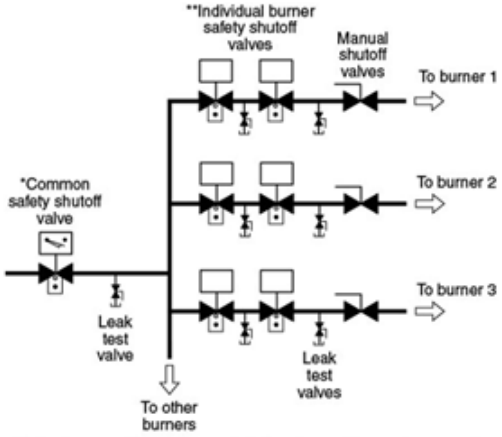
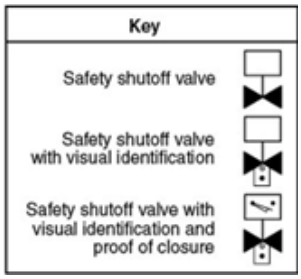
Second Revision No. 20-NFPA 86-2025 [Global Comment]

Split figure A.8.4.1.2.3(2) and move the following part of the figure to A.8.7.1.12 as Figure A.8.7.1.12(b).



*Indicates a proof of closure switch. A valve proving system may also be an option.
**Indicates position indication. Where the individual burner inputs are under 150,000 Btu/h position indication is not required.

Additionally add the following key to figures A.8.7.1.12(a), A.8.7.1.12(b), and A.8.7.2.3



Supplemental Information

File Name	Description	Approved
SR_20.docx	This is how the figures in A.8.4.1.2.3(2) and A.8.7.1.12 should look like after the move and the figure split.	
86_Global_SR-20.docx	For prod use	
86_Global_SR-20_For_Ballot.docx		

Submitter Information Verification

Committee: OVE-AAA
Submittal Date: Fri Aug 15 11:15:29 EDT 2025

Committee Statement

Committee Statement: The burner arraignment figure in A.8.4.1.2.3(2) is moving to A.8.7.1.12 as that figure is explaining multiple burner systems and the requirement text is on those multiple burner systems. Additionally the key in A.8.4.1.2.3(2), needs to be added to all the figures in order to explain the diagrams.

Response Message: SR-20-NFPA 86-2025

Public Comment No. 12-NFPA 86-2025 [Section No. A.8.7.1.12]

Public Comment No. 11-NFPA 86-2025 [Section No. 8.4.1.2.3]

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8.4.1.2.3

To begin the timed preignition purge interval, all of the following conditions shall be satisfied:

(1) *The minimum required preignition airflow is proved.

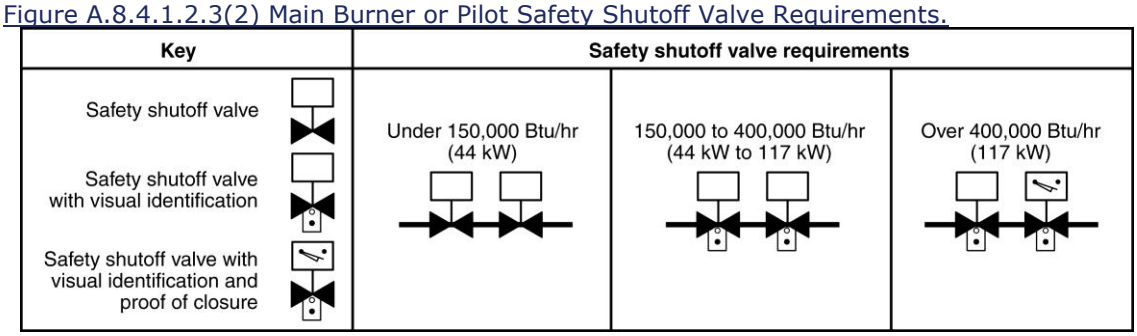
(2) *At least one safety shutoff valve is proved closed between all pilot burners and the fuel supply for ovens with total pilot capacity over 400,000 Btu/hr.

(3) At least one safety shutoff valve is proved closed between all main burners and the fuel supply for ovens with total capacity over 400,000 Btu/hr.

A.8.4.1.2.3(2)

See Figure A.8.4.1.2.3(2).

Figure A.8.4.1.2.3(2) Main Burner or Pilot Safety Shutoff Valve Requirements.



~~**A.8.4.1.2.3(2)**~~

~~See Figure A.8.4.1.2.3(2).~~

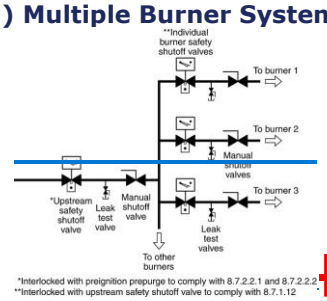
~~Figure A.8.4.1.2.3(2) Example for Multiple Burner System with Independently Operated Burners Using a Common SSOV with Single Proved Closed Interlock for Pre-purge.~~

A.8.7.1.12
Paragraph 8.7.1.12 addresses conditions under which only one safety shutoff valve is to close to isolate a burner from its fuel gas supply. See 8.4.1.8 and 8.4.1.9 for guidance regarding conditions that are needed to allow that burner to be placed back in service. The requirements of 8.4.1.9 might not allow a burner shut off by closing a single safety shutoff valve to be placed back in service without repeating a preignition purge.
The requirements of 8.7.1.12 do not preclude opening of the safety shutoff valve located upstream of the individual burners using single safety shutoff valves during the trial for ignition for the first burner being lighted.
See Figure A.8.7.1.12(A) and Figure A.8.4.1.2.3(B).

A.8.7.1.12
Paragraph 8.7.1.12 addresses conditions under which only one safety shutoff valve is to close to isolate a burner from its fuel gas supply. See 8.4.1.8 and 8.4.1.9 for guidance regarding conditions that are needed to allow that burner to be placed back in service. The requirements of 8.4.1.9 might not allow a burner shut off by closing a single safety shutoff valve to be placed back in service without repeating a preignition purge.
The requirements of 8.7.1.12 do not preclude opening of the safety shutoff valve located upstream of the individual burners using single safety shutoff valves during the trial for ignition for the first burner being lighted.
See Figure A.8.7.1.12(A) and Figure A.8.4.1.2.3(B).

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Figure A.8.7.1.12(a) Multiple Burner System Using Proof-of-Closure Switches.



~~DELETED~~

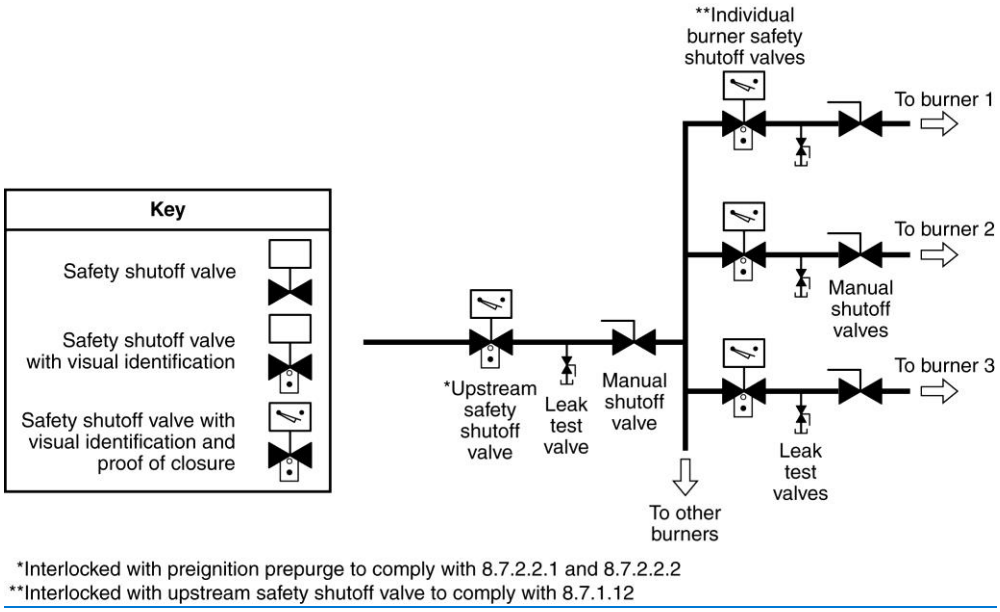
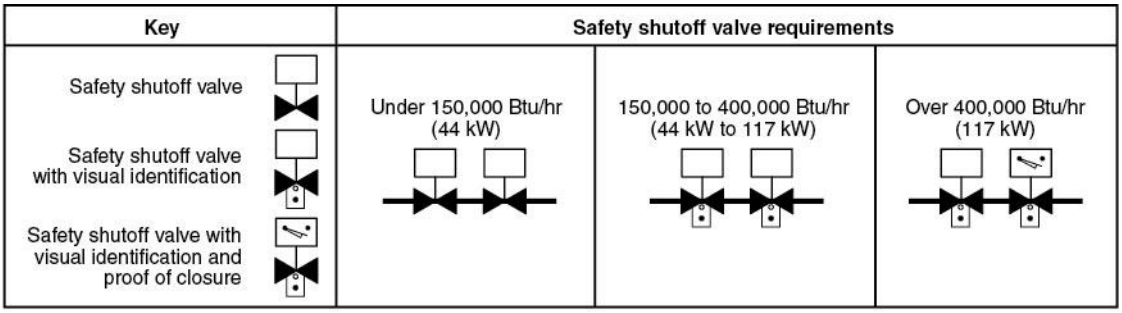
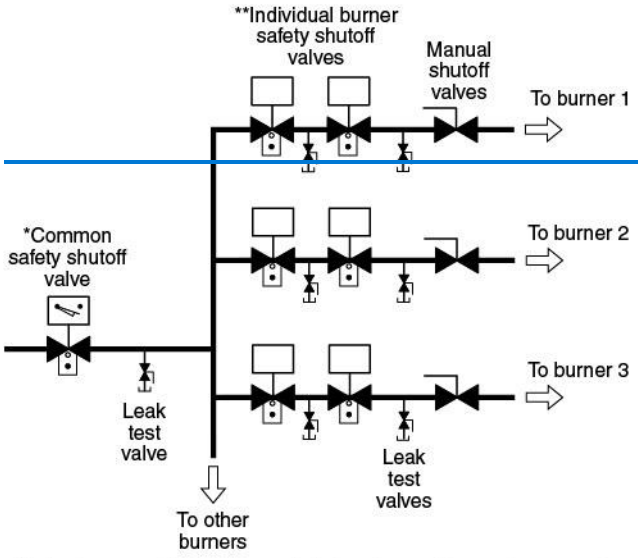


Figure A.8.7.1.12(b) Example for Multiple Burner System with Independently Operated Burners Using a Common SSOV with Single Proved Closed Interlock for Pre-purge.

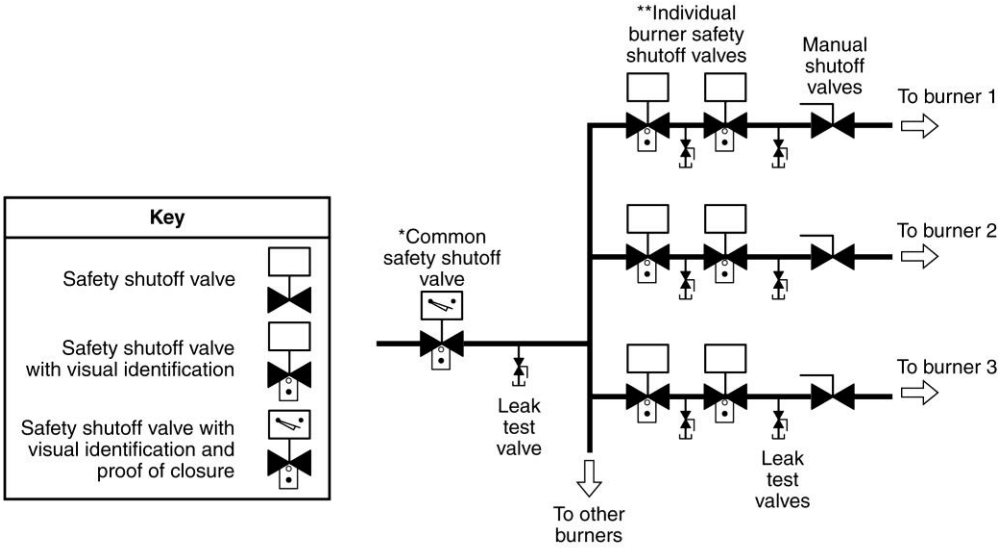
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*Indicates a proof of closure switch. A valve proving system may also be an option.
**Indicates position indication. Where the individual burner inputs are under 150,000 Btu/h position indication is not required.

DELETED



*Indicates a proof of closure switch. A valve proving system may also be an option.
**Indicates position indication. Where the individual burner inputs are under 150,000 Btu/h position indication is not required.

Second Revision No. 18-NFPA 86-2025 [Section No. 1.3.4]

1.3.4*

Section 6.2 shall apply to the following:

(1) Furnace heating systems fired with fuel gases, including the following:

(a) Natural gas

(b) Mixed gas

(c) Manufactured gas

(d) Liquefied petroleum gas (LP-Gas) in the vapor phase

(e) LP-Gas/air systems

(f) * Hydrogen gas and ~~hydrogen gas mixtures~~ hydrogen-enriched fuels

A.1.3.4(1)(f)

NFPA 2 has additional requirements for the installation of ovens and furnaces using hydrogen gas and hydrogen-enriched fuels and is intended to work in conjunction with the requirements in NFPA 86.

(2) Gas-burning portions of dual-fuel or combination burners

Supplemental Information

File Name	Description	Approved
86_SR-18_1.3.4.docx		

Submitter Information Verification

Committee: OVE-AAA

Submittal Date: Wed Aug 13 16:17:38 EDT 2025

Committee Statement

Committee Statement: The terminology is changing to match common industry terms and annex material is being added to explain the relationship between NFPA 2 and NFPA 86 in regards to hydrogen and hydrogen-enriched fuels.

Response Message: SR-18-NFPA 86-2025

Second Revision No. 1-NFPA 86-2025 [Section No. 2.3]

2.3 Other Publications.

2.3.1 ANSI Publications.

American National Standards Institute, Inc. (operations) 1180 Avenue of the Americas, 10th Floor, New York, NY 10036; (headquarters) 1899 L Street, NW, 11th Floor, Washington, DC 20036.

ANSI Z50.1, *Bakery Equipment — Safety Requirements,* 2006, R2016.

2.3.2 API Publications.

American Petroleum Institute, 200 Massachusetts Avenue, NW, Suite 1100, Washington, DC 20001–5571.

API STD 560, *Fired Heaters for General Refinery Services*, 2016.

API RP 556, *Instrumentation and Control Systems for Fired Heaters and Steam Generators*, 2011.

API RP 2001, *Fire Protection in Refineries*, 2019.

2.3.3 ASME Publications.

American Society of Mechanical Engineers, Two Park Avenue, New York, NY 10016-5990.

ASME B31.1, *Power Piping,*~~2020~~ 2024 .

ASME B31.3, *Process Piping,*~~2018~~ 2024 .

ASME B31.12, *Hydrogen Piping and Pipelines*, 2023.

Boiler and Pressure Vessel Code,~~2021~~ 2025 .

2.3.4 ASTM Publications.

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

ASTM D396, *Standard Specifications for Fuel Oils,*~~2021~~ 2024 .

ASTM E136, *Standard Test Method for Assessing Combustibility of Materials Using a Vertical Tube Furnace at 750°C*, ~~2022~~ 2024 .

ASTM E2652, *Standard Test Method for Assessing Combustibility of Materials Using a Tube Furnace with a Cone-shaped Airflow Stabilizer, at 750°C*, ~~2018~~ 2022 .

2.3.5 CGA Publications.

Compressed Gas Association, 8484 Westpark Drive, Suite 220, McLean, VA 22102.

CGA G-4.1, *Cleaning Equipment for Oxygen Service*, 2018.

2.3.6 FM Publications.

FM, 270 Central Avenue, Johnston, RI 02919. www.fm.com

FM 6-11, “Thermal and Regenerative Catalytic Oxidizers,” 2018.

2.3.7 IEC Publications.

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

IEC 61508, *Functional Safety of Electrical/Electronic/Programmable Electronic Safety-Related Systems*, 2010.

2.3.8 Other Publications.

Merriam-Webster’s Collegiate Dictionary, 11th edition, Merriam-Webster, Inc., Springfield, MA, 2020.

Submitter Information Verification

Committee: OVE-AAA
Submittal Date: Wed Jul 23 15:35:25 EDT 2025

Committee Statement

Committee Statement:	This revision was developed by NFPA Staff for editorial purposes, in accordance with 4.4.9.6.2 and 4.4.9.6.3 of the Regulations Governing the Development of NFPA Standards (www.nfpa.org/regs) Reference standards are being updated to the latest edition.
Response Message:	SR-1-NFPA 86-2025

Second Revision No. 2-NFPA 86-2025 [Section No. 2.4]

2.4 References for Extracts in Mandatory Sections.

NFPA 2, *Hydrogen Technologies Code,* ~~2023~~ 2026 edition.

NFPA 30, *Flammable and Combustible Liquids Code,* 2024 edition.

NFPA 54, *National Fuel Gas Code,* 2024 edition.

NFPA 68, *Standard on Explosion Protection by Deflagration Venting,* 2023 edition.

NFPA 69, *Standard on Explosion Prevention Systems,* 2024 edition.

NFPA 70®, *National Electrical Code®,* ~~2023~~ 2026 edition.

NFPA 85, *Boiler and Combustion Systems Hazards Code,* 2023 edition.

NFPA 99, *Health Care Facilities Code,* 2024 edition.

NFPA 211, *Standard for Chimneys, Fireplaces, Vents, and Solid Fuel–Burning Appliances,* 2024 edition.

NFPA 302, *Fire Protection Standard for Pleasure and Commercial Motor Craft,* 2025 edition.

NFPA 820, *Standard for Fire Protection in Wastewater Treatment and Collection Facilities,* 2024 edition.

NFPA 5000®, *Building Construction and Safety Code®,* 2024 edition.

Submitter Information Verification

Committee: OVE-AAA

Submittal Date: Wed Jul 23 16:20:04 EDT 2025

Committee Statement

Committee Statement: This revision was developed by NFPA Staff for editorial purposes, in accordance with 4.4.9.6.2 and 4.4.9.6.3 of the Regulations Governing the Development of NFPA Standards (www.nfpa.org/regs)

Reference standards are being updated to the latest edition year.

Response Message: SR-2-NFPA 86-2025

Second Revision No. 14-NFPA 86-2025 [New Section after 5.2.6.2]

5.2.6.3*

Means shall be provided to allow for the cleaning of oven and the removal of accumulated combustible debris or residues.

A.5.2.6.3

Examples of combustible debris or residues that can accumulate in ovens can include, but are not limited to, drippings from painted metal parts, lint or oily residues from processed cloth, or organic material from food processing. Accumulations can be found in any section of an oven, including the heating chamber or ductwork. Workers need access to oven components so they can be cleaned to reduce the hazard. This should include all areas where combustible materials could accumulate.

Submitter Information Verification

Committee: OVE-AAA

Submittal Date: Wed Aug 13 13:50:39 EDT 2025

Committee Statement

Committee Statement: This change specifically addresses the design of the furnace with regards to ability to clean surfaces and to remove accumulations. This is intended to convey that maintenance activities include cleaning.

Response Message: SR-14-NFPA 86-2025

Public Comment No. 4-NFPA 86-2025 [New Section after 5.2.6.2]

Second Revision No. 7-NFPA 86-2025 [Section No. 5.3.1]

5.3.1*

Additional explosion control shall be provided for Class A ovens where flammable constituents evolve in the process of heating except in the following cases:

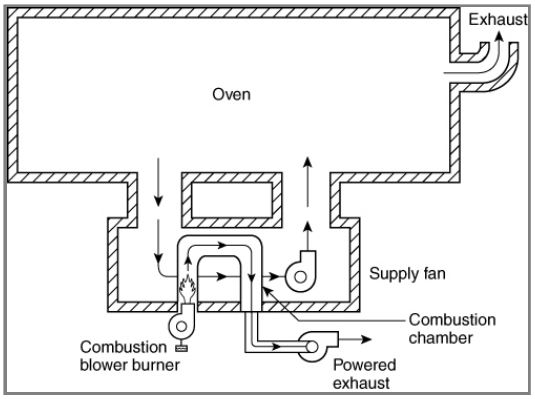
(1) Low-oxygen atmosphere ovens designed and protected in accordance with Section 11.7.

(2)* In the heating chamber of indirectly heated ovens where it is demonstrated by calculation that the combustible concentration in the heating chamber cannot exceed 25 percent of the lower flammable limit (LFL) under any operating conditions.

A.5.3.1(2)

Because the combustion air has only one path from the combustion blower through the supervised powered exhaust, there is no buildup of products of combustion in the heat exchanger. The minimum exhaust rate for the heat exchanger should be determined using 11.6.6.1, which requires 183 scfm (5.18 standard m^3/min) per 1,000,000 Btu/hr (293.1 kW) burner rating. Refer to Figure A.5.3.1(5).

Figure A.5.3.1(2) Example of a Non-Recirculating, Indirect-Fired Oven.



(3) 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.

(4)* Direct-fired ovens where all of the following conditions are met:

(a) It is demonstrated by calculation that the combustible concentration in the heating chamber cannot exceed 25 percent of the LFL when operating in accordance with the design parameters.

(b) The 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) The 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 the LFL aspirating detection system calibration is maintained and posted at each system.

(f) The calibration of the LFL aspirating detection systems is performed in accordance with the manufacturer's instructions.

(g) The calibration of the LFL aspirating detection systems is performed at least once per month.

(5) A direct-fired oven where the process exhaust is not recirculated through the air heater and it is demonstrated by calculation that the combustible concentration cannot exceed 25 percent of the LFL when operating in accordance with the design parameters.

Supplemental Information

File Name	Description	Approved

86_SR-7_5.3.1.docx

Submitter Information Verification

Committee: OVE-AAA

Submittal Date: Tue Aug 12 14:48:13 EDT 2025

Committee Statement

Committee Statement: This revision was made to correct an editorial issue by moving the asterisk to the appropriate item (2) of section as that annex material explains the requirement in 5.3.1(2) rather than 5.3.1(5).

Response Message: SR-7-NFPA 86-2025

Public Comment No. 15-NFPA 86-2025 [Section No. A.5.3.1(5)]

Second Revision No. 8-NFPA 86-2025 [Section No. 5.3.3]

5.3.3*

Damage-limiting construction shall be based on one of the following:

(1)* The amount of deflagration vent area shall be at least 1 ft^2 (0.093 m^2) for each 15 ft^3 (0.424 m^3) of furnace volume.

A.5.3.3(1)

When reviewing furnace volumes with the intent of considering damage-limiting construction, it is important to include all locations and areas where recirculating combustible materials can be found. The volumes used for determining damage-limiting construction often includes the heating chamber, internal and external circulating ductwork, as well as external heaters. Once-though airflow passages that do not recirculate are often excluded from these calculations. Such areas can include fresh air intakes and fresh air supply ductwork as well as dedicated exhaust plenums, ductwork and stacks.

(2) The amount of deflagration vent area shall be based on the requirements of NFPA 68.

(3) Deflagration pressure containment shall be in accordance with NFPA 69.

(4)* Approved damage-limiting construction shall be in accordance with available standards.

5.3.3.1

Deflagration vents shall be allowed to release into the space adjacent to the oven.

5.3.3.1.1*

If venting to the space adjacent to the oven creates an additional hazard that cannot be mitigated by other means, then a deflagration prevention method shall be used.

Submitter Information Verification

Committee: OVE-AAA

Submittal Date: Tue Aug 12 14:55:18 EDT 2025

Committee Statement

Committee Statement: Annex material is being added to explain what is considered to be protected volume in the context of the calculation for deflagration venting.

Response Message: SR-8-NFPA 86-2025

Public Comment No. 16-NFPA 86-2025 [New Section after A.5.3.3]

Second Revision No. 16-NFPA 86-2025 [Section No. 6.2.4.2]

6.2.4.2* Piping and Fittings.

6.2.4.2.1*

Piping materials shall be compatible with the fluid and service conditions.

6.2.4.2.1.1

Natural gas, manufactured gas, or liquefied petroleum gas (LP-Gas in vapor phase) piping shall comply with NFPA 54 or ASME B31.3, *Process Piping*.

6.2.4.2.1.2

Hydrogen gas or hydrogen gas mixture piping shall comply with NFPA 2 or ASME B31.12, *Hydrogen Piping and Pipelines*.

6.2.4.2.1.3

Gas piping not addressed in 6.2.4.2.1.1 and 6.2.4.2.1.2 shall comply with the applicable requirements of ASME B31.3, *Process Piping*.

6.2.4.2.1.4

Where threaded fuel gas piping is used it shall be a minimum schedule 40.

6.2.4.2.2

Fuel gas piping shall be sized to provide flow rates and pressure to maintain a stable flame over the burner operating range.

6.2.4.2.3*

The interior of gas pipe, tubing, and fittings shall be free of debris before putting into service.

6.2.4.2.4*

Where flange connections are used, they shall have the same dimensional specifications of the mating flange.

A.6.2.4.2.4

Examples of dimensional specifications for welded connections are as follows:

(1) For gray cast iron and white cast iron flange connections, see the following:

(a) ASME B16.1, *Gray Iron Pipe Flanges and Flanged Fittings: Classes 25, 125, and 250*

(b) ISO 7005-2, *Metallic flanges — Part 2: Cast iron flanges*

(2) For copper flanges, see the following:

(a) ANSI/ASME B16.24, *Cast Copper Allow Pipe Flanges and Flanged Fittings: Classes 150, 300, 600, 900, 1500, and 2500*

(b) ISO 7005-3, *Metallic flanges - Part 3: Copper alloy and composite flanges*

(3) For other flanged connections, see the following:

(a) ASME B16.5, *Standard for Pipe Flanges and Flanged Fittings: NPS ½ through NPS 24, Metric/Inch Standard*

(b) ISO 7005-1, *Metallic flanges — Part 1: Steel flanges for industrial and general service piping systems*

Additional flange specifications exist; however, those listed in this section are the most common.

Supplemental Information

File Name	Description	Approved
86_SR-16_6.2.4.2.docx		

Submitter Information Verification

Committee: OVE-AAA

Submittal Date: Wed Aug 13 14:02:41 EDT 2025

Committee Statement

Committee Statement: This revision clarifies that the flanges need to mate correctly in accordance with their dimensional specifications and allows for other specifications other than NFPA 54 or ASME B31 series. There are instances where ISO flanges and ASME flanges have been incorrectly mated as they approximately fit but when bolted together the bolt is incorrectly inserted.

Response Message: SR-16-NFPA 86-2025

Public Comment No. 8-NFPA 86-2025 [Section No. 6.2.4.2]

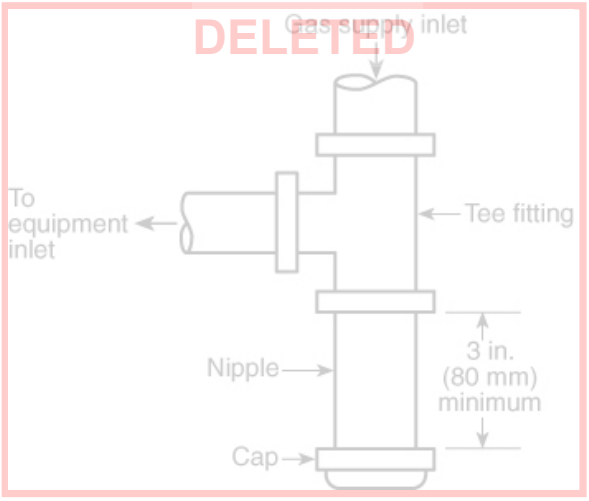
Second Revision No. 9-NFPA 86-2025 [Section No. 6.2.5.2]

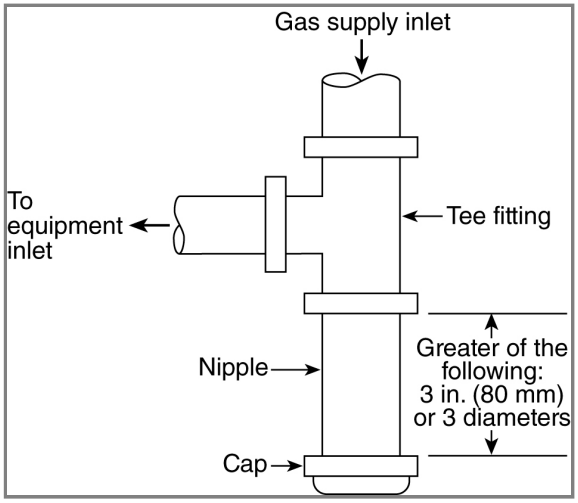
6.2.5.2*

Sediment traps shall have a descending vertical gas supply inlet with horizontal outlet to the equipment and a serviceable lower vertical leg with a minimum length of ~~three pipe diameters [minimum of~~ 3 in. (80 mm)~~] of the same size as the supply pipe~~ or three nominal pipe diameters of straight pipe as run between adjacent fittings, whichever is greater, as shown in Figure 6.2.5.2.

Figure 6.2.5.2 Method of Installing a Tee Fitting Sediment Trap. ~~**[54:Fig. 9.6.8]**~~

DELETED





A.6.2.5.2

A drip leg and sediment trap are the same assemblies of piping but serve different purposes. Drip legs are used where the gas is “wet” or contains liquids. Sediment traps are installed to remove debris in the gas piping system before it reaches critical components or appliances. Some authorities having jurisdiction or appliance manufacturers require drip legs or sediment traps in all gas piping systems.

Typically, most debris is introduced during and immediately after the installation of the gas piping system, such as weld slag or dirt that entered the system before pressure testing or charging with fuel gas.

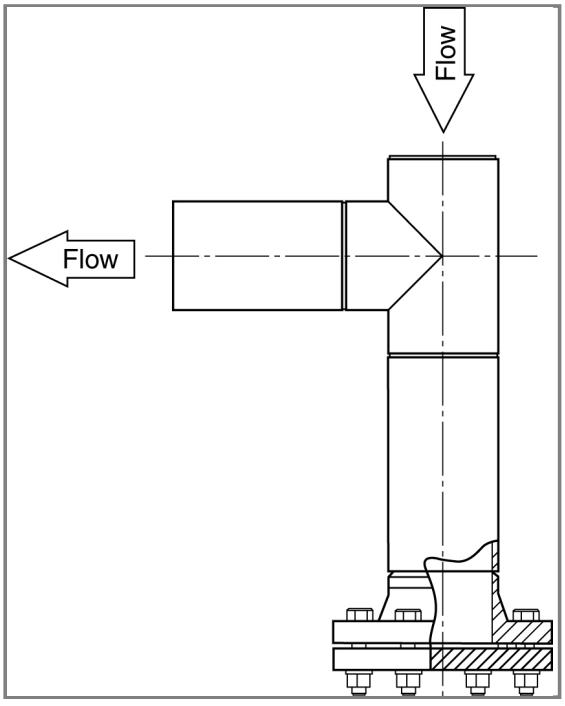
Sediment traps are intended to be serviceable items, and means for field inspection should be provided. It is recognized that the inspection frequency of sediment traps varies, but it is recommend that if a strainer or filter is noted as having collected a reasonable level of debris that the sediment trap be inspected.

Consider adding further steps if nonconventional contaminants or moisture in the supply fuel exist or enhanced serviceability is desired.

It is recognized that welded piping could create extended sediment trap lengths due to weldments. One such acceptable alternate is shown in Figure A.6.2.5.2 .

Where multiple equipment branch piping takeoffs for a single appliance are manifolded from a common gas supply inlet, the manifold from the equipment isolation valve through to the bottom of the sediment trap should be arranged as a single vertical column of continuous size for the full descending span.

Figure A.6.2.5.2 Alternate Sediment Trap for Welded Piping.



Supplemental Information

File Name	Description	Approved
SR_9_Figures.pdf	Prod: These figures need to be revised. The one with the flange is the annex figure, the other one is the requirement figure.	

Submitter Information Verification

Committee: OVE-AAA
Submittal Date: Tue Aug 12 15:06:48 EDT 2025

Committee Statement

Committee Statement:	For pipe diameters greater than 1”, 3 diameters is needed to maintain a significant enough volume to collect debris and create an appropriate vortex to drop the debris out of the fluid flow. Additionally, the inlet needs to be vertical, so the force of gravity pulls the sediment out of the vortex. The figure is also being corrected to match the requirement text. Annex material is added to explain conditions where sediment traps may need to be cleaned more often and provide an example of a welded sediment trap. Explanation of drip leg protection for multiple equipment branch piping take offs has been added to explain how those installations should be protected.
Response Message:	SR-9-NFPA 86-2025

Second Revision No. 10-NFPA 86-2025 [Section No. 6.2.5.3]

6.2.5.3*

A gas filter or strainer with an element sized for the application shall be installed in the fuel gas piping ~~and shall be located downstream of the equipment isolation valve and sediment trap and upstream of all other fuel gas system components~~ .

A.6.2.5.3

When the fuel train is opened for service, the risk of dirt entry exists. ~~It is not required that existing piping be opened for the sole purpose of the addition of a filter or strainer. It is good practice to have the sediment trap located upstream of the filter.~~ The intent of the sediment trap is to remove larger particulates, while the intent of the filter is to remove smaller particulates. The reverse arrangement will result in additional maintenance and could result in removal of the filter element from service. The mesh size should be ~~sized~~ selected to protect downstream controls as prescribed by the downstream components' manufacturer(s).

6.2.5.3.1

The gas filter or strainer required in 6.2.5.3 shall be located downstream of the equipment isolation valve and sediment trap and upstream of all other fuel gas system components.

Supplemental Information

File Name	Description	Approved
86_SR-10_6.2.5.3.docx		

Submitter Information Verification

Committee: OVE-AAA

Submittal Date: Tue Aug 12 15:37:02 EDT 2025

Committee Statement

Committee Statement: A mesh or filter sized for the application needs to be provided to protect the downstream components. The previous language did not specify a size, and it is now up to the designer and downstream component manufacturer to determine the size of the mesh or filter to protect those downstream components.

Second Revision No. 11-NFPA 86-2025 [Section No. 6.2.8]

6.2.8 Overpressure Protection.

6.2.8.1

Overpressure protection shall be provided in either of the following cases:

(1) Where the supply pressure exceeds the ~~maximum~~ operating pressure limitation of any downstream component

(2) Where the failure of a single upstream line regulator or service pressure regulator results in a supply pressure exceeding the ~~maximum~~ operating pressure limitation of any downstream component

6.2.8.2

Overpressure protection shall be provided by any one of the following:

(1) A series regulator in combination with a line regulator or service pressure regulator

(2) A monitoring regulator installed in combination with a line regulator or service pressure regulator

(3)* A full-capacity pressure relief valve

(4)* An overpressure cutoff device

(5) A high-pressure switch in combination with a rated shutoff valve

6.2.8.3*

The overpressure protection device (OPD) shall be set no higher than the maximum operating pressure of the downstream component having the lowest rated pressure.

A.6.2.8.3

Overpressure protection devices (OPD) should be set to prevent a pressure that causes loss of containment, leakage into the furnace or oven, or unsafe operation of the burner. This setting should consider the operating pressure limitation or rating for safety shutoff valves, gas pressure switches / sensing devices, gas pressure regulators, and manual shutoff valves.The setting of the OPD should additionally consider the burst pressure (pressure the causes loss of gas containment) for gauges, fittings, test valves, flow control valves, and other components installed that don't provide proper operation of the burner, or devices, if they fail, don't cause an increase in hazardous conditions.

Sometimes the actual pressure downstream of an ~~overpressure protection device~~ OPD can exceed its setting. This is due to the response time of the ~~overpressure protection device~~ OPD and the failure mode of the upstream system. However, the system should be designed to minimize this delay in response time.

Submitter Information Verification

Committee: OVE-AAA

Submittal Date: Tue Aug 12 16:08:18 EDT 2025

Committee Statement

Committee Statement: There are many variations in how pressure ratings and limitations are marked and the change provides a performance approach rather than a prescriptive limitation for designers. There are too many variations in system design to provide a prescriptive number to design for. Annex material has been provided to explain the performance design approach.

Response Message: SR-11-NFPA 86-2025

Public Comment No. 2-NFPA 86-2025 [Section No. 6.2.8]

Second Revision No. 15-NFPA 86-2025 [New Section after 7.4.3]

7.4.3.1*

The user shall establish a cleaning/housekeeping schedule that mitigates the accumulation of combustible material before quantities become sufficient to be ignited.

A.7.4.3.1

A PHA or material testing could be needed to determine cleaning frequency *(see Annex N)* . Additional information to assist in determining the cleaning frequency can be found in FM Property Loss Prevention Data Sheet 6-9, “Industrial Ovens and Dryers.”

Submitter Information Verification

Committee: OVE-AAA

Submittal Date: Wed Aug 13 13:54:26 EDT 2025

Committee Statement

Committee Statement: This change specifically addresses the cleaning frequency to be established by the user based upon ignitible concentrations. This is intended to convey that maintenance activities include cleaning. Annex material provides guidance on how to establish the frequency and extent of cleaning. Includes pointers to Annex N and FM Data Sheet 6-9.

Response Message: SR-15-NFPA 86-2025

Public Comment No. 5-NFPA 86-2025 [New Section after 7.4.3]

Public Comment No. 6-NFPA 86-2025 [Section No. O.1.2.10]

Second Revision No. 12-NFPA 86-2025 [Section No. 8.2.7]

8.2.7

Safety devices shall not be bypassed electrically or mechanically.

8.2.7.1

The requirement in 8.2.7 shall not prohibit a time delay when used in accordance with all requirements in 8.2.7.1.1 through 8.2.7.1.6 . ~~safety device testing and maintenance in accordance with 8.2.5 . Where a system includes a "built-in" test mechanism that bypasses any safety device, it shall be interlocked to prevent operation of the system while the device is in the test mode, unless listed for that purpose.~~

8.2.7.1.1*

Time delays shall only be applied to the action of pressure-proving, flow-proving, or proof-of-closure safety switch as used in accordance with 8.7.1.12.3(3)

A.8.2.7.1.1

No delay timers should be installed on devices that directly measure the flammability risk, such as continuous vapor concentration controllers or oxygen measurement systems on LOC equipment.

8.2.7.1.2

There shall be a documented operational need demonstrated for the time delay.

8.2.7.1.3

The time delay shall be approved.

8.2.7.1.4

The time delay shall not be adjustable beyond 5 seconds.

8.2.7.1.5

A single time delay shall not serve more than one pressure-proving or flow-proving safety device.

8.2.7.1.6

The time from an abnormal pressure or flow condition until the holding medium is removed from the safety shutoff valves shall not exceed 5 seconds.

8.2.7.2*

The requirement in 8.2.7 shall not prohibit the installation of "built-in" test mechanisms that bypasses any safety device when used in accordance with all the requirements in 8.2.7.2.1 and 8.2.7.2.2 . ~~a time delay applied to the action of pressure-proving, flow-proving, or proof-of-closure safety switch as used in accordance with 8.7.1.12.3(3) , where the following conditions exist:~~

~~There is an operational need demonstrated for the time delay.~~

~~The use of a time delay is approved.~~

~~The time delay feature is not adjustable beyond 5 seconds.~~

~~A single time delay does not serve more than one pressure-proving or flow-proving safety device.~~

~~The time from an abnormal pressure or flow condition until the holding medium is removed from the safety shutoff valves does not exceed 5 seconds.~~

A.8.2.7.2

A "built-in" test mechanisms can include electrical devices, logical programming, isolation valves, or test ports that can render a safety device ineffective if not returned to normal operation. The test mechanism could be integral to the safety device or a separate device as part of an assembly.

8.2.7.2.1

The test mechanism(s) shall be necessary to conduct documented safety device testing and documented maintenance in accordance with 8.2.5 .

8.2.7.2.2

The test mechanism(s) shall be either interlocked in accordance with Section 8.2 to prevent operation of the system while the device is in the test mode or alterative protective measures implemented in accordance with 8.2.7.2.2.1 through 8.2.7.2.2.3 .

8.2.7.2.2.1*

Alterative protective measures shall be defined within a documented PHA.

A.8.2.7.2.2.1

Alterative protective measures could include administrative controls.

8.2.7.2.2.2

The defined alterative protective measures shall be implemented.

8.2.7.2.2.3

The documented PHA shall be approved.

Supplemental Information

File Name	Description	Approved
86_SR-12_8.2.7.docx		

Submitter Information Verification

Committee: OVE-AAA

Submittal Date: Tue Aug 12 16:42:19 EDT 2025

Committee Statement

Committee Statement: Ovens often contain components or devices to enable testing or maintenance on the system that if left in the incorrect state would render safety system ineffective. The changes to section 8.2.7 adds additional requirements to ensure that systems are returned to normal operation so that the safety system will function when required. The requirements include either interlocking of the test mechanism to prevent system operation or through the implementation of alternative protective measures.

Response Message: SR-12-NFPA 86-2025

Public Comment No. 3-NFPA 86-2025 [Section No. 8.2.7]

Second Revision No. 19-NFPA 86-2025 [Section No. 8.7.1.8]

8.7.1.8

Valves shall not be subjected to ~~supply~~ pressures in excess of the manufacturer's ratings.

Submitter Information Verification

Committee: OVE-AAA
Submittal Date: Wed Aug 13 16:24:47 EDT 2025

Committee Statement

Committee Statement: All pressures are of concern here not just supply pressure.
Response Message: SR-19-NFPA 86-2025

Second Revision No. 13-NFPA 86-2025 [Section No. 8.9.6]

8.9.6*

A line burner, pipe burner, ~~or~~ radiant burner, or other burner arrangements with multiple burner components considered to be a single burner with a heated length in excess of 3 ft (0.9 m) shall have at least one flame detector installed to sense main burner flame at the end of the assembly farthest from the source of ignition.

8.9.6.1

A line burner, pipe burner, ~~or~~ radiant burner, or burner arrangements with multiple burner components considered to be a single burner with a pilot shall have one flame detector installed to sense pilot burner flame at the source of ignition, unless compliant with 8.9.5(2) and 8.9.5(3) .

8.9.6.2

A line burner, pipe burner, radiant burner, or burner arrangements with multiple burner components considered to be a single burner shall be equipped and installed with flame propagation devices for reliable flame-propagation characteristics from one burner component to the next.

8.9.6.3

Where conditions are required for reliable flame-propagation characteristics from one burner to the next, those conditions shall be proven and interlocked into the burner management system.

Submitter Information Verification

Committee: OVE-AAA

Submittal Date: Wed Aug 13 13:39:02 EDT 2025

Committee Statement

Committee Statement: There are other types of burner arrangements that need to be considered when implementing these requirements and these need to be added to the requirement. Additionally all of these types of burners need to have flame propagation devices installed to prove proper ignition of the burners and need to be interlocked to control their operation when out of control.

Response Message: SR-13-NFPA 86-2025

Second Revision No. 21-NFPA 86-2025 [Section No. 10.4.2]

10.4.2* Operations.

A.10.4.2

See FM 6-11, “Thermal and Regenerative Catalytic Oxidizers,” for additional guidance.

10.4.2.1

The oxidizer system shall be started and brought to operating temperature prior to introducing ~~fume (dirty gas)~~ process flow.

10.4.2.2

The user shall be responsible for ensuring that the exhaust stream of the ~~volatile organic compound (VOC)~~ process flow source is not ~~in~~ within the designed flammable range for the mixture ~~of VOC~~ being destroyed in the oxidizer system.

10.4.2.3

The operator shall ensure the process flow is within the designed flammability range before reintroducing a process stream to an operating thermal oxidizer.

~~**10.4.2.3**~~

~~Where it cannot be demonstrated that the exhaust stream of the VOC source cannot exceed 25 percent of the lower flammable limit (LFL), the owner or operator of the oxidizer system shall install both of the following:~~

~~At least one continuous vapor concentration high limit interlock in the duct that conveys the VOC and air mixture to the oxidizer system, in accordance with 11.6.9.3.1 .~~

~~A 3-way diverter valve that redirects the oven exhaust flow to an exhaust stack that leads directly to atmosphere.~~

~~**10.4.2.4**~~

~~The continuous vapor concentration high-limit interlock sensor shall be located as close as possible to the point where the VOC conveying duct leaves the source oven.~~

~~**10.4.2.4.1**~~

~~Redundant continuous vapor concentration high-limit interlock sensors shall be permitted to be installed downstream of the nearest upstream sensor by a distance greater than two duct diameters.~~

~~**10.4.2.5**~~

~~The location of the 3-way diverter valve shall be as close as possible to the tie-point for the downstream oxidizer system.~~

~~**10.4.2.5.1**~~

~~The 3-way diverter valve shall be located at least 200 ft (61 m) downstream of the primary continuous vapor concentration high-limit interlock sensor location.~~

10.4.2.6

All of the following automatic actions shall be taken when any continuous vapor concentration high limit interlock is tripped:

The source oven's heating system shall be shut off.

The introduction of new feed material into the source oven shall be halted.

* The source of VOC fumes shall be diverted to atmosphere until the vapor concentration limit interlock is clear and the fault has been reset by the operator.

A.10.4.2.6(3) –

Oxidizer systems are nearly always installed to mitigate the environmental impact of airborne volatile organic compound (VOC) emissions from processes such as solvent-drying ovens by destroying the VOC before the exhaust is emitted to atmosphere. This process is beneficial to the environment and for the health of nearby residents. However, if the solvent in the exhaust gas stream approaches a flammable concentration, protecting the safety of the personnel and nearby structures becomes a more important goal than protecting the environment from several ounces (or a few hundred grams) of a volatile pollutant compound. This is a simple observation that some risks are more dangerous than others and mitigating the greater risk, to the temporary detriment of the smaller risk, is the prudent choice. The only practical method of explosion protection for an unintentional excursion of VOC concentration into a dangerous proximity to the lower flammable limit (LFL) is temporarily diverting the exhaust gas flow away from an oxidizer system and to the outdoor atmosphere as required, preferably at the top of a tall stack.

Explosion safety professionals who understand the need for an emergency diversion of fume gas that is nearly flammable may get pushback from air pollution authorities who do not want pollutants to ever be emitted into the atmosphere. Anecdotes about air pollution regulators who have rejected engineering plans that include a diverter valve upstream of an oxidizer system are relatively common. It is intended that this annex be used by operating entities who are seeking construction permits and operating permits for air pollution equipment that contain a diverter valve as a vital safety feature that the fire safety community deems to be a requirement.

Entities who own and operate ovens and oxidizer systems that require an emergency diverter valve should be willing to express their dedication to the principle that any safety-driven diversion of VOC compounds to atmosphere will be as short-lived as possible and will emit the smallest mass of VOC possible. This principle can be demonstrated by the owner's willingness to employ measures that immediately reduce the production of the VOC during any period when a diversion to atmosphere is necessary. Such measures include shutting down the oven's heating system and halting the introduction of new solvent-laden material into the oven. Owners of oxidizer systems should also be willing to provide process data (e.g., datalogger values of the continuous vapor concentration controller's LFL percentage and the time period for which the diverter valve is open) that parallels routine stack data already provided to the environmental regulating authority (e.g., stack gas velocity, temperature, carbon dioxide, and oxygen). Oxidizer system owners should also be willing to pay appropriate fines for excursions of VOC emissions.

As a fallback, if air quality regulators are intransigent about relaxing their rules to permit safety venting of flammable mixtures that could otherwise cause an explosion, other safety measures should be considered. The following safety measures are not as simple or as effective as a 3-way flow diverter valve, but they are mentioned here as a last resort:

Introduce a dilution airstream to ensure vapor concentration is below 25 percent LFL prior to being introduced to the operating oxidizer system.

When purging equipment that contains an indeterminate (possibly flammable) atmosphere, introduce airflow to the equipment being purged slowly, and open the damper to the oxidizer gradually, thereby reducing vapor concentration in the ductwork. The purge timer would start after minimum purge airflow rate is reached.

Use another engineered system (e.g., extra residence time in pre-oxidizer ductwork combined with extra dilution air) specifically designed to prevent a slug of high-concentration gas flow from reaching the oxidizer.

See FM 6-11, *Thermal and Regenerative Catalytic Oxidizers* , for additional guidance.

~~**10.4.2.7**~~

~~The continuous vapor concentration controller shall be permitted to be used to initiate an additional dilution process that minimizes solvent reduction concentration before it reaches the high-limit threshold.~~ ~~(*See 11.6.10.9* .)~~

~~**10.4.2.8**~~

~~The operator shall ensure the VOC concentration is less than 25 percent of LFL before deactivating the 3-way diverter valve to reintroduce a VOC and air fume stream to an operating thermal oxidizer.~~

Supplemental Information

File Name	Description	Approved
86_SR-21_10.4.2.docx		

Submitter Information Verification

Committee: OVE-AAA

Submittal Date: Fri Aug 15 12:46:59 EDT 2025

Committee Statement

Committee Statement: Not all things that go into a thermal oxidizer are VOC and the term is broadened to specify what it applies to. Not all thermal oxidizers process flows that are outside the flammable range and some are designed to do it as a percentage of the flammable range. Regardless they need to operate in the range they were designed to. The deleted requirements and annex are redundant with chapter 11 requirements (e.g. 11.6.10.2) as 10.2.1 requires thermal oxidizers to follow the Class A requirements for construction and are not operating requirements. Additionally some of the requirements are also related to items required when doing a PHA (see annex e).

Response Message: SR-21-NFPA 86-2025

Public Comment No. 7-NFPA 86-2025 [Section No. 10.4.2]

Second Revision No. 5-NFPA 86-2025 [Section No. 11.4.1.1]

11.4.1.1 Solvent Atmosphere Ovens.

The safety design data form or nameplate for solvent atmosphere ovens shall include all of the following design data:

(1) Solvent used

(2) Quantity ~~of solvent~~ expressed in gallons (~~liters~~ L) or pounds (kg) per batch or in gallons (L) or pounds (kg) per hour ~~entering the oven~~ as applicable for the batch or continuous process, respectively

(3) Required purge time

(4) Oven operating temperature

(5) Exhaust blower rating for the quantity of solvent in gallons (~~liters~~ L) or pounds (kg) per batch or in gallons (L) or pounds (kg) per hour at the maximum operating temperature, as applicable for the batch or continuous process, respectively

Supplemental Information

File Name	Description	Approved
86_SR-5_11.4.1.1.docx		

Submitter Information Verification

Committee: OVE-AAA

Submittal Date: Tue Aug 12 13:53:53 EDT 2025

Committee Statement

Committee Statement: The quantity of solvents either need to be in an amount if the process is batch or rate if the process is continuous. The rate information is being added to convey this information.

Response Message: SR-5-NFPA 86-2025

Public Comment No. 17-NFPA 86-2025 [Section No. 11.4.1.1]

Second Revision No. 6-NFPA 86-2025 [Section No. 11.6.1.3]

11.6.1.3

The determination of safety ventilation shall be based on all of the following:

(1) Volume of products of combustion entering the oven heating chamber

(2) Weight or volume of flammable or combustible constituents released during the heating process, based on maximum loading

(3) ~~Solvent that requires the greatest amount of ventilation air per gallon (liter) when a combination of solvents is used~~ When a combination of solvents is used or the solvent characteristics of the mixture is unknown, the ventilation rate is determined by the methods in 11.6.8 or 11.6.9 using either of the following:

(a) The constituent solvent requiring the greatest ventilation rate

(b) By testing the mixture for its characteristics to determine its required ventilation rate

(4) Design of the oven heating and ventilation system with regard to all of the following:

(a) Materials to be processed

(b) Temperature to which processed materials are raised

(c) Method of heating with regard to direct or indirect venting of combustion products versus alternative use of steam or electrical energy

(d) General design of the oven with regard to continuous or batch-type operation

(e) Type of fuel and chemicals to be used and any by-products generated in the heating chamber

Submitter Information Verification

Committee: OVE-AAA

Submittal Date: Tue Aug 12 14:03:48 EDT 2025

Committee Statement

Committee Statement: There are cases in which the the calculation based on the worst case solvent scenario does not accurately predict the solvent characteristics (e.g. those mixtures that deviate from Raoult's Law) and testing the mixture is the most accurate way to determine the characteristics. Additionally if the solvent characteristics are unknown they need to be tested to determine their characteristics. The calculation methods are also being pointed to for ease of use.

Response Message: SR-6-NFPA 86-2025

Public Comment No. 18-NFPA 86-2025 [Section No. 11.6.1.3]

Second Revision No. 17-NFPA 86-2025 [Section No. A.5.3]

A.5.3

Many ovens include an explosion hazard related to the fuels used for heating, flammable vapors released from the work in process, or the use of special atmospheres. To control these hazards, several methods from NFPA 69 can be applied, including the following:

(1) Avoiding combustion through the control of the following:

(a) Combustible concentration [i.e., keeping combustible material below its lower flammable limit (LFL)]

(b) Oxidant concentration (i.e., reducing oxygen below the level needed for ignition)

(2) Limiting damage by confining deflagration pressures.

Table A.5.3 identifies explosion controls in NFPA 86 that apply to different classes of oven.

Table A.5.3 Explosion Controls

Control Method	Oven Class			
	A	B	C	D
Controlling Combustible Concentration				
Safety shutoff valves per Chapter 8	X	X	X	X
Preignition purge per Chapter 8	X	X	X	X
Trials-for-ignition per Chapter 8	X	X	X	X
Flame supervision per Chapter 8	X	X	X	X
Safety ventilation per Chapter 11	X			
Controlling Oxidant Concentration				
Low oxygen atmosphere oven per Chapter 11	X			
Special atmosphere control per Chapter 13			X	~~X~~
Special atmosphere control per Chapter 14				X
Confining Deflagration Pressure				
Pressure vessel design per Chapter 14				X

Beyond these explosion controls, Section 5.3 provides additional guidance on explosion control options for Class A ovens. Explosion hazards can be mitigated based on oven design considerations (such as the heat source or recirculation of the exhaust air), added controls (such as LFL monitoring), and the use of deflagration venting.

For additional information regarding deflagration venting see NFPA 68.

Submitter Information Verification

Committee: OVE-AAA

Submittal Date: Wed Aug 13 15:48:58 EDT 2025

Committee Statement

Committee Statement: In the 2023 code cycle, the relevant portions of Chapter 13 were merged into Chapter 14 in order to make Chapter 14 independent of Chapter 13. Now all requirements regarding Oxidant Concentration for vacuum furnaces are found in Chapter 14.

Response Message: SR-17-NFPA 86-2025

Public Comment No. 9-NFPA 86-2025 [Section No. A.5.3]

Second Revision No. 3-NFPA 86-2025 [Section No. O.1.2]

O.1.2 Other Publications.

O.1.2.1 AIChE Publications.

American Institute of Chemical Engineers, 120 Wall Street, Floor 23, New York, NY 10005-4020.

www.aiche.org/ccps

CCPS *Guidelines for Hazard Evaluation Procedures,* 2008.

O.1.2.2 ANSI Publications.

American National Standards Institute, Inc. (operations) 1180 Avenue of the Americas, 10th Floor, New York, NY 10036; (headquarters) 1899 L Street, NW, 11th Floor, Washington, DC 20036.

ANSI A14.3, *Safety Requirements for Fixed Ladders*, 2008.

ANSI Z21.18/CSA 6.3, *Standard for Gas Appliance Pressure Regulators*, 2019.

ANSI Z21.21/CSA 6.5, *Automatic Valves for Gas Appliances*, 2023.

ANSI Z117.1, *Safety Requirements for Confined Spaces*, 2022.

ANSI/IEC 31010, *Risk Management - Risk Assessment Techniques*, 2019.

ANSI/ISA 84.00.01, *Functional Safety: Safety Instrumented Systems for the Process Industry Sector - Part 1: Framework, Definitions, System, Hardware and Software Requirements*, 2004.

O.1.2.3 API Publications.

American Petroleum Institute, 200 Massachusetts Avenue, NW, Suite 1100, Washington, DC 20001-5571.

API 510, *Pressure Vessel Inspection Code: In-Service Inspection, Rating, Repair, and Alteration*, 2022.

API STD 520 P1, *Sizing, Selection, and Installation of Pressure-Relieving Devices in Refineries, Part 1: Sizing and Selection*, 2020.

API STD 520 P2, *Sizing, Selection, and Installation of Pressure-Relieving Devices in Refineries, Part 2: Installation*, 2020.

API 570, *Piping Inspection Code: Inspection, Repair, Alteration, and Rerating of In-Service Piping Systems*, ~~2016~~ 2024 .

O.1.2.4 ASME Publications.

American Society of Mechanical Engineers, Two Park Avenue, New York, NY 10016-5990.

ASME B16.1, *Gray Iron Pipe Flanges and Flanged Fittings Classes 25, 125, and 250*, 2020.

ASME B16.5, *Pipe Flanges and Flanged Fittings NPS 1/2 Through NPS 24 Metric/Inch Standard*, ~~2020~~ 2025 .

ASME B16.22, *Wrought Copper and Copper Alloy Solder-Joint Pressure Fittings*, 2021.

ASME B16.23, *Cast Copper Alloy Solder Joint Drainage Fittings: DWV*, 2016.

ASME B16.24, *Cast Copper Alloy Pipe Flanges and Flanged Fittings Class 150, 300, 400, 600, 900, 1500, and 2500*, 2021.

ASME B31.3, *Process Piping*, ~~2022~~ 2024 .

ASME B31.12, *Hydrogen Piping and Pipelines*, 2023.

ASME *Boiler and Pressure Vessel Code*, Section VIII-*Rules for Construction of Pressure Vessels*, Division 1, ~~2023~~ 2025 .

O.1.2.5 ASTM Publications.

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

ASTM E681, *Standard Test Method for Concentration Limits of Flammability of Chemicals (Vapors and Gases),* 2009, reapproved ~~2015~~ 2023 .

O.1.2.6 AVS Publications.

American Vacuum Society, 125 Maiden Lane, 15th Floor, New York, NY 10038.

"Graphic Symbols in Vacuum Technology," *J. Vac. Sci. Technol.*, Vol. 4, No. 3 (1967), pp. 139–142.

Glossary of Terms Used in Vacuum Technology, New York: Pergamon Press, 1958.

O.1.2.7 CENELEC Publications.

CENELEC, European Committee for Electrotechnical Standardization, CEN-CENELEC Management Centre, Rue de la Science 23, B - 1040 Brussels, Belgium.

BS EN 161, *Automatic Shut-off Valves for Gas Burners and Gas Appliances*, 2011, Amendment 3, 2022.

BS EN 1643, *Safety and Control Devices for Gas Burners and Gas Burning Appliances - Valve Proving Systems for Automatic Shut-off Valves*, 2022.

BS EN 13611, *Safety and Control Devices for Burners and Appliances Burning Gaseous and/or Liquid Fuels,* amended 2021.

O.1.2.8 CGA Publications.

Compressed Gas Association, 8484 Westpark Drive, Suite 220, McLean, VA 22102.

CGA G-2, *Anhydrous Ammonia*, 2021.

CGA G-2.1/ANSI K61.1, *Safety Requirements for the Storage and Handling of Anhydrous Ammonia*, 2023.

CGA G-4.1, *Cleaning Equipment for Oxygen Service*, 2018.

CGA G-4.4, *Oxygen Pipeline and Piping Systems*, 2020.

CGA G-5, *Hydrogen*, 2024.

CGA G-6, *Carbon Dioxide*, 2019.

CGA G-6.1, *Standard for Insulated Liquid Carbon Dioxide Systems at Consumer Sites*, 2022.

CGA P-1, *Standard for Safe Handling of Compressed Gases in Containers*, ~~2015~~ 2022 .

O.1.2.9 CSA America Publications.

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

CSA B149.6, *Code for Digester Gas, Landfill Gas, and Biogas Generation and Utilization*, 2020.

O.1.2.10 FM Publications.

FM, 270 Central Avenue, P.O. Box 7500, Johnston, RI 02919.

FM Approval 7400, *Approval Standard for Liquid and Gas Safety Shutoff Valves*, 2016.

FM Property Loss Prevention Data Sheet 1-44, "Damaged-Limiting Construction," ~~2023~~ 2024 .

~~FM Property Loss Prevention Data Sheet 6-11, "Thermal and Regenerative Catalytic Oxidizers," 2018.~~

FM Property Loss Prevention Data Sheet 6-9, "Industrial Ovens and Dryers," 2020.

FM Property Loss Prevention Data Sheet 6-13, "Waste Fuel Fired Facilities," updated January 2021.

FM Property Loss Prevention Data Sheet 6-17, "Rotary Kilns and Dryers," updated July 2023.

O.1.2.11 IEC Publications.

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

IEC 61508, *Functional Safety of Electrical/Electronic/Programmable Electronic Safety-Related Systems*, 2010.

IEC 61511, *Functional Safety: Safety Instrumented Systems for the Process Industry Sector*, 2024.

IEC 62061, *Safety of Machinery – Functional Safety – Related Control Systems*, 2021.

O.1.2.12 ISO Publications.

International Organization for Standardization, ISO Central Secretariat, BIBC II, Chemin de Blandonnet 8, CP 401 - 1214 Vernier, Geneva, Switzerland. www.iso.org

ISO 7005-1, *Metallic flanges — Part 1: Steel flanges for industrial and general service piping systems* , 2011.

ISO 7005-2, *Metallic flanges — Part 2: Cast iron flanges* , 1998.

ISO 7005-3, *Metallic flanges — Part 3: Copper Alloy and Composite flanges* , 1988.

ISO 13849-1, *Safety of Machinery*, 2023.

O.1.2.13 JIC Publications.

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

Hydraulic Standards for Industrial Equipment.

O.1.2.14 NEMA Publications.

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

NEMA TR 27, *Commercial, Institutional and Industrial Dry-Type Transformers*, 1976 (withdrawn).

O.1.2.15 NIOSH Publications.

National Institute for Occupational Safety and Health, Centers for Disease Control and Prevention, 1600 Clifton Road, Room 4505, MS E-20, Atlanta, GA 30329-4027.

NIOSH Pocket Guide to Chemical Hazards, 2007.

O.1.2.16 PCI Publications.

The Powder Coating Institute, 5040 Old Taylor Mill Road, PMB 13, Taylor Mill, KY 41015.

Recommended Procedure No. 9, "Volatile Content."

O.1.2.17 UL Publications.

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

Bulletin of Research No. 43, "The Lower Limit of Flammability and the Autogenous Ignition Temperature of Certain Common Solvent Vapors Encountered in Ovens," January 1950.

UL 353, *Limit Controls*, 1994, revised 2011.

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O.3 References for Extracts in Informational Sections.

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NFPA 69, *Standard on Explosion Prevention Systems*, 2024 edition.

NFPA 99, *Health Care Facilities Code*, 2024 edition.

NFPA 307, *Standard for the Construction and Fire Protection, of Marine Terminals, Piers, and Wharves*, ~~2021~~ 2026 edition.

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