Public Input No. 2-NFPA 68-2018 [New Section after 6.4.3.2.2]

6.4.3.2.3

When multiple vents are located on opposite, horizontal walls of a wide, horizontally orientated unit and 1/2 their distance between each other exceeds the vertical H value for maximum straight line (not diagonal) distance, this value can then be used for H.

6.4.3.2.4

If a singular vent is used on one side of a wise, horizontally orientated unit, and the horizontal distance from the opposite solid is greater than the vertical distance of H, then use the larger distance as this is the maximum, straight line (not diagonal) distance to the vent.

(Please also add indexed diagrams for this.)

Additional Proposed Changes

File Name	Description	Approved
Wider_than_Tall_Collector_with_Explosion_Vents_on_Either_End_-_Steve_Varga_-_Nederman_-_2018-06-05_16-46-28.jpg	A horizontal collector with explosion vents on both sides exceeding the H value vertically for any vent placement in the horizontal direction.	

Statement of Problem and Substantiation for Public Input

Horizontal collectors are not addressed very much in the NFPA explosion venting as most diagrams show a vertical box.

This would encompass more explosion vent design solutions that are out there.

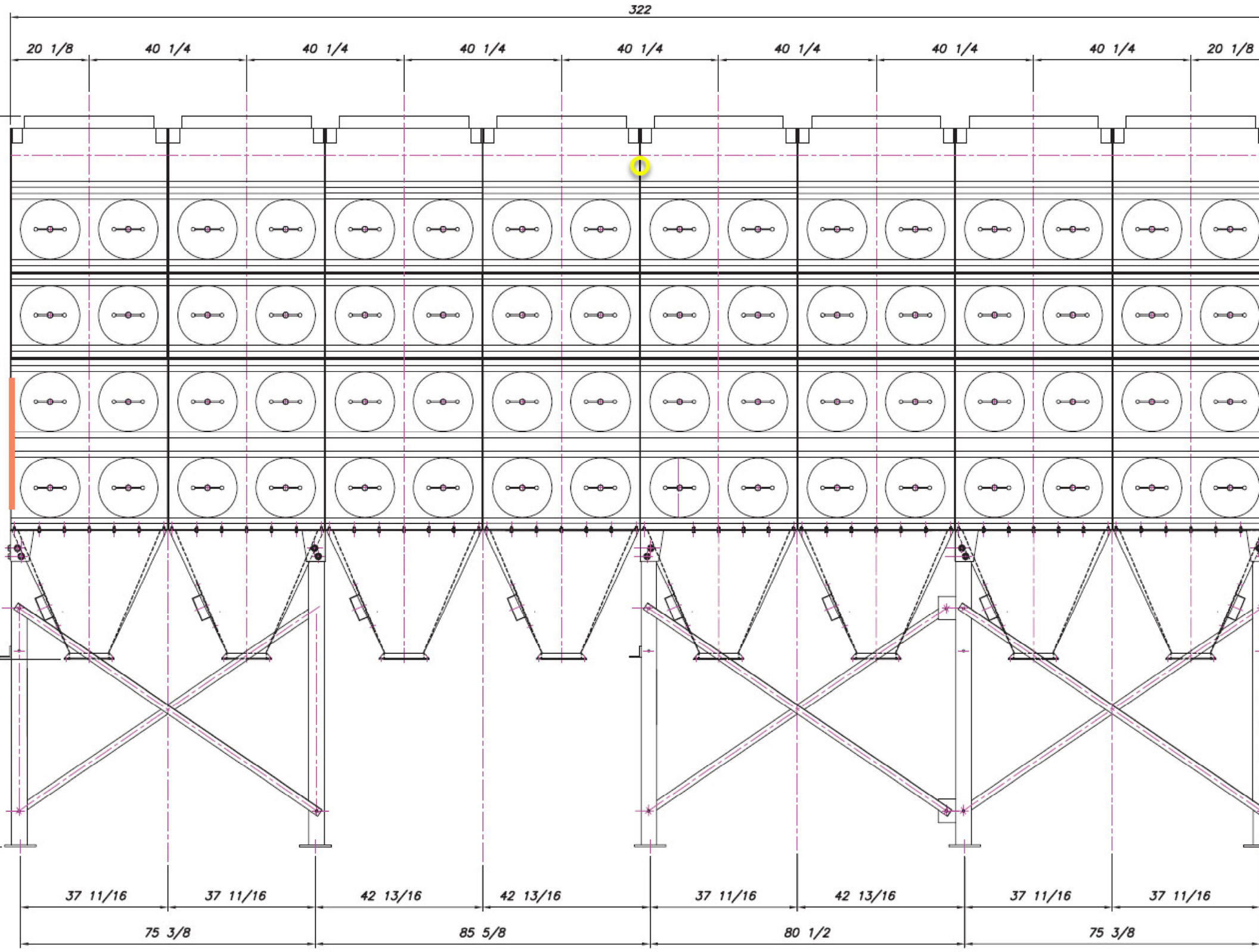
Submitter Information Verification

Submitter Full Name: Steve Varga
Organization: Nederman
Street Address:
City:
State:
Zip:
Submittal Date: Wed Jun 06 11:33:11 EDT 2018
Committee: EXL-AAA

Committee Statement

Resolution: This concept is already covered in 6.4.3 and subsections. H in those sections can apply

either vertically or horizontally depending on the orientation of the enclosure.


322
20 1/8
40 1/4
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40 1/4
40 1/4
20 1/8
37 11/16
37 11/16
42 13/16
42 13/16
37 11/16
42 13/16
37 11/16
37 11/16
75 3/8
85 5/8
80 1/2
75 3/8

Public Input No. 13-NFPA 68-2019 [Section No. 6.4.3.3]

6.4.3.3

The effective volume of the enclosure, V_{eff}, shall be determined based on the volume of that part of the enclosure through which the flame can pass as it travels along the maximum flame length, *H*.

6.4.3.3.1 –

~~Partial volume *(see Section 8.4)* shall not be considered in the determination of effective volume per this section.~~

~~6.4.3.3.2~~ –

When multiple vents are provided, a single value of V_{eff} shall be permitted to be determined for the enclosure based upon the farthest vent.

6.4.3.3.~~3~~ – 2

When multiple vents are located along the central axis, V_{eff} shall be permitted to be determined for each section using the maximum distance from the closest end of one vent to the opposite end of the next vent.

6.4.3.3.4 – 3

When V_{eff} is less than the total volume of the enclosure, only those vents located within the effective volume shall be considered as providing venting for the event.

Additional Proposed Changes

File Name	Description	Approved
TIA_68-18-1.pdf	68_TIA1370	

Statement of Problem and Substantiation for Public Input

"NOTE: This public input originates from Tentative Interim Amendment No. 18-1 (Log 1370) issued by the Standards Council on August 14, 2018 and per the NFPA Regs., needs to be reconsidered by the Technical Committee for the next edition of the Document.

Substantiation: Section 8.7 methodology for dust collectors was revised for the 2018 edition and specifically eliminated the discounting of internal volume of the elements, as described by this section. Removing statement 6.4.3.3.1 eliminates the dangerous confusion this statement creates, as the user could incorrectly reduce the relevant dust collector volume for vent sizing and thus provide too little vent area.

Emergency Nature: The standard contains an error or an omission that was overlooked during the regular revision process. The NFPA Standard contains a conflict within the NFPA Standards or within another NFPA Standard. Removing statement 6.4.3.3.1 eliminates the dangerous confusion this statement creates, as the user could incorrectly reduce the relevant dust collector volume for vent sizing and thus provide too little vent area.

Submitter Information Verification

Submitter Full Name: TC ON EXL-AAA

Organization: NFPA TC on Explosion Protection Systems
Street Address:
City:
State:
Zip:
Submittal Date: Mon Mar 11 11:53:23 EDT 2019
Committee: EXL-AAA

Committee Statement

Resolution: The removal of the section approved by this TIA has already been incorporated into the draft.

Tentative Interim Amendment

NFPA® 68

Standard on Explosion Protection by Deflagration Venting

2018 Edition

Reference: 6.4.3.3.1
TIA 18-1
(SC 18-8-21 / TIA Log #1370)

Pursuant to Section 5 of the NFPA *Regulations Governing the Development of NFPA Standards*, the National Fire Protection Association has issued the following Tentative Interim Amendment to NFPA 68, *Standard on Explosion Protection by Deflagration Venting*, 2018 edition. The TIA was processed by the Technical Committee on Explosion Protection Systems, and was issued by the Standards Council on August 14, 2018, with an effective date of September 3, 2018.

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 public input of the proponent for the next edition of the standard; as such, it then is subject to all of the procedures of the standards-making process.

1. Delete 6.4.3.3.1 and renumber subsequent paragraphs as follows:

6.4.3.3 The effective volume of the enclosure, V_{eff}, shall be determined based on the volume of that part of the enclosure through which the flame can pass as it travels along the maximum flame length, H.

~~**6.4.3.3.1** Internal volume of dust collector bags, filters, or cartridges shall be permitted to be eliminated when determining the effective volume of an elongated enclosure, when the vent is positioned as required by 8.7.1(1) or 8.7.1(2).~~

6.4.3.3.~~2~~1 Partial volume *(see Section 8.4)* shall not be considered in the determination of effective volume per this section.

6.4.3.3.~~3~~2 When multiple vents are provided …

6.4.3.3.~~4~~3 When multiple vents are located …

6.4.3.3.~~5~~4 When V_{eff} …

Issue Date: August 14, 2018

Effective Date: September 3, 2018

(Note: For further information on NFPA Codes and Standards, please see www.nfpa.org/docinfo**)**

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NATIONAL FIRE PROTECTION ASSOCIATION

Public Input No. 19-NFPA 68-2020 [Section No. 6.7.3]

6.7.3

If the total mass of a closure divided by the area of the vent opening does not exceed the panel densities calculated by Equation 7.4. 3 ~~.2~~ and Equation 8.3.2 (for gas and dust, respectively), all vent area correlations presented in this standard shall be permitted to be used without correction [111].

Statement of Problem and Substantiation for Public Input

Incorrect reference

Submitter Information Verification

Submitter Full Name: Mark Mannex
Organization: Fm Global
Street Address:
City:
State:
Zip:
Submittal Date: Fri Nov 13 10:57:32 EST 2020
Committee: EXL-AAA

Committee Statement

Resolution: FR-11-NFPA 68-2021
Statement: This revision fixes an incorrect cross reference.

Public Input No. 28-NFPA 68-2021 [New Section after 6.9]

6.10 Venting of Metal Dust Deflagrations

6.10.1 For aluminum, hafnium, magnesium, tantalum, titanium, zirconium, and similar alloys or mixtures with adiabatic flame temperature higher than 3300°C, unless KSt and Pmax are determined in nominal 1 m3 or larger calibrated test vessels, the KSt value shall be multiplied by a factor of 2 for application of the venting design methods [Refs 1 - 3].

1. Taveau, J. (2014). Combustible metal dusts: a particular class. 17th Mary Kay O'Connor Process Safety Center International Symposium, 594-606, College Station, Texas, USA

2. Taveau, J., Lemkowitz, S., Hochgreb, S., Roekaerts, D. (2018). Scaling up metal dusts deflagration severity. 12th International Symposium on Hazards, Prevention, and Mitigation of Industrial Explosions, Kansas City, USA

3. Taveau, J., Lemkowitz, S., Hochgreb, S., Roekaerts, D. (2019). Metal dusts explosion hazards and protection. Chemical Engineering Transactions, Volume 77, 7-12

Statement of Problem and Substantiation for Public Input

It is proposed to move current paragraph 6.1.2.3. to a new paragraph 6.10 dedicated to the venting of metal dust deflagrations. Explanatory references have been added as well.

Related Public Inputs for This Document

Related Input	Relationship
Public Input No. 29-NFPA 68-2021 [New Section after A.7.1.1]	

Submitter Information Verification

Submitter Full Name: Jerome Taveau
Organization: Jensen Hughes
Street Address:
City:
State:
Zip:
Submittal Date: Tue Jan 05 19:16:40 EST 2021
Committee: EXL-AAA

Committee Statement

Resolution: Relocating this section could cause confusion or lead to the requirement being missed when Kst is being calculated in section 6.1.2.

Public Input No. 30-NFPA 68-2021 [New Section after 6.9.8]

6.10 Venting of Metal Dust Deflagrations

6.10.2 Deflagration vents and flameless venting devices shall be tested and certified under realistic deflagration conditions with a representative metal dust and at a test vessel volume representative of the actual application [Refs 1 - 3].

1. Taveau, J.R., Hochgreb, S., Lemkowitz, S., Roekaerts, D. (2018). Explosion hazards of aluminium finishing operations. Journal of Loss Prevention in the Process Industries, 51, 84-93

2. Taveau, J., Lemkowitz, S., Hochgreb, S., Roekaerts, D. (2018). Scaling up metal dusts deflagration severity. 12th International Symposium on Hazards, Prevention, and Mitigation of Industrial Explosions, Kansas City, USA

3. Taveau, J., Lemkowitz, S., Hochgreb, S., Roekaerts, D. (2019). Metal dusts explosion hazards and protection. Chemical Engineering Transactions, Volume 77, 7-12

Statement of Problem and Substantiation for Public Input

It is proposed to adopt here some adaptation of the text already included in the next edition of NFPA 484 (Second Revision No. 4-NFPA 484-2020).

Rationale submitted to NFPA 484:

There is a growing amount of evidence that metal dust deflagrations pose more severe challenges to explosion protection systems than organic dusts that are traditionally used for the testing and certification of such devices. And therefore, that conventional explosion protection systems may fail to mitigate metal dust deflagrations, resulting in unmitigated hazards and catastrophic losses.

For example, vent panels may experience fragmentation (due to metal dusts higher rates of pressure rise and temperatures), flameless venting devices and suppression systems may not be able to quench the expanding fireball (due to metal dusts higher heat release rates) and isolation systems may not activate fast enough to isolate a propagating metal dust deflagration (due to metal dusts higher flame speeds).

Also, a scaling issue related to the venting of aluminum dust deflagrations has been identified, with higher than expected Preds as the volume to be protected increases, which has been attributed to the effect of thermal radiation (which can be an order of magnitude greater for metal dusts compared to common organic dusts), and raises doubts concerning the adequate protection of industrial-scale equipment using current venting correlations.

Therefore, a specific testing and certification path is required for explosion protection systems used to mitigate metal dust hazards. Testing using the same metal dust and at a volume representative of the actual application is crucial to be able to certify explosion protection systems. Explosion protection systems intended for metal dusts must not be tested and certified using an organic combustible dust, such as cornstarch, which exhibits weaker combustion characteristics.

This text supplements information and warnings already available in A.11.2.4.4.1, A.11.2.4.4.11.2, A.11.2.4.4.11.4, A.11.2.4.4.15.6, A.11.5.1.6, A.11.6.1.2.2 of NFPA 484, 2019 edition about limitations of conventional explosion protection systems when dealing with metal dusts.

Submitter Information Verification

Submitter Full Name: Jerome Taveau

Organization: Jensen Hughes
Street Address:
City:
State:
Zip:
Submittal Date: Tue Jan 05 19:32:19 EST 2021
Committee: EXL-AAA

Committee Statement

Resolution: FR-15-NFPA 68-2021
Statement: The committee recognizes the need to address adiabatic flame temperature when applying flameless venting to metal dusts.

Public Input No. 22-NFPA 68-2021 [Section No. 7.3.2]

7.3.2

A partial volume fill fraction, X_r, shall be calculated as follows:

$$X_r = \frac{V_{gas} / V_{enc}}{x_{st}} \quad \text{[7.3.2]}$$

where:

V_{gas} = maximum volume of gas that can be mixed with air in the enclosure

V_{enc} open = open volume of the enclosure ~~volume~~

x_{st} = stoichiometric volume concentration of gas

Additional Proposed Changes

File Name	Description	Approved
Eqtn_7.3.2.PNG	Revised eqtn 7.3.2	

Statement of Problem and Substantiation for Public Input

The open volume of the enclosure is the total volume of the enclosure less the volume of solid obstructions, not the total volume of the enclosure. This distinction becomes relevant as the fraction of the enclosure volume filled with solid obstructions increases, reducing the open-air volume available for mixing. If the partial volume effects were calculated using the total volume of the enclosure, the required vent area would be under-predicted. This error is commonly made when calculating vent areas for Battery Energy Storage Systems, which prompted this suggested change to NFPA 68. This explanation is also proposed for inclusion in the appendix.

Related Public Inputs for This Document

Related Input	Relationship
Public Input No. 23-NFPA 68-2021 [New Section after A.7.2.6.1]	Explanatory material for appendix
Public Input No. 23-NFPA 68-2021 [New Section after A.7.2.6.1]	

Submitter Information Verification

Submitter Full Name: Bryant Hendrickson
Organization: Blue Engineering and Consulting
Affiliation: None
Street Address:
City:
State:
Zip:
Submittal Date: Mon Jan 04 15:51:50 EST 2021

Committee: EXL-AAA

Committee Statement

Resolution: FR-13-NFPA 68-2021

Statement: The volume of solid objects should be subtracted from the enclosure volume to accurately calculate the volume available for mixing of gas and air and the required vent area. This clarification was prompted by the calculation of vent areas for Battery Energy Storage Systems.

$$X_r = \frac{V_{gas}/V_{open}}{x_{st}}$$

Public Input No. 3-NFPA 68-2018 [Section No. 7.6.1]

7.6.1

The hazard zone from a vented gas deflagration shall be calculated by the following equation:

$$D = 3.1 \cdot \left(\frac{V}{n}\right)^{0.402} \quad \text{[7.6.1]}$$

where:

D = axial distance (front-centerline) from vent (m)

V = volume of vented enclosure (m^3)

n = number of ~~evenly distributed~~ vents directed in different directions

Statement of Problem and Substantiation for Public Input

The fireball length is only significantly reduced when multiple vents are oriented in different directions. For instance placing two or more vents on the same side of a vessel where the space between the vents is small relative to the length of the fireball(s) does not significantly reduce the fireball length compared to length of a fireball from a single vent of the same size as the multiple vents. The multiple fireballs from multiple vents overlap a short distance from the dust collector and behave similarly to a single fireball form a single larger vent.. In contrast vents located on one or more opposite sides of a dust collector do result in multiple fireballs of a shorter extent.

Related Public Inputs for This Document

Related Input	Relationship
Public Input No. 4-NFPA 68-2018 [Section No. 8.9.2 [Excluding any Sub-Sections]]	Similar equation and issue

Submitter Information Verification

Submitter Full Name: Timothy Myers
Organization: Exponent Inc
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State:
Zip:
Submittal Date: Sun Jul 01 15:47:29 EDT 2018
Committee: EXL-AAA

Committee Statement

Resolution: FR-16-NFPA 68-2021

Statement: Language was needed to explain how to evaluate the number of evenly distributed vents and the statements were realigned to mirror the order in Chapter 8 for dust fireball dimensions.

Public Input No. 9-NFPA 68-2019 [Section No. 8.1]

8.1 Introduction.

8.1.1

This chapter shall apply to all enclosures with $L/D \leq 6$ handling combustible dusts or hybrid mixtures.

8.1.1.1

This chapter shall be used with the information contained in the rest of this standard.

8.1.1.2

In particular, Chapters 6, 7, 10, and 11 shall be reviewed before the information in this chapter is applied.

8.1.1.3

This chapter provides a number of equations and calculation procedures that shall be used to treat a variety of vent sizing applications.

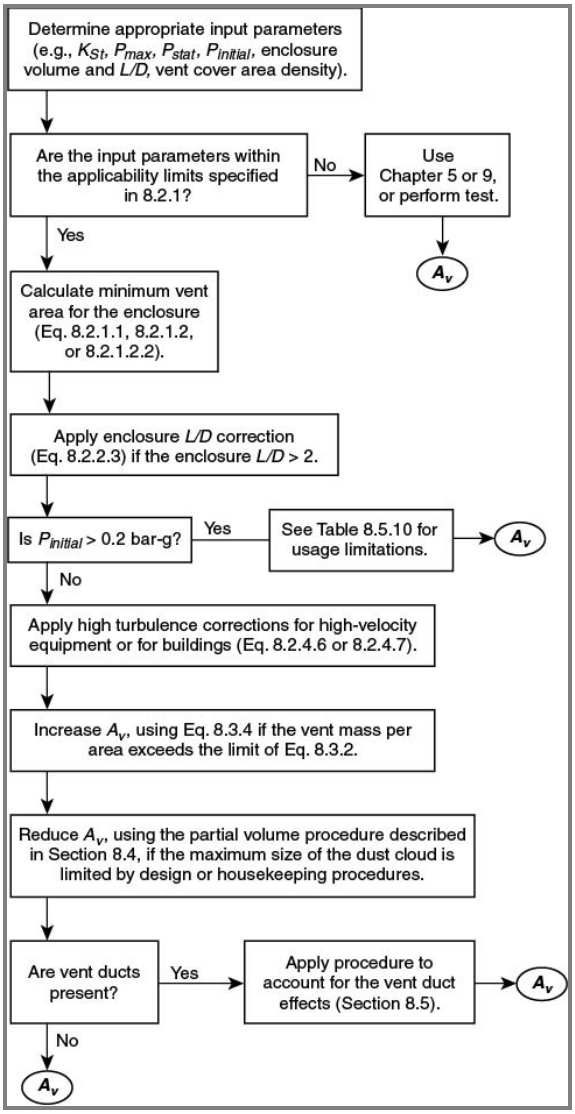
8.1.1.4

The general flowchart given in Figure 8.1.1.4 shall be permitted to be used to select applicable vent sizing methods.

8.1.1.5

It shall be permitted to use EN 14491:2012 to calculate the required vent area for an enclosure.

Figure 8.1.1.4 Dust Explosion Vent Sizing Calculation Flowchart.



8.1.2*

Where actual material is not available for test, vent sizing shall be permitted to be based on K_{St} values for similar composition materials of particle size no greater than the specified particle size range per the chosen standard: ASTM E1226, *Standard Test Method for Explosibility of Dust Clouds,* or ISO 6184-1, *Explosion Protection Systems — Part 1: Determination of Explosion Indices of Combustible Dust in Air*.

8.1.2.1

Where the actual material intended to be produced is smaller than the size determined by 8.1.2, tests shall be performed near the intended particle size.

8.1.2.2

When the actual material is available, the K_{St} shall be verified by test.

Statement of Problem and Substantiation for Public Input

The vent sizing calculations per NFPA 68 are becoming extremely complicated, especially considering all the constraints on variables and special situations. There is no commercially available software (that I am aware of) to calculate the required vent area per NFPA 68 . This is a huge burden keeping up with all the changes that have occurred with updates every cycle. I don't believe that anyone that has not done a lot of vent sizing calculations and keeps up with the updates would be able to do a vent sizing calculation accurately. This places a huge financial burden on small to medium sized companies and also is a huge financial burden for large companies that have experts that need to keep up with the standard. By allowing the use of the EN 14491:2012 standard, a company can purchase commercial software for a nominal fee that allows calculating the vent area for an enclosure. The EN standard is a recognized international standard that is peer reviewed. There are literature articles (Dust explosion venting in silos: A comparison of standards NFPA 68 and EN 14491, Alberto Tasco´n, Pedro J. Aguado, Alvaro Ramı´rez, Journal of Loss Prevention in the Process Industries 22 (2009) 204–209 and Dust explosion venting of small vessels at the elevated static activation overpressure, Xingqing Yan, Jianliang Yu, Powder Technology 261 (2014) 250–256) that indicate the EN standard is less conservative on the calculated vent area, so using the EN standard would not pose an increased risk of vessel failure.

Submitter Information Verification

Submitter Full Name: James Koch
Organization: The Dow Chemical Company
Street Address:
City:
State:
Zip:
Submittal Date: Fri Jan 04 14:08:13 EST 2019
Committee: EXL-AAA

Committee Statement

Resolution: NFPA 68 is more complex and requires the application of additional equations compared to EN-14491-2012. There is not currently a commercial tool available for applying the NFPA 68 equations. The committee is aware that EN-14491 does not always provide more conservative vent area requirements than NFPA 68. NFPA 68 deals with specific applications that EN-14491 doesn't address, such as partial volume deflagration. As such, NFPA 68 cannot support the use of this alternative methodology. The support for using EN-14491 in place of NFPA 68 should be developed by the user, for their specific application. A further comparison could be made if the committee was provided with the data or process used to develop the methods in EN-14491.

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

8.2 Venting by Means of Low-Inertia Vent Closures.

The committee is encouraged to evaluate the changes made to this chapter in the 2013 edition. The changes refer to the L/D ratio, disallowance for volume of media and the impact on the calculation of mass threshold for the vent panel. The changes have a great impact especially on smaller size AMS as there is limited space to add vent panels on the structure. The writer would like to present to the committee full scale testing done on one type AMS where the vent panel size was calculated based on the ATEX formulas. The specific AMS has a volume of 1.1 m^2, L/D of 2.91 (based on 2013/2018 ed,) and P_{red} = 0.5 bar. The test was done with K_{st} = 280 bar*m/s and P_{max} = 7.2 bar. The NFPA calculation require 0.275 m^2 and the ATEX calculation require 0.038 m^2. The test AMS had a vent area of 0.1 m^2 i.e. 1/3 of the area required by the NFPA calculation. The highest pressure in the AMS was 0.33 bar.

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:

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

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.

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

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 $L/D \leq 1$

(2) Panel density $M \leq M_T$ 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 $\leq P_{max} \leq$ 12 bar-g

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

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

(4) $P_{stat} \leq 0.75(1 + P_{initial})$ 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]):

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

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:

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

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]:

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

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]:

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

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.

Statement of Problem and Substantiation for Public Input

The current calculation for vent panel area results in panel sizes that are significantly bigger that actual full scale test shows. The writer encourage the committee to reevaluate the significant changes implemented in the 2013 edition.

Submitter Information Verification

Submitter Full Name: Niels Pedersen
Organization: Nederman LLC
Street Address:
City:
State:
Zip:
Submittal Date: Tue Jan 05 11:45:41 EST 2021
Committee: EXL-AAA

Committee Statement

Resolution: CI-6-NFPA 68-2021

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.

Public Input No. 32-NFPA 68-2021 [Section No. 8.3.3]

8.3.3

Where $M > 40$ kg/m^2, it shall be permitted to use the procedure provided in Annex G.

Statement of Problem and Substantiation for Public Input

It is not clear to me why Annex G procedure (used to correct vent area due to increased vent panel mass when M > 40 kg/m2) is only referred in Chapter 8 (dust and hybrid deflagrations, paragraph 8.3.3), and not in Chapter 7 (gas and mists deflagrations, paragraph 7.4.1, as it only considers the case where M < 40 kg/m2).

Submitter Information Verification

Submitter Full Name: Jerome Taveau
Organization: Jensen Hughes
Street Address:
City:
State:
Zip:
Submittal Date: Wed Jan 06 14:34:17 EST 2021
Committee: EXL-AAA

Committee Statement

Resolution: The annex G information is an implementation of Factory Mutual methodology at high panel inertias, and as far as the committee is aware, there is no data to support an extension of this application to gases.

Public Input No. 21-NFPA 68-2020 [Sections 8.8.3.3, 8.8.3.4]

Sections 8.8.3.3, 8.8.3.4

8.8.3.3

Additional vents shall be installed in each casing at center-to-center spacing distance along the elevator axis based on the bucket elevator classification, the K_{St} of the material being handled, and the design strength based on P_{red}, as given in Table 8.8.3.3. For a P_{red} that falls between one of the P_{red} values on Table 8.8.3.3 then interpolation is allowed.

Table 8.8.3.3 Additional Vent Spacing

Bucket Elevator Classification	K_{St} (bar-m/s)	P_{red} 0.2 bar-g	Spacing (m) P_{red} 0.5 bar-g	P_{red} 1.0 bar-g	
Double-casing (twin leg)	<100	6	None required	None required	
	-	100–150	3	10	19
	-	151–175	N/A	4	8
	-	176–200	N/A	3	4
	-	>200	N/A	N/A	3
Single-casing (single leg)	<100	N/A*	None required	None required	
	-	100–150	N/A	7	14
	-	151–175	N/A	4	5
	-	176–200	N/A	3	4
	-	>200	N/A	N/A	3

N/A: Not allowed.

*For P_{red}= 0.3 bar-g, vent spacing of 6 m is appropriate.

Source: [120]

8.8.3.4*

Where plastic buckets are used, ~~the corresponding~~ resulting deflagration pressures will increase and require a higher Pred for equivalent spacing using metal buckets. The corresponding required elevator design P_{red} of 0.2, 0.5, or 1.0 bar-g shall be increased by the factors given in Table 8.8.3.4.

Table 8.8.3.4 Design P_{red} Adjustment for Plastic Buckets

K_{St} (bar-m/s)	Percent Increase
<100	20
100–150	35
151–200	50

Source: [120, 124].

Additional Proposed Changes

File Name	Description	Approved
image_6_.png	Revised Table 8.8.3.3 to include plastic bucket Pred requirements.	

Statement of Problem and Substantiation for Public Input

The way this section is written can be interpreted to mean that plastic buckets are an advantage to the owner, and that less vents would be needed due to plastic buckets increasing the designed Pred. Percent Increase given in Table 8.8.3.4 makes it seem like you can increase your Pred and thereby increase your spacing. Which then gives rise to the question, can you interpolate in-between the values in Table 8.8.3.3? Intuition would say yes, for a twin leg elevator with Kst 100-150, if my elevator is rated to withstand Pred of 0.35 BARG then spacing vents at 3 m would be overly conservative and double the cost of venting and installation costs since interpolating would allow spacing every 7.5 m.

Clear guidance on if interpolation is acceptable will be much appreciated. Also adding a column for the Plastic bucket Pred requirement would add clarity.

Submitter Information Verification

Submitter Full Name: Daniel Thorne
Organization: Fike Corporation
Street Address:
City:
State:
Zip:
Submittal Date: Mon Nov 16 14:43:39 EST 2020
Committee: EXL-AAA

Committee Statement

Resolution: FR-18-NFPA 68-2021

Statement: Guidance has been added to clarify that interpolation is acceptable, but not extrapolation. The section for plastic buckets was revised to make it clear that plastic buckets result in a required increase in the design strength of the elevator (due to an increase in Pred) vs metal buckets. In lieu of adding a new column to 8.8.3.3 as proposed in the Public Input, clarification was added to the headings of Table 8.8.3.4.

Venting Procedure - NFPA 68, 2018 (cont.)

Enclosure Strength Adjustment for Plastic Buckets applied to Table 8.8.3.4

Bucket Elevator Classification	K_{St} (bar-m/s)	Spacing (m) P_{red} 0.2 bar-g	Adj. Pred	P_{red} 0.5 bar-g	Adj. Pred	P_{red} 1.0 bar-g	Adj. Pred
Double-casing (twin leg)	<100	6	0.24 barg	None required	0.6 barg	None required	1.2 barg
	100–150	3	0.27 barg	10	0.7 barg	19	1.4 barg
	151–175	N/A		4	0.8 barg	8	1.5 bar
	176–200	N/A		3		4	
	>200	N/A		N/A		3	
Single-casing (single leg)	<100	N/A*	0.36 barg	None required	0.6 barg	None required	1.2 barg
	100–150	N/A		7	0.7 barg	14	1.4 barg
	151–175	N/A		4	0.8 barg	5	1.5 barg
	176–200	N/A		3		4	
	>200	N/A		N/A		3	

N/A: Not allowed.

*For P_{red} = 0.3 bar-g, vent spacing of 6 m is appropriate.

Source: [120]

Public Input No. 4-NFPA 68-2018 [Section No. 8.9.2 [Excluding any Sub-Sections]]

In the case of dust deflagration venting, the distance, *D*, shall be expressed by Equation 8.9.2:

$$D = K \cdot \left(\frac{V}{n}\right)^{1/3} \quad \textbf{[8.9.2]}$$

where:

D = axial distance (front) from the vent (m)

K = flame length factor: 10 for metal dusts, 8 for chemical and agricultural dusts

V = volume of vented enclosure (m^3)

n = number of ~~evenly distributed~~ vents directed in different directions

Statement of Problem and Substantiation for Public Input

The fireball length is only significantly reduced when multiple vents are oriented in different directions. For instance placing two or more vents on the same side of a dust collector where the space between the vents is small relative to the length of the fireball(s) does not significantly reduce the fireball length compared to length of a fireball from a single vent of the same size as the multiple vents. The multiple fireballs from multiple vents overlap a short distance from the dust collector and behave similarly to a single fireball form a single larger vent.. In contrast vents located on one or more opposite sides of a dust collector do result in multiple fireballs of a shorter extent.

Related Public Inputs for This Document

Related Input	Relationship
Public Input No. 3-NFPA 68-2018 [Section No. 7.6.1]	

Submitter Information Verification

Submitter Full Name: Timothy Myers
Organization: Exponent Inc
Street Address:
City:
State:
Zip:
Submittal Date: Sun Jul 01 15:55:59 EDT 2018
Committee: EXL-AAA

Committee Statement

Resolution: FR-17-NFPA 68-2021

Statement: Language was needed to explain how to evaluate the number of evenly distributed vents and the statements were realigned to mirror the order in Chapter 7 for gas fireball dimensions. The figure for fireball dimensions was revised to show that the dimensions of D are significantly greater than the dimensions of the vessel, noting that the figure is not

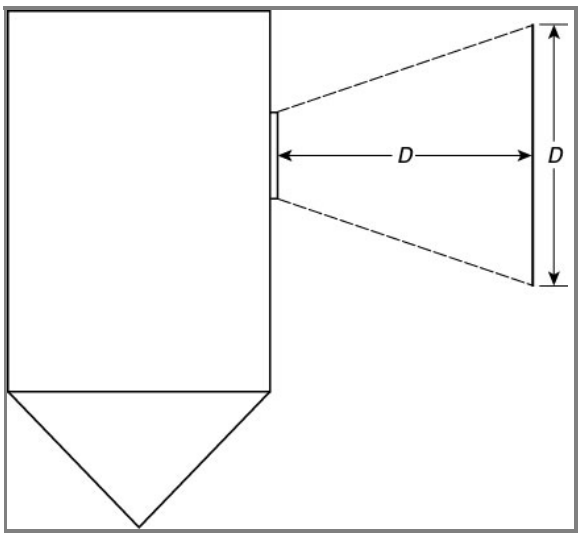
drawn to scale.

Public Input No. 5-NFPA 68-2018 [Section No. 8.9.2.2]

8.9.2.2 *

The maximum width and height of the projected flame shall be taken as *D* and shall be assumed to be equally distributed around the centerline of the vent discharge *(see Figure 8.9.2.2)*.

Figure 8.9.2.2 Fireball Dimensions.



The figure should be revised as it is misleading. It shows a fireball that is similar to the dimensions of the vessel, when in reality the equation generates fireball lengths significantly greater than the dimensions of the vessel.

Statement of Problem and Substantiation for Public Input

The figure should be revised as it is misleading. It shows a fireball that is similar to the dimensions of the vessel, when in reality the equation generates fireball lengths significantly greater than the dimensions of the vessel.

Submitter Information Verification

Submitter Full Name: Timothy Myers
Organization: Exponent Inc
Street Address:
City:
State:
Zip:
Submittal Date: Sun Jul 01 15:58:12 EDT 2018
Committee: EXL-AAA

Committee Statement

Resolution: FR-17-NFPA 68-2021

Statement: Language was needed to explain how to evaluate the number of evenly distributed vents and the statements were realigned to mirror the order in Chapter 7 for gas fireball dimensions. The figure for fireball dimensions was revised to show that the dimensions of D are significantly greater than the dimensions of the vessel, noting that the figure is not drawn to scale.

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

8.11.1

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~~ and bin vent 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:

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

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

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

Statement of Problem and Substantiation for Public Input

The current wording of 8.11.1 implies that the value of H is only to the top of a silo and not the maximum potential flame length in the silo-collector combination as used in 6.4.3. The 8.11.1 H value is a shorter distance which is non-conservative compared to established 6.4.3 methods and may not be technically justified; the silo-collector opening does not seem, at first glance, to provide enough of a restriction to deviate from the 6.4.3 established method for a conservative value of L/D. I would also like the committee to review if the silo-collector scenario is closer, technically, to the dust collector scenario described in section 8.7. In section 8.7.1, the value of H is even more conservative (longer) by extending the measurement to include the entire dirty side length of the silo/collector vessel. Please evaluate which scenario has the appropriate degree of conservatism for sizing explosion vents.

Submitter Information Verification

Submitter Full Name: Richard Berg
Organization: Corning, Incorporated
Street Address:
City:
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Zip:

Submittal Date: Fri Nov 06 11:25:07 EST 2020
Committee: EXL-AAA

Committee Statement

Resolution: CI-7-NFPA 68-2021

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.

Public Input No. 26-NFPA 68-2021 [Chapter 11]

Chapter 11– Testing, Certification, Installation, Inspection and Maintenance of Deflagration Venting Systems

11.1 General.

11.1.1

This chapter covers the testing, certification, installation, inspection, and maintenance procedures necessary for the proper functioning and operation of vent closures for venting deflagrations.

11.1.2

Sections 11.4 through 11.11 shall be applied retroactively.

11.2* Design Parameters and Documentation.

Data sheets, installation details, and design calculations shall be developed and maintained for each vent closure application, suitable for review by an authority having jurisdiction that verifies the vent area is sufficient to prevent deflagration pressure from exceeding the enclosure strength and identifies areas exposed to potential overpressure, event propagation, and fireball effects during venting. Documentation shall include all of the following:

(1) Manufacturer's data sheets and instruction manuals

(2) Design calculations

(3) General specifications

(4) Vent closure specifications

(5) End user inspection/maintenance forms

(6) User documentation of conformity with applicable standards

(7) Vent closure identification

(8) Combustible material properties test report

(9) Copy of vent identification label

(10) Process plan view

(11) Process elevation view

(12) Vent relief (pressure and fireball) path

(13) Proximity of personnel to vent relief path

(14) Mechanical installation details

(15) Electrical supervision (if provided) installation details

(16) Vent restraint installation and design documentation (if required)

(17) Process interlocks (if provided)

(18) Event deflagration isolation requirements (if required)

(19) Employee training requirements

11.3 Installation.

11.3.1

Mounting frames shall be fabricated and mounted so that the vent closure is not stressed in any way that will contribute to fatiguing the vent closure.

11.3.2

Vent closures shall be installed in accordance with the manufacturer's requirements.

11.3.3

The final installation shall be inspected to verify its conformance to the design.

11.3.4*

Vent closures shall be clearly marked as follows:

WARNING:

Explosion relief device.

11.4* Inspection.

11.4.1

Vent closures shall be inspected according to 11.4.4 at least annually.

11.4.2*

The frequency of the inspection described in 11.4.4 shall be permitted to be increased or decreased based on documented operating experience.

11.4.3

The owner/operator of the facility in which the deflagration vent closures are located shall be responsible for inspecting and maintaining such devices after they are installed.

11.4.4

The inspector shall verify, as applicable, that the vent inspection determines the following:

(1) The opening is free and clear of any obstructions on both sides.

(2) The discharged material and fireball pathway does not extend into an area normally occupied by personnel or critical process equipment.

(3) The closure has been properly installed according to manufacturer's instructions.

(4) The closure is not corroded or mechanically damaged.

(5) The closure is clearly identified with manufacturer's information.

(6) The closure is clearly labeled as an explosion relief device.

(7) The closure has no damage and is protected from the accumulation of water, snow, ice, or debris after any act of nature.

(8) The closure has not been painted or coated other than by manufacturer.

(9) The closure has no buildup of deposits on the inside surfaces or between layers of the vent.

(10) The closure has not been tampered with.

(11) The closure shows no fatigue and has not released.

(12) The closure hinges (if provided) are lubricated and operate freely.

(13) The closure restraints (if provided) are in place and operational.

(14) The closure seals, tamper indicators, or vent rupture indicators (e.g., breakwire switches), if provided, are in place.

(15) The flame-arresting and particulate-retention device is being maintained, is clean, and is unobstructed in accordance with the manufacturer's listing.

(16) The closure has no conditions that would hinder its operation.

11.4.5

The owner/operator shall verify by signature on the inspection form that the production process material has not changed since the last inspection.

11.5 Procedures Following Vent Closure Actuation.

11.5.1

In the event of vent closure actuation, inspection and maintenance as specified in Sections 11.4 and 11.10, respectively, shall be performed before the system is placed back into service.

11.5.2

An investigation and a review of the cause of the actuation shall be made.

11.6* Vent Closure Design Parameters.

The vent closure design parameters shall be maintained and made available for management of change review, employee training information, inspection, and reordering purposes.

11.7 Inspection Reports.

Deficiencies found during inspections shall be reported to the owner/operator.

11.8 Recordkeeping.

11.8.1

A record shall be maintained that indicates the date and the results of each inspection and the date and description of each maintenance activity.

11.8.2

The records of inspections shall be retained for a minimum of 3 years.

11.9 Management of Change.

Management shall implement and maintain written procedures to evaluate proposed changes to facility and processes, both physical and human, for the impact on safety, loss prevention, and control.

11.9.1

Management of change procedures shall be followed for any change to process, materials, technology, equipment, process flow, exposure, or procedures affecting equipment protected by requirements in this document.

11.9.2*

Management of change documentation shall be available for review by the relevant authority having jurisdiction.

11.9.3

The management of change procedures shall ensure that the following issues are addressed prior to any change:

(1) The technical basis for the proposed change

(2) Safety and health implications

(3) Review of fire and explosion prevention systems

(4) Whether the change is permanent or temporary

(5) Personnel exposure changes

(6) Modifications to operating maintenance procedures

(7) Employee training requirements

(8) Authorization requirements for the proposed change

11.9.4

Implementation of the management of change procedures shall not be required for replacements-in-kind.

11.9.5

Design documentation as required by Section 11.2 shall be updated to incorporate the change.

11.10 Maintenance.

11.10.1

Vent closure maintenance shall be performed after every act of nature or process upset condition to ensure that the closure has not been physically damaged and there are no obstructions, including but not limited to snow, ice, water, mud, or process material, that could lessen or impair the efficiency of the vent closure.

11.10.2

An inspection shall be performed in accordance with 11.4.4 after every process maintenance turnaround.

11.10.3

If process material has a tendency to adhere to the vent closure, the vent closure shall be cleaned periodically to maintain vent efficiency.

11.10.4

Process interlocks, if provided, shall be verified.

11.10.5

Known potential ignition sources shall be inspected and maintained.

11.10.6

Records shall be kept of any maintenance and repairs performed.

11.11 Employee Training.

11.11.1

Initial and refresher training shall be provided and training records maintained for employees who are involved in operating, maintaining, and supervising facilities that utilize devices for venting of deflagrations.

11.11.2

Initial and refresher training shall ensure that all employees are knowledgeable about the following:

(1) Hazards of their workplace

(2) General orientation, including plant safety rules

(3) Process description

(4) Equipment operation, safe startup and shutdown, and response to upset conditions

(5) The necessity for proper functioning of related fire and explosion protection systems

(6) Deflagration vent(s) location, vent relief path, and maintenance requirements and practices

(7) Housekeeping requirements

(8) Emergency response and egress plans

Statement of Problem and Substantiation for Public Input

Current edition of NFPA 68 does not provide comprehensive paragraphs on testing and certification. It is therefore proposed that the Committee set up a Task Group to develop two new paragraphs 11.2

and 11.3 on testing and certification.
EN 14797 "Explosion venting devices" could be used as a starting point.

Submitter Information Verification

Submitter Full Name: Jerome Taveau
Organization: Jensen Hughes
Street Address:
City:
State:
Zip:
Submittal Date: Tue Jan 05 13:22:54 EST 2021
Committee: EXL-AAA

Committee Statement

Resolution: See First Revisions 8 and 9.

Public Input No. 31-NFPA 68-2021 [New Section after 11.2]

11.2 Testing

11.2.1 Deflagration vents should be tested periodically under realistic deflagration conditions to verify relevant design parameters (e.g. Pstat) are within the manufacturer's tolerance.

Statement of Problem and Substantiation for Public Input

It is proposed to include additional requirements for real deflagration venting tests to periodically verify the correct operation of deflagration vents (part of quality control).

Submitter Information Verification

Submitter Full Name: Jerome Taveau
Organization: Jensen Hughes
Street Address:
City:
State:
Zip:
Submittal Date: Tue Jan 05 19:38:19 EST 2021
Committee: EXL-AAA

Committee Statement

Resolution: It is not appropriate to require "periodic real deflagration vent testing" as a means of quality control. Testing requirements are established in 10.2.2.

Public Input No. 14-NFPA 68-2019 [Section No. A.6.4.3]

A.6.4.3

Example 1. Cylindrical enclosure with a hopper and vented in the roof:

(1) H equals the vertical height of the enclosure = 6 m.

(2) V_{eff} equals the total free volume of the enclosure.

(3) The volume of the cylindrical part = $(\pi \cdot D^2/4) \cdot h =$

$[\pi \cdot (1.8)^2/4] \cdot 4 = 10.18\ m^3$.

(4) The volume of the hopper, with diameters D_1 and $D_2 = \pi \cdot h \cdot [(D_1)^2 + (D_1 \cdot D_2) + (D_2)^2]/12 = \pi \cdot 2 \cdot [($

~~2~~

(a) $1.8)^2 + ($

~~2~~

(a) $1.8 \cdot 0.5) + (0.5)^2]/12 = 2.$

~~75 m~~

(a) $30\ m^3$.

(b) $V_{eff} = 10.18 + 2.$

~~75~~

(a) $30 = 12.$

~~93 m~~

(a) $48\ m^3$.

(b) V_{eff} is the shaded region in Figure A.6.4.3(a).

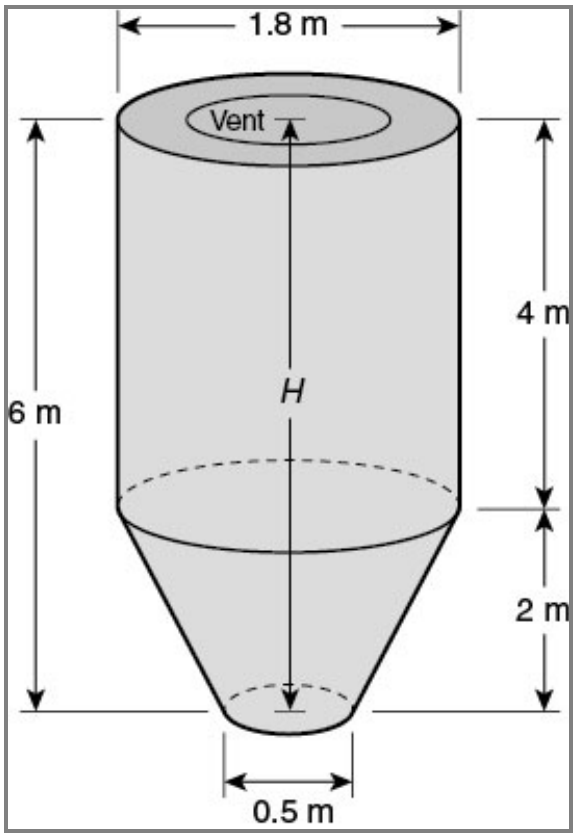
(5) $A_{eff} = V_{eff}/H = 12.~~93~~ 48/6 = 2.~~155 m~~ 080\ m^2$.

(6) $D_{he} = 4 \cdot A_{eff}/p = (4 \cdot A_{eff}/\pi)^{0.5}$, assuming a cylindrical cross section.

(7) $D_{he} = 1.~~656 m~~ 627$ m.

(8) $L/D = H/D_{he} = 6/1.~~656~~ 627 = 3.~~62~~ 69$.

Figure A.6.4.3(a) Calculating *L/D* Ratio for a Cylindrical Vessel with a Hopper and a Top Vent.



In this example, D_{he} is less than the diameter of the cylindrical portion of the enclosure; thus L/D will be greater than if it had been calculated by taking the actual physical dimensions.

Example 2. Cylindrical enclosure with a hopper and vented at the side:

(1) H equals the vertical distance from the bottom of the hopper to the top of the vent = 4 m.

(2) V_{eff} equals the volume of the hopper plus the volume of the cylinder to the top of the vent.

(3) The volume of the cylindrical part = $(\pi \cdot D^2/4) \cdot h =$

$[\pi \cdot (1.8)^2/4] \cdot 2 = 5.09\ m^3$.

(4) The volume of the hopper, with diameters D_1 and $D_2 = \pi \cdot h \cdot [(D_1)^2 (D_1 \cdot D_2) (D_2^2)] / 12 = \pi \cdot 2 \cdot [($

~~2~~

(a) $1.8)^2 ($

~~2~~

(a) $1.8 \cdot 0.5)(0.5)^2] / 12 = 2.$

~~75 m~~

(a) $30\ m^3$.

(b) V_{eff} = 5.09 + 2.

~~75~~

(a) 30 = 7.

~~84 m~~

(a) 39 m^3.

(b) V_{eff} is the shaded region in Figure A.6.4.3(b).

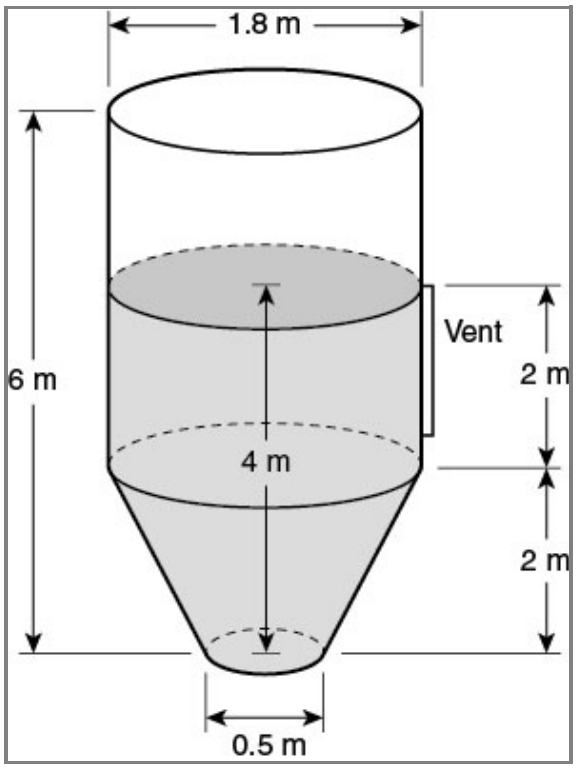
(5) $A_{eff} = V_{eff}/H$ = 7.~~84~~ 39 /4 = 1.~~96 m~~ 85 m^2.

(6) $D_{he} = 4 \cdot A_{eff}/p = (4 \cdot A_{eff} / \pi)^{0.5}$, assuming a cylindrical cross section.

(7) D_{he} = 1.~~58 m~~ 53 m.

(8) $L/D = H/D_{he}$ = 4/1.~~58~~ 53 = 2.~~53~~ 61.

Figure A.6.4.3(b) Calculating *L/D* Ratio for a Cylindrical Vessel with a Hopper and a Side Vent.



Example 3. Rectangular enclosure with a hopper and a side vent:

(1) H equals the vertical distance from the bottom of the hopper to the top of the vent = 5 m.

(2) V_{eff} equals the volume of the hopper plus the volume of the rectangular vessel to the top of the vent.

(3) The volume of the rectangular part = $A \cdot B \cdot h$ = 1.8 · 1.5 · 3 = 8.1 m^3.

(4) The volume of the hopper [see Figure A.6.4.3(c)] = (a_1) · h · (b_2 - b_1)/2 + (b_1) · h · (a_2 - a_1)/2 + h ·

$(a_2 - a_1) \cdot (b_2 - b_1)/3 + (a_1) \cdot (b_1) \cdot h = (0.5) \cdot 2 \cdot$

$(1.5 – 0.3)/2 + (0.3) \cdot 2 \cdot (1.8 - 0.5)/2 + 2 \cdot$

$(1.8 - 0.5) \cdot (1.5 - 0.3)/3 + (0.5) \cdot (0.3) \cdot 2 = 2.33 \text{ m}^3$.

(5) $V_{eff} = 8.1 + 2.33 = 10.43 \text{ m}^3$.

(6) V_{eff} is the shaded region in Figure A.6.4.3(d).

(7) $A_{eff} = V_{eff}/H = 10.43/5 = 2.09 \text{ m}^2$.

(8) $D_{he} = 4 \cdot A_{eff} / p = (A_{eff})^{0.5}$, assuming a square cross section.

$D_{he} = 1.44$ m.

(9) $L/D = H/D_{he} = 5/1.44 = 3.47$.

Figure A.6.4.3(c) Rectangular Hopper.

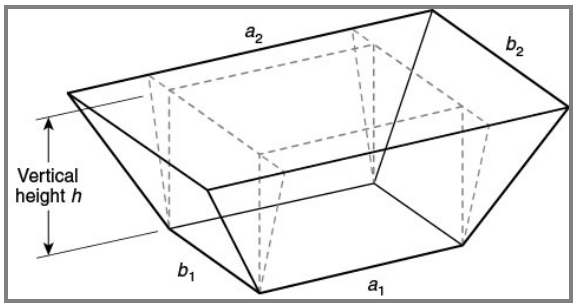
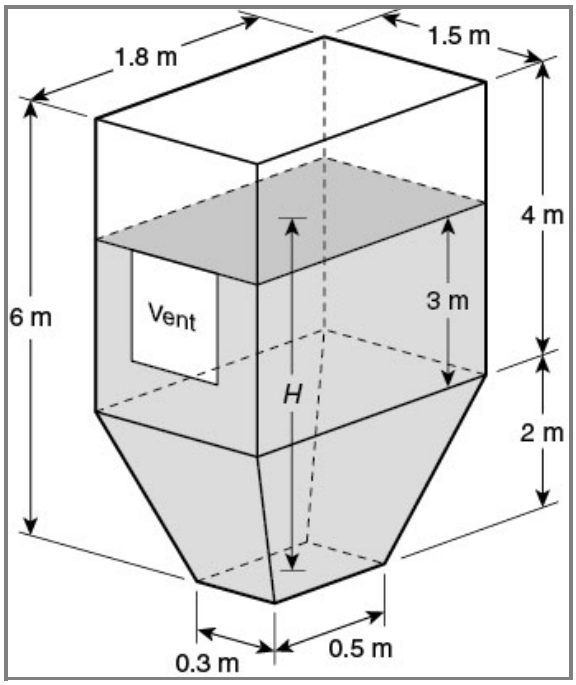


Figure A.6.4.3(d) Rectangular Enclosure with a Hopper and a Side Vent.



Example 4. Rectangular enclosure with a hopper and a side vent located close to the hopper:

(1) H equals the vertical distance from the top of the rectangular vessel to the bottom of the vent. H is the longest flame path possible because the vent is closer to the hopper bottom than it is to the vessel top = 4.5 m.

(2) V_{eff} equals the volume from the top of the rectangular vessel to the bottom of the vent.

(3) $V_{eff} = A \cdot B \cdot h$

(4) $V_{eff} = 1.8 \cdot 1.5 \cdot 4.5 = 12.15 \text{ m}^3$.

(5) V_{eff} is the shaded region in Figure A.6.4.3(e).

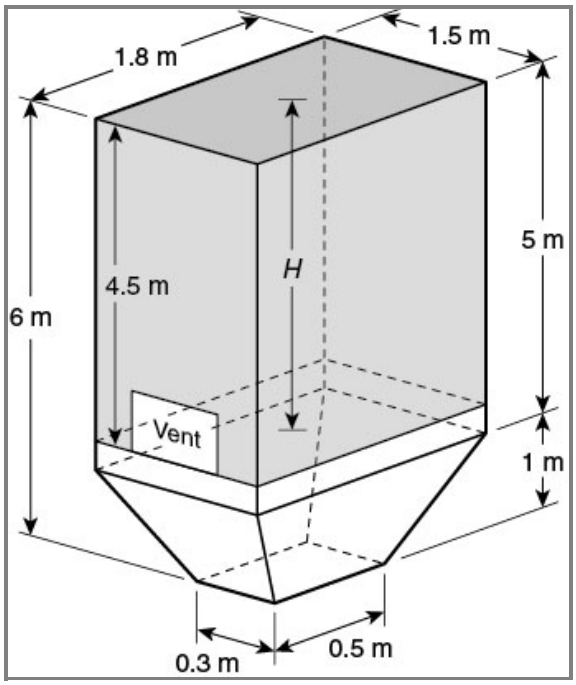
(6) $A_{eff} = V_{eff}/H = 12.1 / 4.5 = 2.7 \text{ m}^2$.

(7) $D_{he} = 4 \cdot A_{eff}/p = 4 \cdot A_{eff} / [2 \cdot (A + B)]$.

$D_{he} = 4 \cdot 2.7/[2 \cdot (1.8 + 1.5)] = 1.64$ m.

(8) $L/D = H/D_{he} = 4.5/1.64 = 2.74$.

Figure A.6.4.3(e) Rectangular Enclosure with a Hopper and a Side Vent Close to the Hopper.



Example 5. General calculation of the volume of a hopper.

(1) Rectangular hopper:

$$V = \frac{(a_1)\cdot(h)\cdot(b_2 - b_1)}{2} + \frac{(b_1)\cdot(h)\cdot(a_2 - a_1)}{2} + \frac{(h)\cdot(a_2 - a_1)\cdot(b_2 - b_1)}{3} + (a_1)\cdot(b_1)\cdot h \qquad \text{[A.6.4.3a]}$$

(2) Conical hopper:

$$V = \pi\cdot(h)\frac{\left[(D_1)^2 + (D_1\cdot D_2) + (D_2)^2\right]}{12} \qquad \text{[A.6.4.3b]}$$

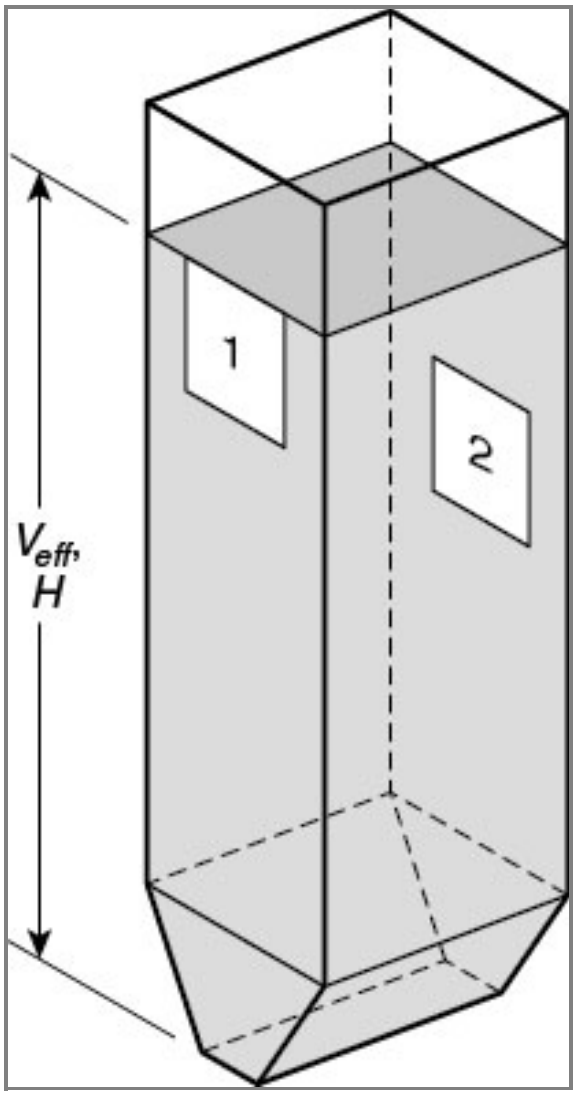
where:

D_1 = diameter of the base

D_2 = diameter of the top

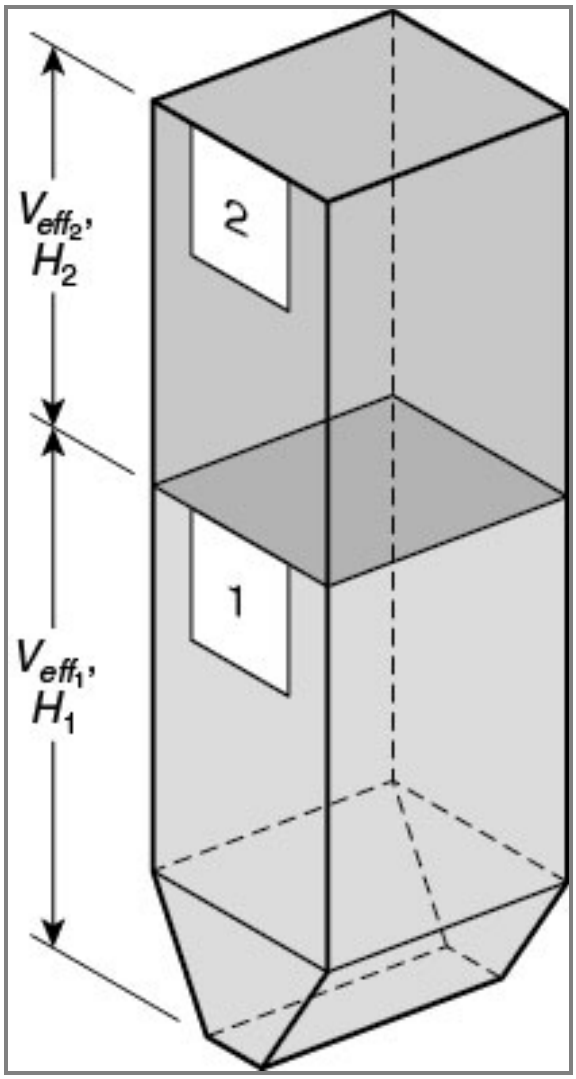
Example 6. Two vents, slightly offset vertically but on opposite sides of the enclosure [see Figure A.6.4.3(f)]. Because the vents overlap along the vertical axis, V_{eff} equals the volume from the bottom of the rectangular vessel to the top of the highest vent.

Figure A.6.4.3(f) Rectangular Enclosure, with a Hopper and Two Vents on Opposite Sides of the Enclosure.



Example 7. Two vents located on the same vertical line, offset from each other along the central axis, with the upper vent top located at the top of the enclosure [see Figure A.6.4.3(g)]. With multiple vents along the central axis, V_{eff} for the bottom vent is the volume from the bottom of the enclosure to the top of the lowest vent. V_{eff} for the next vent is the volume from the top of the lower vent to the top of the upper vent.

Figure A.6.4.3(g) Rectangular Enclosure with a Hopper and Two Vents on the Same Vertical Line.



Statement of Problem and Substantiation for Public Input

I noticed that the diameter D1 for calculating the volume of the hopper in Example 1 and Example 2 in this paragraph was incorrect taken 2 meters, while it should be 1.8 meters according to the Figure A.6.4.3 (a) and Figure A.6.4.3 (b). The remainder of the calculated values in these examples are therefore incorrect.

Submitter Information Verification

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Submittal Date: Wed Mar 13 12:42:06 EDT 2019
Committee: EXL-AAA

Committee Statement

Resolution: FR-21-NFPA 68-2021

Statement: The calculations are being revised to match the measurements in the figure for D1.

Public Input No. 6-NFPA 68-2018 [Section No. A.6.4.3]

A.6.4.3

Example 1. Cylindrical enclosure with a hopper and vented in the roof:

(1) H equals the vertical height of the enclosure = 6 m.

(2) V_{eff} equals the total free volume of the enclosure.

(3) The volume of the cylindrical part = $(\pi \cdot D^2/4) \cdot h =$

$[\pi \cdot (1.8)^2/4] \cdot 4 = 10.18\ m^3$.

(4) The volume of the hopper, with diameters D_1 and $D_2 = \pi \cdot h \cdot [(D_1)^2 + (D_1 \cdot D_2) + (D_2)^2]/12 = \pi \cdot 2 \cdot [(2)^2 + (2 \cdot 0.5) + (0.5)^2]/12 = 2.75\ m^3$.

(5) $V_{eff} = 10.18 + 2.75 = 12.93\ m^3$.

(6) V_{eff} is the shaded region in Figure A.6.4.3(a).

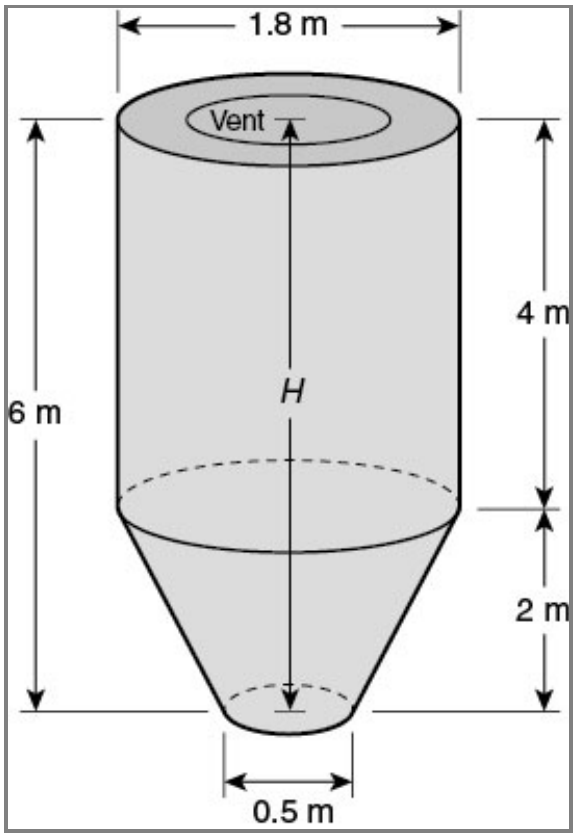
(7) $A_{eff} = V_{eff}/H = 12.93/6 = 2.155\ m^2$.

(8) $D_{he} = 4 \cdot A_{eff}/p = (4 \cdot A_{eff}/\pi)^{0.5}$, assuming a cylindrical cross section.

(9) $D_{he} = 1.656$ m.

(10) $L/D = H/D_{he} = 6/1.656 = 3.62$.

Figure A.6.4.3(a) Calculating *L/D* Ratio for a Cylindrical Vessel with a Hopper and a Top Vent.



In this example, D_{he} is less than the diameter of the cylindrical portion of the enclosure; thus *L/D* will be greater than if it had been calculated by taking the actual physical dimensions.

Example 2. Cylindrical enclosure with a hopper and vented at the side:

(1) *H* equals the vertical distance from the bottom of the hopper to the top of the vent = 4 m.

(2) V_{eff} equals the volume of the hopper plus the volume of the cylinder to the top of the vent.

(3) The volume of the cylindrical part = $(\pi \cdot D^2/4) \cdot h =$

$[\pi \cdot (1.8)^2/4] \cdot 2 = 5.09\ m^3$.

(4) The volume of the hopper, with diameters D_1 and $D_2 = \pi \cdot h \cdot [(D_1)^2 + (D_1 \cdot D_2) + (D_2^2)] / 12 = \pi \cdot 2 \cdot [($

~~2~~

(a) $1.8)^2$

~~(2 ·~~

(a) $+ (1.8 \cdot 0.5) + (0.5)^2] / 12 = 2.$

~~75 m~~

(a) $29\ m^3$.

(b) $V_{eff} = 5.09 + 2.$

~~75~~

(a) $29 = 7.$

~~84 m~~

(a) $38\ m^3$.

(b) V_{eff} is the shaded region in Figure A.6.4.3(b).

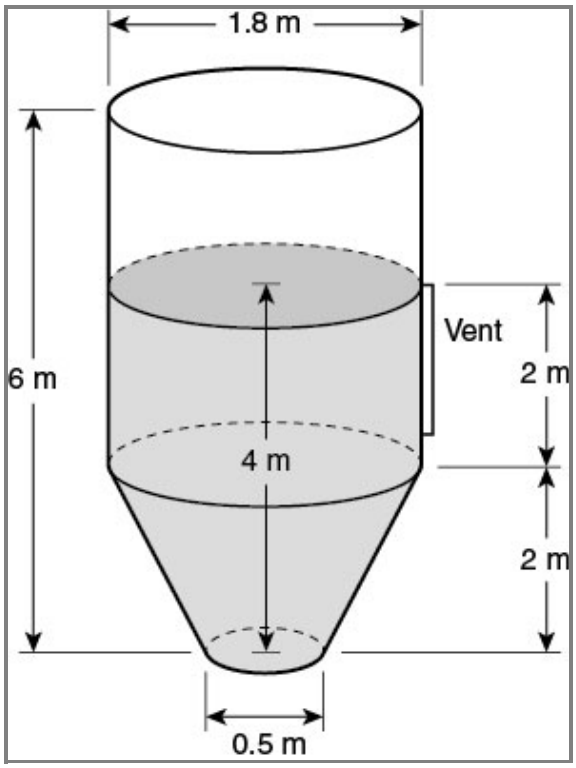
(5) $A_{eff} = V_{eff}/H = 7.~~84~~ 38/4 = 1.~~96 m~~ 85\ m^2$.

(6) $D_{he} = 4 \cdot A_{eff}/p = (4 \cdot A_{eff} / \pi)^{0.5}$, assuming a cylindrical cross section.

(7) $D_{he} = 1.~~58 m~~ 53$ m.

(8) $L/D = H/D_{he} = 4/1.58 = 2.~~53~~ 61$.

Figure A.6.4.3(b) Calculating *L/D* Ratio for a Cylindrical Vessel with a Hopper and a Side Vent.



Example 3. Rectangular enclosure with a hopper and a side vent:

(1) H equals the vertical distance from the bottom of the hopper to the top of the vent = 5 m.

(2) V_{eff} equals the volume of the hopper plus the volume of the rectangular vessel to the top of the vent.

(3) The volume of the rectangular part = $A \cdot B \cdot h = 1.8 \cdot 1.5 \cdot 3 = 8.1\ m^3$.

(4) The volume of the hopper [see Figure A.6.4.3(c)] = $(a_1) \cdot h \cdot (b_2 - b_1)/2 + (b_1) \cdot h \cdot (a_2 - a_1)/2 + h \cdot$

$(a_2 - a_1) \cdot (b_2 - b_1)/3 + (a_1) \cdot (b_1) \cdot h = (0.5) \cdot 2 \cdot$

$(1.5 – 0.3)/2 + (0.3) \cdot 2 \cdot (1.8 - 0.5)/2 + 2 \cdot$

$(1.8 - 0.5) \cdot (1.5 - 0.3)/3 + (0.5) \cdot (0.3) \cdot 2 = 2.33\ m^3$.

(5) $V_{eff} = 8.1 + 2.33 = 10.43\ m^3$.

(6) V_{eff} is the shaded region in Figure A.6.4.3(d).

(7) $A_{eff} = V_{eff}/H = 10.43/5 = 2.09\ m^2$.

(8) $D_{he} = 4 \cdot A_{eff} / p = (A_{eff})^{0.5}$, assuming a square cross section.

$D_{he} = 1.44$ m.

(9) $L/D = H/D_{he} = 5/1.44 = 3.47$.

Figure A.6.4.3(c) Rectangular Hopper.

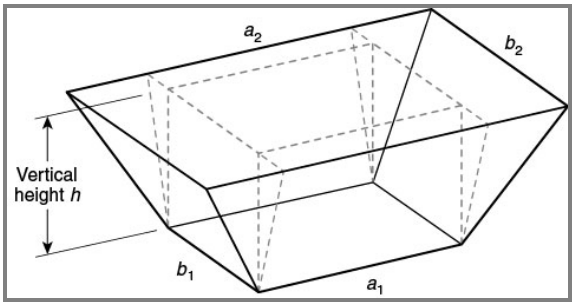
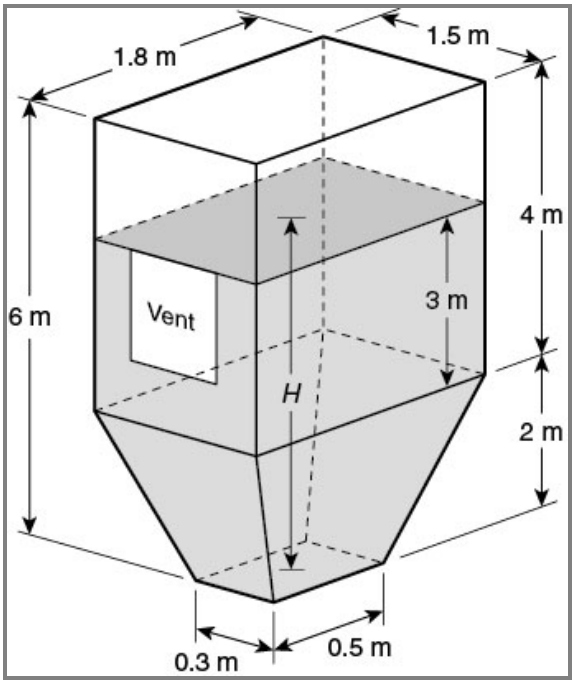


Figure A.6.4.3(d) Rectangular Enclosure with a Hopper and a Side Vent.



Example 4. Rectangular enclosure with a hopper and a side vent located close to the hopper:

(1) H equals the vertical distance from the top of the rectangular vessel to the bottom of the vent. H is the longest flame path possible because the vent is closer to the hopper bottom than it is to the vessel top = 4.5 m.

(2) V_{eff} equals the volume from the top of the rectangular vessel to the bottom of the vent.

(3) $V_{eff} = A \cdot B \cdot h$

(4) $V_{eff} = 1.8 \cdot 1.5 \cdot 4.5 = 12.15\ m^3$.

(5) V_{eff} is the shaded region in Figure A.6.4.3(e).

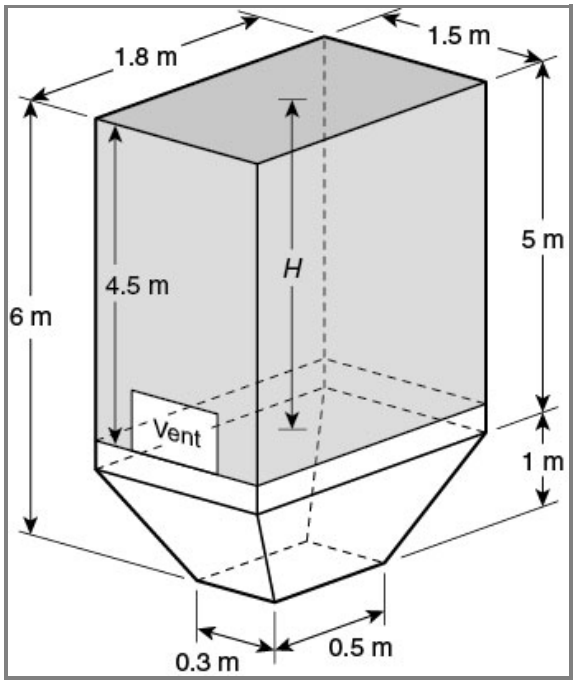
(6) $A_{eff} = V_{eff}/H = 12.1/4.5 = 2.7\ m^2$.

(7) $D_{he} = 4 \cdot A_{eff}/p = 4 \cdot A_{eff} / [2 \cdot (A + B)]$.

$D_{he} = 4 \cdot 2.7/[2 \cdot (1.8 + 1.5)] = 1.64$ m.

(8) $L/D = H/D_{he} = 4.5/1.64 = 2.74$.

Figure A.6.4.3(e) Rectangular Enclosure with a Hopper and a Side Vent Close to the Hopper.



Example 5. General calculation of the volume of a hopper.

(1) Rectangular hopper:

$$V = \frac{(a_1)\cdot(h)\cdot(b_2 - b_1)}{2} + \frac{(b_1)\cdot(h)\cdot(a_2 - a_1)}{2} + \frac{(h)\cdot(a_2 - a_1)\cdot(b_2 - b_1)}{3} + (a_1)\cdot(b_1)\cdot h \qquad \text{[A.6.4.3a]}$$

(2) Conical hopper:

$$V = \pi \cdot (h)\frac{\left[(D_1)^2 + (D_1 \cdot D_2) + (D_2)^2\right]}{12} \qquad \text{[A.6.4.3b]}$$

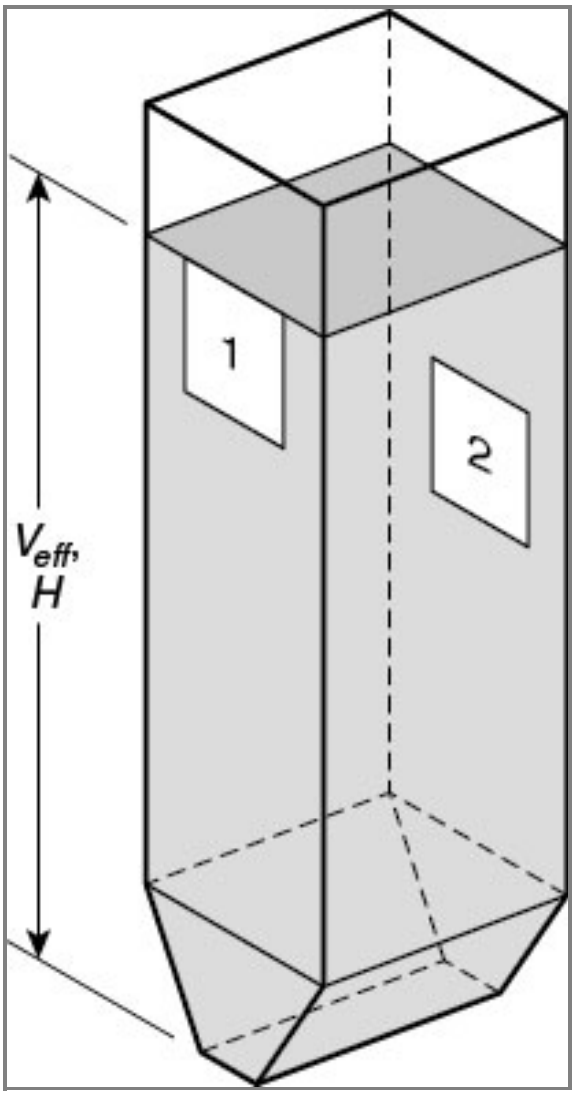
where:

D_1 = diameter of the base

D_2 = diameter of the top

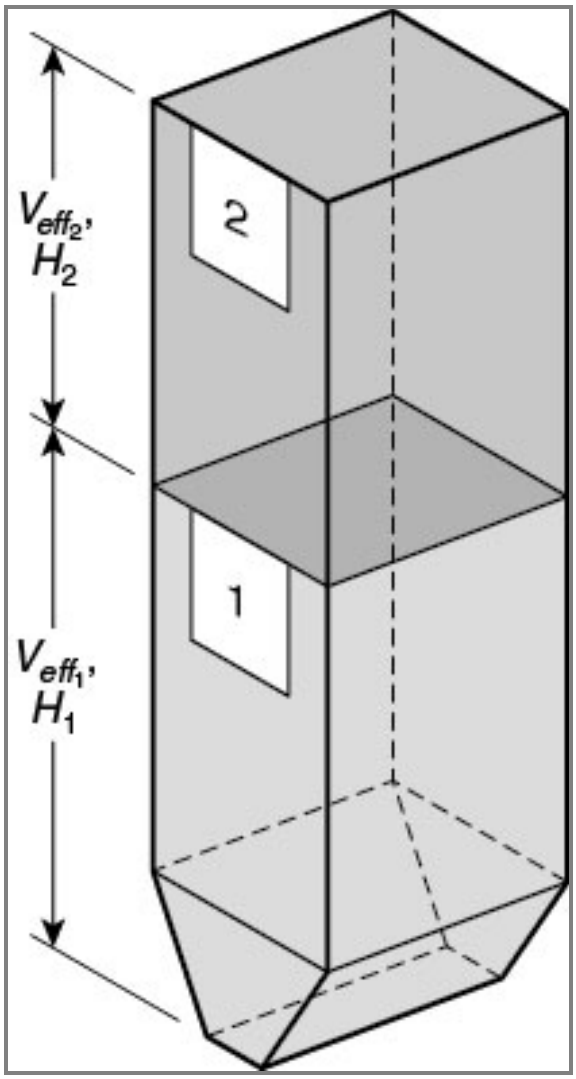
Example 6. Two vents, slightly offset vertically but on opposite sides of the enclosure [see Figure A.6.4.3(f)]. Because the vents overlap along the vertical axis, V_{eff} equals the volume from the bottom of the rectangular vessel to the top of the highest vent.

Figure A.6.4.3(f) Rectangular Enclosure, with a Hopper and Two Vents on Opposite Sides of the Enclosure.



Example 7. Two vents located on the same vertical line, offset from each other along the central axis, with the upper vent top located at the top of the enclosure [see Figure A.6.4.3(g)]. With multiple vents along the central axis, V_{eff} for the bottom vent is the volume from the bottom of the enclosure to the top of the lowest vent. V_{eff} for the next vent is the volume from the top of the lower vent to the top of the upper vent.

Figure A.6.4.3(g) Rectangular Enclosure with a Hopper and Two Vents on the Same Vertical Line.



Statement of Problem and Substantiation for Public Input

Good morning,
The problem I found and that I've proposed the correction is the 2nd example of A.6.4.3, and in a short term is just writing/typing error. Wrong value of a diameter was used (and therefore, the results after it are incorrect), and some plus (+) signs were missing from the equation.
I think that both of them are minor mistakes, and If I supposed it wrong I'd like to apologize but also understand why these both are not incorrect.
I thank you all in advance for the attention!

Submitter Information Verification

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Submittal Date: Tue Aug 28 10:57:17 EDT 2018
Committee: EXL-AAA

Committee Statement

Resolution: FR-21-NFPA 68-2021

Statement: The calculations are being revised to match the measurements in the figure for D1.

Public Input No. 29-NFPA 68-2021 [New Section after A.7.1.1]

TITLE OF NEW CONTENT

A.6.10.1 Representative metal dust should have not only a similar KSt, but also a similar maximum adiabatic flame temperature to the dust that will be handled in the process. The test vessel should be selected to closely approximate the volume and geometry of the protected enclosure.

Statement of Problem and Substantiation for Public Input

It is proposed to include here the same text already adopted for the next edition of NFPA 484 (Second Revision No. 4-NFPA 484-2020).

Related Public Inputs for This Document

Related Input	Relationship
Public Input No. 28-NFPA 68-2021 [New Section after 6.9]	Explanatory material

Submitter Information Verification

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Submittal Date: Tue Jan 05 19:22:11 EST 2021
Committee: EXL-AAA

Committee Statement

Resolution: FR-15-NFPA 68-2021
Statement: The committee recognizes the need to address adiabatic flame temperature when applying flameless venting to metal dusts.

Public Input No. 23-NFPA 68-2021 [New Section after A.7.2.6.1]

A.7.3.2

The open volume of the enclosure is the total volume of the enclosure less the volume of solid obstructions, not the total volume of the enclosure. This distinction becomes relevant as the fraction of the enclosure volume filled with solid obstructions increases, reducing the open-air volume available for mixing. If the partial volume effects were calculated using the total volume of the enclosure, the required vent area would be under-predicted.

Statement of Problem and Substantiation for Public Input

This proposed addition to the appendix is linked to the proposed change to equation 7.3.2 to replace 'Venc' with new term 'Vopen'

Related Public Inputs for This Document

Related Input	Relationship
Public Input No. 22-NFPA 68-2021 [Section No. 7.3.2]	Explanatory material for appendix
Public Input No. 22-NFPA 68-2021 [Section No. 7.3.2]	

Submitter Information Verification

Submitter Full Name: Bryant Hendrickson
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Submittal Date: Mon Jan 04 16:06:23 EST 2021
Committee: EXL-AAA

Committee Statement

Resolution: FR-13-NFPA 68-2021
Statement: The volume of solid objects should be subtracted from the enclosure volume to accurately calculate the volume available for mixing of gas and air and the required vent area. This clarification was prompted by the calculation of vent areas for Battery Energy Storage Systems.

Public Input No. 7-NFPA 68-2018 [Section No. A.8.2.1.2]

A.8.2.1.2

Example Problem

Given the following conditions, calculate A_{V0}:

V = 10 m^3

P_{red} = 5 bar-g

$P_{initial}$ = 2 bar-g

P_{max} = 8.5 bar-g (at atmospheric conditions)

K_{St} = 290 bar-m/s

***P stat* = 2.6 bar-g**

Solution

Starting in Section 8.2 and recognizing that $P_{initial}$ is above the upper atmospheric limit of 0.2 bar-g, 8.2.1.2 should be followed for determination of the minimum vent area requirement (A_{V0}). From Equation 8.2.1.2,

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

where:

$P_{effective}$ = 1/3$P_{initial}$ (bar-g) = 1/3·(2) = 0.667 bar-g

P^E_{max} = [(P_{max} + 1) · ($P_{initial}$ + 1)/(1 bar-abs) − 1] = [(8.5 + 1)·(2 + 1)/(1) − 1] = 27.5 bar-g

$\Pi_{effective}$ = (P_{red} − $P_{effective}$)/(P^E_{max} − $P_{effective}$) = (5 – 0.666)/(27.5 – 0.667) = 0.161

$$A_{v0} = 1 \cdot 10^{-4} \left[1 + 1.54 \cdot \left(\frac{2.6 - 2}{1 + 0.667} \right)^{4/3} \right] \cdot 290 \cdot 10^{3/4} \sqrt{\frac{1}{0.161} - 1} \quad \textbf{[A.8.2.1.2b]}$$

$$A_{v0} = 0.518 \text{ m}^2$$

Discussion

Where the application would have been based on a $P_{initial}$ within the atmospheric range, Equation 8.2.1.1 would yield a vent area requirement of 0.888 m^2. The resulting reduction of vent area requirement where $P_{initial}$ is above atmospheric, but the rest of the variables remain the same, can be expected as the pressure difference between P_{stat} and $P_{initial}$ is less than in the atmospheric case. Where this is the case, the deflagration is allowed less time to develop prior to the opening of the vent and thus requires less vent area.

Statement of Problem and Substantiation for Public Input

I only bolded the Pstat and its value, because it doesn't fit the requirements listed in 8.2.1.3 for the venting area calculation, and as shown in FIGURE 8.1.1.4 the example would've been directed to the use of chapters 5, 9 or perform test, instead of using the equations for the venting area in 8.2.1.

But, as I assume the example was made in order to demonstrade de usage of those equations, I'd like only to recommend a new value for Pstat (or Pinitial), in a way that they fit the requirements stated in 8.2.1.3.
I'd like to apologize in case I've understood it all wrong, but as I've made the calculus I've noticed this little mistake in the example.
Thank you very much.

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Submittal Date: Fri Sep 14 16:50:42 EDT 2018
Committee: EXL-AAA

Committee Statement

Resolution: FR-19-NFPA 68-2021
Statement: The example has been edited so that the value used for Pstat aligns with the limitations located in 8.2.1.3(4). The committee will also review the limitations in 8.2.1.3 to ensure that they are correct.

Public Input No. 8-NFPA 68-2018 [Section No. E.1]

E.1 Estimating Method.

Fundamental burning velocity, S_U, is taken as the largest value of laminar burning velocity, S, obtained by any mixture of a flammable gas in air. S_U is determined experimentally and is a characteristic of any particular fuel whether as a single component or as a mixture of flammable components.

The value of S_U can be estimated using the method given here if an experimental value of S_U is not available. Other methods can be used to estimate S_U, such as the maximum experimental safe gap (MESG) correlation in Schampel.

Britton proposed the following correlation for estimating S_U [122]:

$$S_u = 1666.1 - 34.228\left(-\Delta H_c / \chi_{OF}\right) + 0.18039\left(-\Delta H_c / \chi_{OF}\right)^2 \quad \textbf{[E.1]}$$

where:

S_U = fundamental burning velocity (cm/s)

ΔH_C = heat of combustion of the fuel (kcal/mole)

χOF = stoichiometric ratio of oxygen to fuel

For fuel species consisting of carbon, hydrogen, oxygen, nitrogen, or halogens ($C_cH_hO_mN_nX_x$) with stoichiometric coefficients c, h, m, n, x, the stoichiometric ratio of oxygen to fuel is calculated as follows:

$$\chi_{OF} = c + (h\text{-}x\text{-}2m)/4$$

χOF can be used to calculate the stoichiometric ratio of the fuel in air as follows:

$$C_{st} = 100/(1 + 4.773\chi_{OF})$$

Example:

Methane (CH_4)

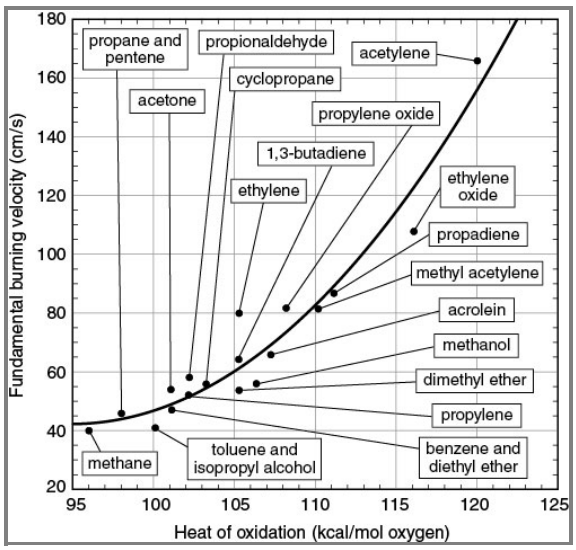
ΔH_C = -192 kcal/mole fuel

χOF = c + (h-x-2m)/4 = 1 + (4-0-0)/4 = 2

$-\Delta H_C/\chi OF$ = (192 kcal/mole fuel) / (2 moles ~~fuel~~ oxygen per mole of ~~oxygen~~ fuel) = 96 kcal/mole oxygen

Figure E.1, from Britton [122], compares the predictions made with the expression given in Equation E.1 with laminar burning velocity (LBV) data. The LBV data are from NFPA 68 (NACA tube data with a reference value of 46 cm/s for propane).

Figure E.1 Comparison of Predicted and Measured Burning Velocities.



Statement of Problem and Substantiation for Public Input

The current units of the denominator do not match the definition of the stoichiometric ratio and do not match the intended units of the answer.

Submitter Information Verification

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Submittal Date: Thu Oct 04 16:23:36 EDT 2018
Committee: EXL-AAA

Committee Statement

Resolution: FR-10-NFPA 68-2021
Statement: The current units of the denominator do not match the definition of the stoichiometric ratio and do not match the intended units of the answer.

Public Input No. 15-NFPA 68-2019 [Section No. F.1]

F.1 Introduction.

Table F.1(a) through Table F.1(e) are based on information obtained from Forschungsbericht Staubexplosionen [86].

Table F.1(a) Agricultural Products

Material	Mass Median Diameter (µm)	Minimum Flammable Concentration (g/m^3)	P_{max} (bar-g)	K_{St} (bar-m/s)	Dust Hazard Class
Cellulose	33	60	9.7	229	2
Cellulose pulp	42	30	9.9	62	1
Cork	42	30	9.6	202	2
Corn	28	60	9.4	75	1
Egg white	17	125	8.3	38	1
Milk, powdered	83	60	5.8	28	1
Milk, nonfat, dry	60	—	8.8	125	1
Soy flour	20	200	9.2	110	1
Starch, corn	7	—	10.3	202	2
Starch, rice	18	60	9.2	101	1
Starch, wheat	22	30	9.9	115	1
Sugar	30	200	8.5	138	1
Sugar, milk	27	60	8.3	82	1
Sugar, beet	29	60	8.2	59	1
Tapioca	22	125	9.4	62	1
Whey	41	125	9.8	140	1
Wood flour	29	—	10.5	205	2

Table F.1(b) Carbonaceous Dusts

Material	Mass Median Diameter (µm)	Minimum Flammable Concentration (g/m^3)	P_{max} (bar-g)	K_{St} (bar-m/s)	Dust Hazard Class
Charcoal, activated	28	60	7.7	14	1
Charcoal, wood	14	60	9.0	10	1
Coal, bituminous	24	60	9.2	129	1
Coke, petroleum	15	125	7.6	47	1
Lampblack	<10	60	8.4	121	1
Lignite	32	60	10.0	151	1
Peat, 22% H_2O	—	125	8.4	67	1

Material	Mass Median Diameter (µm)	Minimum Flammable Concentration (g/m^3)	P_{max} (bar-g)	K_{St} (bar-m/s)	Dust Hazard Class
Soot, pine	<10	—	7.9	26	1

Table F.1(c) Chemical Dusts

Material	Mass Median Diameter (µm)	Minimum Flammable Concentration (g/m^3)	P_{max} (bar-g)	K_{St} (bar-m/s)	Dust Hazard Class
Adipic acid	<10	60	8.0	97	1
Anthraquinone	<10	—	10.6	364	3
Ascorbic acid	39	60	9.0	111	1
Calcium acetate	92	500	5.2	9	1
Calcium acetate	85	250	6.5	21	1
Calcium stearate	12	30	9.1	132	1
Carboxy-methyl-cellulose	24	125	9.2	136	1
Dextrin	41	60	8.8	106	1
Lactose	23	60	7.7	81	1
Lead stearate	12	30	9.2	152	1
Methyl-cellulose	75	60	9.5	134	1
Paraformaldehyde	23	60	9.9	178	1
Sodium ascorbate	23	60	8.4	119	1
Sodium stearate	22	30	8.8	123	1
Sulfur	20	30	6.8	151	1

Table F.1(d) Metal Dusts

Material	Mass Median Diameter (µm)	Minimum Flammable Concentration (g/m^3)	P_{max} (bar-g)	K_{St} (bar-m/s)	Dust Hazard Class
Aluminum	29	30	12.4	415	3
Bronze	18	750	4.1	31	1
Iron carbonyl	<10	125	6.1	111	1
Magnesium	28	30	17.5	508	3
~~Phenolic resin~~	~~55~~	~~—~~	~~7.9~~	~~269~~	~~2~~
Zinc	10	250	6.7	125	1
Zinc	<10	125	7.3	176	1

Table F.1(e) Plastic Dusts

Material	Mass Median Diameter	Minimum Flammable Concentration	P_{max} (bar-	K_{St} (bar-	Dust Hazard Class

	(µm)	(g/m^3)	g)	m/s)		
(poly) Acrylamide	10	250	5.9	12	1	
(poly) Acrylonitrile	25	—	8.5	121	1	
(poly) Ethylene (low-pressure process)	<10	30	8.0	156	1	
Epoxy resin	26	30	7.9	129	1	
Melamine resin	18	125	10.2	110	1	
Melamine, molded (wood flour and mineral filled phenol-formaldehyde)	15	60	7.5	41	1	
Melamine, molded (phenol-cellulose)	12	60	10.0	127	1	
(poly) Methyl acrylate	21	30	9.4	269	2	
(poly) Methyl acrylate, emulsion polymer	18	30	10.1	202	2	
Phenolic resin	<10	15	9.3	129	1	
	-	55	-		7.9	269 2
(poly) Propylene	25	30	8.4	101	1	
Terpene-phenol resin	10	15	8.7	143	1	
Urea-formaldehyde/ cellulose, molded	13	60	10.2	136	1	
(poly) Vinyl acetate/ ethylene copolymer	32	30	8.6	119	1	
(poly) Vinyl alcohol	26	60	8.9	128	1	
(poly) Vinyl butyral	65	30	8.9	147	1	
(poly) Vinyl chloride	107	200	7.6	46	1	
(poly) Vinyl chloride/vinyl acetylene emulsion copolymer	35	60	8.2	95	1	
(poly) Vinyl chloride/ethylene/vinyl acetylene suspension copolymer	60	60	8.3	98	1	

For each dust, the tables show the mass median diameter of the material tested as well as the following test results obtained in a 1 m^3 (35 ft^3) vessel:

(1) Minimum explosive concentration

(2) Maximum pressure developed by the explosion, P_{max}

(3) Maximum rate of pressure rise $(dP/dt)_{max}$

(4) K_{St} value, which is equivalent to $(dP/dt)_{max}$ because of the size of the test vessel

(5) Dust hazard class as St-1, St-2, or St-3, as defined in Table B.1.2.4

Statement of Problem and Substantiation for Public Input

Phenolic resin is not a metal even though it may be used in metal manufacturing. Additionally, this information is redundant as it appears in the plastic dust table already. This table is used in other NFPA standards and this error was noted in a PI submitted to the NFPA 652 committee as well.

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Committee: EXL-AAA

Committee Statement

Resolution: FR-12-NFPA 68-2021
Statement: Phenolic resin is not a metal even though it may be used in metal manufacturing. Additionally, this information is redundant as it appears in the plastic dust table already.