DELETED

First Revision No. 22-NFPA 67-2014 [Global Input]

For definition 3.3.15 Fundamental Burning Velocity, S_U:

Delete ', S_U' from head.

Renumber text to 3.3.1.1.

Add extract citation '[68, 2013]'

Submitter Information Verification

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Committee Statement

Committee Statement: The definition is moved to a sub-section of 3.3.1 to provide a clear comparison of 'Burning Velocity' and 'Fundamental Burning Velocity'. The definition is extracted from NFPA 68 to provide consistency between documents. The symbol, SU, is removed to avoid confusion between 'Burning Velocity' and 'Fundamental Burning Velocity'.

Response Message:

First Revision No. 17-NFPA 67-2014 [New Section after 1.2]

1.3 Piping Installation and Maintenance.

Installation of piping systems addressed in this guide should be designed in accordance with applicable standards, such as NFPA 54 , ASME B31.1, ASME B31.3, or ASME B31.12.

1.3.1

There are additional standards, such as NFPA 2 , NFPA 55 , and NFPA 58 , that also include requirements for specific gases and applications.

1.3.2

Inadvertent formation of flammable gas mixtures during pipe cleaning and purging can be prevented by following the planning and procedures described in NFPA 56 .

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Committee Statement

Committee Statement: This new section addresses design of piping systems that are outside the scope this guide.

Response Message:

First Revision No. 1-NFPA 67-2014 [Section No. 2.2]

2.2 NFPA Publications.

National Fire Protection Association, 1 Batterymarch Park, Quincy, MA 02169-7471.

NFPA 2, *Hydrogen Technologies Code,* 2016 edition.

NFPA 54, *National Fuel Gas Code,* 2015 edition.

NFPA 55, *Compressed Gases and Cryogenic Fluids Code,* 2016 edition.

NFPA 56, *Standard for Fire and Explosion Prevention During Cleaning and Purging of Flammable Gas Piping Systems* 2014 edition.

NFPA 58, *Liquefied Petroleum Gas Code,* 2014 edition.

NFPA 68, *Standard on Explosion Protection by Deflagration Venting,* 2013 edition.

NFPA 69, *Standard on Explosion Prevention Systems,* ~~2008~~ 2014 edition.

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Committee Statement

Committee Statement: Update references.
Response Message:

First Revision No. 19-NFPA 67-2014 [New Section after 2.3.1]

2.3.2 ASME Publications.

American Society of Mechanical Engineers, Two Park Avenue, New York, NY 10016-5990.

ASME B31.1, *Power Piping Code* , 2012.

ASME B31.3, *Process Piping Code* , 2012.

ASME B31.12, *Hydrogen Piping and Pipelines Code* , 2011.

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Committee Statement

Committee Statement: New references.
Response Message:

First Revision No. 2-NFPA 67-2014 [Section No. 2.3.1]

2.3.1 ~~API Publications~~ American Petroleum Institute Publications .
~~American Petroleum Institute~~ API Publishing Services , 1220 L Street, NW, Washington, DC 20005-4070.

API Standard 2000, *Venting Atmospheric and Low-Pressure Storage Tanks*, ~~2009~~ seventh edition, 2014 .

Submitter Information Verification

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Submittal Date: Tue Apr 15 14:52:42 EDT 2014

Committee Statement

Committee Statement: Update references.

First Revision No. 20-NFPA 67-2014 [Section No. 2.3.5]

2.3.6 Other Publications.

Bartknecht, W., *Explosions — Course, Prevention, Protection*, Berlin: Springer-Verlag, 1980.

Berger, S. A., L. Talbot, and L. S. Yao, "Flow in Curved Pipes," *Annual Review of Fluid Mechanics* 15 (1983): 461–512.

Bjerketvedt, D., et al., "Gas Explosion Handbook," *Journal of Hazardous Materials* 52 (1997): 1–150.

Blanchard, R., D. Arndt, R. Gratz, M. Poli, and S. Scheider, "Explosions in Closed Pipes Containing Baffles and 90 Degree Bends," *Journal of Loss Prevention in the Process Industries* 23, no. 2 (2010): 253–259.

Bollinger, L. E., et al., "Experimental measurements and theoretical analysis of detonation induction distances," *ARS Journal*, May 1961: 588–595.

Burgess, M.J., *Pressures Losses in Ducted Flows*, London: Butterworth, 1971.

Chao, T. W., and J. E. Shepherd, "Comparison of Fracture Response of Preflawed under Internal Static and Detonation Loading," PVP2003-1957, 2003 AMSE Pressure Vessels and Piping Conference, Cleveland, OH, July 20–24, 2003. In *7th International Symposium on Emerging Technologies in Fluids, Structures, and Fluid-Structure Interactions*, PVP Vol. 460 (2003): 129–144.

Chatrathi, K., "Deflagration Protection of Pipes," *Plant/Operations Progress* 11 (1992): 116–120.

Chatrathi, K., J. E. Going, and B. Grandestaff, (2001), "Flame propagation in industrial scale piping," *Process Safety Progress* 20, no. 4: 286–294.

Clanet, C., and G. Searby, "On the 'Tulip Flame' Phenomenon," *Combustion and Flame* 105 (1996): 225–238.

Donat C., "Apparatefestigkeit bei Beanspruchung durch Staubexplosionen," VDI-Berichte [VDI-Verlag GmbH, Dusseldorf] 304 (1978): 139–149.

Eckhoff, R. K., *Dust Explosions in the Process Industries*, Oxford: Butterworth-Heinemann, 1991.

Frolov, S. M., "Fast Deflagration-to-Detonation Transition," *Russian Journal of Physical Chemistry* B 2, no. 3 (2008): 442–455.

Going, J. E., K. Chatrathi, and K. Cashdollar, "Flammability limit measurements for dusts in 20-L and 1-m3 vessels," *Journal of Loss Prevention in the Process Industries* 13, no. 3 (2000): 209–219.

Going, J. E., and J. Snoeys, "Explosion Protection with Metal Dust Fuels," *Process Safety Progress*, Vol. 21, No. 4, December 2002.

Gonzalez, M., R. Borghi, and A. Saouab, "Interaction of a Flame Front with Its Self-Generated Flow in an Enclosure: The 'Tulip Flame' Phenomenon," *Combustion and Flame* 88, no. 2 (1992): 201–220.

Green, D. W., *Perry's Chemical Engineer's Handbook*, New York: McGraw-Hill, 1999.

Karnesky, J., *Detonation induced strain in tubes*, Ph.D. thesis, California Institute of Technology, 2010.

Kletz, T. A., "Nitrogen — Our Most Dangerous Gas," *Proceedings of the Third International Symposium on Loss Prevention and Safety Promotion in the Process Industries,* Swiss Society of Chemical Industries, 1980.

Kuznetsov, M., et al., "Dynamic Effects Under Gaseous Detonation and Mechanical Response of Piping Structures," 11/2009; DOI:101115/IMEC 2009-11643, in *Proceedings of ASME 2009 International Mechanical Engineering Congress and Exposition (IMECE2009),* Lake Buena Vista, FL, Vol. 3, pp. 115–124.

Lee, J. H. S., "Dynamic Properties of Gaseous Detonations," *Annual Review of Fluid Mechanics* 16 (1984): 311–336.

Lohrer, C., M. Hahn, D. Arndt, and R. Grätz, "Einfluss Eines 90°-Rohrbogens in Einer Technischen Rohrleitung auf Reaktive Strömungen," *Chemie Ingenieur Technik* 80, no. 5 (2008): 649–657.

McBride, B., and S. Gordon, *Computer Program for Calculating and Fitting Thermodynamic Functions*, NASA Reference Publication 1271, National Aeronautics and Space Administration, November 1992.

Munday, G., "Detonations in Vessels and Pipelines," *The Chemical Engineer*, April 1971: 135–144.

Nettleton, M. A., *Gaseous Detonations*, London: Chapman and Hall, 1987.

OECD Nuclear Energy Agency, "Flame Acceleration and Deflagration-to-Detonation Transition in Nuclear Safety: State of the Art Report by a Group of Experts," Issy-les-Moulineaux, France, August 2000.

Pasman, H. J., and C. J. M. van Wingerden, "Explosion Resistance of Process Equipment," *Proceedings of the Conference on Flammable Dust Explosions*, St. Louis, November 1988.

Peraldi, O., R. Knystautas, and J. H. Lee, C*riteria for Transition to Detonation in Tubes*, 21st Symposium (International) on Combustion, The Combustion Institute, 1988, 1629.

Phylactou, H., M. Foley, and G. E. Andrews, "Explosion Enhancement Through a 90° Curved Bend," *Journal of Loss Prevention in the Process Industries*, Vol. 6, No. 1, 1993, pp. 21–29.

Pritchard, D. K., "An Experiment and Theoretical Study of Blast Effects on Simple Structure (Cantilevers)," *Loss Prevention and Safety Promotion in the Process Industries, 4th International Symposium*, Vol. 3 (1983): D23.

Roy, G. D., S. M. Frolov, A. A. Borisov, and D. W. Netzer, "Pulse Detonation Propulsion: Challenges, Current Status, and Future Perspective," *Progress in Energy and Combustion Science* 30, no. 6 (2004): 545–672.

Sato, K. S., Y. Sakai, and M. Chiga, *Flame Propagation Along 90 Degree Bend in an Open Duct*, 26th Symposium (International) on Combustion, 1996.

Schampel, K., *Flammendurchschlagsicherungen* (Bd. 170), Kontakt & Studium), Ehningen bei Böblingen; Expert-Verlag, 1988.

Shepherd, J. E. "Structural Response of Piping to Internal Gas Detonation," ~~ASME Pressure Vessels and Piping Conference, PVP2006-ICPVT11-93670, 2006.~~ *Journal of Pressure Vessel Technology* , Vol. 131, Issue 3, 2009.

Technical Regulations for Flammable Liquids (TRbF) 20, Germany.

Thomas, G. O., "The Response of Pipes and Supports to Internal Pressure Loads Generated by Gaseous Detonations," *ASME Journal of Pressure Vessel Technology* 124, 66 (2002).

Thomas, G. O., and Williams, R. L., "Detonation Interaction with Wedges and Bends," *Shock Waves* 11 (2002): 481–492.

Thomas, G. O., et al., "Flame acceleration and transition to detonation in pipes," Draft report on behalf of PIPEX Consortium, 15/9/99.

Thomas, G. O., N. Lamoureux, and G. L. Oakley, "Establishment Limits of Fuel-Oxygen Detonations in Pipes at Ambient and Elevated Temperatures and Pressures for a Low Energy Ignition Source," Report UWA/070600, 2000, University of Wales Aberystwyth, Department of Physics.

Williams, R., "Experimental DDT measurements in pure hydrogen/oxygen mixtures in pipes," BNFL, unpublished talk, 23rd UKELG Discussion Meeting on Deflagration to Detonation Transition, ICI Runcorn, 21/4/98.

Zhou, B., A. Sobiesiak, and P. Quan, "Flame Behavior and Flame-Induced Flow in a Closed Rectangular Duct with a 90 Degree Bend," *International Journal of Thermal Sciences* 45 (2006): 457–474.

Merriam-Webster's Collegiate Dictionary, 11th edition, Merriam-Webster, Inc., Springfield, MA, 2003.

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Committee Statement

Committee Statement: Update reference.
Response Message:

First Revision No. 21-NFPA 67-2014 [Section No. 2.4]

2.4 References for Extracts in Advisory Sections. ~~(Reserved)~~

NFPA 68, *Standard on Explosion Protection by Deflagration Venting,* 2013 edition.

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Committee Statement

Committee Statement: Added ref. for extracted text in chapter 3.

Response Message:

First Revision No. 4-NFPA 67-2014 [Section No. 3.3.1]

3.3.1 Burning Velocity~~,~~ ~~S_u~~ .

The rate of flame propagation relative to the velocity of the unburned gas that is ahead of it. [**68,** 2013]

Global FR-22

3.3.1.1 Fundamental Burning Velocity~~,~~ ~~S_u~~ .

The burning velocity of a laminar flame under stated conditions of composition, temperature, and pressure of the unburned gas. [**68,** 2013]

Submitter Information Verification

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Committee Statement

Committee Statement: The definition is extracted from NFPA 68 to provide consistency between documents. The symbol, SU, is removed to avoid confusion between 'Burning Velocity' and 'Fundamental Burning Velocity'.

Response Message:

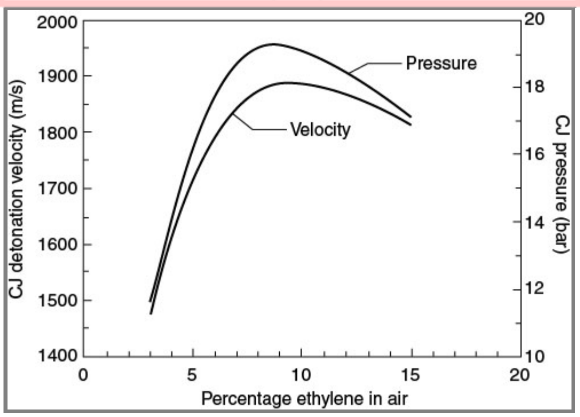
Public Input No. 1-NFPA 67-2013 [Section No. 3.3.1]

First Revision No. 5-NFPA 67-2014 [Section No. 5.3.5]

5.3.5

Chapman-Jouguet detonation velocities and pressures for ethylene-air mixtures are shown in Figure 5.3.5. The near-limit mixture detonation velocities are about 1500 m/s, while the near-stoichiometric mixture detonation velocities are about 1900 m/s.

Figure 5.3.5 Chapman-Jouguet Detonation Velocities and Pressures for Ethylene-Air Mixtures.



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Committee Statement

Committee Statement: Figure 5.3.5 was revised to show which curve is velocity and which is pressure. Upper curve is pressure; lower curve is velocity.

Response Message:

Public Input No. 2-NFPA 67-2013 [Section No. 5.3.5]

First Revision No. 6-NFPA 67-2014 [Section No. 6.2.2.3]

6.2.2.3* In-Line Deflagration Arrester.

A flame arrester that is capable of stopping and extinguishing a deflagration in pipes is called an in-line deflagration arrester. Depending on the mode of installation and the objective of protection, the following two basic situations for in-line application of the safety device can be distinguished:

(1) A deflagration in an enclosure threatens to enter a connected apparatus via a piping system that is necessary for operation *[see Figure 6.2.2.3(a)].* Flame arresters for this application are called pre-volume flame arresters. Pre-volume flame arresters must be used, for example, at connections between fans and vapor pumps that carry mixtures, since after ignition an unintended ignition and propagation of combustion into a connected apparatus must be prevented.

(2) A deflagration can propagate in pipes *[see Figure 6.2.2.3(b)]*. Flame arresters that stop a flame that propagates within a pipe are called in-line deflagration arresters. Typical applications are plants in which the connection between potential ignition sources and safety devices consists only of pipes.

Figure 6.2.2.3(a) Pre-Volume Situation.

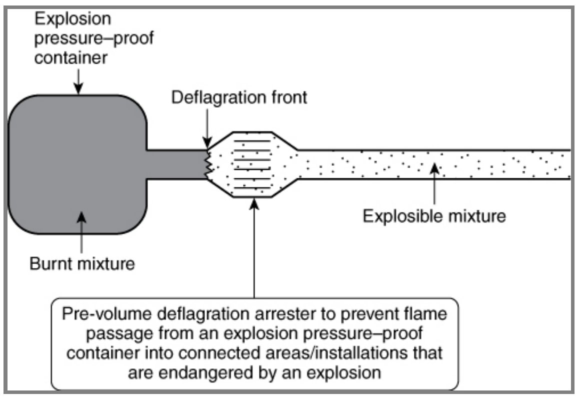
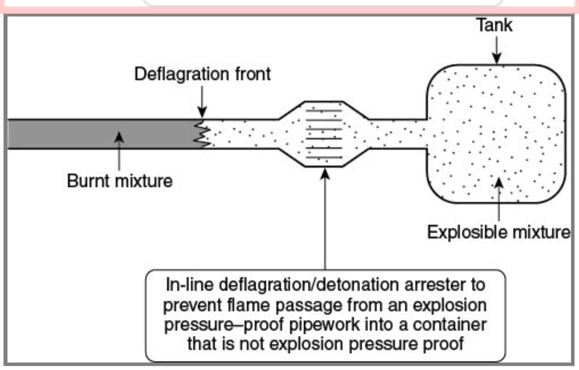


Figure 6.2.2.3(b) In-Line Situation.



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Submitter Full Name: [Not Specified]
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Submittal Date: Thu Apr 17 10:44:12 EDT 2014

Committee Statement

Committee Statement: Add new annex material to direct the user to a valuable source of information for these devices.

Response Message:

Public Input No. 8-NFPA 67-2013 [New Section after 6.2.2.3]

A.6.2.2.3

~~Further~~ Additional information and application criteria for flame and detonation arresters can be found in Annex F of NFPA 69~~, Annex F~~.

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First Revision No. 7-NFPA 67-2014 [Section No. 6.2.2.4]

6.2.2.4

Deflagration arresters are limited to a maximum pipe length between a possible ignition source and the arrester. For that reason, it is important to know the L/D ratio for a tested in-line deflagration arrester. ~~The different test standards developed by USCG, FM, UL, and ISO provide application limitations for flame arresters with respect to process pressure and temperature. If the process pressure or temperature is outside the tested range, the device should be not be applied.~~

6.2.2.4.1

Deflagration arresters are tested and listed or approved for limited L/D ratios. Deflagration arresters installed in piping systems with piping in excess of that tested could experience a detonation rather than a deflagration. Detonation arresters are necessary in these situations. *(See Section 9.1 .)*

6.2.2.5

The different test standards developed by USCG, FM Global , UL, and ISO provide application limitations for flame arresters with respect to process pressure and temperature. If the process pressure or temperature is outside the tested range, the device should be not be applied.

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Committee Statement

Committee Statement: Two different ideas, pipe length and process conditions, are addressed in the original text. These have been separated. Additional criteria related to pipe length issues are added as a sub paragraph.

Response Message:

Public Input No. 3-NFPA 67-2013 [Section No. 6.2.2.4]

Public Input No. 4-NFPA 67-2013 [New Section after 6.2.2.4]

First Revision No. 8-NFPA 67-2014 [Section No. 6.2.3.6]

6.2.3.6 Active Devices for Explosion Isolation .

Active device(s) provide the necessary and adequate action to prevent, protect, or contain a ~~fire or explosion~~ deflagration . The design and characteristic action of the device depend on the system used.

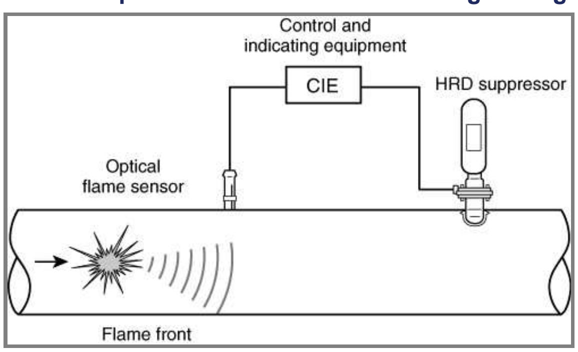
6.2.3.6.1 Chemical Isolation Barriers.

The operation principle of chemical barriers is the same as for explosion suppression systems. The suppressant agent is dispersed into the duct in front of the flame zone. The suppressant agent interacts with the flame, extinguishing it and thus preventing the flame from spreading into other units. The discharge time can be very short, or it might be long, to prolong protection in the system. The chemical barrier is typically activated at the same time as the explosion suppression system and by the same control unit. It should be stressed that with chemical barriers some problems arise if the duct is connected to a large vessel from which flame propagation starts. Combustion in this large volume creates a large amount of gases that flow from the vessel through the duct. The flow can be so large that the suppressant agent is simply swept out of the system by the flow before the flame arrives, which renders the system ineffective. If the barrier is triggered by the pressure detector, the suppressant agent could be swept out of the system by the induced flow. This problem can be prevented by venting the explosion, thus preventing the formation of large amounts of gases that otherwise would flow through the duct. Another approach is to use an additional time lag in activating the chemical barrier, which allows the gases to flow out so that the suppressant is effectively used to extinguish the flame. In systems in which piping and ducts interconnect various units to one another, pressure piling could cause problems due to the increased pressures and turbulence thus generated.

6.2.3.6.1.1

An extinguishing barrier comprises an optical flame sensor and a high rate discharge (HRD) suppressor located downstream of the detected flame front. The effectiveness of an extinguishing barrier is based on its ability to detect an explosion in a pipeline by means of an optical flame sensor whose tripping signal is amplified and then very quickly actuates the HRD valves of the pressurized HRD suppressors *(see Figure 6.2.3.6.1.1 ~~Figure 6.2.3.6.1.1~~ ~~Figure 6.2.3.6.1.1Figure 6.2.3.6.2~~).* If the equipment is protected by a design measure (e.g., containment, suppression, or venting), conventional explosion pressure sensors with correspondingly low activation pressures can also be used to initiate the triggering mechanism for the extinguishing barrier. The extinguishing agent, preferably extinguishing powder, is discharged into the pipeline and forms a thick blanket that extinguishes the incipient flame. This type of barrier does not impede product throughput along the pipeline.

Figure 6.2.3.6.1.1 Schematic of Explosion Isolation with an Extinguishing Barrier.



6.2.3.6.1.2

For the extinguishing barrier, the same HRD suppressors can be used as for explosion suppression. The HRD suppressors shown in Figure 6.2.3.6.1.2(a) ~~Figure 6.2.3.6.1.2(a) Figure 6.2.3.6.1.2(a)Figure 6.2.3.6.3(a)~~ and Figure 6.2.3.6.1.2(b) ~~Figure 6.2.3.6.1.2(b) Figure 6.2.3.6.1.2(b)Figure 6.2.3.6.3(b)~~ are typical examples.

Figure 6.2.3.6.1.2(a) HRD Suppressor with ~~20~~ 75 mm HRD Valve.

Figure 6.2.3.6.1.2(b) HRD Suppressor ~~with Dual 20 mm HRD Valves~~ .

6.2.3.6.1.3

There is a certain distance between the installation site of the optical sensor or detector and the extinguishing barrier that ensures that the suppressant acts directly on the flame. The amount of suppressant required (number of HRD suppressors) depends on the nature of the combustible material, the nominal diameter of the protected pipeline, the flame velocity, and the maximum reduced explosion overpressure in the vessel. Use of such barriers does not reduce the pipe cross section. The explosion pressure is not significantly influenced by the extinguishing procedure. The strength of the piping to be protected must therefore be matched to the expected explosion pressure or, if applicable, to the maximum reduced explosion pressure.

6.2.3.6.2

An extinguishing barrier comprises an optical flame sensor and a high rate discharge (HRD) suppressor located downstream of the detected flame front. The effectiveness of an extinguishing barrier is based on its ability to detect an explosion in a pipeline by means of an optical flame sensor whose tripping signal is amplified and then very quickly actuates the HRD valves of the pressurized HRD suppressors *(see Figure 6.2.3.6.2)*. If the equipment is protected by a design measure (e.g., containment, suppression, or venting), conventional explosion pressure sensors with correspondingly low activation pressures can also be used to initiate the triggering mechanism for the extinguishing barrier. The extinguishing agent, preferably extinguishing powder, is discharged into the pipeline and forms a thick blanket that extinguishes the incipient flame. This type of barrier does not impede product throughput along the pipeline.

Figure 6.2.3.6.2 Schematic of Explosion Isolation with an Extinguishing Barrier.

~~6.2.3.6.3~~

For the extinguishing barrier, the same HRD suppressors can be used as for explosion suppression. The HRD suppressors shown in Figure 6.2.3.6.3(a) and Figure 6.2.3.6.3(b) are typical examples.

Figure 6.2.3.6.3(a) HRD Suppressor with 20 mm HRD Valve.

Figure 6.2.3.6.3(b) HRD Suppressor with Dual 20 mm HRD Valves.

6.2.3.6.4

There is a certain distance between the installation site of the optical sensor or detector and the extinguishing barrier that ensures that the suppressant acts directly on the flame. The amount of suppressant required (number of HRD suppressors) depends on the nature of the combustible material, the nominal diameter of the protected pipeline, the flame velocity, and the maximum reduced explosion overpressure in the vessel. Use of such barriers does not reduce the pipe cross section. The explosion pressure is not significantly influenced by the extinguishing procedure. The strength of the piping to be protected must therefore be matched to the expected explosion pressure or, if applicable, to the maximum reduced explosion pressure.

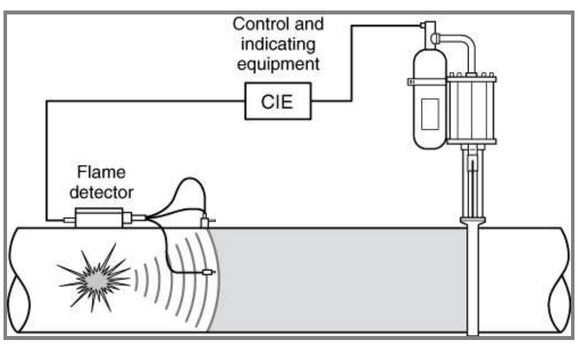
6.2.3.6.2 Fast-Acting Valves.

Physical barriers are fast-acting valves that provide a mechanical barrier against the flame front of an explosion. The mechanical barrier is a fast-acting metal gate that is activated to assume a closed position, thus blocking the cross section of a duct. The closing of the fast-acting valve is driven by compressed gas (typically pressurized nitrogen in the range of 10 to 40 bar) or by means of an electromagnetic valve. The action is initiated by a signal from the control unit. The closing time strongly depends on the diameter of the pipe and varies from 10 ms for a 50 mm diameter up to 67 ms for a diameter of 650 mm. Such valves are suitable for process temperatures up to 200°C. Explosion isolation valves must be sufficiently strong to withstand the high pressure of an explosion. For deflagrations starting at or below atmospheric pressure, pressure resistance to 10 to 20 bar-g is sufficient. For detonations, generated overpressures are so high (particularly due to reflected pressures) that application of an isolation valve alone is not a reliable solution. However, in combination with other systems (venting, explosion suppression) whose actions reduce the pressure reaching the valve, such a solution is practicable (Going and Snoeys, 2002). After every action, the fast-acting valves (i.e., gate valve, butterfly slide valve, louver, and throttle pinch valve, float valve, and flap valve) must be reopened. In the case of an explosive charge or pressure-actuated valves, some parts, such as the driving force (explosive charge or pressurized cartridge) and a shock absorber, have to be replaced. The replacement operation is short — typically less than 1 hour. *(See NFPA 69 for maintenance and additional limitations.)*

6.2.3.6.2.1

An essential characteristic of the explosion protection sliding fast-acting valve is that, apart from preventing propagation of flames, it also prevents propagation of the explosion pressure. Explosion protection sliding valves have the advantage that the closing device is normally outside the pipe cross section. Figure 6.2.3.6.2.1 Figure 6.2.3.6.2.1 shows an example of such a sliding valve. The pipe is completely open and can be built without pockets or dead corners, so that contaminants will not settle or accumulate.

Figure 6.2.3.6.2.1 Schematic of Explosion Isolation with an Explosion Protection a Fast-Acting Sliding Valve.



6.2.3.6.3

The effectiveness of an explosion protection sliding valve is based on its ability to detect an explosion in a pipeline by means of an optical flame sensor whose tripping signal is amplified and then very quickly actuates a compressed-gas-operated release mechanism that initiates the closing procedure and closes the sliding valve . The compressed gas is supplied by pressurized HRD suppressors, compressed air from the operating system, or by means of pressurized-gas producers. The closing time, t_S , depends mainly on the nominal width of the explosion protection sliding valve and is generally less than 50 ms. The sliding valve can be mounted in vertical, horizontal, or sloping pipelines.

6.2.3.6.2.2

The effectiveness of ~~an explosion protection sliding~~ a fast-acting valve is based on its ability to detect an explosion in a pipeline by means of an optical flame sensor whose tripping signal is amplified and then very quickly ~~actuates a compressed-gas-operated release mechanism that~~ initiates the closing procedure ~~and closes the sliding valve~~ . ~~The compressed gas is supplied by pressurized HRD suppressors, compressed air from the operating system, or by means of pressurized-gas producers.~~ The closing time, t_S, depends mainly on the nominal width of the ~~explosion protection sliding~~ fast-acting valve and is generally less than 50 ms. ~~The sliding valve~~ Some valves can be mounted in vertical, horizontal, or sloping pipelines.

6.2.3.6.2.3

~~Between~~ There is a minimum separation distance needed between the location of the sensor or the detector and the ~~explosion protection gate valve, there is a minimum distance, which essentially~~ fast-acting valve to ensure the valve closes before the flame front arrives. This distance depends on the pipe cross section, ~~the~~ explosion velocity, ~~the~~ detection time, ~~the~~ control delay, ~~the~~ closing time, and ~~the~~ explosion pressure in the upstream vessel.

~~**6.2.3.6.3**~~

~~An essential characteristic of the explosion protection sliding valve is that, apart from preventing propagation of flames, it also prevents propagation of the explosion pressure. Explosion protection sliding valves have the advantage that the closing device is normally outside the pipe cross section. Figure 6.2.3.6.6 shows an example of such a sliding valve. The pipe is completely open and can be built without pockets or dead corners, so that contaminants will not settle or accumulate.~~

~~**Figure 6.2.3.6.3 Schematic of Explosion Isolation with an Explosion Protection Sliding Valve.**~~

~~**6.2.3.6.3**~~

~~The effectiveness of a fast-acting valve is based on its ability to detect an explosion in a pipeline by means of an optical flame sensor whose tripping signal is amplified and then very quickly initiates the closing procedure. The closing time, t_S, depends mainly on the nominal width of the fast-acting valve and is generally less than 50 ms. Some valves can be mounted in vertical, horizontal, or sloping pipelines.~~

~~**6.2.3.6.3**~~

~~Between the location of the sensor or the detector and the explosion protection gate valve, there is a minimum distance, which essentially depends on the pipe cross section, the explosion velocity, the detection time, the control delay, the closing time, and the explosion pressure in the upstream vessel.~~

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Committee Statement

Committee Statement: This section was revised to clarify the intent.

Response Message:

Public Input No. 5-NFPA 67-2013 [Section No. 6.2.3.6.6]

Public Input No. 6-NFPA 67-2013 [Section No. 6.2.3.6.8]

First Revision No. 9-NFPA 67-2014 [Section No. 7.2.1]

7.2.1

The transient pressure load at a given position in the pipe has the characteristic shape shown in Figure 7.2.1 prior to any reflections from a closed valve or tube end wall. The peak pressure is effectively the CJ pressure, and the residual pressure far behind the detonation front is the same pressure, $P_3 \approx 0.4\ P_{CJ}$, shown in Figure 7.2.1 . The fluctuations behind the detonation front are produced by transverse waves propagating in a radial direction in the pipe. ~~At longer times, when the reflected detonation wave arrives at the same pipe location, there is a second, distinct shock wave and expansion wave, as seen in Figure 7.2.1(b) . The reflected detonation wave peak pressure is often 2 to 2.5 times the incident pressure at the end wall and decays as it propagates back down the pipe.~~

Figure 7.2.1 Transient Pressure Load Due to CJ Detonation in Pipe. (Source: Shepherd, ~~2006~~ 2009)

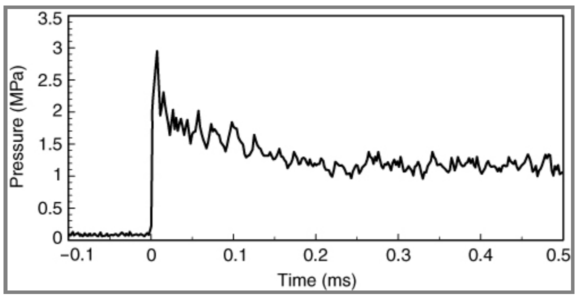


Figure 7.2.1(b) ~~Transient Pressure, Including Reflected Detonation Wave. (Source: Shepherd, 2006)~~

7.2.2

At longer times, when the reflected detonation wave arrives at the same pipe location, there is a second, distinct shock wave and expansion wave, as seen in Figure 7.2.2(a)~~Figure 7.2.1(b)~~ . The corresponding transducer locations from the reference test are shown in Figure 7.2.2(b) . The reflected detonation wave peak pressure is often 2 to 2.5 times the incident pressure at the end wall and decays as it propagates back down the pipe.

Figure 7.2.2(a) ~~Transient Pressure, Including Reflected Detonation Wave. (Source: Shepherd, 2006)~~ Measured Pressure Signals for a Detonation Propagating at 1267 m/s in the GALCIT Large Detonation Tube. a) transducer 1. b) transducer 2. c) transducer 3. (Source: Shepherd, 2009)

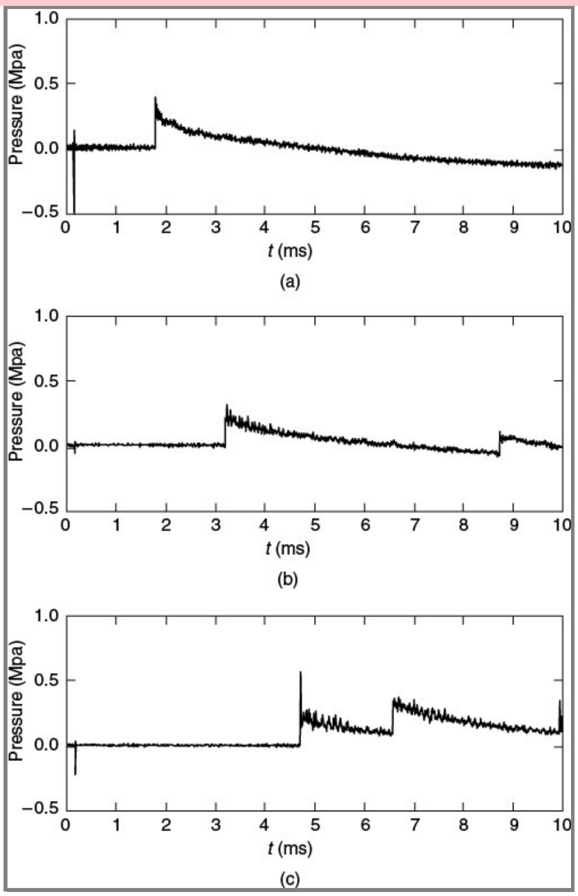
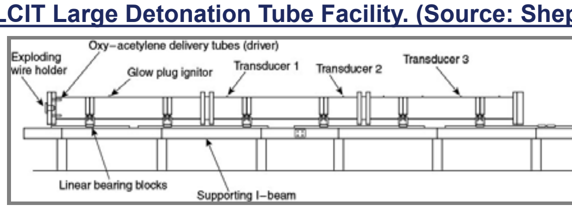


Figure 7.2.2(b) The GALCIT Large Detonation Tube Facility. (Source: Shepherd, 2009)



Supplemental Information

File Name	Description
FR9_FigureA.7.2.2a.docx	

FR9_FigureA.7.2.2b.docx

Submitter Information Verification

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City:
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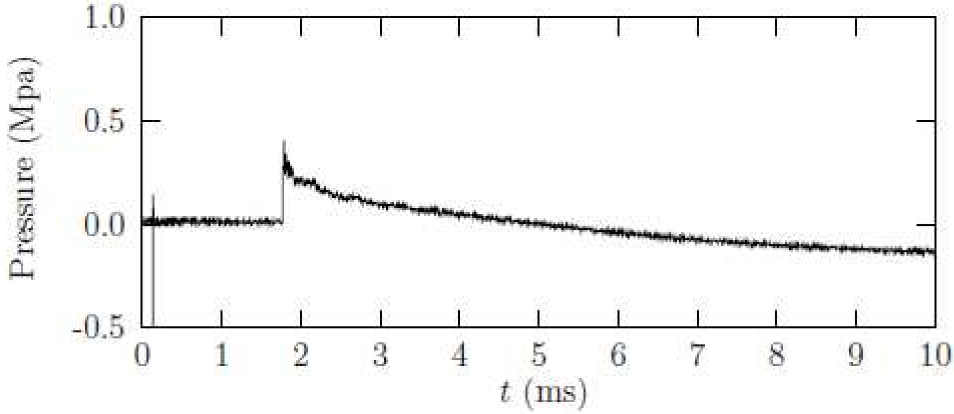
Committee Statement

Committee Statement: The expanded text and figures provide a better description of the detonation pressure wave phenomena.

Response Message:

Public Input No. 7-NFPA 67-2013 [Section No. 7.2.1]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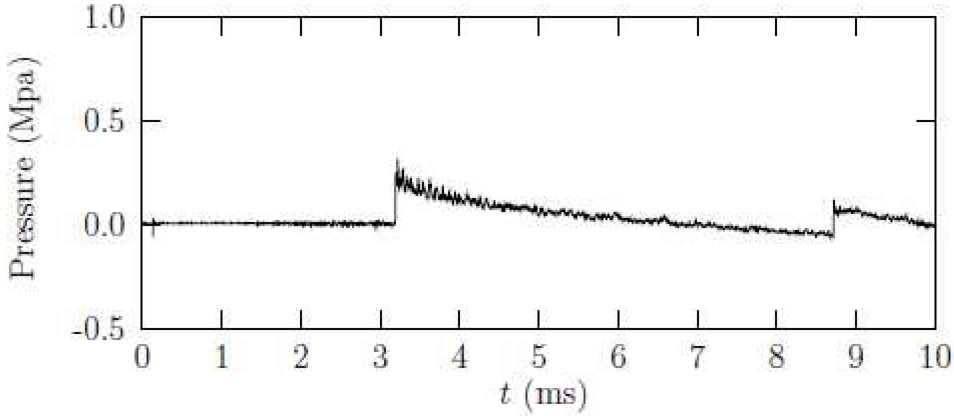
0.0
-0.5
0 1 2 3 4 5 6 7 8 9 10
t (ms)

(a)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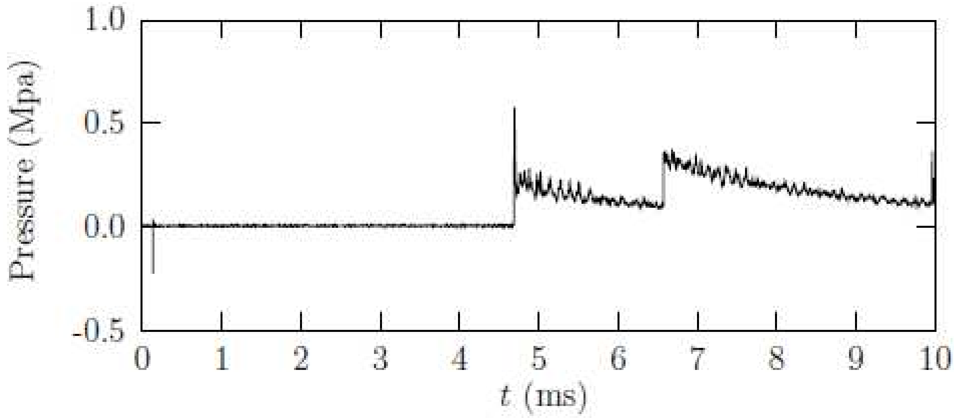
-0.5
0 1 2 3 4 5 6 7 8 9 10
t (ms)

(b)


Pressure (Mpa)
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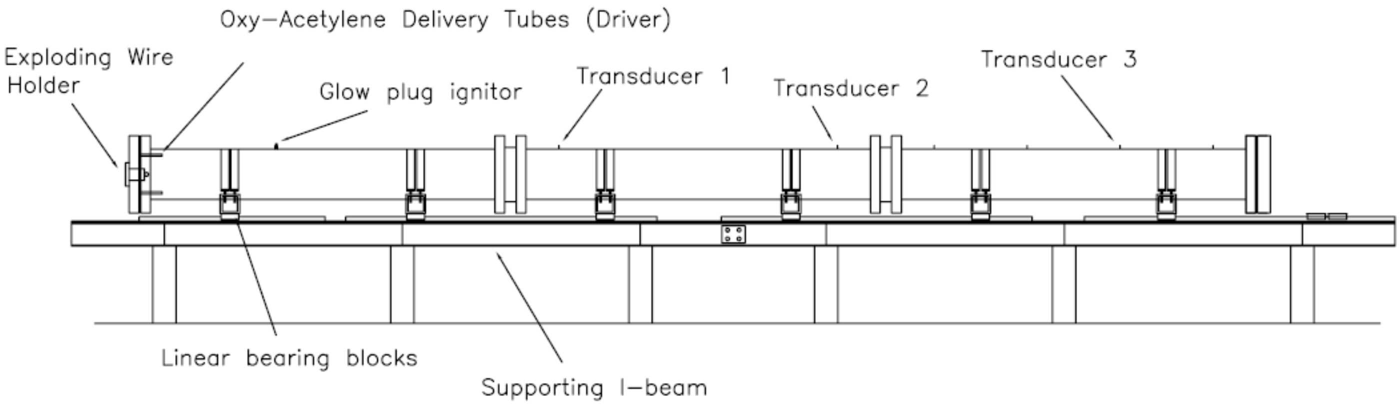
0.5
0.0
-0.5
0 1 2 3 4 5 6 7 8 9 10
t (ms)


Oxy-Acetylene Delivery Tubes (Driver)
Exploding Wire
Holder
Glow plug ignitor
Transducer 1
Transducer 2
Transducer 3
Linear bearing blocks
Supporting I-beam

First Revision No. 10-NFPA 67-2014 [Section No. 7.5.1]

7.5.1

The German TRbF 20 provides good guidance on how to design piping in combination with flame arresters.

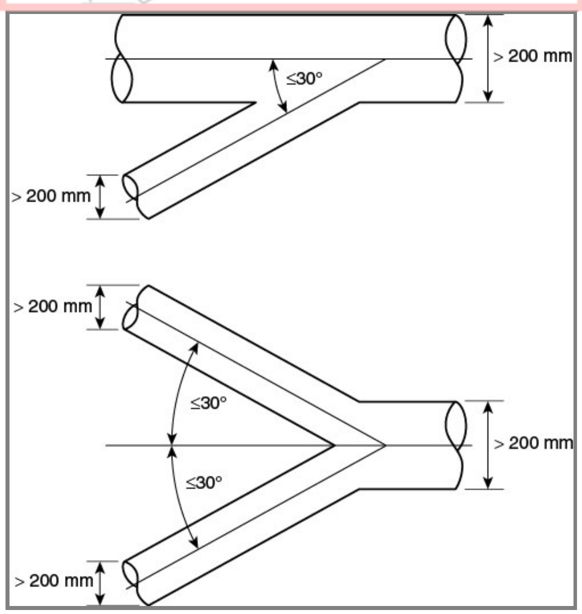
7.5.1.1

Piping and fittings between the detonation flame arrester and a possible ignition location have to resist the expected explosion pressure without bursting. For example, this typically can be achieved if pipes and fittings of nominal ~~widths~~ diameters up to and including ~~DN~~ 200 mm are designed with a ~~nominal~~ pressure of at least ~~PN~~ 10 bar, and pipes and fittings of a nominal ~~width~~ diameter above ~~DN~~ 200 mm are designed with a ~~nominal~~ pressure of at least ~~PN~~ 16 bar.

7.5.1.2

For piping with nominal ~~widths~~ diameters up to and including ~~DN~~ 200 mm , bends with a variable curvature radius, *r*, as well as T-fittings and other fittings, are permitted. For piping with nominal ~~widths~~ diameters above ~~DN~~ 200 mm , bends have to show a ratio of curvature radius *r* to pipe diameter *d* of at least 1.5. T-fittings with a nominal ~~width~~ diameter above ~~DN~~ 200 mm within the diverging limb are not permitted. For examples regarding acceptable divergences, see Figure 7.5.1.2. ~~Cross-section reductions in piping have to be located a distance of 120 pipe diameters before the detonation flame arrester.~~

Figure 7.5.1.2 Design of Piping for Detonation Containment in Combination with Detonation Arresters. (Source: TRbF 20)



7.5.1.3

~~Within piping systems the pipes and fittings located between a detonation flame arrester and the possible ignition location have to be designed in nominal pressure PN 10. The distance between the deflagration flame arrester and the possible ignition location and the fittings arranged hereto have to correspond to the stipulated requirements as per the EC type examination certificate.~~ Cross-section reductions in piping have to be located a distance of 120 pipe diameters before the detonation flame arrester.

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Committee Statement

Committee Statement: The section was revised to clarify the intent.

Response Message:

Public Input No. 10-NFPA 67-2013 [Section No. 7.5.1.2]
Public Input No. 11-NFPA 67-2013 [Section No. 7.5.1.3]

First Revision No. 11-NFPA 67-2014 [Section No. 9.1]

9.1* Passive Detonation Arresters.

Flame arresters that prevent the transmission of a detonative combustion are in general called detonation arresters. Detonations are more typically expected in pipework. According to the mode of installation and intended purpose, the following types of devices are distinguished:

(1) A detonation can propagate into connected pipework. Flame arresters that prevent this type of detonation transmission are called in-line detonation arresters. This application is so predominant that these flame arresters are simply called detonation arresters. They must be applied if deflagrations can propagate over a long distance, so that transition to detonation cannot be excluded.

(2) The combustion wave that is transported by a detonation along pipes can, under certain conditions, propagate into the endangered atmosphere that surrounds the pipe end. Flame arresters that prevent this type of detonation transmission are called end-of-line detonation arresters. They are used, for example, on filling and emptying pipes. If such pipes run dry and an explosive mixture is formed in them, a detonation could propagate through these tubes into the tank. For that reason, the ends of these pipes are equipped with end-of-line detonation arresters.

9.1.1

Concerning the pressure and safety against flame transmission, the load due to detonations must be rated much higher than that owing to deflagrations. Nevertheless, detonation arresters should also be tested against deflagrations. Most modern test standards fulfill this requirement so that most detonation arresters provide safety against detonations and deflagrations.

9.1.2

In the section of the pipe with a length of a few tube diameters in which the transition from deflagration to detonation takes place, extraordinarily high pressure loads occur. If this transition takes place within a detonation arrester, even unstable detonation arresters cannot ensure 100 percent safety. For that reason, a maximum degree of safety is achieved by a layer of protection method.

9.1.3

The distance between the deflagration flame arrester and the possible ignition location and the fittings arranged hereto have to correspond to the stipulated requirements as per the EC type examination certificate.

Supplemental Information

File Name	Description
FR11_A.9.1_edited.docx	

Submitter Information Verification

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Committee Statement

Committee Statement: Add new annex to section 9.1. The addition of Annex A material directs the user to a valuable source of information for these devices.

Subsection 9.1.3 is moved from existing 7.5.1.3. The committee recognizes the need to address piping design criteria within Chapter 9. This section attempts to expand upon that criteria.

Public Input No. 9-NFPA 67-2013 [New Section after 9.1]

A.9.1

~~Further~~ Additional information and application criteria for flame and detonation arresters can be found in Annex F of NFPA 69~~, Annex F~~.

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First Revision No. 13-NFPA 67-2014 [Section No. 10.1.3]

10.1.3

To prevent exceeding a vessel's maximum allowable working pressure (MAWP) and maximum allowable working vacuum (MAWV), a vent pipe to atmosphere typically is installed. The installation of detonation arresters should be considered if flammable atmospheres occur in these during operation. Alternatively, an end-of-line flame arrester can be installed if the length of the vent line is short enough so that the run-up distance from the possible ignition source, which is likely to occur at the end of the vent line, is smaller than the tested L/D ratio of the end-of-line flame arrester. ~~When detonation arresters are added, it is important that the use of the device does not introduce a new risk (e.g., plugged vent or process lines, which could result in equipment overpressure). For systems that contain flammable atmospheres during nonroutine operations such as commissioning and decommissioning, the selection of mitigation strategies should be commensurate with risk.~~

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Committee Statement

Committee Statement: The deleted text is a repeat of information in 10.1 and is unnecessary.
Response Message:
Public Input No. 12-NFPA 67-2013 [Section No. 10.1.3]

First Revision No. 14-NFPA 67-2014 [Section No. 10.2.2]

10.2.2

The connection to the closed systems for vapor balancing is equipped with an in-line detonation arrester because of the possibility of the ignition source being far away. The L/D ratio from the ignition source to the arrester easily can be greater than the typically tested L/D ratio of in-line deflagration arresters. ~~Even though this is only an in-line detonation arrester, it can provide sufficient safety.~~

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Submittal Date: Mon May 19 13:04:27 EDT 2014

Committee Statement

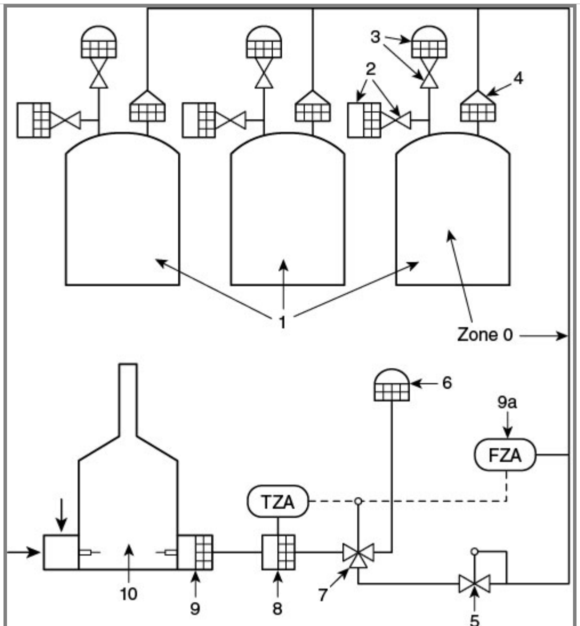
Committee Statement: The deleted sentence was superfluous.
Response Message:

Public Input No. 13-NFPA 67-2014 [Section No. 10.2.2]

First Revision No. 15-NFPA 67-2014 [Section No. 10.3 [Excluding any Sub-Sections]]

The example depicted in Figure 10.3 shows the protection strategy for a thermal combustion unit in which waste gas is processed. It is expected that the waste gas must be assigned to zone 0 (or zone 10) and is fed into a burner, where it is burnt. This means that zone 0 gases are continuously fed into a system with a permanent ignition source being present during normal operation. According to the regulation and safety rules of ISO 16852 and TRbF 20, three independent measures are necessary to protect the process plant and storage area from flashback of the flame. A first measure can be the use of a feeding system installed at burner 9 in Figure 10.3, which is safe against flashback. This can be achieved by monitoring and controlling the velocity of the feed flow. Depending on the explosion group of the expected mixture and the diameter and maximum operating temperature of the feeding pipe, minimum values of the flow velocity must be obtained. In this example, the minimum flow velocity at the burner is produced with the aid of a jet of an auxiliary gas.

Figure 10.3 Protection of Process Unit and Tank Farm from Thermal Oxidizer.



1 Storage tank
2 Vacuum relief valve with end-of-line deflagration arrester
3 Pressure relief valve with end-of-line endurance burning flame arrester
4 In-line detonation arrester
5 Control valve
6 End-of-line endurance burning flame arrester
7 Three-way control valve
8 In-line deflagration arrester with temperature sensor
9 Flashback-proof burner inlet
10 Incinerator
TZA = TIS+A+
FZA = FIS-A-

Supplemental Information

File Name	Description
FR15_Legend-Fig10.3.docx	Content for new legend to be added to Figure 10.3.

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Committee Statement

Committee Statement: Revise Figure 10.3 to add a legend showing all the reference numbers and their descriptions. This will provide clarification of the figure.

Response Message:

Public Input No. 14-NFPA 67-2014 [Section No. 10.3 [Excluding any Sub-Sections]]

1 Storage Tank
2 Vacuum Relief Valve with End-of-Line Deflagration Arrester
3 Pressure Relief Valve with End-of-Line Endurance Burning Flame Arrester
4 In-Line Detonation Arrester
5 Control Valve
6 End-of-Line Endurance Burning Flame Arrester
7 Three-Way control valve
8 In-Line Deflagration arrester with Temperature Sensor
9 Flashback-proof burner inlet
10 Incinerator
TZA = TIS+A+
FZA = FIS-A-

First Revision No. 16-NFPA 67-2014 [New Section after 10.4.1]

Global FR-16 Hide Deleted

10.4.2 Vacuum Regenerated. (Reserved)

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Street Address:
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Committee Statement

Committee Statement: The committee recognizes that there is room for additional information on vacuum regenerated adsorbers. This section is a placeholder, which will be populated at the Comment Stage.

Response Message:

Public Input No. 16-NFPA 67-2014 [Section No. 10.4 [Excluding any Sub-Sections]]

First Revision No. 18-NFPA 67-2014 [Chapter 12 [Title Only]]

Installation, Inspection, and Maintenance of Piping Explosion Protection Systems

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State:
Zip:
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Committee Statement

Committee Statement: The title was revised to clarify that this section applies to the explosion protection equipment, not the process piping.

Response Message: