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Standards

for

INERT GAS
For
FIRE AND EXPLOSION PREVENTION

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Inert Gas for Fire and Explosion Prevention.

This code was prepared jointly by the Committee on Dust Explosion Hazards and the N.F.P.A. Committee on Manufacturing Hazards in 1930 and 1931 and adopted by the N.F.P.A. in 1931. A minor amendment was adopted in 1938. A further amendment was adopted in 1941, on the joint recommendation of the N.F.P.A. Committee on Dust Explosion Hazards and the Committee on Special Extinguishing Systems.

The code was approved by the American Standards Association as American Standard in 1931 and reapproved as amended in 1940 and 1943. A.S.A. No. Z12.10—1943.

It was adopted and published as standards by the National Board of Fire Underwriters in 1933, 1942 and 1946 in N.B.F.U. Pamphlet No. 12.

It was published by the Bureau of Labor Statistics, U. S. Department of Labor, in Bulletin No. 562 in 1931.

CODE FOR THE USE OF INERT GAS FOR FIRE AND EXPLOSION PREVENTION.

Introduction.

1. Carbon dioxide or other inert gases which when mixed with air reduce the oxygen percentage of the atmosphere below the combustion limit can be used successfully in providing protection against fires and explosions in certain hazards.

NOTE: This code covers only the use of inert gas for fire and explosion preventions. For extinguishing fires by carbon dioxide see Standards for Carbon Dioxide Fire Extinguishing Systems.

2. These rules indicate a standard method of using carbon dioxide or other inert gases for the prevention of explosions and fires where the hazards are of such a nature as to make this form of protection necessary or desirable.

NOTE: Examples of where such protection may be called for are ovens, driers, grinders or pulverizers, special machinery and apparatus involving the use or handling of flammable liquids, vapors or dusts within an inclosure, tanks used for storage of flammable liquids, and bins, vaults or other such inclosures containing material through which gas may permeate and where it is unnecessary for anyone to enter the inclosure at frequent intervals.

3. Inert gas protection is not recommended for nitrocellulose or other pyroxylin plastics in large quantities nor to prevent ignitions or explosions of zirconium or magnesium powders, nor in cases where decomposition or the release of combustion supporting agents may occur and render ineffective inert gas protection.

4. Neither carbon dioxide nor nitrogen are poisonous but in sufficient quantity they are suffocating and it is not intended that inert gas should be used in inclosures where employees are at work.

NOTE: Ordinarily no one would be overcome in an atmosphere of air and carbon dioxide or nitrogen in the concentrations recommended within a time amply sufficient for retirement from the room or inclosure.

5. Neither carbon dioxide nor nitrogen will injure metals, fabrics, food products, or other perishable material. They do not freeze, deteriorate, nor will they conduct electricity.

6. Where other inert gases such as flue gas, internal combustion, engine exhaust, carbon tetrachloride, sulphur dioxide, di-chloro methane, etc., are used special precautions are necessary to prevent possible injurious effects on employees or on the product being protected. Carbon monoxide is poisonous even in minute quantities and, where inert gas is liberated through the room, carbon monoxide alarms or recorders may be necessary to protect operators.

NOTE: Flue gas is generally the most readily available and most frequently used inert gas because it is economical and contains a relatively high percentage of carbon dioxide. Injurious gases, particularly carbon monoxide, may be present in flue gas or internal combustion engine exhaust and no one should be permitted to enter any inclosure where poisonous gas is present or has been used until the inclosure has been thoroughly ventilated and a test or an analysis shows that no injurious gas remains.

In certain processes the use of steam is necessary or desirable and in such cases it may be used in combination with other inert gases provided it does not introduce any additional fire hazards due to high temperatures.

7. Since the use of inert gas for fire and explosion prevention is a comparatively new development it is recommended that these rules be used with discretion. Only general essentials and the average necessary specifications to make a workable code are given. Details for each installation will necessarily vary according to the local conditions and the hazard involved. Inspection departments having jurisdiction should be consulted as to the application of these standards and all details of installation, including the question of what additional special hazard protection, if any, should be provided and what other standards are applicable.

General.

8. The reduction of the oxygen content of air (normally 21 per cent) necessary to prevent explosions and fires varies with the different materials being handled. Detailed information concerning the oxygen reduction necessary is given under the section entitled "Determining the Amount of Inert Gas Required."

9. Apparatus protected should be inclosed as tightly as possible and arranged so that the supply of inert gas may mix with and dilute the air entering the inclosure before any possible sources of ignition are reached.

10. Inert gas should be injected into inclosures at the top or in such a way that it will be distributed as uniformly as possible.

11. In tubes, spouts, conveyors, etc., or where drafts are present the gas should be injected into the inclosure so as to be carried along with the draft or stock.

12. At spreaders, belt feeders or other machines where hoods are provided to carry away dust or fumes the gas should be introduced at the point of hazard and distributed in such a way as to sufficiently dilute the air entering the hood.

13. Before any inert gas equipment is installed or remodeled complete working plans showing necessary details of the local conditions, hazards and of the proposed equipment shall be submitted for approval to the inspection department having jurisdiction.

14. All apparatus and devices used shall be approved and standard so far as such approvals and standards apply.

Determining the Amount of Inert Gas Required.

15. Before the amount of inert gas required can be determined it is necessary to know the volume of air entering the inclosure or hood where the hazard exists and the reduction of the oxygen percentage necessary to prevent ignition. In closed rooms or bins the normal air leakage or rate of air change represents the volume to be considered. This determination should be made by actual measurement if possible but may be computed if necessary.

16. Table I indicates the percentage to which the oxygen must be reduced to prevent ignitions or explosions of the dusts and gases listed when the required oxygen percentage is obtained by adding to air pure carbon dioxide. Where gases other than pure carbon dioxide are used lower oxygen percentages are required. The information at present available indicates that when nitrogen is used instead of carbon dioxide the oxygen percentage should be reduced about 10% below the figure given in the table. Both carbon dioxide and nitrogen are present in different percentages in flue gas, the medium most generally used in installations requiring extremely large quantities of inert gas. When it is desired to provide inert gas protection for a dust or vapor not listed or to use an inert gas other than pure carbon dioxide or where any unusual condition exists the inspection department having jurisdiction should be consulted and if the information is not available arrangements should be made for laboratory tests to determine the oxygen reduction necessary under the existing conditions.

Table I.

Permissible Percentage of Oxygen Based on the Addition of Carbon Dioxide.

Material	Maximum Permissible Oxygen Percentage
Pittsburgh Coal Dust	16
Pyrethrum Flower Dust	15.5
Acetone	15
Cotton Lint or Dust in Suspension in air	15
Ethyl Alcohol	15
Gasoline Vapor	15
Kerosene Vapor	15
Methane	14.5
Cork Dust	14.1
Wheat, Corn or Oat Elevator Dust	14
Ground Oat Hulls	13.7
Ether	13
Hard Rubber Dust	13
Wheat Starch	12
White Dextrine	12
Sulphur	11
Ethylene	10
Carbon Disulphide	8
Cotton in Bulk—to prevent smouldering and reignition	8
Jute	8
Carbon Monoxide	5.9
Hydrogen	5.9

17. If a pure inert gas is to be used, i.e., a gas which contains no oxygen or other combustible component the amount required is calculated on the basis of the percentage of oxygen permitted by using the formula:

$$x = \frac{21 - O}{O} V$$

in which x is the amount of inert gas required, O is the maximum percentage of oxygen permitted and V is the volume of fresh air containing 21% oxygen within an inclosure and to be introduced into a machine or inclosure.

For example, if 12% is the maximum amount of oxygen permitted and the inclosure to be protected contains 1000 cubic feet of fresh air.

$$x = \left(\frac{21 - 12}{12}\right) 1000$$

$$x = 750$$

Under such conditions it would be necessary to introduce 750 cubic feet of pure inert gas into an inclosure to replace 750 cubic feet of the 1000 cubic feet of air or gas and air contained therein before it would be safe to start the process creating the hazard. To maintain this safe condition it would be necessary to add 750 cubic feet of inert gas to each 1000 cubic feet of fresh air admitted to the inclosure to replace leakage or as a part of the process.

18. When the inert gas to be used already contains a certain percentage of oxygen as is the case when flue gas is the source of supply the amount is calculated on the basis of the percentage of oxygen permitted and the percentage of oxygen already present in the gas by using the following formula:

$$x = \left(\frac{21 - O}{O - O_F}\right) V$$

in which x is the amount of inert gas required, O is the maximum percentage of oxygen permitted. O_F is the percentage of oxygen in the flue gas and V is the volume of fresh air containing 21% oxygen within an inclosure or to be introduced into a machine or inclosure.

For example, if 12% is the maximum amount of oxygen permitted and the flue gas contains 11% of oxygen and the inclosure contains 1000 cubic feet of fresh air

$$x = \left(\frac{21 - 12}{12 - 11}\right) 1000$$

$$x = 9000$$

Under such conditions it would be necessary to pass 9000 cubic feet of flue gas containing 11% oxygen into and through an inclosure of 1000 cubic feet capacity before it would be safe to start the process creating the hazard. To maintain this safe condition it would be necessary to mix 9000 cubic feet of flue gas with each 1000 cubic feet of fresh air admitted to the inclosure to replace leakage or as a part of the process.

NOTE: In cases such as cited in the foregoing example where the proportion of flue gas to fresh air is so large it is recommended that flue gas be used in the full amount necessary to replace leakage or carry on the process without making any attempt to combine or mix it with fresh air.

Sources of Inert Gas Supply.

19. Inert gas for fire and explosion prevention shall be obtained from a dependable source capable of supplying continuously the amount required to dilute the oxygen within the inclosure protected to the predetermined point where ignitions will be impossible. Gas may be obtained from storage tanks, gas producers, boiler settings, special furnaces, internal combustion engines, or similar sources.

20. If gas is obtained from storage tanks or gasometers provision shall be made to maintain the gas supply while recharging the tank or tanks. A duplicate set of tanks may be necessary unless the system is arranged so that a sufficient reserve supply can be maintained to provide protection during the recharging period.

21. If gas producers are used to furnish the inert gas they shall have twice the gas producing capacity necessary to protect the hazard unless they are used in connection with storage tanks or gasometers, and can be operated to replenish the stored supply during periods when no gas is needed for protection.

22. When inert gas is obtained from boiler settings or special furnaces provision shall be made to maintain the supply at all times while the hazard exists. Where the gas supply may fail and the process protected is continuous a reserve supply in storage tanks may be necessary. If gas is obtained from the breeching of a battery of boilers provision shall be made through the use of dampers or valves to prevent dilution of the flue gas with fresh air drawn through the grates or openings of any boilers which are idle or shut down.

23. If power is necessary to operate the equipment in which the hazard exists an internal combustion engine can often be used as a source of power and the exhaust gases used to provide protection against fire and explosion. The engine can also be used to operate a compressor to compress the exhaust gases or force them through pipes to the point where they are to be used.

24. When exhaust gases from an internal combustion engine are used precaution shall be taken to keep the air-fuel ratio 12 to 1 or higher, otherwise the exhaust gases themselves may contain sufficient combustibles to form explosive mixtures with air.

Gas Conditioning Equipment.

25. When flue gas or any gas which may be injurious to the product or plant equipment is used suitable cooling and conditioning apparatus shall be installed. No conditioning equipment will be necessary if clean, pure carbon dioxide or other commercially available inert gas is obtained from an approved source.

26. Gas shall be cooled below the temperature at which it would be a fire hazard to the product or equipment. Cooling of flue gas may be accomplished by using it as the source of heat in preheaters, economizers, or similar boiler room equipment in which air or water is heated, or by passing it through cooling towers consisting of long runs of straight or spiral air or water cooled pipe.

27. Conditioning equipment may consist of a dust or soot separator, a coke or wooden grid scrubber, a spray washer, one of the many types of

filters, or air cleaners now on the market, a moisture trap or a combination of these or similar equipment designed to remove the objectionable impurities or render the gas suitable for use.

NOTE: Special fans or filters can be used to remove a large percentage of the dust, soot, and cinders generally present in flue gas.

Spray washers can be used to remove very fine dust, soot, and certain other impurities.

A good and low cost scrubber of the grid type may be constructed by grouping inside a steel shell through which the gas passes a number of grids consisting of thin boards on edge and spaced a short distance apart. The boards of one grid should cross the boards in the grid immediately below or above at a slight angle to induce a spiral flow of gas and the entire interior of the scrubber kept moist by a flow of water counter to the flow of gas.

Moisture traps may be provided to catch any excess moisture in the gas leaving the cleaning equipment, where moisture would be injurious to the product or material being protected or the gas distributing system.

Gas Distributing System.

28. Equipment for distributing inert gas to the various machines, inclosures, or points where an explosion and fire hazard exists will consist of a fan, blower pump or compressor near the source of gas supply with the necessary piping and valves. Fans or blowers may be unnecessary if sufficient suction is provided by the process creating the hazard, but care should be taken in such installations to guard against the dilution of the inert gas due to the entrance of fresh air through leaky joints or fittings.

29. Fans, blowers or compressors shall be of ample capacity to handle the required amount of gas and shall be installed in accordance with the N.F.P.A. Standards for the Installation of Blower and Exhaust Systems for Dust, Stock and Vapor Removal.*

30. The distributing pipes where gas is to be used at more than one point should be installed so that the cross sectional areas of the various branch lines are proportional to the amount of gas they are to carry.

31. Piping should be of ample size to deliver the required amount of gas without unnecessary friction loss. High or low pressure systems may be used.

32. Valves which can be sealed after the proper setting is determined shall be installed to control and regulate the flow of gas in all branch lines.

33. Drains shall be provided in the pipe line where necessary for the removal of condensed moisture.

34. Pipe connections to the inclosures to be supplied with inert gas shall be arranged to distribute the gas uniformly and when high pressure systems are used provision shall be made to reduce the pressure before it enters any inclosure so that the contents would not be disturbed by the entering stream of high pressure gas.

35. Where spray nozzles, discharge cones or horns are found necessary to distribute the gas uniformly they should be designed to particularly apply to the local conditions and shall be made of heat resisting material.

36. Non-corrosive pipe and fittings should be used where no conditioning equipment is used to remove from the gas, sulphur or other impurities which would attack ordinary iron piping.

*Published in the National Fire Codes, Volume III, Building Construction and Equipment.