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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.

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 and health 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*

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:*

F 722 Specification for Welded Joints for Shipboard Piping Systems[2]

F 1155 Practice for Selection and Application of Piping System Materials[2]

2.2 *ANSI Standard:*

[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.

Current edition approved April 1, 1991. Published June 1991.

[2] *Annual Book of ASTM Standards,* Vol 01.07.

B16.5 Pipe Flanges and Flanged Fittings[3]

2.3 *Other Documents:*

ASME Boiler and Pressure Vessel Code: Section VIII, Division 1, Pressure Vessels[4]

ASME Boiler and Pressure Vessel Code: Section IX, Welding and Brazing Qualifications[4]

International Maritime Organization, Maritime Safety Committee: MSC/Circ. 373/Rev. 1 Revised Standards for the Design, Testing and Locating of Devices to Prevent the Passage of Flame into Cargo Tanks in Tankers[5]

International Electrotechnical Commission: Publication 79-1 Electrical Apparatus for Explosive Gas Atmospheres[6]

3. Terminology

3.1 *Definitions:*

3.1.1 *flame arrester*—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*—the transmission of a flame through a flame arrester.

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

3.1.4 *gasoline vapors*—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 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 F 1155, 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 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 B–16 standards in Practice F 1155. Welded joints shall comply with Specification F 722.

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 F 722. 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.

[3] Available from American National Standards Institute (ANSI), 25 W. 43rd St., 4th Floor, New York, NY 10036.

[4] Available from American Society of Mechanical Engineers (ASME), ASME International Headquarters, Three Park Ave., New York, NY 10016-5990.

[5] Available from International Maritime Organization, 4 Albert Embankment, London SE1 7SR, England.

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

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.

9.1.2 Hexane, propane, gasoline, and chemical vapors shall be mixed with air to form the most easily ignitable mixture.[7]

9.2 *Flashback Test*:

9.2.1 A flashback test shall be carried out as follows:

9.2.1.1 The test rig shall consist of an apparatus producing an explosive mixture, a small tank with a diaphragm, a prototype of the flame arrester, a plastic bag,[8] and a firing source in three positions (see Fig. 1).[9]

9.2.1.2 The tank, flame arrester assembly, and plastic bag enveloping the prototype flame arrester shall be filled so that this volume contains the most easily ignitable vapor/air mixture.[7] The concentration of the mixture should be verified by appropriate testing of the gas composition in the plastic bag. Three ignition sources shall be installed along the axis of the bag, one close to the flame arrester, another as far away as possible therefrom, and the third at the midpoint between these two. These three sources shall be fired in succession, one during each of the three tests. Flame passage shall not occur during this test.

9.2.1.3 If flame passage occurs, the tank diaphragm will burst and this will be audible and visible to the operator by the emission of a flame. Flame, heat, and pressure sensors may be used as an alternative to a bursting diaphragm.

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[7] See IEC Publication 79-1.

[8] The dimensions of the plastic bag are dependent on those of the flame arrester. The plastic bag may have a circumference of 2 m, a length of 2.5 m, and a wall thickness of 0.05 m.

[9] To prevent remnants of the plastic bag from falling back onto the flame arrester being tested after ignition of the fuel/air mixture, it may be useful to mount a coarse wire frame across the flame arrester within the plastic bag. The frame should be constructed so as not to interfere with the test result.

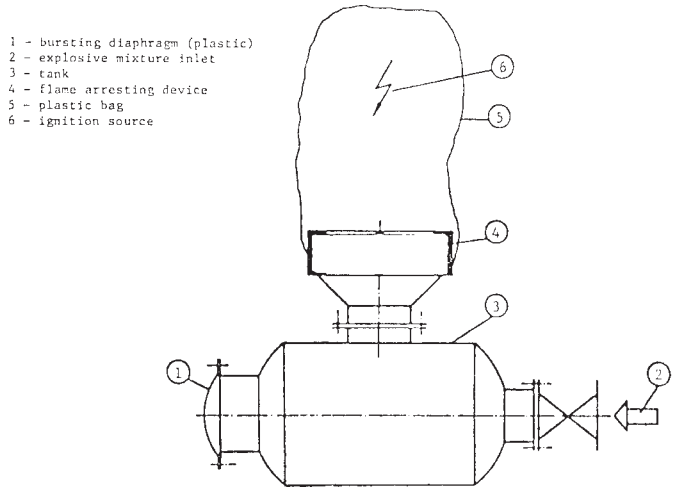

FIG. 1 Test Rig for Flash Back Test

9.3 *Endurance Burn Test*:

9.3.1 An endurance burning test shall be carried out as follows:

9.3.1.1 The test rig referred to in 9.2.1.1 may be used, without the plastic bag. The flame arrester shall be so installed that the mixture emission is vertical. The mixture shall be ignited in this position.

9.3.1.2 Endurance burning shall be achieved by using the most easily ignitable test vapor/air mixture with the aid of a pilot flame or a spark igniter at the outlet. By varying the proportions of the flammable mixture and the flow rate, the arrester shall be heated until the highest obtainable temperature on the cargo tank side of the arrester is reached. The highest attainable temperature may be considered to have been reached when the rate of temperature increase does not exceed 0.5°C per minute over a 10-min period. This temperature shall be maintained for a period of 10 min, after which the flow shall be stopped and the conditions observed. If difficulty arises in establishing the highest attainable temperature, the following criteria shall apply. When the temperature appears to be approaching the maximum temperature, using the most severe conditions of flammable mixtures and flow rate, but increases at a rate in excess of 0.5°C per minute over a 10-min period, endurance burning shall be continued for a period of 2 h, after which the flow shall be stopped and the conditions observed. Flame passage shall not occur during this test.

10. Inspection

10.1 The manufacturer shall afford the purchaser's inspector all reasonable facilities necessary to ensure that the material is being furnished in accordance with this specification. All examinations and inspections shall be made at the place of manufacture, unless otherwise agreed upon.

10.2 Each finished flame arrester shall be visually and dimensionally checked to ensure that the device corresponds to this specification, is certified in accordance with Section 11, and is marked in accordance with Section 12. Special attention shall be given to checking the proper fit-up of joints (see 7.5 and 7.6).

11. Certification

11.1 Manufacturer's certification that a flame arrester has been constructed in accordance with this specification shall be provided in an instruction manual. The manual shall include the following, as applicable:

11.1.1 Installation instructions and a description of all configurations tested (see 8.2.4.1 and 8.2.4.2). Installation instructions to include manufacturer's recommended limitations based on all configurations tested.

11.1.2 Operating instructions.

11.1.3 Maintenance requirements.

11.1.3.1 Instructions on how to determine when flame arrester cleaning is required and the method of cleaning.

11.1.4 Copy of the test report (see 8.1.1).

11.1.5 Flow test data, including flow rates under both positive and negative pressures, operating sensitivity, flow resistance, and velocity.

11.1.6 The ambient air temperature range over which the device will effectively prevent the passage of flame.

NOTE 2—Other factors such as condensation and freezing of vapors should be evaluated at the time of equipment specification.

12. Product Marking

12.1 Each flame arrester shall be permanently marked indicating:

12.1.1 Manufacturer's name or trademark,

12.1.2 Style, type, model, or other manufacturer's designation for the flame arrester,

12.1.3 Size of the inlet and outlet,

12.1.4 Type of device (Type I or II),

12.1.5 Direction of flow through the flame arrester,

12.1.6 Test laboratory and report number,

12.1.7 Lowest MESG of gases for which the flame arrester is suitable,

12.1.8 Ambient air operating temperature range, and

12.1.9 Specification F 1273.

13. Quality Assurance

13.1 Flame arresters shall be designed, manufactured, and tested in a manner that ensures they meet the characteristics of the unit tested in accordance with this specification.

13.2 The flame arrester manufacturer shall maintain the quality of the flame arresters that are designed, tested, and marked in accordance with this specification. At no time shall a flame arrester be sold with Specification F 1273 that does not meet the requirements herein.

14. Keywords

14.1 combustible liquid; flame arrester; flammable liquid; marine technology; ships; tank vent; tank vent flame arrester