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An American National Standard

# Standard Specification for Tank Vent Flame Arresters[1]

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## 1. Scope

1.1 This specification provides the minimum requirements for design, construction, performance, and testing of tank vent flame arresters.

1.2 This specification is intended for flame arresters protecting systems containing vapors of flammable or combustible liquids where vapor temperatures do not exceed 60°C. The test media defined in 9.1.1 can be used except where arresters protect systems handling vapors with a maximum experimental safe gap (MESG) below 0.9 mm. Flame arresters protecting such systems must be tested with appropriate media (the same vapor or a media having a MESG no greater than the vapor). Various gases and their respective MESG are listed in Table 1.

~~NOTE 1—Flame arresters meeting this specification also comply with the minimum requirements of the International Maritime Organization, Maritime Safety Committee Circular No. 373 (MSC/Circ. 373/Rev. 1).~~

1.3 The values stated in ~~either inch-pound or~~ SI units are to be regarded as ~~the~~ standard. The values given in parentheses ~~are for information only.~~after SI units are provided for information only and are not considered standard.

1.4 The following precautionary caveat pertains only to the test methods portions, Sections 8 and 9, of this specification: *This standard does not purport to address all of the safety concerns, if any, associated with its use. It is the responsibility of the user of this standard to establish appropriate safety, health, and environmental practices and determine the applicability of regulatory limitations prior to use.*

1.5 *This standard should be used to measure and describe the properties of materials, products, or assemblies in response to heat and flame under controlled laboratory conditions and should not be used to describe or appraise the fire hazard or fire risk of materials, products, or assemblies under actual fire conditions. However, results of this test may be used as elements of a fire risk assessment which takes into account all of the factors which are pertinent to an assessment of the fire hazard of a particular end use*

1.6 *This international standard was developed in accordance with internationally recognized principles on standardization established in the Decision on Principles for the Development of International Standards, Guides and Recommendations issued by the World Trade Organization Technical Barriers to Trade (TBT) Committee.*

[1] This specification is under the jurisdiction of ASTM Committee F25 on Ships and Marine Technology and is the direct responsibility of Subcommittee F25.11 on Machinery and Piping Systems.

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**TABLE 1 Gases and Their MESGs**

| Inflammable Gas or Vapor | Maximum Experimental Safe Gap | |
|---|---|---|
| | mm | in. |
| Methane | 1.170 | 0.046 |
| Blast furnace gas | 1.193 | 0.047 |
| Propane | 0.965 | 0.038 |
| Butane | 1.066 | 0.042 |
| Pentane | 1.016 | 0.040 |
| Hexane | 0.965 | 0.038 |
| Heptane | 0.965 | 0.038 |
| Iso-octane | 1.040 | 0.041 |
| Decane | 1.016 | 0.040 |
| Benzene | 0.99 | 0.039 |
| Xylene | 1.066 | 0.042 |
| Cyclohexane | 0.94 | 0.037 |
| Acetone | 1.016 | 0.040 |
| Ethylene | 0.71 | 0.028 |
| Methyl-ethyl-ketone | 1.016 | 0.040 |
| Carbon monoxide | 0.915 | 0.036 |
| Methyl-acetate | 0.990 | 0.039 |
| Ethyl-acetate | 1.04 | 0.041 |
| Propyl-acetate | 1.04 | 0.041 |
| Butyl-acetate | 1.016 | 0.040 |
| Amyl-acetate | 0.99 | 0.039 |
| Methyl alcohol | 0.915 | 0.036 |
| Ethyl alcohol | 1.016 | 0.040 |
| Iso-butyl-alcohol | 0.965 | 0.038 |
| Butyl-alcohol (normal) | 0.94 | 0.037 |
| Amyl-alcohol | 0.99 | 0.039 |
| Ethyl-ether | 0.864 | 0.034 |
| Coal gas ($H_2$ 57 %) | 0.482 | 0.019 |
| Acetylene | <0.025 | <0.001 |
| Carbon disulphide | 0.203 | 0.008 |
| Hydrogen | 0.102 | 0.004 |
| Blue water gas ($H_2$ 53 % CO 47 %) | 0.203 | 0.008 |
| Ethyl nitrate | <0.025 | <0.001 |
| Ammonia | 3.33 | 0.133 |
| Ethylene oxide | ~0.65 | ~0.026 |
| Ethyl nitrite | 0.922 | 0.038 |



## 2. Referenced Documents

2.1 *ASTM Standards:*[2]

F722 Specification for Welded Joints for Shipboard Piping Systems

F1155 Practice for Selection and Application of Piping System Materials

~~2.2 *ANSI Standard:*[3]~~

~~B16.5 Pipe Flanges and Flanged Fittings~~

2.2 *Other Documents:*

ASME Boiler and Pressure Vessel ~~Code:~~Code Section VIII, Division ~~1, Pressure Vessels~~1[3]

ASME Boiler and Pressure Vessel ~~Code:~~Code Section ~~IX, Welding and Brazing Qualifications~~IX[3]

~~International Maritime Organization, Maritime Safety Committee: MSC/Circ. 373/Rev. 1~~ASME B16.5 ~~Revised Standards for the Design, Testing and Locating of Devices to Prevent the Passage of Flame into Cargo Tanks in Tankers~~Pipe Flanges and Flanged Fittings: NPS 1/2 through NPS 24 Metric/Inch Standard

International Electrotechnical Commission: Publication 60079-1 ~~International Electrotechnical Commission: Publication 79-1Electrical Apparatus for Explosive Gas Atmospheres~~Explosive atmospheres — Part 1: Equipment protection by flameproof enclosures 'd'[4]

[2] For referenced ASTM standards, visit the ASTM website, www.astm.org, or contact ASTM Customer Service at service@astm.org. For *Annual Book of ASTM Standards* volume information, refer to the ~~standard's~~standard's Document Summary page on the ASTM website.

~~[3] Available from American National Standards Institute (ANSI), 25 W. 43rd St., 4th Floor, New York, NY 10036, http://www.ansi.org.~~

[3] Available from American Society of Mechanical Engineers (ASME), ASME International Headquarters, Two Park Ave., New York, NY 10016-5990, http://www.asme.org.

[4] Available from International Electrotechnical Commission, 3 rue de Varembe, Case Postale 131, CH-1211, Geneva 20, Switzerland.

## 3. Terminology

3.1 *Definitions:*

3.1.1 *flame ~~arrester~~—arrester, n—*a device to prevent the passage of flame in accordance with a specified performance standard. Its flame arresting element is based on the principle of quenching.

3.1.2 *flame ~~passage~~—passage, n—*the transmission of a flame through a flame arrester.

3.1.3 *flame ~~speed~~—speed, n—*the speed at which a flame propagates along a pipe or other system.

3.1.4 *gasoline ~~vapors~~—vapors, n—*a nonleaded petroleum distillate consisting essentially of aliphatic hydrocarbon compounds with a boiling range of approximately 65 to 75°C.

## 4. Classification

4.1 The two types of flame arresters covered in this specification are classified as follows:

4.1.1 *Type I*—Flame arresters acceptable for end-of-line applications.

4.1.2 *Type II*—Flame arresters acceptable for in-line applications.

## 5. Ordering Information

5.1 Orders for flame arresters under this specification shall include the following information, as applicable:

5.1.1 Type (I or II),

5.1.2 Nominal pipe size,

5.1.3 Each gas or vapor in the tank being protected by the flame arrester and the corresponding MESG,

5.1.4 Inspection and tests other than those specified by this specification,

5.1.5 Anticipated ambient air temperature range,

5.1.6 ~~Purchaser's~~Purchaser's inspection requirements (see 10.1),

5.1.7 Description of installation (distance and configuration of pipe between the arrester and the atmosphere or potential ignition source) (see 8.2.4.2),

5.1.8 Materials of construction (see Section 6), and

5.1.9 Maximum flow rate and the design pressure drop for that maximum flow rate.

## 6. Materials

6.1 The flame arrester housing, and other parts or bolting used for pressure retention, shall be constructed of materials listed in Practice F1155, or Section VIII, Division 1, of the ASME Boiler and Pressure Vessel Code.

6.1.1 Arrester, elements, gaskets, and seals shall be of materials resistant to attack by seawater and the liquids and vapors contained in the tank being protected (see 5.1.3).

6.2 Nonmetallic materials, other than gaskets and seals, shall not be used in the construction of pressure-retaining components of the flame arrester.

6.2.1 Nonmetallic gaskets and seals shall be noncombustible and suitable for the service intended.

6.3 Bolting materials, other than those in 6.1, shall be at least equal to those listed in Table 1 of ~~ANSI~~ASME B16.5.

6.4 The possibility of galvanic corrosion shall be considered in the selection of materials.

6.5 All other parts shall be constructed of materials suitable for the service intended.

**7. Other Requirements**

7.1 Flame arrester housings shall be gastight to prevent the escape of vapors.

7.2 Flame arrester elements shall fit in the housing in a manner that will ensure tightness of metal-to-metal contacts in such a way that flame cannot pass between the element and the housing.

7.2.1 The net free area through flame arrester elements shall be at least 1.5 times the cross-sectional area of the arrester inlet.

7.3 Housings and elements shall be of substantial construction and designed for the mechanical and other loads intended during service. In addition, they shall be capable of withstanding the maximum and minimum pressures and temperatures to which the device may be exposed under both normal and the specified fire test conditions in Section 9.

7.4 Threaded or flanged pipe connections shall comply with the applicable B16 standards in Practice F1155. Welded joints shall comply with Specification F722.

7.5 All flat joints of the housing shall be machined true and shall provide for a joint having adequate metal-to-metal contact.

7.6 Where welded construction is used for pressure-retaining components, welded joint design details, welding, and nondestructive testing shall be in accordance with Section VIII, Division 1, of the ASME Code and Specification F722. Welders and weld procedures shall be qualified in accordance with Section IX of the ASME Code.

7.7 The design of flame arresters shall allow for ease of inspection and removal of internal elements for replacement, cleaning, or repair without removal of the entire device from the system.

7.8 Flame arresters shall allow for efficient drainage of condensate without impairing their efficiency to prevent the passage of flame.

7.8.1 Where the design does not permit complete drainage of condensate through its connection to the tank, the housing shall be fitted with a plugged drain opening on the side of the atmospheric outlet of not less than ½-in. nominal pipe size (NPS ½).

7.9 All fastenings shall be protected against loosening.

7.10 Flame arresters shall be designed and constructed to minimize the effect of fouling under normal operating conditions.

7.11 Flame arresters shall be capable of operating over the full range of ambient air temperatures anticipated.

7.12 End-of-line flame arresters shall be so constructed as to direct the efflux vertically upward.

7.13 Flame arresters shall be of first class workmanship and free from imperfections that may affect their intended purpose.

7.14 Tank vent flame arresters shall show no flame passage when subjected to the tests in 8.2.4.

**8. Prototype Tests**

8.1 Tests shall be conducted by an independent laboratory capable of performing the tests. The manufacturer, in choosing a

laboratory, accepts that it is a qualified independent laboratory by determining that it has (or has access to) the apparatus, facilities, personnel, and calibrated instruments that are necessary to test flame arresters in accordance with this specification.

8.1.1 A test report shall be prepared by the laboratory that shall include the following:

8.1.1.1 Detailed drawings of the flame arrester and its components (including a parts list identifying the materials of construction).

8.1.1.2 Types of tests conducted and results obtained,

8.1.1.3 Specific advice on approved attachments (see 8.2.4.1),

8.1.1.4 Types of gases or vapors for which the flame arrester is approved (see 5.1.3),

8.1.1.5 Drawings of the test rig,

8.1.1.6 Records of all markings found on the tested flame arrester, and

8.1.1.7 A report number.

8.2 One of each model Type I and Type II flame arrester shall be tested. Where approval of more than one size of a flame arrester model is desired, the largest and smallest sizes shall be tested. A change of design, material, or construction that may affect the corrosion resistance, endurance burn, or flashback capabilities of the flame arrester shall be considered a change of model.

8.2.1 The flame arrester shall have the same dimensions, configuration, and the most unfavorable clearances expected in production units.

8.2.2 A corrosion test shall be conducted. In this test, a complete arrester, including a section of pipe similar to that to which it will be fitted, shall be exposed to a 20 % sodium chloride solution spray at a temperature of 25°C for a period of 240 h and allowed to dry for 48 h. Following this exposure, all movable parts shall operate properly and there shall be no corrosion deposits that cannot be washed off.

8.2.3 Performance characteristics as declared by the manufacturer, such as flow rates under both positive and negative pressure, operating sensitivity, flow resistance, and velocity, shall be demonstrated by appropriate tests.

8.2.4 Tank vent flame arresters shall be tested for endurance burn and flashback in accordance with the test procedures in Section 9. The following constraints apply:

8.2.4.1 Where a Type I flame arrester is provided with cowls, weather hoods, deflectors, and so forth, it shall be tested in each configuration in which it is provided.

8.2.4.2 Type II arresters shall be specifically tested with the inclusion of all pipes, tees, bends, cowls, weather hoods, and so forth, which may be fitted between the arrester and the atmosphere.

8.2.5 Devices that are provided with a heating arrangement shall pass the required tests at the heated temperature.

8.2.6 After all tests are completed, the device shall be disassembled and examined, and no part of the device shall be damaged or show permanent deformation.

## 9. Test Procedures for Flame Arresters

9.1 *Media/Air Mixtures:*

9.1.1 For vapors from flammable or combustible liquids with a MESG greater than or equal to 0.9 mm, technical grade hexane or gasoline vapors shall be used for all tests in this section, except technical grade propane may be used for the flashback test in 9.2. For vapors with a MESG less than 0.9 mm, the specific vapor (or alternatively, a media with a MESG less than or equal to the MESG of the vapor) shall be used as the test medium in all Section 9 tests.