NFPA No.

204

GUIDE FOR

SMOKE AND HEAT VENTING 1968

Fifty Cents

NATIONAL FIRE PROTECTION ASSOCIATION
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Official NFPA Definitions

Adopted Jan. 23, 1964: Revised Dec. 9, 1969. Where variances to these definitions are found, efforts to eliminate such conflicts are in process.

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Guide for
SMOKE AND HEAT VENTING

NFPA No. 204 — May, 1968

This Guide, developed by the Committee on Building Construction, was adopted by the National Fire Protection Association at the annual meeting on May 23, 1968. This 1968 edition contains a new section on Inspection and Maintenance, which is the only change from the 1961 edition.

This project was initiated in July 1956 when the NFPA Board of Directors voted to refer the subject to the Committee on Building Construction. After extensive committee consideration, a Tentative Guide was submitted to the NFPA in 1958. It was revised and tentatively adopted in 1959, further revised and again tentatively adopted in 1960, and officially adopted in 1961.

COMMITTEE ON BUILDING CONSTRUCTION

E. E. Miller, *Chairman*,
Factory Insurance Assn., 300 W. Adams St., Chicago, Ill. 60606

Charles W. Crouch, General Motors Corp., Argonaut Realty Div.

A. D. DesRoches, Office of the Fire Marshal, Canadian Forces Hdqrs.

Robert E. Grimditch, Conference of Special Risk Underwriters.

John L. Jablonsky, American Insurance Assn.

Edwin B. Lancaster, American Institute of Architects.

R. L. Parks, Underwriters' Laboratories, Inc.

Edwin N. Searl, Western Actuarial Bureau.

Herman H. Spaeth, Pacific Fire Rating Bureau.

Wm. R. Tripp, Fire Marshals Assn. of North America.

J. A. Wilson, Factory Mutual Engineering Corporation.

Alternates.

R. P. Day, Factory Insurance Assn. (Alternate to E. E. Miller.)

L. S. Shook, Western Actuarial Bureau. (Alternate to Edwin N. Searl.)

Lyndon Welch, American Institute of Architects. (Alternate to Edwin B. Lancaster.)

SCOPE: The design, installation and maintenance of building construction features not covered by other NFPA committees. (This committee does not cover building code requirements, exits, protection of openings, vaults, air conditioning, blower systems, etc., which are handled by other committees.)

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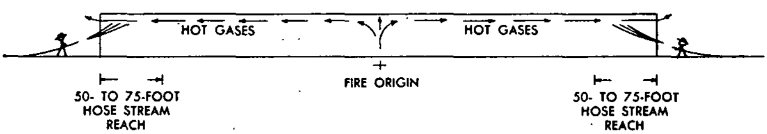
CONTENTS



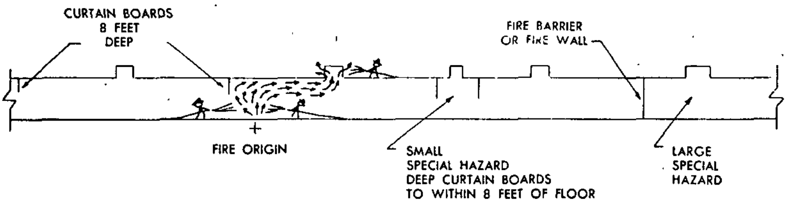
BEHAVIOR OF HOT GASES UNDER FLAT ROOF
Flat-roofed building, 900 feet wide, 20 feet high.

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.

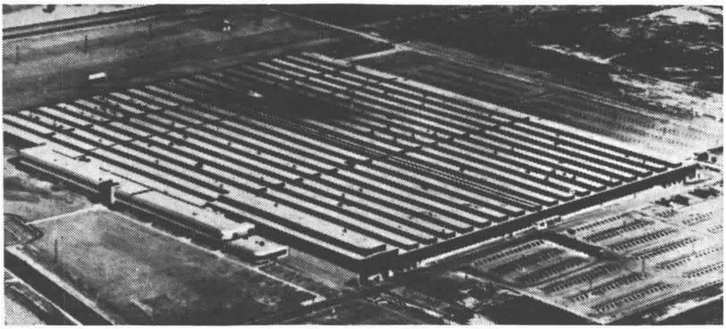
115. If this guide were to be applied to multiple-story buildings, there are many features that would be difficult or impractical for incorporation into the lower floors of such buildings.

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:

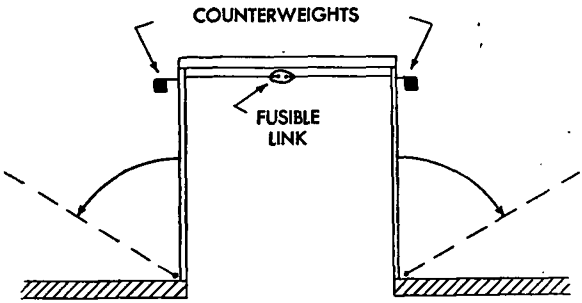
(a) Monitors: This type usually depends upon the breakage of ordinary glass (not over ⅛ inch thick) in the side walls to provide venting, although, where light is unimportant, metal panels may be used in lieu of glass, and arranged to open automatically in event of fire. Where conservation of building 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.

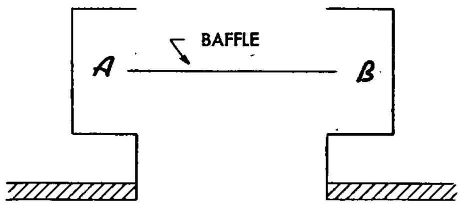
240. Venting Ratios

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

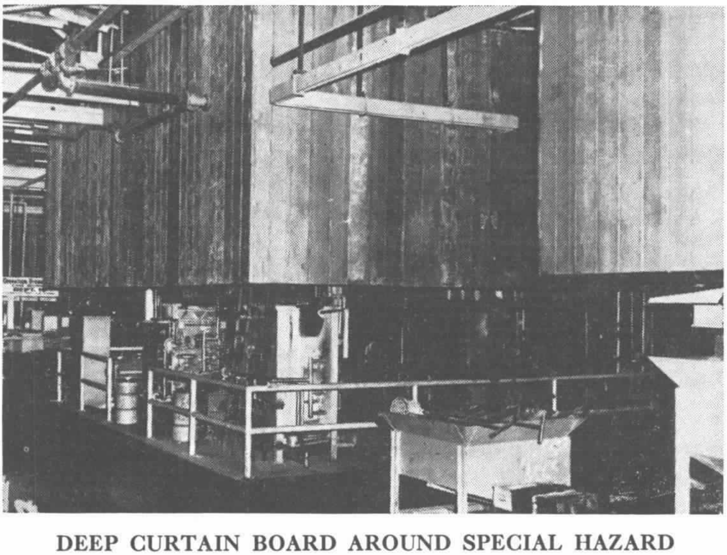
321. Curtain boards should extend down from the ceiling for a minimum depth of 6 feet. Around special hazards, the depth should be 12 feet, and where a high ceiling is involved, the curtains should preferably extend down to within 8 or 10 feet of the floor.

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.

SECTION 4. INSPECTION AND MAINTENANCE

400. Importance

401. Vents should be maintained in operating condition at all times.

402. The malfunction of smoke and heat venting facilities during a fire could have a critical influence on the final outcome, and as a minimum would serve to void an important investment. Vents, like any other mechanical equipment, are vulnerable to poor performance or failure if not inspected and maintained at regular intervals. This is particularly true of units which are intended solely for fire emergency and may not be operated for many years.

410. Frequency of Inspection and Maintenance

411. Frequency of inspection and maintenance is largely influenced by the basic design of the vent and by the nature and severity of its exposure, both internal and external, to corrosive atmosphere and weathering conditions. In view of these variable influences, some of which may not be anticipated or adequately evaluated, the following inspection program is advocated as a sound basic policy, with implementation in accordance with recommendations and suggestions of the vent manufacturer.

(a) An acceptance performance test of all vents should be conducted immediately following installation to ascertain proper operation of all components.

(b) A schedule should be established for the operation of units at frequent intervals. Operation of one-sixth of the units at least every six months under summer and winter conditions is recommended. Visual inspection of units not operated is advised.

(c) All pertinent characteristics of performance should be logged to permit comparison of results with those of previous inspection or acceptance tests. These comparisons will provide a basis for determining need for maintenance or for modifying the frequency of the inspection schedule to fit the experience.

(d) A review of the inspection schedule should be made if there is a change in plant occupancy, or in neighboring plants, which might introduce a significant change in nature or severity of corrosive atmosphere exposure.

420. Conduct and Observation of Operational Tests

421. Where feasible, release of the vent should simulate actual fire conditions by disconnecting the restraining cable at the fusible link (or other releasing device) and suddenly releasing the restraint, thus permitting the trigger or latching mechanism to operate normally.

422. Since the fusible link restrained cable is usually under considerable tension, its whip and travel should be observed to determine any likelihood of wrapping about any protrusion of the vent, building construction feature, or service piping, which could obstruct complete release. Any possible interference should be corrected by removal of obstruction, enclosure of cable in a suitable conduit, or other appropriate rearrangement. Following any modification, the unit should be retested for evaluation of adequacy of corrective measures.

423. The latch should release smoothly, and the vent should start to open immediately and move through its design travel to full open position without any prompting and without undue delay indicative of sticking weather seal, corroded or unaligned bearings, or distortion binding, etc.

424. Manual releases, where provided, should be tested to determine that the vents will operate.

425. All operating levers, latches, hinges, and weather-sealed surfaces should be examined to determine any indication of deterioration, accumulation of foreign material, etc., which, might warrant corrective action or suggest another inspection in advance of the normal schedule.

426. Following painting of the interior or exterior of vents, the units should be opened and inspected as a check against the gluing characteristic of paint between matching surfaces. Painted fusible links should be replaced with links having an equivalent temperature and load rating.

430. Ice and Snow Conditions

431. Removal of ice and snow from vents should be scheduled as part of the regular snow removal program.

440. Plain Glass Vents

441. Plain glass windows, depending on thermal influence of fire for breakage to provide venting, require only that care be taken in replacement and that only plain, single strength glass be used.

SECTION 5. APPENDIX

A-500. Heat Release from Burning Surfaces

A-501. The amount of heat released, in British thermal units per square foot of floor area is dependent upon many variables. Of these, the area exposed to fire and availability of oxygen are of principal importance and are closely related to each other.

The calorific value or fuel content in British thermal units per pound of various combustible materials are determined under laboratory conditions with small samples and an abundance of oxygen available for complete combustion. For this reason, judgment must be exercised in the use of such laboratory determinations.

A-502. In industrial properties, the size and shape in piles of combustible materials, both individually and collectively varies greatly. In some instances, such as closely packed piling of material in boxes, only the perimeter surfaces are exposed to fire. By contrast, with loosely packed piles, or irregularly shaped containers, large internal areas are also exposed for good combustion.

There is invariably a good supply of oxygen available for small fires. However, when a fire reaches sizable proportions, an oxygen deficiency is created due to its relatively tight enclosure by the building, particularly during cold weather.

Material	**Heat Release** British Thermal Units per Minute per Square Foot of Floor Area
Gasoline	10,000
Wood pallets in pile 8 feet high	25,000
Simulated packed stock, piled to provide an 8-inch chimney effect between piles 8 feet high	16,000
Same, piles 12 feet high	45,000

A-503. There have been no large-scale fire tests to determine heat release. Since the small-scale tests have been made by different organizations, correlation between the various tests is quite difficult. The test results in the accompanying table are presented as an indication of heat release as determined by some of these laboratory tests and may not be indicative of actual conditions encountered in the field. Numerous tests will be necessary simulating actual field conditions to draw definite conclusions. The fact that Btu-release may be great should spur activity in this direction.

A-504. The extinguishing action of water is based upon its absorption of heat raising its temperature and evaporating it into steam, thus reducing the temperature of the burning gases below the autogenous ignition temperature. One pound of water applied at 50 degrees Fahrenheit and evaporated into steam absorbs 1133 British thermal units (Btu). One gallon contains 8 pounds. Therefore, one gallon of water would absorb 9,064 Btu. Assuming a density of 0.33 gallons per minute per square foot for sprinkler discharge, and ignoring the water which runs off onto the floor, only ⅓ gallon of water is discharged per square foot of floor area; this quantity is capable of absorbing 3,021 Btu per minute.

A-505. When the heat-absorption rate is compared with the heat-release rates for several materials, it is obvious that venting as much heat as possible to the outside will materially assist the control of the fire. In many occupancies, venting is necessary to bring the amount of heat to be absorbed within the capacity of the available water.

A-506. With extremely hot fires, such as in rubber tire storage, venting of heat and smoke is essential to permit the fire department to approach the burning material for direct hose stream application and for manual overhaul operations.

A-510. Test Data

A-511. Prior to 1961 an extensive test program was conducted upon a scale model structure to establish general design criteria for emergency smoke and heat venting facility in industrial buildings. The behavior of hot gases under scale fire conditions was studied and the effect of various size and spacing of venting facility carefully evaluated. Much of the test data was made available to the Committee and many of the conclusions in the Guide are based, at least in part, upon that information.

83-0

TIA 68-1
NFPA 204
Reference:**113**

Tentative Interim Amendment 204-68-1

to the

Guide for Smoke and Heat Venting

NFPA 204-1968

Pursuant to Section 15 of the NFPA Regulations Governing Committee Projects, the National Fire Protection Association has issued the following Tentative Interim Amendment to the 1968 edition of the *Guide for Smoke and Heat Venting,* NFPA 204. The TIA was processed by the Committee on Building Construction and was approved for release by the Standards Council on October 30, 1980.

A Tentative Interim Amendment is tentative because it has not been processed through the entire standards-making procedures. It is interim because it is effective only between editions of the standard. A TIA automatically becomes a Proposal of the proponent for the next edition of the standard; as such, it then is subject to all the procedures of the standards-making process.

1. Revise Paragraph 113 to read as follows:

113. Venting may be desirable in either sprinklered or nonsprinklered buildings. If, however, venting is applied to sprinklered properties, the following considerations should be taken into account.

Two popular elements of hazard control have been developed over the years — viz., sprinklers and vents. Each was developed independent of the other. The previous sections represent the state of the technology of vent design in the absence of sprinklers. A generalized design basis for using *both* sprinklers and vents together for hazard control in some sense (e.g., property protection, life safety, water usage, obscuration, etc.) has not been developed and is not presently available. In this regard there are likely to be some deployable, combined (vent/sprinkler) element systems where hazard control, in some sense, is increased and others where hazard control is decreased when compared to single element approach.

— *Continued* —