Committee Input No. 14-NFPA 68-2021 [Global Input]

The committee received input to revise the burning velocity values in D.1. The majority of values could decrease by a ratio of 39/46 based on newest evaluations of propane burning velocity.
The venting calculations were developed using the burning velocity values in D.1, so a task group has been formed to review this change, along with how it would impact NFPA 68 and other correlations, to determine if there are unknown ramifications.

The task group will:
-Review for errors in burning velocity values
-Review a data correction for fundamental burning velocity of propane
-Review ratios that are impacted
-If changes are proposed, compile a table comparison of old vs new values
-Research the impact throughout NFPA 68 and beyond (if other correlations use this data)

Submitter Information Verification

Committee: EXL-AAA

Submittal Date: Wed May 26 11:23:43 EDT 2021

Committee Statement

Committee Statement: See committee input language.

Response Message: CI-14-NFPA 68-2021

Committee Input No. 33-NFPA 68-2021 [Section No. 6.6.2.3]

6.6.2.3*

Where a deflector is provided in accordance with 6.6.2.4 and 6.6.2.5, it shall be permitted to reduce the axial (front-centerline) hazard distance to 50 percent of the value calculated in 7.6.2 or 8.9.2. ~~This method shall not be used to reduce the radial hazard distance as defined in 7.6.3 and 8.9.2.3 [115].~~

Submitter Information Verification

Committee: EXL-AAA

Submittal Date: Tue Aug 17 09:41:39 EDT 2021

Committee Statement

Committee Statement: This CI was developed by NFPA staff for editorial purposes, in accordance with 4.3.9.3.2 and 4.3.9.3.3 of the Regulations Governing the Development of NFPA Standards (www.nfpa.org/regs).

The Technical Committee needs to review this sentence at the Second Draft stage because the referenced sections have been removed from Chapter 7 and Chapter 8.

Response Message: CI-33-NFPA 68-2021

Committee Input No. 6-NFPA 68-2021 [Section No. 8.2]

8.2 Venting by Means of Low-Inertia Vent Closures. [See Committee Statement]

8.2.1 Minimum Vent Area Requirement.

Minimum vent area shall be determined per 8.2.1 based on the initial pressure in the enclosure prior to ignition.

8.2.1.1 Minimum Vent Area Requirement for Near Atmospheric Initial Pressure.

When enclosure pressure is initially between –0.2 bar-g (–20 kPa) and 0.2 bar-g (20 kPa), A_{v0} shall be determined from Equation 8.2.1.1:

$$A_{v0} = 1 \cdot 10^{-4} \cdot \left(1 + 1.54 \cdot P_{stat}^{4/3}\right) \cdot K_{St} \cdot V^{3/4} \cdot \sqrt{\frac{P_{max}}{P_{red}} - 1} \quad \textbf{[8.2.1.1]}$$

where:

A_{v0} = vent area (m^2)

P_{stat} = nominal static burst pressure of the vent (bar-g)

K_{St} = deflagration index (bar-m/s)

V = enclosure volume (m^3)

P_{max} = maximum pressure of an unvented deflagration initially at atmospheric pressure (bar-g)

P_{red} = reduced pressure after deflagration venting (bar-g)

[115]

8.2.1.2* Minimum Vent Area Requirement for Elevated or Subatmospheric Initial Pressure.

When enclosure pressure is initially >0.2 bar-g (20 kPa) or <–0.2 bar-g (–20 kPa), A_{v0} shall be determined from Equation 8.2.1.2:

$$A_{v0} = 1 \cdot 10^{-4} \cdot \left[1 + 1.54 \cdot \left(\frac{P_{stat} - P_{initial}}{1 + P_{effective}}\right)^{4/3}\right] \cdot K_{St} \cdot V^{3/4} \sqrt{\frac{1}{\Pi_{effective}} - 1} \quad \textbf{[8.2.1.2]}$$

where:

A_{v0} = vent area (m^2)

P_{stat} = static burst pressure of the vent (bar-g)

$P_{initial}$ = enclosure pressure at moment of ignition (bar-g)

$P_{effective}$ = $1/3 P_{initial}$ (bar-g)

$\Pi_{effective}$ = $(P_{red} - P_{effective})/(P^E_{max} - P_{effective})$

P_{red} = reduced pressure (bar-g)

P^E_{max} = $[(P_{max} + 1)\cdot(P_{initial} + 1)/(1 \text{ bar-abs}) - 1]$ maximum pressure of the unvented deflagration at pressure (bar-g)

P_{max} = maximum pressure of an unvented deflagration initially at atmospheric pressure (bar-g)

8.2.1.2.1*

When enclosure pressure is initially <−0.2 bar-g (−20 kPa), the vent area in Equation 8.2.1.2 shall be evaluated over the range between operating pressure and atmospheric pressure and the largest vent area correction applied.

8.2.1.2.2

When enclosure pressure is initially <–0.2 bar-g (–20 kPa), it shall be permitted to determine minimum vent area per Equation 8.2.1.2.2.

$$A_{v0} = 1.1 \cdot 10^{-4} \cdot \left[1 + 1.54 \cdot P_{stat}^{\ 4/3}\right] \cdot K_{St} \cdot V^{3/4} \sqrt{\frac{P_{max}}{P_{red}} - 1} \qquad [8.2.1.2.2]$$

8.2.1.2.3

When enclosure pressure is initially > 0.2 bar-g (20 kPa), deflagration vents shall be permitted only when the following conditions are met:

(1) Vent duct length $L/D \le 1$

(2) Panel density $M \le M_T$ and ≤ 40 kg/m^2

(3) v_{axial} and $v_{tan} < 20$ m/s

(4) No allowance for partial volume

8.2.1.3

The following limitations shall be applicable to 8.2.1:

(1) 5 bar-g $\le P_{max} \le$ 12 bar-g

(2) 10 bar-m/s $\le K_{St} \le$ 800 bar-m/s

(3) 0.1 m$^3 \le V \le$ 10,000 m^3

(4) $P_{stat} \le 0.75(1 + P_{initial})$ bar-g when $P_{initial}$ is >0.2 bar-g

(5) $P_{stat} < 0.75$ bar-g when $P_{initial}$ is <0.2 bar-g

8.2.2 Effects of Elevated *L/D*.

8.2.2.1

The *L/D* of the enclosure shall be determined according to Section 6.4.

8.2.2.2

When $L/D \le 2$, A_{v1} shall be set equal to A_{v0}.

8.2.2.3

For $2 < L/D \le 6$, the required vent area, A_{v1}, shall be calculated as follows (where exp $(A) = e^A$, e is the base of the natural logarithm [114]):

$$A_{v1} = A_{v0} \cdot \left[1 + 0.6 \cdot \left(\frac{L}{D} - 2\right)^{0.75} \cdot \exp\left(-0.95 \cdot \left(\frac{P_{red}}{1 + P_{initial}}\right)^2\right)\right] \qquad [8.2.2.3]$$

where:

A_{v0} = vent area as calculated by 8.2.1

L/D = length-to-diameter ratio

P_{red} = reduced pressure after deflagration venting (bar-g)

$P_{initial}$ = enclosure pressure at moment of ignition (bar-g)

8.2.2.4

When initial pressure in the enclosure is less than 0.2 bar-g (20 kPa), $P_{initial}$ in Equation 8.2.2.3 shall be set to zero.

8.2.2.5*

It shall be permitted to extend Equation 8.2.2.3 to values of *L/D* of 8 for top-fed bins, hoppers, and silos, provided the calculated required vent area, after application of all correction factors, does not exceed the enclosure cross-sectional area.

8.2.2.6

For situations where vents can be distributed along the major axis of the enclosure, Equation 8.2.1.1 and Equation 8.2.2.3 shall be permitted to be applied where *L* is the spacing between vents along the major axis.

8.2.3 Reserved.

8.2.4 Effects of Additional Turbulence.

8.2.4.1*

For this application, average air axial velocity shall be calculated according to the following equation:

$$v = \frac{Q}{A} \qquad \textbf{[8.2.4.1]}$$

where:

v = average axial gas velocity (m/s)

Q = volumetric air flow rate (m^3/s)

A = average cross-sectional area of the flow path (m^2) [118, 119]

8.2.4.2*

If a circumferential (i.e., tangential) air velocity is in the equipment, v_{tan} shall be given by 0.5 v_{tan_max}, where v_{tan_max} is the maximum tangential air velocity in the equipment.

8.2.4.3

Values of Q, v_{axial}, v_{tan_max}, and v_{tan} shall be measured or calculated by engineers familiar with the equipment design and operation.

8.2.4.4

The measurements or calculations shall be documented and made available to vent designers and the authority having jurisdiction.

8.2.4.5

When the maximum values derived for v_{axial} and v_{tan} are less than 20 m/s, A_{v2} shall be set equal to A_{v1}.

8.2.4.6*

When either v_{axial} or v_{tan} is larger than 20 m/s, A_{V2} shall be determined from the following equation where *max* (*A*, *B*) = maximum value of either *A* or *B* [118, 119]:

$$A_{v2} = \left[1 + \frac{max\left(v_{axial}, v_{\tan}\right) - 20}{36} \cdot 0.7\right] \cdot A_{v1} \quad [8.2.4.6]$$

where:

v_{axial} = axial air velocity (m/s)

v_{tan} = tangential air velocity (m/s)

A_{V1} = vent area calculated by 8.2.2

8.2.4.7*

Vent areas for buildings in which there is a dust explosion hazard shall be determined from Equation 8.2.4.7 [118, 119]:

$$A_{v2} = 1.7 \cdot A_{v1} \quad [8.2.4.7]$$

where:

A_{V1} = vent area calculated by 8.2.2

8.2.4.8

The required vent areas for these buildings shall be permitted to be reduced through use of the partial volume Equation 8.4.1.

Submitter Information Verification

Committee: EXL-AAA

Submittal Date: Tue May 25 10:20:42 EDT 2021

Committee Statement

Committee Statement: The committee is aware of concerns by some users of the changes introduced in this section and the effect on vent areas for dust collectors. The committee is requesting input of specific test results (including detailed test methodology) which will enable further evaluation of the changes. The result of such input could be further modifications to this section up to and including reversion to the prior methodology.

Response Message: CI-6-NFPA 68-2021

Public Input No. 24-NFPA 68-2021 [Section No. 8.2]

Committee Input No. 20-NFPA 68-2021 [Section No. 8.2.1.3]

8.2.1.3

The following limitations shall be applicable to 8.2.1:

(1) 5 bar-g ≤ P_{max} ≤ 12 bar-g

(2) 10 bar-m/s ≤ K_{St} ≤ 800 bar-m/s

(3) 0.1 m^3 ≤ V ≤ 10,000 m^3

(4) P_{stat} ≤ 0.75(1 + $P_{initial}$) bar-g when $P_{initial}$ is >0.2 bar-g [reviewing this limit]

(5) P_{stat} < 0.75 bar-g when $P_{initial}$ is <0.2 bar-g

Submitter Information Verification

Committee: EXL-AAA

Submittal Date: Thu May 27 11:12:25 EDT 2021

Committee Statement

Committee Statement: As flagged by Public Input 7, the annex example used a Pstat value that was outside this limitation. The committee will review the limitations in 8.2.1.3 to ensure that they are correct.

Response Message: CI-20-NFPA 68-2021

Committee Input No. 25-NFPA 68-2021 [Section No. 8.4]

8.4* Effects of Partial Volume.

8.4.1

When the volume fill fraction, X_r, can be determined for a worst-case explosion scenario, the minimum required vent area shall be permitted to be calculated from the following equation:

$$A_{v4} = A_{v3} \cdot X_r^{-1/3} \cdot \sqrt{\frac{X_r - \Pi}{1 - \Pi}} \quad [8.4.1]$$

where:

A_{V4} = vent area for partial volume deflagration

A_{V3} = vent area for full volume deflagration as determined from Equation 8.3.4 or from 8.3.6

X_r = fill fraction > Π

$\Pi = P_{red}/P_{max}$

8.4.1.1*

If $X_r \leq \Pi$, deflagration venting shall not be required.

8.4.1.2

Where partial volume is not applied, A_{V4} shall be set equal to A_{V3}.

8.4.2* Process Equipment Partial Volumes.

Process equipment involving nonsolvent drying shall be permitted to use partial volume venting in accordance with Equation 8.4.1.

8.4.2.1

In applications involving dryers with recirculation of dry product, the fill fraction shall be taken as 1.0.

8.4.2.2

If the solvent is flammable, hybrid deflagration K_{St} values shall be determined.

8.4.2.3

In applications such as a spray dryer or fluidized bed dryer, the specific fill fraction to be used for vent design shall be based on measurements with representative equipment and process materials.

8.4.2.4

In applications involving spray dryers where a partial volume venting is calculated in accordance with Equation 8.4.1, the vent shall be mounted within the chosen partial volume zone of the dryer that contains the driest fraction of material.

8.4.2.5

In these applications, the determination of X_r shall be documented and submitted to the authority having jurisdiction for review and concurrence.

8.4.3 Building Partial Volumes.

(See Annex J.)

8.4.3.1

This subsection shall apply to large process buildings in which a dust explosion hazard is associated with combustible material deposits on the floor and other surfaces, and with the material contained in process equipment.

8.4.3.2

The minimum required deflagration vent area for the building dust explosion hazard shall be based either on the full building volume or on a partial volume determined as follows:

(1) Collect at least three representative samples of the floor dust from either the actual building or a facility with similar process equipment and materials. The samples shall be obtained from measured floor areas, A_{fs}, that are each 0.37 m^2 (4 ft^2) or larger.

(2) Weigh each sample and calculate the average mass, $\bar{M}_f$ (grams), of the floor samples.

(3) Collect at least two representative samples from measured sample areas, A_{ss}, on other surfaces with dust deposits. These surfaces on any plane could include beams, shelves, and external surfaces of process equipment and structures. Calculate the total area, A_{sur}, of these surfaces with dust deposits.

(4) Weigh each sample and calculate the average mass, $\bar{M}_f$ (grams), of the surface samples.

(5) Determine the total mass, M_e, of combustible dust that could be released from the process equipment in the building.

(6) Test the dust samples per ASTM E1226, *Standard Test Method for Explosibility of Dust Clouds*, to determine P_{max}, K_{St}, and the worst-case concentration, c_w, corresponding to the largest value of K_{St}.

(7) Using the highest values of P_{max} and K_{St}, the building volume, V, and $\Pi = P_{red}/P_{max}$, use Equation 8.3.5 or 8.3.6 to calculate the vent area, A_{V3}, needed if the full building volume were filled with combustible dust.

(8) Calculate the worst-case building partial volume fraction, X_r, in accordance with 8.4.3.3.1.

(9) If the calculated $X_r > 1$, the minimum required vent area is equal to A_{V3} .

(a) If $X_r \leq \Pi$, no deflagration venting is needed.

(b) If $1 > X_r > \Pi$, the minimum required vent area, A_{V4}, is calculated from Equation 8.4.1 as follows:

$$A_{v4} = A_{v3} \cdot X_r^{-1/3} \cdot \sqrt{\frac{X_r - \Pi}{1 - \Pi}} \quad \textbf{[8.4.3.2]}$$

where:

A_{V4} = vent area for partial volume deflagration

A_{V3} = vent area for full volume deflagration as determined from Equation 8.3.4 or from 8.3.6

X_r = fill fraction > Π

$\Pi = P_{red}/P_{max}$

8.4.3.3

The worst-case building partial volume fraction, X_r, shall be calculated from the following equation:

$$X_r = \frac{\bar{M}_f \cdot A_{f\text{-}dusty} \cdot \eta_{Dfloor}}{A_{fs} \cdot V \cdot c_w} + \frac{\bar{M}_s \cdot A_{sur} \cdot \eta_{Dsur}}{A_{ss} \cdot V \cdot c_w} + \frac{M_e}{V \cdot c_w} \qquad \textbf{[8.4.3.3]}$$

where:

X_r = worst-case building partial fraction

$\bar{M}_f$ = average mass of floor samples (g)

$A_{f\text{-}dusty}$ = total area of floor with dust deposits (m^2)

η_{Dfloor} = entrainment factor for floor accumulations

A_{fs} = measured floor areas (m^2)

V = building volume (m^3)

c_w = worst-case dust concentration (g/m^3)

$\bar{M}_s$ = average mass of surface samples (g)

A_{sur} = total area of surfaces with dust deposits (m^3)

η_{Dsur} = entrainment factor for surface accumulations

A_{ss} = measured sample areas of surfaces with dust deposits (m^2)

M_e = total mass of combustible dust that could be released from the process equipment in the building (g)

8.4.3.3.1

If a measured value of c_w is available, the lowest value of c_w for the various samples shall be used in Equation 8.4.3.3.

8.4.3.3.2

If a measured value of c_w is not available, a value of 200 g/m^3 shall be permitted to be used in Equation 8.4.3.3.

8.4.3.3.3*

If measured values of $\bar{M}_f / A_f$ and $\bar{M}_s / A_{ss}$ are not available, and if the facility is to be maintained with dust layer thickness in accordance with NFPA 654, an approximate value for these ratios shall be permitted to be used, based on a dust layer bulk density of 1200 kg/m^3 and a layer thickness of 0.8 mm (1⁄32 in.) over the entire floor area and other surfaces defined in 8.4.3.3.4.

8.4.3.3.4

The total mass of dust that could be released from process equipment in the building/room M_e, shall be determined as follows:

(1) Evaluate equipment with exposed dust accumulations, such as but not limited to screeners, open-top conveyors or conveyor belts, open packaging or shipping containers, and enclosureless dust collectors

(2) Evaluate anticipated episodic spills from equipment in light of current housekeeping procedures and practices

(3) Do not include material in closed packaging or shipping containers, material in enclosed silos or storage bins, or in otherwise explosion-protected equipment

8.4.3.3.5

The entrainment factor, η_D for each representative area shall be determined by one of the following methods:

(1) Assume an entrainment factor of 1

(2) Calculate the entrainment factor as follows:

(a) Determine the average particle density, ρ_p for each sampled dust layer

(b) Determine the entrainment threshold velocity using the following equation:

$$U_t = 0.46 \cdot \rho_p^{1/3} \quad \textbf{[8.4.3.3.5a]}$$

where:

U_t = threshold velocity (m/s)

ρ_p = particle density (kg/m^3)

(c) Assume a maximum free-stream velocity, U, of 50 m/s or establish a different free-stream velocity calculated from a maximum credible initiating event

(d) Determine a maximum entrainment rate using the following equation:

$$m'' = 0.002 \cdot \rho \cdot U \cdot \left(U^{1/2} - U_t^2 / U^{3/2}\right) \quad \textbf{[8.4.3.3.5b]}$$

where:

m'' = entrained mass flux (kg/m^2-s)

ρ = gas density (kg/m^3)

U = free-stream velocity (m/s) > U_t

U_t = threshold velocity (m/s)

(e) Determine initiating event time, t, by dividing the building's or enclosure's longest dimension by ½ the maximum free-stream velocity

(f) Using the appropriate surface area, A, determine the maximum mass, M_{max}, from the presumed initiating event using the following equation:

$$M_{max} = m'' \cdot A \cdot t \quad \textbf{[8.4.3.3.5c]}$$

where:

m'' = entrained mass flux (kg/m^2-s)

A = surface area (m^2)

t = initiating event time (s)

(g) Determine the entrainment factor using the following equation:

$$\eta_D = \begin{cases} \dfrac{M_{max}}{M}, \text{ if } \dfrac{M_{max}}{M} < 1 \\ 1, \text{ if } \dfrac{M_{max}}{M} \geq 1 \end{cases} \quad \textbf{[8.4.3.3.5d]}$$

where:

M = average mass of the sample (g)

Supplemental Information

File Name	Description	Approved
68_CI_25_8.4_Proposed_Revision_of_Dust_Partial_Volume_Adjustment.docx		

Submitter Information Verification

Committee: EXL-AAA

Submittal Date: Thu May 27 12:52:41 EDT 2021

Committee Statement

Committee Statement: The committee will be reviewing 8.4 to clarify and provide guidance for worst-case scenarios for partial volume calculations, and develop guidance on determining cw for different materials. See Word attachment.

Response Message: CI-25-NFPA 68-2021

Proposed Committee Input on Dust Building Partial Volume Adjustment

Proposal is to modify section 8.4.3 as explained here.

Start with a slightly different calculation of the π value in Eqn 8.4.3.2 (same Eqn 8.4.3.2, just modified π).

(9) If the calculated $X_r > 1$, the minimum required vent area is equal to A_{v3} .

(a) If $X_r \leq \Pi$, no deflagration venting is needed.

(b) If $1 > X_r > \Pi$, the minimum required vent area, A_{v4}, is calculated from Equation 8.4.1 as follows:

[8.4.3.2]

$$A_{v4} = A_{v3} \cdot X_r^{-1/3} \cdot \sqrt{\frac{X_r - \Pi}{1 - \Pi}}$$

where:

A_{v4} = vent area for partial volume deflagration

A_{v3} = vent area for full volume deflagration as determined from Equation 8.3.4 or from 8.3.6

X_r = fill fraction > Π

$$\pi = \frac{P_{red}}{P_m}$$

P_m is the closed vessel explosion pressure measured in ASTM E 1226 tests for the specific concentrations used in Equation 8.4.3.3 as follows.

Δ 8.4.3.3 The worst-case building partial volume fraction, X_r, shall be calculated from the following equation:

$$X_r = \frac{\bar{M}_f \cdot A_{f\text{-}dusty} \cdot \eta_{Dfloor}}{A_{fs} \cdot V \cdot c_w} + \frac{\bar{M}_s \cdot A_{sur} \cdot \eta_{Dsur}}{A_{ss} \cdot V \cdot c_w} + \frac{M_e}{V \cdot c_w} \qquad [8.4.3.3]$$

where:

X_r = worst-case building partial fraction

$\bar{M}_f$ = average mass of floor samples (g)

$A_{f\text{-}dusty}$ = total area of floor with dust deposits (m^2)

η_{Dfloor} = entrainment factor for floor accumulations

A_{fs} = measured floor areas (m^2)

V = building volume (m^3)

c_w = worst-case dust concentration (g/m^3)

$\bar{M}_s$ = average mass of surface samples (g)

A_{sur} = total area of surfaces with dust deposits (m^3)

η_{Dsur} = entrainment factor for surface accumulations

A_{ss} = measured sample areas of surfaces with dust deposits (m^2)

M_e = total mass of combustible dust that could be released from the process equipment in the building (g)

Propose to modify the equation such that the concentration c_w in Eqn 8.4.3.3 would be three different values:

- C_w = Worse-case concentration corresponding to $(dP/dt)_{max}$, from ASTM E1226 test data.
- $0.75c_w$, with π calculation based on corresponding closed vessel pressure, P_m for this concentration,
- $0.50c_w$, with π calculation based on corresponding closed vessel pressure, P_m for this concentration.

New 8.4.3.3.1 Use the three calculated pairs of X_r and π in Eqn 8.4.3.2 to determine the corresponding values of A_{v4}.

New 8.4.3.3.2. The value of A_{v4} to use is the largest of the three calculated values.

Delete existing 8.4.3.3.1 and 8.4.3.3.2.

See following examples of dust P_m values and effect on A_{v4} calculation for possible use in Annex.

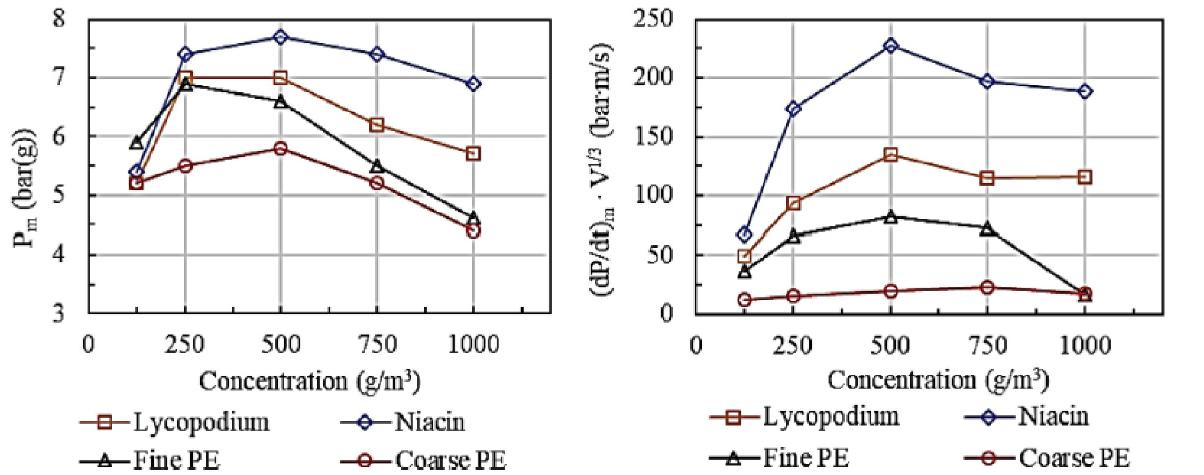

Fig. 3. Summary results of explosion severity parameters (P_{max} and K_{St}) in the 20-L chamber using 10-kJ ignition energy.

Figure 1 20-liter Data from Addo et al Niacin, lycopodium and polyethylene powder explosibility in 20-L and 1-m3 test chambers

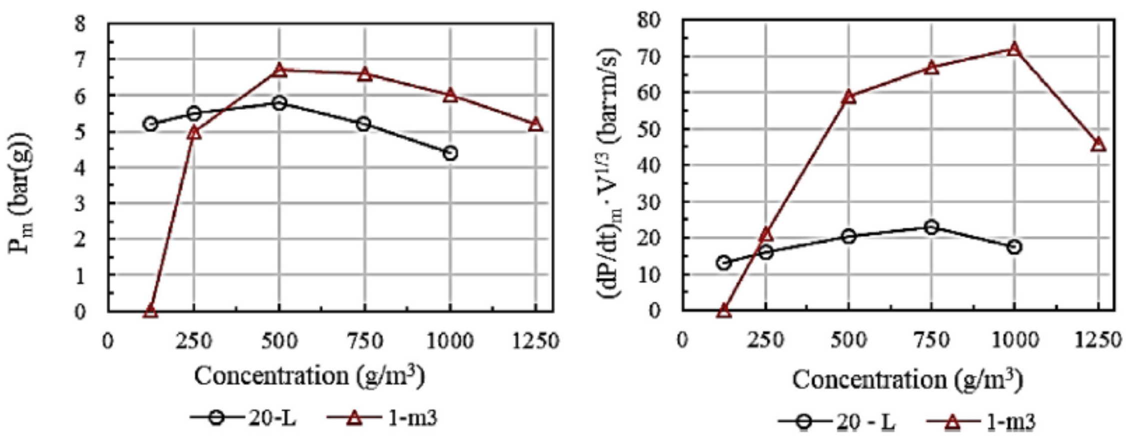

Fig. 5. Comparison of explosion severity of coarse PE in the 20-L vessel and 1-m^3 chamber (at ignition delay time of 550 ms).

Figure 2 1-m^3 and 20-liter data from Addo et for coarse polyethylene

Using the data in Figure 1 for Niacin, c_w = 500 g/m^3, and P_{max} 7.6 bar-g. The interpolated value for P_m at 375 g/m^3 is 7.5 bar-g, and the value at 250 g/m^3 is 7.4 bar-g. This implies that X_r at a concentration of 375 g/m^3 would be 1.33 times as large as with c_w, and π would be 7.6/7.5 (= 1.013) times as large. The X_r at a concentration of 250 g/m^3 would be twice as large and π would be 7.6/7.4 (= 1.027) times as large. As an example, if P_{red} = 0.1 bar-g and X_r = 0.1 for c_w=500 g/m^3, the corresponding ratios of A_{v4}/A_{v3} values would be:

A_{v4}/A_{v3} = 0.639 for c_w = 500 g/m^3,

A_{v4}/A_{v3} = 0.683 for c = 375 g/m^3,

A_{v4}/A_{v3} = 0.743 for c = 250 g/m^3.

Therefore, the value of A_{v4}/A_{v3} used should be 0.743 for this example.

In the case of the coarse polyethylene data from the 1-m^3 test vessel, C_w = 1000 g/m3, P_m = 6.0 bar-g.

Using the same P_{red} = 0.1 barg and Xr = 0.1 using C_w= 1000 g/m^3, now

A_{v4}/A_{v3} = 0.625 for c_w = 1000 g/m^3,

A_{v4}/A_{v3} = 0.677 for c = 750 g/m^3,

A_{v4}/A_{v3} = 0.741 for c = 500 g/m^3.

BZ 5/25/2021

Committee Input No. 24-NFPA 68-2021 [Section No. 8.5.1]

8.5.1*

If there is no vent duct, $A_{vf} = A_{v4}$; otherwise, the effect of vent ducts shall be calculated from the following equations:

$$A_{vf} = A_{v4} \cdot \left(1 + 1.18 \cdot E_1^{0.8} \cdot E_2^{0.4}\right) \cdot \sqrt{\frac{K}{K_0}} \quad \textbf{[8.5.1a]}$$

$$E_1 = \frac{A_{vf} \cdot L_{duct}}{V} \quad \textbf{[8.5.1b]}$$

$$E_2 = \frac{10^4 \cdot A_{vf}}{\left(1 + 1.54 \cdot P_{stat}^{4/3}\right) \cdot K_{St} \cdot V^{3/4}} \quad \textbf{[8.5.1c]}$$

$$K \equiv \frac{\Delta P}{\frac{1}{2} \cdot \rho \cdot U^2} = K_{inlet} + \frac{f_D \cdot L_{duct}}{D_h} + K_{elbows} + K_{outlet} + \cdots \quad \textbf{[8.5.1d]}$$

where:

A_{vf} = vent area required when a duct is attached to the vent opening (m^2)

A_{v4} = vent area after adjustment for partial volume (m^2), per Equation 8.3.1

K = overall resistance coefficient of the vent duct application

K_0 = 1.5, the resistance coefficient value assumed for the test configurations that generated the data used to validate Equations 8.2.2 and 8.2.3

L_{duct} = vent duct overall length (m)

V = enclosure volume (m^3)

P_{stat} = nominal static opening pressure of the vent cover (bar-g)

ΔP = static pressure drop from the enclosure to the duct exit at average duct slow velocity, U (bar)

ρ = gas density (kg/m^3)

U = fluid velocity (m/s)

K_{inlet}, K_{elbows}, K_{outlet} = resistance coefficients for fittings

f_D = D’Arcy friction factor for fully turbulent flow; see A.8.5 for typical formula [114]

D_h = vent duct hydraulic diameter (m)

A.8.5.1

This solution of Equation 8.5.1a is iterative, because E_1 and E_2 are both functions of A_{vf}.

Submitter Information Verification

Committee: EXL-AAA

Submittal Date: Thu May 27 12:14:17 EDT 2021

Committee Statement

Committee Statement:	The committee will review these equations and the use of Lduct to determine what guidance to provide in evaluating the effects of elbow circumferential length.
Response Message:	CI-24-NFPA 68-2021

Committee Input No. 7-NFPA 68-2021 [Section No. 8.11.1]

8.11.1– [See Committee Statement]

Where bin vents (air material separators) are installed in common with a silo or any other storage vessel, they shall be protected as follows:

(1) The protected volume shall be calculated as the sum of the volume of the silo and the volume of the collector in accordance with Section 8.7.

(2) The *L/D* of the combination shall be calculated based on the dimensions of the silo alone in accordance with Section 6.4.

(3) Vent panels shall be located on the silo top surface or on the side walls above the maximum level of the contents of the silo.

(4) It shall be permitted to locate a portion of the venting on the bin vent surface in accordance with the following proportions:

$$A_{v,bin\ vent} = A_{v,\ total} - A_{v,silo\ min} \quad \text{[8.11.1a]}$$

$$A_{v,silo\ min} = \left(\frac{V_{silo}}{V_{total}}\right)^{2/3} A_{v,\ total} \quad \text{[8.11.1b]}$$

where:

$A_{v,bin\ vent}$ = vent area of the bin vent/collector

$A_{v,\ total}$ = total vent area calculated for the bin vent–silo combination

$A_{v,\ silo\ min}$ = minimum explosion venting area required to be on the silo

$A_{v,\ silo}$ = actual explosion venting area installed on the silo

Submitter Information Verification

Committee: EXL-AAA

Submittal Date: Tue May 25 10:30:52 EDT 2021

Committee Statement

Committee Statement: As proposed by PI 18, the addition of the vertical length of the bin vent to the effective flame length, H, but stated as L, would also necessitate including the change in effective diameter, D, due to the smaller diameter of the bin vent. For a small increase in L, the reduction in D could be much larger on a percentage basis with a resultant significant increase in L/D. Without the support of additional data, it is not possible to support such a recommended change.

Recent Spanish test data for silos [Tascon and colleagues in a series of papers] suggests that the current L/D correction may be non-conservative in some cases. The committee is considering a reevaluation of the L/D effect in the Chapter 8 equations. For this reevaluation supplemental test data would be helpful.

Response Message: CI-7-NFPA 68-2021

Public Input No. 18-NFPA 68-2020 [Section No. 8.11.1]

Committee Input No. 31-NFPA 68-2021 [Section No. H.1 [Excluding any Sub-Sections]]

The new equations for Chapter 8 have been developed using material based on the following research conducted by Factory Mutual Research Corporation.

Submitter Information Verification

Committee: EXL-AAA

Submittal Date: Fri Jul 02 13:26:38 EDT 2021

Committee Statement

Committee Statement: NFPA Staff has created this Committee Input during the editorial review of the standard. This language should be reviewed during the Second Draft stage as it has existed since at least the 2002 edition and may no longer be correct in referencing "new equations".

Response Message: CI-31-NFPA 68-2021