(5) EMERGENCY RELIEF VENTING FOR FIRE EXPOSURE FOR ABOVEGROUND TANKS. (a) Every aboveground storage tank shall have some form of construction or device that will relieve excessive internal pressure caused by exposure fires.

Note: See subsection Ind 8.10 (4) (a) for further requirements.

(b) In a vertical tank the construction referred to in Ind 8.21 (5) (a) may take the form of a floating roof, lifter roof, a weak roof-to-shell seam or other approved pressure relieving construction. The weak roof-to-shell seam shall be constructed to fail preferential to any other seam.

(c) Where entire dependence for emergency relief is placed upon pressure relieving devices, the total venting capacity of both normal and emergency vents shall be enough to prevent rupture of the shell or bottom of the tank if vertical, or of the shell or heads if horizontal. If unstable liquids are stored, the effects of heat or gas resulting from polymerization, decomposition, condensation, or self-reactivity shall be taken into account. The total capacity of both normal and emergency venting devices shall be not less than that derived from table 6 through 9 except as provided in section Ind 8.21 (5) (d) or (e). Such device may be of a self-closing manhole cover, or one using long bolts that permit the cover to lift under internal pressure, or an additional or larger relief valve or valves. The wetted area of the tank shall be calculated on the basis of 55% of the total exposed area of a sphere or spheroid, 75% of the total exposed area of a sphere or spheroid, 75% of the total exposed area of a horizontal tank and the first 30 feet above grade of the exposed shell area of a vertical tank.

Note: See tables 6 through 9 for the square footage of typical tank sizes.

TABLE 6

WETTED AREA VERSUS CUBIC FEET FREE AIR PER HOUR (14.7 psia and 60° F.)

Sq. Ft.	CFH	Sq. Ft.	CFH	Sq. Ft.	CFH
20	21,100	200	211,000	1,000	524,000
30	31,600	250	239,000	1,200	557,000
40	42,100	300	265,000	1,400	587,000
50	52,700	350	288,000	1,600	614,000
60	63,200	400	312,000	1,800	639,000
70	73,700	500	354,000	2,000	662,000
80	84,200	600	392,000	2,400	704,000
90	94,800	700	428,000	2,800	742,000
100	105,000	800	462,000	end over	
120	126,000	900	493,000		
140	147,000	1,000	524,000		
160	168,000				
180	190,000				
200	211,000				

Note: 1. Interpolate for intermediate values.
2. For reference see N.F.P.A. No. 30.

The wetted area of the tank shall be calculated on the basis of 55% of the total exposed area of a sphere or spheroid, 75% of the total exposed area of a horizontal tank and the first 30 feet abovegrade of the exposed shell area of a vertical tank.

(d) For tanks and storage vessels designed for pressures over 1 psig, the total rate of venting shall be determined in accordance with table 6, except that when the exposed wetted area of the surface is greater than 2,800 square feet, the total rate of venting shall be calculated by the following formula:

$$CFH = 1{,}107A\ 0.82$$

Where: CFH = venting requirement, in cubic feet of free air per hour.
A = exposed wetter surface in square feet.

Note: The foregoing formula is based on

$$Q = 21{,}000\ A^{0.82}$$

(e) The total emergency relief venting capacity for any specific stable liquid may be determined by the following formula:
Cubic feet of free air per hour equals

$$\frac{V\ 1337}{L\ \sqrt{M}}$$

Where: V = cubic feet of free air per hour from table 6.
L = latent heat of vaporization of specific liquid in BTU per lb.
M = molecular weight of specific liquids.

Note: The following information is given to correlate with requirements of above rule:

Emergency Relief Venting for Fire Exposure
For Aboveground Tanks

The requirements for emergency venting given in Table 6 and the modification factors section in Ind 8.21 (5) (e) are derived from a consideration of:

1. Probable maximum rate of heat transfer per unit area;
2. Size of tank and the percentage of total area likely to be exposed;
3. Time required to bring tank contents to boil;
4. Time required to heat unwet portions of the tank shell or roof to a temperature where the metal will lose strength;
5. Effect of drainage, insulation and the application of water in reducing fire exposure and heat transfer.

Table 6 is based on a composite curve which is considered to be composed of three straight lines when plotted on log-log paper. The curve may be defined in the following manner:

The first straight line is drawn on log-log paper between the point 400,000 Btu/hr., at 20 sq. ft. exposed surface area and the point 4,000,000 Btu/hr., 200 sq. ft. exposed surface area. The equation for this portion of the curve is Q = 20,000A.

The second straight line is drawn on log-log graph paper between the

TABLE 7

$Q = 20{,}000\ A$		$Q = 199{,}300\ A.^{566}$ & $.^{338}$		$Q = 963{,}400\ A.^{566}$ & $.^{338}$	
A	Q	A	Q	A	Q
20	400,000	200	4,000,000	1,000	10,000,000
30	600,000	250	4,539,000	1,200	10,593,000
40	800,000	300	5,032,000	1,400	11,122,000
50	1,000,000	350	5,491,000	1,600	11,601,000
60	1,200,000	400	5,922,000	1,800	12,040,000
70	1,400,000	500	6,719,000	2,000	12,449,000
80	1,600,000	600	7,450,000	2,400	13,188,000
90	1,800,000	700	8,129,000	2,800	14,000,000
100	2,000,000	800	8,768,000	and over	
120	2,400,000	900	9,372,000		
140	2,800,000	1,000	10,000,000		
160	3,200,000				
180	3,600,000				
200	4,000,000				

bottom of the tank and shall be installed to avoid excessive vibration.

(g) Filling and emptying connections which are made and broken shall be located outside of buildings at a location free from any source of ignition and not less than 5 feet away from any building opening. Such connection shall be closed and liquid tight when not in use. The connections shall be properly identified.

(10) TANKS LABELED. Aboveground tanks for class I and II liquids, other than at refineries, or marine or pipeline terminals shall have painted conspicuously thereon in letters at least 5 inches high, the wording "FLAMMABLE—KEEP FIRE AWAY."

(11) TANKS NOT IN USE. Aboveground tanks temporarily out of service or abandoned shall be equipped with valves and vents in accordance with Ind 8.21 or made gas free and have pipe plugs installed in all tank openings.

History: Cr. Register, August, 1971, No. 188, eff. 9–1–71.

Ind 8.22 Installation of underground tanks. (1) LOCATION. Excavation for underground storage tanks shall be made with due care to avoid undermining of foundations of existing structures. Underground tanks or tanks under buildings shall be so located with respect to existing building foundations and supports that the loads carried by the latter cannot be transmitted to the tank. The distance from any part of a tank storing class I liquids to the nearest wall of any basement or pit shall be not less than one foot, and to any property line that may be built upon, not less than 3 feet. The distance from any part of a tank storing class II or class III liquids to the nearest wall of any basement, pit or property line shall be not less than one foot.

(2) DEPTH AND COVER. Underground tanks shall be set on firm foundations and surrounded with at least 6 inches of noncorrosive, inert materials such as clean sand, earth or gravel well tamped in place. The tank shall be placed in the hole with care since dropping or rolling of the tank into the hole can break a weld, puncture or damage the tank or scrape off the protective coating of coated tanks. Tanks shall be covered with a minimum of 2 feet of earth, or shall be covered with not less than one foot of earth, on top of which shall be placed a slab of reinforced concrete not less than 4 inches thick. When underground tanks are, or are likely to be, subjected to traffic, they shall be protected against damage from vehicles passing over them by at least 3 feet of earth cover, or 18 inches of well-tamped earth, plus 6 inches of reinforced concrete or 8 inches of asphaltic concrete. When asphaltic or reinforced concrete paving is used as part of the protection, it shall extend at least one foot horizontally beyond the outline of the tank in all directions. Where a tank cannot be entirely buried it shall be covered with earth to the depth of at least 2 feet with a slope on all sides not steeper than 1-½ feet horizontal to one foot vertical.

(3) CORROSION PROTECTION. Corrosion protection for the tank and its piping shall be provided by one or more of the following methods:

(a) Use of protective coatings or wrappings.

(b) Cathodic protection or

(c) Corrosion resistant materials of construction.

(4) VENTS. (a) *Location and arrangement of vents for class I liquids.* Vent pipes from tanks storing class I liquids shall be so located that the discharge point is outside the buildings, higher than the fill pipe opening, and not less than 12 feet above the adjacent ground level. Vent pipes shall discharge only upward in order to disperse vapors. Vent pipes 2 inches or less in nominal inside diameter shall not be obstructed by devices that will cause excessive back pressure. Vent pipe outlets shall be so located that flammable vapors will not enter building openings, or be trapped under eaves or other obstructions. If the vent pipe is less than 10 feet in length or greater than 2 inches in nominal inside diameter, the outlet shall be provided with a vacuum and pressure relief device or there shall be an approved flame arrester located in the vent line at the outlet or within the approved distance from the outlet.

Note: See subsection Ind 8.10 (4) (b) for further requirements.

(b) *Size of vents.* Each tank shall be vented through piping adequate in size to prevent blowback of vapor or liquid at the fill opening while tank is being filled. Vent pipes shall be not less than 1¼ inch nominal inside diameter.

TABLE 10
VENT LINE DIAMETERS

Maximum Flow GPM	Pipe Length*		
	50 Ft.	100 Ft.	200 Ft.
100	1¼ inch	1¼ inch	1¼ inch
200	1¼ inch	1¼ inch	1¼ inch
300	1¼ inch	1¼ inch	1½ inch
400	1¼ inch	1½ inch	2 inch
500	1½ inch	1½ inch	2 inch
600	1½ inch	2 inch	2 inch
700	2 inch	2 inch	2 inch
800	2 inch	2 inch	3 inch
900	2 inch	2 inch	3 inch
1,000	2 inch	2 inch	3 inch

*Note: Vent lines of 50 feet, 100 feet, and 200 feet of pipe plus 7 ells.

Note: The vent size depends upon the filling or withdrawal rate whichever is larger, the vent line length and tank design pressure. Vent piping sized in accordance with this table will prevent the pressure in the tank from exceeding 2.5 psig.

(c) *Location and arrangement of vents for class II or class III liquids.* Vent pipes from tanks storing class II or class III flammable liquids shall terminate outside of buildings and higher than the fill pipe opening. Vent outlets shall be above normal snow level. They may be fitted with return bends, coarse screens or other devices to minimize ingress of foreign material.

(d) *Vent piping.* Vent piping shall be constructed in accordance with section Ind 8.30, Pipes, Valves and Fittings. Vent pipes shall be so laid as to drain toward the tank without sags or traps in which liquid can collect. They shall be located so that they will not be subject to physical damage. The tank end of the vent pipe shall enter the tank through the top.