where a fan is essential for purge or safety ventilation of an oven or allied equipment, fan operation shall be proved and interlocked into the safety circuitry burner management system.

Submitter Information Verification

Submitter Full Name: [Not Specified]
Organization: [Not Specified]
Street Address:
City:
State:
Zip:
Submittal Date: Wed Oct 16 15:56:55 EDT 2013

Committee Statement

Committee Statement: Substituting "Burner Management System" for "safety circuitry" as burner management system is a defined term and safety circuitry is not being used in the standard.
Response Message:

Public Comment No. 39-NFPA 86-2013 [Section No. 8.6.1 [Excluding any Sub-Sections]]
### Second Revision No. 32-NFPA 86-2013 [Section No. 8.6.3]

<table>
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<tr>
<td>In any combustion system where the combustion air supply can be diverted to an alternate flow path than a burner (e.g., to a regenerative burner system's exhaust path), that burner's associated combustion air flow path valve(s) shall be proven open, and its alternate air flow path valve(s) shall be proven closed, before that burner's fuel safety shutoff valve(s) are energized.</td>
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### Submitter Information Verification
- **Submitter Full Name:** [Not Specified]
- **Organization:** [Not Specified]
- **Street Address:** [Not Specified]
- **City:**
- **State:**
- **Zip:**
- **Submittal Date:** Fri Oct 25 10:52:06 EDT 2013

### Committee Statement
- **Committee Statement:** This requirement (also repeated as 8.7.6) is covered by 8.7.2 and should be deleted from the main body in this location and will be modified and included at 8.7.6. See action on Public Comment No. 32.
- **Response Message:** Public Comment No. 31-NFPA 86-2013 [Section No. 8.6.3]
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 air flow path valve(s) shall be proven open, and its alternate air flow path valve(s) shall be proven closed, before that burner’s fuel safety shutoff valve(s) are energized.

Submitter Information Verification

Submitter Full Name: [Not Specified]
Organization: [Not Specified]
Street Address: [Not Specified]
City: [Not Specified]
State: [Not Specified]
Zip: [Not Specified]
Submittal Date: Fri Oct 25 10:59:17 EDT 2013

Committee Statement

Committee Statement: Text has been deleted at 8.6.3 where it was duplicated; the Committee believes it belongs here and has made slight editorial changes in addition to keeping the requirement at 8.7.6.

Response Message:

Public Comment No. 32-NFPA 86-2013 [Section No. 8.7.6]
Second Revision No. 22-NFPA 86-2013 [ New Section after 8.8.1.11 ]

8.8.1.12
Safety shutoff valves shall meet one of the following requirements:

(1) The safety shutoff valves shall close in 1 second or less upon being de-energized.

(2) Where safety shutoff valve closure time exceeds 1 second, the combined time for safety shutoff valve closure and flame failure response shall not exceed 5 seconds.

Submitter Information Verification

Submitter Full Name: [ Not Specified ]
Organization: [ Not Specified ]
Street Address:
City:
State:
Zip:
Submittal Date: Wed Oct 16 16:35:46 EDT 2013

Committee Statement

Committee Statement: This new requirement clarifies the performance of safety shutoff valves (SSOV) as related to flame failure response time (FFRT), which is established as 4 seconds or less in accordance with 8.10.3 of NFPA 86.

Response Message:
8.8.3.3
Where an oil safety shutoff valve is required to be proved closed in 8.8.3.2, it shall be accomplished by the use of a proof-of-closure switch incorporated in a listed safety shutoff valve assembly in accordance with the terms of the listing.

Submitter Information Verification

Submitter Full Name: [ Not Specified ]
Organization: [ Not Specified ]
Street Address:
City:
State:
Zip:
Submittal Date: Fri Oct 25 11:15:59 EDT 2013

Committee Statement

Committee Statement: The current wording for oil valve POC switches is inconsistent with that of fuel gas POC switches (section 8.8.2.2). Adding the requirement that the POC switch shall be incorporated in "listed safety shutoff valve" ensures oil shutoff valves are held to the same standard as fuel gas shutoff valves.

Response Message:
Public Comment No. 45-NFPA 86-2013 [New Section after 8.8.3.2]
8.9.1
A low fuel pressure switch or sensor shall be provided and shall be interlocked into the burner management system.

Submitter Information Verification

Submitter Full Name: [Not Specified]
Organization: [Not Specified]
Street Address: 
City: 
State: 
Zip: 
Submittal Date: Fri Oct 25 11:21:08 EDT 2013

Committee Statement

Committee Statement: Added "switch or sensor" for consistency with use of these terms throughout the document.
Response Message: 
Public Comment No. 41-NFPA 86-2013 [Section No. 8.9.1]
### 8.9.2

A high fuel pressure switch or sensor shall be provided and shall meet the following criteria:

1. It shall be interlocked into the burner management system.
2. It shall be located downstream of the final pressure-reducing regulator.

---

**Submitter Information Verification**

- **Submitter Full Name**: [Not Specified]
- **Organization**: [Not Specified]
- **Street Address**: [Not Specified]
- **City**: [Not Specified]
- **State**: [Not Specified]
- **Zip**: [Not Specified]
- **Submittal Date**: Fri Oct 25 11:24:51 EDT 2013

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**Committee Statement**

- **Committee Statement**: Added "switch or sensor" for consistency with use of these terms throughout the document.
- **Response Message**: [Public Comment No. 42-NFPA 86-2013 [Section No. 8.9.2]](http://submittals.nfpa.org/TerraViewWeb/ContentFetcher?commentPara...41 of 64 12/6/2013 4:58 PM)
8.9.3 Pressure switch or sensor settings shall be made in accordance with the operating limits of the burner management system.

Submitter Information Verification

Submitter Full Name: [ Not Specified ]
Organization: [ Not Specified ]
Street Address:
City:
State:
Zip:
Submittal Date: Fri Oct 25 11:26:42 EDT 2013

Committee Statement

Committee Statement: Added "switch or sensor" for consistency with use of these terms throughout the document.
Response Message:
Public Comment No. 44-NFPA 86-2013 [Section No. 8.9.3]
8.10 Combustion Safeguards and Flame Supervision.

8.10.1 Combustion Safeguards

8.10.1.1 Each burner flame shall have a combustion safeguard that is interlocked into the burner management system unless otherwise permitted in 8.10.1.2.

8.10.1.2 The following burner flames shall not require a combustion safeguard:

(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 open at one or both ends. If heat recovery systems are used, they shall be of explosion-resistant construction.
   (b) The entire radiant tube heating system, including any associated heat recovery system, is of 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).

8.10.1.3* A combustion safeguard and the logic system shall have a flame response time of 4 seconds or less.

8.10.1.4 The logic system shall perform a safe-start check.

8.10.2 Flame Supervision.

8.10.2 Each burner shall have a supervised flame monitored by a flame detector and combustion safeguard that are interlocked into the burner management system unless otherwise permitted in 8.10.2.

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 open at one or both ends. If heat recovery systems are used, they shall be of explosion-resistant construction.
   (b) The entire radiant tube heating system, including any associated heat recovery system, is of 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).

8.10.3* The flame failure response time shall be 4 seconds or less.

8.10.4 A safe-start check shall be performed during each burner startup sequence.

8.10.5* Flame Supervision.
8.10.5.1
Where a combustion safeguard is required for a burner flame, 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

8.10.5.2*
Line burners, pipe burners, and radiant burners, where installed adjacent to one another or connected with flame-propagating devices, shall be considered to be a single burner and shall have at least one flame safeguard installed to sense burner flame at the end of the assembly farthest from the source of ignition.

8.10.5.3
Where a combustion safeguard is required for a burner flame, flame supervision shall not be required in the burner management system of a furnace zone when that zone temperature is greater than 1400°F (760°C) and the following criteria are met:

1. When the zone temperature drops to less than 1400°F (760°C), the burner is interlocked to allow its operation only if flame supervision has been re-established.
2. A 1400°F (760°C) bypass interlock is used to meet the requirement of 8.10.1.2(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

8.10.6*
Line burners, pipe burners, and radiant burners, where installed adjacent to one another or connected with flame-propagating devices, shall be considered to be a single burner and shall have at least one flame detector installed to sense burner flame at the end of the assembly farthest from the source of ignition.

8.10.7
Where a combustion safeguard is required for a burner flame, flame supervision shall not be required in the burner management system of a furnace zone when that zone temperature is greater than 1400°F (760°C) and the following criteria are met:

1. When the zone temperature drops to less than 1400°F (760°C), the burner is interlocked to allow its operation only if flame supervision has been re-established.
2. A 1400°F (760°C) bypass interlock is used to meet the requirement of 8.10.2 (2).

Supplemental Information

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<td>Wed Oct 16 16:39:35 EDT 2013</td>
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**Committee Statement**

| Committee Statement: | The changes to the numbering and headings are editorial. The changes also incorporate newly defined terms such as flame detector, supervised flame, and flame failure response time. In paragraph 8.10.4 the revised text uses a defined term, "safe-start check" and deletes reference to a logic system which is no longer a defined term. This revision is consistent with UL 372. Revisions to both 8.10.5 and 8.10.6 introduce the defined terms. Annex has been added to 8.10.1. |

| Response Message: |  |
Attachment to SR 23, 8.10.1 and A.8.10.1

Add new annex to 8.10.1; insert “*” indicating annex text
Delete existing annex A.8.10.2 and merge with A.8.10.1

A.8.10.1 Subsections 8.2.2 and 8.2.5 require that the flame detector and the combustion safeguard be applied and installed according to the manufacturer’s instructions. Where flame detectors (scanners) with combustion safeguards that continuously operate without a shutdown beyond the maximum interval recommended by the combustion safeguard and flame detector manufacturer’s instructions, such continuous operation without a shutdown and safe-start check would not be compliant.

Ultraviolet sensors can fail in such a manner that the loss of flame is not detected. Where these sensors are placed in continuous service, failures can be detected by a self-checking ultraviolet detector or by periodic testing of the detector for proper operation.
A.3.3.21 Flame Rod.
The resulting electrical current, which passes through the flame, is rectified, and this rectified current is detected and amplified by the combustion safeguard flame detector.

Submitter Information Verification

Submitter Full Name: [ Not Specified ]
Organization: [ Not Specified ]
Street Address:
City:
State:
Zip:
Submittal Date: Wed Oct 16 15:31:59 EDT 2013

Committee Statement

Committee Statement: The annex has been modified to properly use the defined term "flame detector” in place of "combustion safeguard.”
A.6.2.6.3

Paragraph 6.2.6.3 covers venting of flammable and oxidizing gases only. Gases that are asphyxiants, toxic, or corrosive are outside of the scope of this standard. In this regard, other standards should be consulted for appropriate venting. Flammable gases and oxidizers should be vented to a safe location to prevent fire or explosion hazards. When gases are vented, the vent pipe should be located in accordance with the following:

1. Gas should not impinge on equipment, support, building, windows, or materials because the gas could ignite and create a fire hazard.
2. Gas should not impinge on personnel at work in the area or in the vicinity of the exit of the vent pipe because the gas could ignite and create a fire hazard.
3. Gas should not be vented in the vicinity of air intakes, compressor inlets, or other devices that utilize ambient air.

The vent exit should be designed in accordance with the following:

1. The pipe exit should not be subject to physical damage or foreign matter that could block the exit.
2. The vent pipe should be sized to minimize the pressure drop associated with length, fitting, and elbows at the maximum vent flow rate.
3. The vent piping should not have any shutoff valves in the line.

If the gas is to be vented inside the building, the following additional guidance is offered:

1. If the gas is flammable and lighter than air, the flammable gases should be vented to a location where the gas is diluted below its LFL before coming in contact with sources of ignition and the gas cannot re-enter the work area without extreme dilution.
2. If the gas is oxygen or air enriched with oxygen, the vent gas should be vented to a location where the gas will blend with atmospheric air to a point between 19 percent and 23 percent oxygen before coming in contact with combustibles or personnel.
3. See also Chapter 4 of NFPA 56, Standard for Fire and Explosion Prevention During Cleaning and Purging of Flammable Gas Piping Systems, which provides information about the development and implementation of written procedures for the discharge of flammable gases.

Submitter Information Verification

Submitter Full Name: [Not Specified]
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Street Address: [Not Specified]
City:
State:
Zip:
Submittal Date: Fri Oct 25 16:28:25 EDT 2013

Committee Statement

Committee Statement: The revised annex text directs the reader to NFPA 56, which provides significant additional information on flammable gas piping systems.
A.7.1.7
The evacuation/purging, charging, and confirmation of the fuel or combustible flammable gas supply in the piping upstream of the equipment isolation valve is governed by other codes, standards, and recommended practices. One example is Section 8.3 of NFPA 54, *National Fuel Gas Code*, which requires charging to be stopped upon detection of combustible gas at the point of discharge which establishes requirements based upon the fuel gas pressure, pipe size, and pipe length. Careful consideration should be given to the potential hazards that may be created in the surrounding area for any fuel or combustible flammable gas discharge.

In NFPA 54, the term *appliance* is analogous to the term *equipment isolation valve* in NFPA 86.

NFPA 54 does not address the use of nitrogen for an inert purge and its property as an asphyxiant, nor does it address how to monitor that nitrogen has displaced sufficient oxygen in the piping system prior to the introduction of flammable gas. In this regard, 7.3.5 of NFPA 56 is helpful in identifying the requirements for an oxygen detector and 7.2.2.3 is helpful for determining an adequate inert (oxygen depleted) condition.

Paragraphs 7.1.2.1 and 7.1.2.2 of NFPA 56 might also be helpful in engaging the involvement of the fuel gas supplier with the evacuation and charging procedure and implementation.

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<td><strong>Committee Statement:</strong></td>
<td>New annex text is added to clarify that industrial ovens and furnaces are called &quot;equipment&quot; and not &quot;appliances.&quot; NFPA 54 does not provide complete information needed for evacuation and charging of combustible gas piping systems. The new annex directs readers to NFPA 56, which provides significant additional information on flammable gas piping systems.</td>
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<td><strong>Response Message:</strong></td>
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A.7.4.9
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, proceed 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.**

```
Gas supply

Safety shutoff valve No. 1

Safety shutoff valve No. 2

Leak test valve

To burner system
```

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

```
Auxiliary switch for safety shutoff valve No. 1

Safety shutoff valve No. 1

Safety shutoff valve No. 2

Flame safeguard

Momentary leak test switch
```

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, proceed 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) Acceptable Leakage Rates

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Here is another method to perform a leak test of the valve. Leakage of the valve seat can be determined by knowing the following:

Initial test pressure \( (p_{\text{test}}) \)

Final test pressure \( (p_{\text{test}}) \)
Test time \((T_{\text{test}})\)

Test volume \((V_{\text{test}})\)

\[
L = \frac{|\Delta p| \times V_{\text{test}} \times 3600}{P_{\text{atm}} \times T_{\text{test}}} \tag{A.7.4.9}
\]

where:

- \(L\) = leakage rate \((\text{cm}^3/\text{hr})\)
- \(|\Delta p|\) = absolute value of initial test pressure \((\text{mbar})\) — final test pressure \((\text{mbar})\)
- \(V_{\text{test}}\) = total volume of the test \((\text{cm}^3)\)
- \(P_{\text{atm}}\) = atmospheric pressure \((\text{atmospheres})\)
- \(T_{\text{test}}\) = test time \((\text{seconds})\)

Conversion factors

- \(1\ \text{in. water col.} = 2.44\ \text{mbar}\)
- \(1\ \text{psi} = 27.7\ \text{in. Water col.}\)
- \(1\ \text{atmosphere} = 14.7\ \text{psi}\)

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) shows a sample calculation of the measured leakage on a valve seat based on measured values and known quantities (note: actual values are measured in metric units):

- Test volume is 0.226 liters
- Test time is 10 seconds
- Measured initial test pressure is 27.7"WC (1 psi)
- Measured final test pressure is 25.7"WC

This test method is solving for \(L_{\text{V2 leakage}}\) (leakage on \(V2\)) since the leakage rate on \(V2\) is measured using the pressure decay leak test method.
### Table A.7.4.9(b) Test Methods.

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

### Supplemental Information

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<th>Description</th>
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### Submitter Information Verification

- **Submitter Full Name:** [Not Specified]
- **Organization:** [Not Specified]
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- **City:**
- **State:**
- **Zip:**
- **Submittal Date:** Wed Oct 30 11:45:40 EDT 2013

### Committee Statement

- **Committee Statement:** The Committee replaced the two equations for leakage rate in A.7.4.9 with a single equation to simplify the calculation and also the units for this application.
Replace existing equations in A.7.4.9 with the single equation below and additional description of the variables.

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

where:
- \(L\) = leakage rate (cm³/hr)
- \(|\Delta p|\) = absolute value of initial test pressure (mbar) – final test pressure (mbar)
- \(V_{\text{test}}\) = total volume of the test (in cm³)
- \(P_{\text{atm}}\) = atmospheric pressure (atmospheres)
- \(T_{\text{test}}\) = test time (in seconds)

Conversion factors:
- \(1\,\text{WC in. water col.} = 2.44\,\text{mbar}\)
- \(1\,\text{PSI psi} = 27.7\,\text{WC in. Water col.}\)
- \(1\,\text{atmosphere} = 14.7\,\text{PSI psi}\)

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

<table>
<thead>
<tr>
<th>Test port Port location</th>
<th>Location</th>
<th>Test method Method</th>
</tr>
</thead>
<tbody>
<tr>
<td>A test port in between both safety shutoff valves</td>
<td>Pressure decay on (V_2)</td>
<td>Pressure rise on (V_1)</td>
</tr>
<tr>
<td>A test port 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>
<td></td>
</tr>
<tr>
<td>A test port \textbf{that is} upstream of both valves</td>
<td>Pressure decay on V₁ and V₂ (requires a leak tightness test on the upstream, manual isolation valve)</td>
<td></td>
</tr>
</tbody>
</table>
In accordance with 8.5.1.8(4)(c), fuels other than natural gas, butane, or propane may 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 8.5.1.8(4)(d) 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 m³/hr @ 21°C).

The following thoughts are offered regarding the selection of the 1 scfh (0.0283 m³/hr @ 21°C) safety shutoff valve seat leakage rate.

Limited data reviewed by the committee indicates that valve seat leakage rates over 1 scfh (0.0283 m³/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 8.5.1.8(4) 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 m³/hr @ 21°C) is considered conservative.

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

1. The use of a safety shutoff valve seat leakage rate of 1 scfh (0.0283 m³/hr @ 21°C) safety shutoff valve seat leakage rate.
2. Providing two safety shutoff valves for each fuel path
3. Using valve proving to prove each safety shutoff valve closed
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 a United States Department of the Interior, 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)
$L_{25} = \text{LFL at } 25°C$

$T = \text{Desired elevated temperature (°C)}$

**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 of 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%
- **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 or 482°C
- **Oxygen in furnace atmosphere:** 18%
- **Fuel:** Methane

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

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

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

$$L_{900°F} = L_{25°C} = L_{25°} \left( 1 - 0.000721(T - 25°C) \right)$$

$$= 5.8 \left[ 1 - 0.000721(482°C - 25°C) \right]$$

$$= 3.6\% \text{ by volume}$$

**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:

$$\% \text{ volume methane to air} = \left( \frac{Q_{LEAK}}{Q_{AIR}} \right) (100\%)$$

$$= (5 \text{ scfh/500 scfh})(100\%)$$

$$= 1\%$$
Step 6. Determine the percent LFL resulting from the methane flow through all burner fuel paths at 900°F:

\[
\% LFL_{900°F} = \left( \frac{\text{volume methane to air}}{LFL_{900°F}} \right) (100\%) \\
= \left( \frac{1\%}{3.5\%} \right) (100\%) \\
= 28.57\%
\]

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

\[
t_{\text{FCE 25\% LFL}} = \left[ \frac{L_{900°F}}{(0.25)} \right] / \left[ \frac{(Q_{\text{LEAK}} / V_{\text{FCE}})}{(60 \text{ min/hr})} \right] \\
= \left[ \frac{(0.036)(0.25)}{5 \text{ ft}^3/\text{hr} / 384 \text{ ft}^3} \right] (60 \text{ min/hr}) \\
= 41.5 \text{ minutes}
\]

Conclusions. Where the value of \% percent LFL_{900°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°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\% 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 \( \times \) 1.828 m deep \( \times \) 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: 900°F or 482°C 482°C (900°F)
- Oxygen in furnace atmosphere: 18\% percent
- Fuel: Methane

\(^*\)The flow path is across one set of closed safety shutoff valves proven closed.

\(^**\)The number of flow paths is the number of sets of safety shutoff valves which that are closed that may can leak into the furnace enclosure.

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

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

Step 2. Determine the furnace volume:
Step 3. Determine the methane leak rate into the furnace with all burners off:

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

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

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

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

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

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

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

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

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

Conclusions. Where the value of \% percent LFL_{482^\circ \text{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 \( t_{\text{FCE 25\% percent LFL}} \). After \( t_{\text{FCE 25\% percent LFL}} \) is exceeded, a repurge of the furnace is required. Where the value of \% percent LFL_{482^\circ \text{C}} 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.

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Submittal Date: Fri Oct 25 14:17:28 EDT 2013

Committee Statement

Committee Statement: Main body text of 8.5.1.8.4 does not require valve proof of closure unless closing only 1 valve under 8.8.1.3. The Committee agrees with the submitter’s substantiation and accepts the comment.
Response
Message:
Public Comment No. 33-NFPA 86-2013 [Section No. A.8.5.1.8(4)(d)]
A system designer can choose not to use pressure switches in a pilot. However, gas pressure switches on a pilot can be desirable, and the following conditions should be considered in deciding whether or not switches should be used:

1. If it's a continuous pilot. If a reliable pilot after light off is still a desirable part of the safety during operation of the burner, the switches help prove the reliability of the pilot so that the gas pressure to the pilot is proven to be within designed parameters.

2. If the pilot burner capacity is above 400,000 Btu/hr. Direct sparking a burner in excess of 400,000 Btu/hr could introduce added risks if a delayed ignition occurs due to too much or too little gas pressure.

3. If the pilot burner uses its own pressure regulator. Failure of that regulator could cause instability of the burner or expose downstream components to pressures exceeding their ratings.

4. If the inlet pressure to the pilot regulator exceeds \( \frac{1}{2} \) psi. The higher the pressure to the pilot burner, the greater the risk of a problem due to incorrect gas pressure. The failure or overloading of a pilot regulator can be at a significantly higher risk where inlet pressures to the pilot regulator exceed \( \frac{1}{2} \) psi.

5. Where providing overpressure protection for a pilot line in order to comply with 8.2.10 6.2.7, a high gas pressure switch on the pilot line in combination with a shutoff valve may be used.
A.8.10.3
Subsections 8.2.1, 8.2.2, and 8.2.5 require the combustion safeguard be listed, applied, and installed according to the manufacturer's instructions. Manufacturer's instructions can limit the operating time of a combustion safeguard without shutdown and safe-start check or a self-checking logic. Figure A.8.10.1.3 shows the difference between flame response time (FRT) and flame failure response time (FFRT). Figure A.8.10.3 (not to scale) is a diagram showing sequences that need to occur to achieve a safety shutoff valve (SSOV) closing time of not more than 5 seconds following loss of flame. Typical SSOVs have a maximum closing time of 1 second; however, some listed or approved valves can have longer times. Figure A.8.10.3 Example of the Difference Between FRT and FFRT. Response Times on Loss of Flame.

Supplemental Information

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Submitter Information Verification

Submitter Full Name: [ Not Specified ]
Organization: [ Not Specified ]
Street Address:
City:
State:
Zip:
Submittal Date: Fri Oct 25 14:55:41 EDT 2013

Committee Statement

Committee Statement: The Committee agrees with the submitter that the diagram is not clear; the modification to the annex includes a revised figure A.8.10.3 (renumbered per action on SR No. 23). The figure now shows the sequences that occur to achieve the SSOV closing time as specified in the standard. It also shows the relationship between the various response times defined within the standard.

Response Message:
Public Comment No. 16-NFPA 86-2013 [Section No. A.8.10.3]
A.8.10.3 Figure A.8.10.3 (not to scale) is a diagram showing sequences that need to occur to achieve a safety shutoff valve (SSOV) closing time of not more than 5 seconds following loss of flame. Typical SSOVs have a maximum closing time of 1 second; however some listed or approved valves can have longer times.

**Figure A.8.10.3.** Response times on loss of flame.