

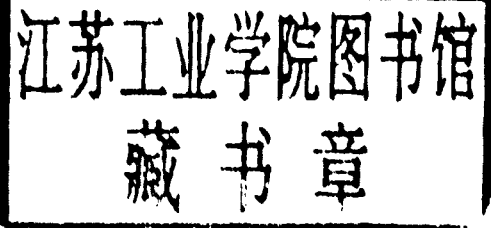


# National Fire Codes<sup>®</sup> 1985

# *National Fire Codes®*

A Compilation of NFPA Codes, Standards,  
Recommended Practices, Manuals and Guides

Volume 4



This is one of 8 volumes of the *National Fire Codes* published by the National Fire Protection Association. The complete set contains the codes, standards, recommended practices, manuals and guides developed by the technical committees of the Association and processed in accordance with the NFPA Regulations Governing Committee Projects.

National Fire Protection Association  
Batterymarch Park, Quincy, MA 02269

## **NATIONAL FIRE PROTECTION ASSOCIATION**

**Batterymarch Park, Quincy, MA 02269**

The National Fire Protection Association was organized in 1896 to promote the science and improve the methods of fire protection and prevention, to obtain and circulate information on these subjects and to secure the cooperation of its members in establishing proper safeguards against loss of life and property by fire. The Association is an international, charitable, technical and educational organization. Its membership includes over one hundred and fifty national and regional societies and associations and over thirty-two thousand individuals, corporations, and organizations. Anyone interested may become a member; membership information is available on request.

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Rev. 11/84

## *National Fire Codes*

The *National Fire Codes* are annual compilations of the Codes, Standards, Recommended Practices, Manuals, Guides and Model Laws prepared by Technical Committees organized under NFPA sponsorship in accordance with the published procedures of the Association. Only those documents which have been adopted by the Association are included in the *National Fire Codes*.

The Board of Directors of the Association appoints persons from those vitally interested, qualified, and active in the areas with which the Committees are concerned so as to achieve a fair balance of affected interests. All service on these NFPA Technical Committees is contributed voluntarily in support of the Association's program for firesafety. While these procedures assure the highest degree of care, neither the National Fire Protection Association, its members, nor those participating in its activities accept any liability resulting from compliance with the provisions given herein, for any restrictions imposed on materials or processes, or for the completeness of the text. Users should realize that complete reliance for firesafety can never rest exclusively on any single safeguard.

The committees responsible for the various texts published herein are given in the introductory sections preceding each. Current committee lists are published in the *NFPA Yearbook*, which may be obtained from the Association. Official records of the adoption of each standard will be found in the *NFPA Technical Committee Reports*, the *Technical Committee Documentation* and *Fire Journal*, a bimonthly membership publication of the Association.

Volumes 1 through 6 contain documents which have been judged suitable for legal adoption and enforcement (Codes and Standards).

Volumes 7 and 8 contain Recommended Practices, Manuals and Guides which are generally referred to as good engineering practices. Also included in these volumes are such documents as model laws and enabling acts which will be found to be particularly helpful to enforcing agencies.

Many of the documents have been approved by the American National Standards Institute as American National Standards. Most of the documents contained in these volumes are also published by the Association in separate pamphlet form.

Users of this document should consult applicable Federal, State and local laws and regulations. NFPA does not, by the publication of this document, intend to urge action which is not in compliance with applicable laws and this document may not be construed as doing so.

### **Policy adopted by NFPA Board of Directors on December 3, 1982**

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

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

# Official NFPA Definitions

Extracted from the *Regulations Governing Committee Projects*

## Section 2. Terms and Definitions.

**2-2 Definitions.** Where the following terms, commonly found in the Association Committee Documents, are used or defined in the body of the text of a Standard, Code, Recommended Practice, Manual or Guide, they shall be consistent with the intent of these meanings, but these “definitions” may be altered by a Committee to fit the individual needs of the Document. Such altered definition shall be clear and unambiguous in the context in which it is used.

**Approved:** means “acceptable to the authority having jurisdiction.”

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

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

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

**Code:** A Document containing only mandatory provisions using the word “shall” to indicate requirements and in a form generally suitable for adoption into law. Ex-

planatory material may be included only in the form of “fine print” notes, in footnotes, or in an appendix.

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

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

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

**Manual or Guide:** A Document which is informative in nature and does not contain requirements.

**Recommended Practice:** A Document containing only advisory provisions (using the word “should” to indicate recommendations) in the body of the text.

**Shall:** Indicates a mandatory requirement.

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

**Standard:** A Document containing only mandatory provisions using the word “shall” to indicate requirements. Explanatory material may be included only in the form of “fine print” notes, in footnotes, or in an appendix.

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*Notes and footnotes are informative only and are not mandatory.*

## NOTICE

All questions or other communications relating to documents in this volume should be sent only to NFPA Headquarters, addressed to the attention of the Committee responsible for the document.

For information on obtaining Formal Interpretations of the documents, proposing Tentative Interim Amendments, proposing amendments for Committee consideration, and on matters relating to the content of the document, write to the Secretary, Standards Council, National Fire Protection Association, Batterymarch Park, Quincy, MA 02269.

A statement, written or oral, that is not processed in accordance with Section 16 of the Regulations Governing Committee Projects shall not be considered the official position of NFPA or any of its Committees and shall not be considered to be, nor be relied upon as, a Formal Interpretation.



## VOLUME 4

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**NFPA 86**  
**Standard for**  
**Ovens and Furnaces**  
**1985 Edition**

This first edition of NFPA 86, *Standard for Ovens and Furnaces*, representing the combination of the former NFPA 86A and NFPA 86B, was prepared by the Technical Committee on Ovens and Furnaces, and acted on by the National Fire Protection Association, Inc. at its Fall Meeting held November 12-15, 1984 in San Diego, California. It was issued by the Standards Council on December 7, 1984, with an effective date of December 27, 1984, and supersedes all previous editions.

This first edition, 1985, of this standard has been approved by the American National Standards Institute.

**Origin and Development of NFPA 86**

This first edition of NFPA 86 is the result of the combination of the former NFPA 86A and NFPA 86B. The Committee introduced a change in the definition of Class A and Class B ovens which was published in the 1982 edition of 86B and by a tentative interim amendment, in 1983, included in the 1977 edition of 86A.

The effect of the change in definitions eliminated the principal differences in the two standards except for the ventilation requirements contained in NFPA 86A.

By providing a separate chapter, Chapter 5, for ventilation requirements in this combined document it was no longer necessary or desirable to maintain two separate documents which would address the same subjects.

Among the changes that have been incorporated into the new document are:

A new chapter has been added to the text dealing with low oxygen atmosphere ovens in keeping with recent developments in processes, the definitions of subjects contained in the text have been updated and new definitions provided, refinements in the text were made in an effort to make the document more understandable, and the material was rearranged to better comply with the NFPA manual of style.

**Origin and Development of Former NFPA 86A**

The 1950 edition of NFPA 86 was tentatively adopted at the 1948 Annual Meeting, and officially adopted in 1950. It superseded the NFPA *Standard for Ovens for Japan, Enamel, and Other Flammable Finishes*, edition of 1931.

The proposed revisions of the 1950 edition were published as a progress report in August 1962. Comments on the progress report were reviewed by the Committee and a final revision was prepared, which was adopted at the Annual Meeting in 1963. Additional amendments were prompted by the expansion of the scope to include ovens and furnaces operating at temperatures not exceeding 1400°F (760°C), and a revised edition was adopted at the Annual Meeting in 1966.

New material and editorial changes for clarification were incorporated in the 1969 edition. The 1971 edition included a new Article on "Furnace Hydraulic Systems" and a new Section on "After-Burner Systems." Requirements for powder coating operations were added in the 1973 edition.

The 1977 edition of the *Standard for Ovens and Furnaces — Design, Location, and Equipment*, was prepared by the Sectional Committee on Class A Ovens and Furnaces, and superseded the 1973 edition. The 1977 edition was a complete revision, including rearrangement as well as deletion of much superfluous material.

### Origin and Development of Former NFPA 86B

This Standard was introduced and first adopted as a tentative standard in 1968. After further study by the Committee, new material was added and editorial changes were made for clarification. These amendments were adopted in May 1969, but the Standard still retained its tentative status. It was adopted as an official standard in 1971. In the 1973 edition major revisions were adopted, covering operator training, furnace construction and exhaust systems, combustible gas indicators, and safety shutoff valves.

The Standard was revised and a new edition published in 1974. The major revision specified the conditions under which a safety shutoff valve may be used as a dual purpose valve.

This Standard was prepared by the Sectional Committee on Class B Ovens and Furnaces and was approved by the Committee on Ovens and Furnaces.

The major revisions to the 1982 publication included:

- a revision of the definitions of Class A, Class B and Class C Ovens and Furnaces;
- a consolidation and expansion of definitions and rearrangement of material in a new order;
- the elimination of a requirement for the location of a vent line between two approved safety shutoff valves; and
- the presentation of a standard format to correlate with NFPA 86A, *Ovens and Furnaces*.

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**NFPA 86**  
**Standard for**  
**Ovens and Furnaces**  
**1985 Edition**

Information on referenced publications can be found in Chapter 11 and Appendix B.

**Foreword**

Explosions and fires in fuel-fired and electric heat utilization equipment constitute a loss potential in terms of life, property, and production. This standard is a compilation of guidelines, rules and methods applicable to safe operation of this type of equipment.

There are other regulations and conditions that should be considered when designing and operating furnaces that are not covered in this standard, such as toxic vapors, noise levels, heat stress, and local, state, and federal regulations (EPA and OSHA).

The causes of practically all failures can be traced back to human failure. The most significant failures have been found to be:

- (a) Inadequate training of operators
- (b) Lack of proper maintenance
- (c) Improper application of equipment.

Users and designers must utilize engineering skill to bring together that proper combination of controls and training necessary for the safe operation of the equipment.

The standard for ovens and furnaces is set forth under classifications as follows:

**Class A** ovens or furnaces are heat utilization equipment operating at approximately atmospheric pressure, wherein there is a potential explosion and/or fire hazard which may be occasioned by the presence of flammable volatiles or combustible material processed or heated in the oven. Such flammable volatiles and/or combustible material may, for instance, originate from paints, powder, or finishing processes, including dipped, coated, sprayed, impregnated materials or wood, paper and plastic pallets, spacers or packaging materials. Polymerization or similar molecular rearrangements and resin curing are processes which may produce flammable residues and/or volatiles. Potentially flammable materials, such as quench oil, waterborne finishes, cooling oil, etc., in sufficient quantities to present a hazard are ventilated according to Class A standards. Ovens may also utilize low-oxygen atmosphere to evaporate solvent.

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

**Class C** furnaces are those in which there is a potential hazard due to a flammable or other special atmosphere being used for treatment of material in process. This type

of furnace may use any type of heating system and includes the special atmosphere supply systems. Also included in the Class C standard are integral quench and molten salt bath furnaces.

**Class D** furnaces are vacuum furnaces which operate at temperatures above ambient to over 5000°F (2760°C) and at pressures below atmospheric using any type of heating system. These furnaces may include the use of special processing atmospheres.

**Chapter 1 General**

**1-1 Scope.** This standard applies to Class A/B ovens or furnaces. The words "ovens" and "furnaces" shall be used interchangeably. When chapters or specific paragraphs in this standard apply only to Class A or B ovens, they are so noted.

Within the scope of this standard, an oven shall be any heated enclosure operating at approximately atmospheric pressure and used by industry for the processing of materials.

A Class A oven may also utilize a low-oxygen atmosphere.

This standard also applies to bakery ovens in all respects and reference is made to those sections of the American National Standard Safety Code for Bakery Equipment, ANSI Z50.1-1977, which covers bakery oven construction and safety.

Not included in this standard are coal- (or other solid fuel-) firing systems and heating systems for furnaces having a liquid heat transfer medium.

**1-2 Purpose.** Since the heat processing of materials may involve a serious fire and explosion hazard endangering the furnace and the building in which the process is located, and possibly the lives of employees, adequate safeguards shall be provided as appropriate for the location, equipment, and operation of such furnaces.

**1-3 Application.** This standard shall apply to new installations or alterations or extensions to existing equipment.

Because this standard is based upon the present state of the art, application to existing installations is not mandatory. Nevertheless, users are encouraged to adopt those features of this standard which are considered applicable and reasonable for existing installations. Inspection and maintenance (Chapter 9) shall be applied to all operating furnaces and ovens.

**1-4 Definitions.** For the purpose of this standard, the following definitions shall apply:

**Afterburner System.** See definition of Fume Incinerator.

**Air, Combustion.** All the air burned with fuel gas to supply heat in a furnace.

**Airflow Switch.** See Switch, Airflow.

**Air-Fuel Gas Mixer.** See Mixer, Air-Fuel Gas.

**Air Jet Mixer.** See Mixer, Air Jet

**Air, Primary.** All air supplied through the burner, including atomizing and combustion air.

**Air, Secondary.** All of the combustion air that is intentionally allowed to enter the combustion chamber in excess of primary air.

**Air System, High Pressure [air pressure 5 psig (34 kPa) or higher].** A system using the kinetic energy of a jet of high pressure air to entrain fuel gas, or air and fuel gas to produce a combustible mixture.

**Air System, Low Pressure [air pressure up to 5 psig (34 kPa)].** A system using the kinetic energy of a jet of low pressure air to entrain fuel gas to produce a combustible mixture where all, or nearly all, of the air required for combustion is supplied by separate means such as a combustion air blower.

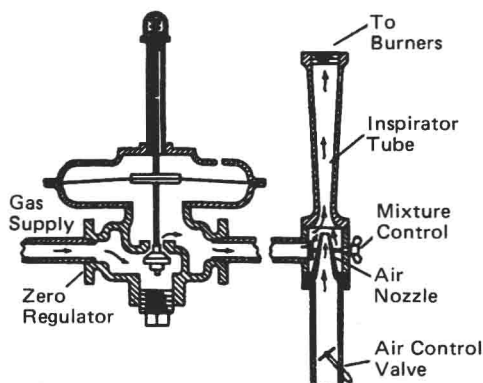


Figure 1-4.1 Example of a Typical Low Pressure Air System.

**Analyzer, Fuel Gas.** A device which measures concentrations, directly or indirectly, of some or all components in a flammable gas or mixture.

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

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

**Atmosphere, Special.** The gas, other than air, which contacts the work as it undergoes heat processing in a furnace.

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

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

**Bath, Molten Salt.** See Furnaces, Molten Salt Bath.

**Blower, Mixing.** See Mixers.

**Branch Circuit-Individual.** A branch circuit that supplies only one utilization equipment.

**Burners.**

**Burner (or Nozzle).** A device through which combustion air and fuel are released into the combustion zone. If the fuel gas and air are introduced separately, the burner is said to be "nozzle-mixing"; otherwise, an air-gas mixing device is used to supply the nozzle, which then is said to be of the (partial) premixing-type. Either way, additional means are required to control or limit the flow of the fuel and air. Oil burners are always "nozzle-mixing," even if air is used for atomization.

**Burner — Air or Steam Atomizing Type.** A burner where oil is divided into a fine spray by an atomizing agent, such as steam or air.

**Burner, Atmospheric.** A burner used in the low pressure fuel gas or "atmospheric" system which requires secondary air for complete combustion.

**Burner, Blast.** A burner delivering a combustible mixture under pressure, normally above 0.3 in. w.c. (75 kPa) to the combustion zone.

**Burner, Blast Tip.** A small metallic or ceramic burner nozzle so made that flames will not blow away from it.

**Burner, Combination Fuel Gas and Oil.** A burner which can burn either fuel gas or oil, or both together.

**Burner, Diaphragm.** A burner which utilizes a porous refractory diaphragm at the port so that the combustion takes place over the entire area of this refractory diaphragm.

**Burner, Dual-Fuel.** A burner designed to burn either fuel gas or oil, but not both together.

**Burner, Enclosed Combustion.** A burner which confines the combustion in a small chamber of a furnace and only the high temperature completely combusted gases, in the form of high velocity jets or streams, are used for heating.



**Burner, Excess Air.** A nozzle-mixing burner delivering a fixed volume of air and a variable volume of fuel gas such that complete combustion of fuel gas occurs at all rates of firing, to provide relatively uniform flow of air and products regardless of firing rates.

**Burner, Flame-Retaining Nozzle.** Any burner nozzle with built-in features to hold the flame at high mixture pressures.

**Burner, Line.** A burner whose flame is a continuous "line" from one end to the other (normally applied to a blast burner).

**Burner, Luminous Flame.** A burner which discharges nonturbulent parallel strata of air and fuel gas to produce an extended flame of high luminosity.

**Burner, Luminous Wall.** A porous refractory liner to permit fuel gas-air mixtures to flow through, forming a luminous wall.

**Burner, Multijet.** A form of burner which generally consists of fuel gas manifolds with a large number of jets arranged to fire horizontally through openings in a vertical refractory plate.

**Burner, Multiport.** A burner having two or more separate discharge openings or ports. (These ports may be either flush or raised.)

**Burner, Nozzle-Mixing.** A burner in which the fuel gas and air are kept separate until discharged from the burner into the combustion chamber or tunnel. Generally used with low pressure fuel gas [up to  $\frac{1}{2}$  psig or 14 in. w.c. (3.5 kPa)] and low pressure air [up to 5 psig (34 kPa)].

**Burner, Open Port.** Any type of burner that fires across a gap into an opening in the furnace or combustion chamber wall and is not sealed into the wall.

**Burner, Pipe.** Any type of atmospheric or blast burner in the form of a tube or pipe with ports or tips spaced over its length.

**Burner, Power.** A fuel gas burner in which either fuel gas or air, or both, are supplied at pressure exceeding, for fuel gas, the line pressure, and for air, the atmospheric pressure. Examples are fuel gas burners having zero governor inspirator mixers, those supplied by blower mixers or an approved gas-mixing machine and those supplied with air by a blower, compressor, or forced-draft fan.

**Burner, Premixed.** A burner that utilizes a positive and dependable air-fuel gas mixer to furnish the air needed for complete combustion of the fuel supplied to the burner independently of the concentration or pressure of the atmosphere inside the enclosure where the burner fires. The zero governor inspirator mixer, the high pressure [fuel gas pressure 1.0 psi (7 kPa) or higher] atmospheric inspirator mixer, the blower mixer, and the approved fuel gas-mixing machine are illustrative of such a mixer.

**Burner, Pressure.** Same as Burner Blast.

**Burner, Pressure-Atomizing.** A burner where oil under high pressure is forced through small orifices.

**Burner, Radiant.** A burner designed to transfer a significant part of the combustion heat in the form of radiation from surfaces of various shapes which are usually of refractory material.

**Burner, Radiant-Tube.** A burner of the atmospheric, premix or nozzle-mixing type specially designed to provide a long flame within a tube to assure substantially uniform radiation from the tube surface.

**Burner, Ribbon.** A burner having many small closely spaced ports, usually made up by pressing corrugated metal ribbons in a slot or other shaped opening.

**Burner, Ring.** A burner made with one or more concentric rings. Combustion air may be supplied by natural, induced, or forced draft.

**Burner, Rotary.** A burner where oil is atomized by centrifugal force, such as that applied by a whirling cone or plate.

**Burner, Self-Piloted.** A burner where the pilot fuel is issued from the same ports as the main flame and/or merges with the main flame to form a common flame envelope with a common flame base. In effect, the pilot flame is simply enlarged to become the main flame.

**Burner, Single Port.** A burner having only one discharge opening or port.

**Burner, Tunnel.** A burner sealed in the furnace wall in which combustion takes place mostly in a refractory tunnel or tuyere which is really part of the burner.

**Burner, Turndown.** The ratio of maximum to minimum burner fuel-input rates.

**Burner, Vaporizing.** A burner where oil is vaporized by heat.

**Catalytic Combustion System (Direct or Indirect Heater).** A furnace heater of any construction that employs catalysts to accelerate the oxidation or combustion of fuel-air mixtures for eventual release of heat to a furnace process.

**Check, Safe-Start.** A checking circuit incorporated in a safety control circuit that prevents lighting-off if the flame-sensing relay of the combustion safeguard is in the unsafe (flame-present) position due to component failure within the combustion safeguard, or due to the presence of actual or simulated flame.

**Cock, Supervising.** A special approved cock incorporating in its design means for positive interlocking with a main fuel safety shutoff valve so that before the main fuel safety shutoff valve can be opened, all individual burner supervising cocks must be in the fully closed position.



Figure 1-4.2 Example of a Supervising Cock, Electrical Interlocking.

**Cock, Supervising, Electric Interlocking.** A conventional straight-through cock with a special built-in switch assembly protected against tampering, and arranged so that switch contacts are closed only when the cock is in the fully closed position.

NOTE: This type of supervising cock is suitable for both gas or oil fuels. The switch contacts of all cocks are wired in series in the safety control circuit, so that all supervising cocks must be closed before the main fuel safety shutoff valve can be opened.

**Cock, Supervising, Pneumatic Type.** A special approved cock similar to the usual burner fuel gas cock, except that it has two side outlets which furnish a small independent passageway which is opened only after the main fuel gas passage is completely closed.

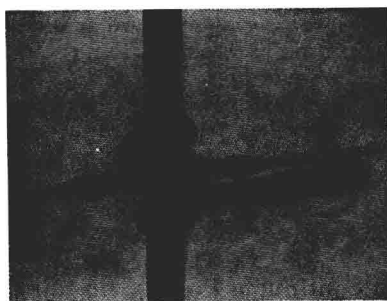


Figure 1-4.3 Example of a Supervising Cock, Pneumatic Type.

The keyway width is narrow enough in respect to size and proportions of the main fuel gas ports to ensure positive closure of the main fuel gas way before opening the side outlets. This particular type of supervising cock is not suitable for fuel oil.

**Combustion Safeguard.** See Safeguard, Combustion.

**Continuous Vapor Concentration Indicators and Controllers.** Devices which measure and indicate, directly or indirectly, in percentage of the lower explosive limit (LEL), the concentration of a flammable vapor-air mixture.

**Controller, Continuous Vapor Concentration.** Devices which measure and indicate, directly or indirectly, in percentage of the lower explosive limit, the concentration of a flammable vapor-air mixture.

**Controller, Temperature.** A device which measures the temperature and automatically controls the heat input into the furnace.

**Controls, Fuel Safety.** Devices such as safety shutoff valves, flame detection units, fuel pressure switches (high and low), combustible gas detectors, flowmeters, fire-checks, reliable ignition sources, and supervisory cocks.

**Controls, Ventilation.** Devices such as flow switches, pressure switches, fan shaft rotation detectors, dampers, position limit switches, time delay and electrical interlocks, which are placed in the system to ensure adequate ventilation prior to establishing the source of heat and during the operation of the heating equipment.

**Cut-Off Room.** See Room, Cut-Off.

**Damper Cut-Away.** A restricting airflow device that, when placed in the maximum closed position, will permit a minimum amount of airflow past the restriction. Cut-away dampers are normally placed in the exhaust and/or fresh air intake ducts to ensure that the required minimum amount of exhaust and/or fresh air is handled by the ventilating fans to keep the solvent vapor concentration in the furnace below the designed concentration level.

**Device, Flame Detection.** A device which will detect the presence or absence of flame. Flame detection devices may be based on:

- (a) Flame rectification
- (b) Ultraviolet radiation
- (c) Infrared radiation
- (d) Heat actuation.

**Device, Photoelectric, Infrared and Ultraviolet Detecting.** A detector based on the radiant energy of specific wave lengths of the flame. The current passing through the detector is amplified by the combustion safeguard to actuate suitably arranged relays to make or interrupt the power to the fuel safety shutoff valves.

**Dielectric Heater.** See Heater, Dielectric.

**Direct-Fired.** Any heating system where the products of combustion enter the furnace chamber and come in contact with the work in process.

**Direct-Fired External Heater.** See Heater, Direct-Fired External.

**Direct-Fired External Nonrecirculating Heater.** See Heater, Direct-Fired External Nonrecirculating.

**Direct-Fired External Recirculating Heater.** See Heater, Direct-Fired External Recirculating.