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Building Construction

Tentative Guide for

SMOKE AND HEAT VENTING

Tentatively Adopted May, 1960

NOTICE

This pamphlet circulates for review and comment these recommendations of the NFPA Committee on Building Construction which were Tentatively Adopted at the 1960 NFPA Annual Meeting.

Readers are warned that this text does not present official recommendations of the National Fire Protection Association in its present form.

Comments are solicited on these Tentative Recommendations from all those interested.

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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. Its membership includes two hundred national and regional societies and associations (list on outside back cover) and nearly eighteen thousand individuals, corporations, and organizations. Anyone interested may become a member; membership information is available on request.

This is one of a large number of publications on fire safety issued by the Association; a complete list is available without charge on request. All NFPA standards adopted by the Association are published in the **National Fire Codes** which are re-issued annually. The standards, prepared by the technical committees of the NFPA and adopted in the annual meetings of the Association, are intended to prescribe reasonable measures for minimizing losses of life and property by fire. All interests concerned have opportunity through the Association to participate in the development of the standards and to secure impartial consideration of matters affecting them. Complete information on Committees will be found in the NFPA Year Book.

Official NFPA Definitions

SHALL is intended to indicate requirements.

SHOULD is intended to indicate recommendations, or that which is advised but not required.

APPROVED refers to approval by the authority having jurisdiction.

Units of measurements used here are U. S. standard. 1 U. S. gallon = 0.83 Imperial gallons = 3.785 liters. One foot = 0.3048 meters. One inch = 24.50 millimeters. One pound per square inch = 0.06805 atmospheres = 2.307 feet of water.

Approved Equipment

The National Fire Protection Association does not "approve" individual items of fire protection equipment, materials or services. The suitability of devices and materials for installation under these standards is indicated by the listings of nationally recognized testing laboratories, whose findings are customarily used as a guide to approval by agencies applying these standards. Underwriters' Laboratories, Inc., Underwriters' Laboratories of Canada, the Factory Mutual Laboratories and the American Gas Association (gas devices) test devices and materials for use in accordance with the appropriate standards, and publish lists which are available on request.

GUIDE FOR SMOKE AND HEAT VENTING

(NFPA No. 204-T — 1960)

This Guide for Smoke and Heat Venting, No. 204-T, was tentatively adopted by the Association at its 1959 Annual Meeting. The 1959 Guide so adopted was a revision of the 1958 text, "A Tentative Guide for Emergency Smoke and Heat Venting in Industrial Properties," published in the 1958 Advance Reports as Memorandum No. 204-P. The present Guide (No. 204-T) is the 1959 Guide with editorial rewording of Paragraph 115. It is retained in tentative status for circulation so that the Committee may have the benefit of any further test or field experience that may develop as well as comments or criticisms from informed sources prior to final adoption.

GUIDE FOR SMOKE AND HEAT VENTING

NFPA No. 204-T, 1960

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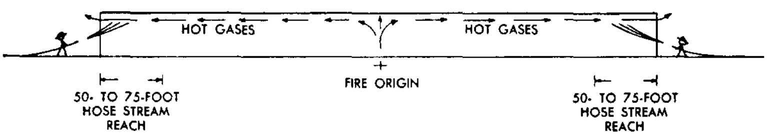


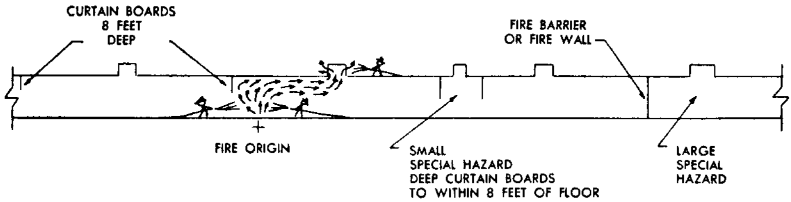
BEHAVIOR OF HOT GASES UNDER FLAT ROOF
Flat-roofed building, 900 feet wide, 20 feet high.

SECTION 1. GENERAL INFORMATION

100. Importance

101. There has been a general trend, since the end of World War II, toward large single-area, one-story buildings using light construction, to gain an increased efficiency in assembly line operations. Production-minded industrialists do not favor division walls as they restrict the mobility of conveyor lines and make operational changes and expansions more difficult. The result, from the fire protection viewpoint, has been the very vulnerable exposure of high values, within large single fire areas, to extensive fire loss with accompanying production interruption of staggering proportion.

This has increased the difficulty of fire fighting, since the fire department must enter these buildings to combat fire in the central sections of the plant. If unable to enter the building, because of heat and smoke, efforts may be reduced to vain application of hose streams to the perimeter areas, while fire consumes the vast interior of the plant.



BEHAVIOR OF HOT GASES UNDER MONITORED AND CURTAINED ROOF

Flat-roofed building same size as that illustrated on preceding page, 900 feet wide, 20 feet high with monitors 8 feet wide having ordinary glass side lights 5 feet high, spaced 100 feet on centers. With these arrangements, note that firemen can reach seat of fire inside of building and also reach it from the roof.

102. Fire extinguishment is normally accomplished by absorption of heat by water applied by sprinklers or hose streams with resultant reduction of the temperature of the burning material below its ignition point. The release of heat from its confinement within a building, through proper venting facility, reduces the amount of required cooling and generally retards spread of the fire.

103. Vents are not a substitute for sprinklers or other extinguishing facilities. Their purpose is to relieve smoke and heat from the building and to improve accessibility for the fire department so as to permit close approach and direct action against the seat of the fire.

110. Application and Scope

111. These provisions are intended to offer guidance in the design of facilities for the emergency venting of heat and smoke from uncontrolled fires. They do not attempt to specify under what conditions venting must be provided as this is dependent upon an analysis of the individual situation. However, venting is particularly desirable in those situations where manual fire fighting may be unduly handicapped or where automatic protection may be overtaxed as, for example, in large area industrial buildings or warehouses, windowless buildings, underground structures or in areas housing hazardous operations.

112. This guide does not apply to other ventilation (or lighting, as may be the case with monitors and skylights) designed for regulation of temperature within a building, for personnel comfort or production equipment cooling.

113. Venting may be desirable in either sprinklered or unsprinklered buildings. A serious fire may occur during a period when all, or a portion, of the automatic sprinkler protection may be out of service for repair or changes. In addition, a fire, in concentrated operations involving highly combustible materials and warehousing, may spread rapidly and overtax the sprinklers. Because of this, the combined counteracting effect of heat and smoke relief and fire department action may be essential to check its spread.

114. Building construction of all types is included, although it is to be recognized that superior fire-resistive construction has inherent advantages.

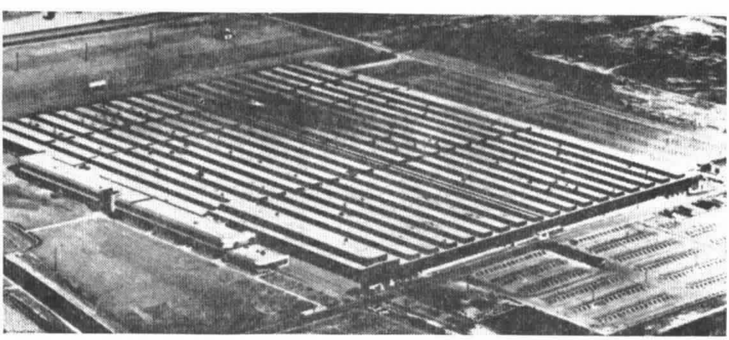
115. If this guide were to be applied to multiple-story buildings, there are many features that would be difficult or impractical for incorporation into the lower floors of such buildings.

120. Principles of Venting

121. There are so many variables which apply to the burning of combustible material that no exact mathematical formula is possible for determining precise venting requirements. The rate of combustion varies appreciably according to the nature, shape, size and packaging of the combustible material, the size and height of piling and other factors; the volume of heat and smoke to be vented differs accordingly. Vent sizes and ratios have therefore been developed from tests and experience, using theory only for guidance.

122. If severe damage to exposed structural steel is to be avoided, temperature of vented heat must not be sufficient to overheat the steel, thus materially reducing its strength.

123. The height of a column of hot gases has a direct relationship to the volume of hot gas that will be discharged by thermal updraft through an opening of a given size. Curtain boards, or their equivalent, increase the column effect which is essential to good venting.



PLANT WITH MONITORS

The plant shown is well equipped with roof monitors with side lights of ordinary glass. Such a plant has ample venting facilities. Curtain boards are required along lines across the monitors.

130. Classification of Occupancies

131. Tests and studies provide a basis for division of plants into classes depending upon the fuel available for contribution to fire. There is a wide variation in the quantities of combustible materials in the many kinds of industrial plants and between various buildings and areas of most any individual plant. Classification should take into account the average or anticipated fuel loading and the rate of heat release anticipated from the combustible materials or flammable liquids contained therein.

(a) Low Heat Release Occupancies: This class includes those buildings or portions of buildings containing scattered small quantities of combustible materials. Such areas might be found in:

Metal stamping plants
Machine shops, with dry machining and like operations
Foundries
Breweries
Dairy products processing plants
Bakeries
Meat packing plants

(b) Moderate Heat Release Occupancies: This class includes those buildings or portions of buildings containing moderate quantities of combustible material which are fairly uniformly distributed. Such areas might be found in:

Automobile assembly plants
Leather goods manufacturing
Printing and publishing plants
Machine shops using combustible oil coolants, hydraulic fluids, or involving similar hazards

(c) High Heat Release Occupancies: This class includes buildings or portions of buildings containing either hazardous operations or concentrated quantities of combustible materials or both. Such areas might be found in:

Painting departments
Oil quenching departments
Chemical plants
Paper mills
Rubber products manufacturing plants
General warehouses

132. It is to be recognized that many plants will have buildings or areas falling into each of the above classifications. An automobile plant, for example, might contain stamping presses and dry machining (Low Heat Release); upholstery and trim (Moderate Heat Release); and large paint spraying and dipping operations, and rubber tire storage (High Heat Release). Accordingly, venting facilities should be designed for the different classifications.

133. In new construction, consideration should be given to means of future increase in venting if heat release classification is likely to be either increased or relocated, or both.

SECTION 2. VENTS

200. Types of Vents

201. Venting can be accomplished by use of the following facilities:

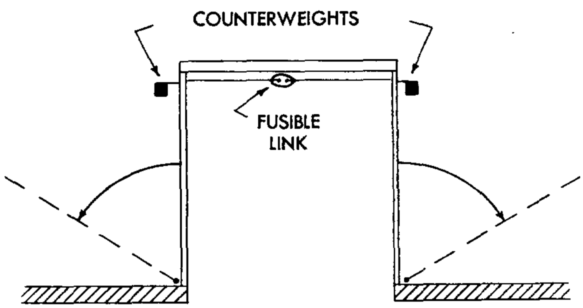
(a) Monitors: This type usually depends upon the breakage of ordinary glass (not over 1/8 inch thick) in the side walls to provide venting, although, where light is unimportant, metal panels may be used in lieu of glass, and arranged to open automatically in event of fire. Where conservation of building heat is not a factor, louvers are often used. Wired glass is unacceptable unless the sash is arranged to open automatically. Both sides of monitors should be designed to vent to assure that wind direction, at time of fire, will not impede its effectiveness.

(b) Continuous Gravity Vents: This type of vent is a continuous narrow slot opening, with a weather hood above, similar to those frequently used along the gable of a pitched-roof, foundry-type building. If movable shutters are provided to control temperature, they should be automatic-opening in event of fire.

(c) Unit Type Vents: This type of vent is of relatively small area, usually 4 by 4 feet to 10 by 10 feet, and is distributed about the roof according to the occupancy requirement. Generally they are lightweight metal frames and housing, with hinged dampers which may be operated manually or automatically opened in event of fire.

(d) Sawtooth Roof Skylights: Since wired glass in fixed sash is generally used in sawtooth skylights, it offers no value as a venting facility, unless plain glass is used or movable sash is provided and equipped with devices to open automatically in case of fire.

(e) Exterior Wall Windows: These may be considered as effective vents provided the windows are along the eaves. Lower windows are of very limited venting benefit since heat will bank up against the ceilings. In multiple-story buildings, exterior windows may be the only practical means for venting of all but the top floor.



SIMPLE VENT RELEASE

Simple unit vent or monitor with panels hinged at bottoms. Panels open by force of gravity on counterweights when weights are released when heat from fire operates fusible link.

210. Release Methods

211. It is essential that release of the venting facility be automatic in operation to eliminate the uncertainty of the human element. The release should be relatively simple in design and independent of electrical power since electrical services may be interrupted by the fire.

212. Automatic operation is best secured by a simple linkage with a fusible link in connection with counterweights, and associated equipment, utilizing the force of gravity for opening the vents.

213. It is permissible to utilize the vents for normal ventilation by means of motor-driven or manually operated shutters, dampers, covers, and like equipment. However, an automatic release is still essential and must be capable of releasing the vent independently of any other device.

214. Noncorrodible materials shall be used for hinges, latches, and related details to prevent sticking and consequent failure to open.

215. Release devices which permit automatic opening from internal pressure are undesirable over occupancies which are susceptible to water damage. Vents so equipped may open as a result of pressure differential during wind and rain storms. Authorities having jurisdiction should be consulted.

220. Effective Vent Area

221. The effective venting area is the minimum cross-sectional area through which the hot gases must pass enroute to atmosphere. In the case of monitors, this would be the cross-sectional area of the throat of the monitor or the area of the side lights on one side of the monitor, whichever is the lesser.

222. No consideration may be given to the increased air movement obtained by power-operated fans, since it must be assumed, at least to the vents involved, that, in event of fire, power will be interrupted, or fans damaged by heat.

230. Dimensions and Spacing of Vents

231. The minimum dimension for an effective vent opening should not be less than 4 feet in any direction. This would also be applicable to the vertical openings in monitors.

232. Well-distributed smaller vents are more effective than a smaller number of large vents. A theoretical ideal would be sufficient vents so that one could open directly above any fire which might occur. This, of course, is impractical. However, it does emphasize the importance of limiting the spacing between vents. The maximum spacing between vents for the three occupancy classifications is:

(a) Low Heat Release Content: 150 feet between centers.

(b) Moderate Heat Release Content: 120 feet between centers.

(c) High Heat Release Content: 75 to 100 feet between centers, depending upon the severity of fire potential.

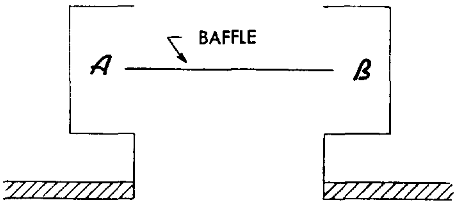
240. Venting Ratios

The following ratios of effective area of vent openings to floor areas should be provided for the various occupancy classifications:

(a) Low Heat Release Content: 1:150.

(b) Moderate Heat Release Content: 1:100.

(c) High Heat Release Content: 1:30 to 1:50.



EFFECTIVE VENT AREA

The baffle in this unit vent greatly reduces the net cross-section area through which hot gases are vented to atmosphere. The effective vent area in the example would equal A plus B.

SECTION 3. CURTAIN BOARDS

300. General

301. Curtain boards (draft curtains) are essential for proper venting as they bank up heat and smoke within the curtained area, resulting in a pressure differential which directs the heat and smoke toward the vents for relief. It has been established that vents are ineffective without curtain boards, since only the heat and smoke near the vents will be vented.

302. In sprinklered properties, curtain boards serve an important purpose since banked-up heat within the curtained area will speed the operation of automatic sprinklers. In the case of flash fires, heat is retarded by curtain boards from spreading throughout the building and opening sprinklers unnecessarily.

310. Construction

311. Curtain boards are usually made of sheet metal. However, any substantial noncombustible material may be used: asbestos board, metal lath and plaster, and the like.

320. Location and Depth

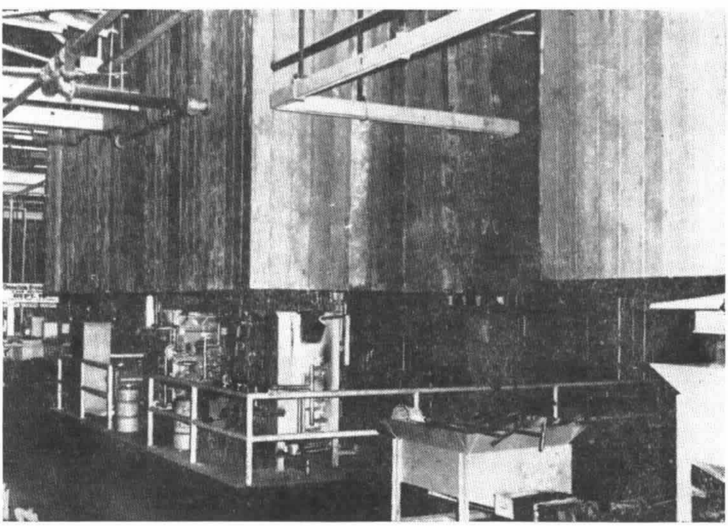
321. Curtain boards should extend down from the ceiling for a minimum depth of 6 feet. Around special hazards, the depth should be 12 feet, and where a high ceiling is involved, the curtains should preferably extend down to within 8 or 10 feet of the floor.

330. Spacing

331. The distance between curtain boards should not exceed 250 feet and the curtained area should preferably be limited to 50,000 square feet. In high heat release occupancies, the distance between curtain boards should not exceed 100 feet and the curtained area should preferably be limited to 10,000 square feet.

332. If monitors, or continuous gravity vents, are utilized, with prescribed spacing, no parallel curtains will be necessary.

333. In sprinklered buildings, the curtain boards should preferably be located so as to separate sprinkler systems.



DEEP CURTAIN BOARD AROUND SPECIAL HAZARD

Equipped with proper venting, a noncombustible curtain board extending down from ceiling around special hazards will prevent smoke and heat from mushrooming throughout the plant. Curtain board for a heat treating department is shown.