



UL 525

STANDARD FOR SAFETY

Flame Arresters

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UL Standard for Safety for Flame Arresters, UL 525

Eighth Edition, Dated May 9, 2008

Summary of Topics

This revision of ANSI/UL 525 is being issued to reflect the reaffirmation of ANSI approval. No changes in requirements have been made.

Text that has been changed in any manner or impacted by UL's electronic publishing system is marked with a vertical line in the margin. Changes in requirements are marked with a vertical line in the margin and are followed by an effective date note indicating the date of publication or the date on which the changed requirement becomes effective.

The revised requirements are substantially in accordance with Proposal(s) on this subject dated August 4, 2017.

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UL 525

Standard for Flame Arresters

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The most recent designation of ANSI/UL 525 as a Reaffirmed American National Standard (ANS) occurred on October 12, 2017. ANSI approval for a standard does not include the Cover Page, Transmittal Pages, and Title Page.

Comments or proposals for revisions on any part of the Standard may be submitted to UL at any time. Proposals should be submitted via a Proposal Request in UL's On-Line Collaborative Standards Development System (CSDS) at <https://csds.ul.com>.

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INTRODUCTION

1 Scope

1.1 These requirements cover tank vent deflagration flame arresters and in-line detonation flame arresters.

1.2 The requirements for tank vent deflagration flame arresters cover arresters for use on vents of storage tanks for petroleum oil and gasoline. These flame arresters are intended to prevent propagation of flame into the storage tank. Combination flame arrester-vent valves are also covered.

1.3 The requirements for in-line detonation flame arresters cover arresters for use in piping systems containing flammable vapors and gases in mixture with air. These flame arresters are unidirectional or bidirectional and are intended to prevent the transmission of detonation and deflagration.

2 Glossary

2.1 For the purpose of this Standard, the following definitions apply.

2.2 **BIDIRECTIONAL** – An in-line detonation flame arrester is determined to be bidirectional with respect to direction of flow when:

- a) The investigation shows that the flame arrester performs its intended function with a detonation or deflagration approaching from either direction; or
- b) The design of the flame arrester is symmetrical and each end is determined as identical when approached by a detonation or deflagration from either direction.

2.3 **DEFLAGRATION** – A very rapid burning of a flammable gas- or vapor-air mixture where the flame front of the combustion wave propagates at subsonic velocity.

2.4 **DETONATION** – An extremely rapid burning of a flammable gas- or vapor-air mixture where the flame front of the combustion wave propagates at sonic or supersonic velocity and a shock wave precedes the flame front.

2.5 **DETONATION, STABLE** – A detonation that has a velocity equal to the speed of sound in the gas- or vapor-air mixture.

2.6 **DETONATION, UNSTABLE (OVERDRIVEN)** – A detonation that has a velocity higher than the speed of sound in the gas- or vapor-air mixture.

2.7 **FLASHBACK** – The transmission of flame through an arrester.

2.8 **TYPE I FLAME ARRESTER** – A flame arrester that will not flash back when subjected to the Endurance Burn Test.

2.9 **TYPE II FLAME ARRESTER** – A flame arrester that:

- a) Flashes back when subjected to the Endurance Burn Test, 11.2, and
- b) Is marked with a continuous burn time.

2.10 UNIDIRECTIONAL – An in-line detonation flame arrester is considered to be unidirectional with regard to direction of flow if it is not symmetrical and is investigated with detonations approaching only from one direction.

3 Units of Measurement

3.1 Values stated without parentheses are the requirement. Values in parentheses are explanatory or approximate information.

4 Undated References

4.1 Any undated reference to a code or standard appearing in the requirements of this standard shall be interpreted as referring to the latest edition of that code or standard.

5 Terminology

5.1 The term "flame arrester" as used in this Standard refers to all flame arresters covered by the scope of this Standard unless specifically noted otherwise in the text or in the headings preceding the text. For example, Sections 10 – 14 apply only to tank vent deflagration flame arresters, as noted in 9.1 and by the heading preceding Section 10.

CONSTRUCTION

6 Materials

6.1 A flame arrester element shall be of a metal resistant to corrosion under conditions of use.

6.2 The casing or housing shall be of cast aluminum, stainless steel, ductile cast iron in accordance with ASTM A395, or the equivalent.

Exception: Cast, malleable, or ductile iron may be used for a tank vent deflagration flame arrester.

6.3 A gasket such as one made of animal or vegetable fibers shall not be used in the construction or assembly of a flame arrester. Nonmetallic gaskets shall be noncombustible. For the purpose of these requirements a material classed 5VA in accordance with the Standard for Tests for Flammability of Plastic Materials for Parts in Devices and Appliances, UL 94, is considered to be noncombustible.

7 Casings

7.1 The casing or housing of a flame arrester shall withstand the internal pressure resulting from explosions without damage. See Explosion and Flashback Tests, Section 12 and Detonation and Deflagration Tests, Section 18.

7.2 The casing or housing of an in-line detonation flame arrester shall be gas tight. See Pneumatic-Leakage Test, Section 20.

7.3 A flat joint in a flame arrester and a flat surface to be mounted to a tank or pipe shall be machined to provide an arithmetical average roughness of not more than 250 microinches in accordance with the Standard for Surface Texture, ANSI/ASME B46.1-1995. The machined surface shall provide for a joint having a metal-to-metal width of not less than 1/4 inch (6.4 mm).

7.4 All fastenings shall be protected against loosening by some means such as lock washers.

8 Provisions for Connection and Inspection

8.1 A flame arrester shall have provisions for flanged or threaded connection to pipe.

8.2 An in-line detonation flame arrester shall be constructed to permit ease of inspection and cleaning without removing the complete arrester from the system.

PERFORMANCE

GENERAL

9 General

9.1 The performance requirements for tank vent deflagration flame arresters are covered in Sections 10 – 14.

9.2 The performance requirements for in-line detonation flame arresters are covered in Sections 15 – 21.

9.3 At the manufacturer's request, the Endurance Burn and Continuous Flame Tests, Sections 11 and 17, the Explosion and Flashback Tests, Section 12, and the Detonation and Deflagration Tests, Section 18, are able to be conducted with a different flammable gas or vapor than those specified when the arrester is marked in accordance with 23.4.

9.4 The propane and n-hexane used in the tests is to be technical grade. The gasoline is to be Naphtha "R", a nonleaded distillate consisting essentially of aliphatic hydrocarbon compounds and having a specific gravity of 60 – 70 degrees API at 15.6°C (60°F).

9.5 With the exception of the Continuous Flame Test following the Endurance Burn Test 17.1.2, the tests are able to be conducted in whatever order is convenient.

TANK VENT DEFLAGRATION FLAME ARRESTERS

10 Flow Capacity

10.1 The flow capacity of a flame arrester shall be determined at the operating pressures (both positive and negative) specified for the arrester by the manufacturer.

10.2 When a flame arrester is intended for use as an emergency vent, the flow capacity shall be determined at the pressure at which the valve reaches the full open position. If the pressure at full open position is greater than 2.5 psi, and the start to open pressure is less than 2.5 psi, the flow capacity shall also be determined at 2.5 psi.

11 Endurance Burn and Continuous Flame Tests

11.1 General

11.1.1 A Type I flame arrester shall be subjected to the Endurance Burn Test described in 11.2.1 – 11.2.9 and there shall be no passage of flame, both during the test and when the gas valve is closed at the conclusion of the test.

11.1.2 A Type II flame arrester shall be subjected to the Continuous Flame Test specified in 11.3.1 – 11.3.5 and marked in accordance with 24.1(e).

11.1.3 When a flame arrester is to be provided with cowls, weatherhoods, deflectors, and similar components, it is to be tested in each configuration in which it is to be provided.

11.2 Endurance burn test

11.2.1 The flammable mixture for the test is to be a 2.5 percent mixture by volume of n-hexane in air or a 1.9 percent mixture by volume of gasoline vapor in air.

11.2.2 The flame arrester is to be mounted on a tank so that the mixture emission is vertically upwards, or mounted in the position for which it is designed and which will result in the most severe heating of the arrester. When the arrester is provided with a vent valve, the valve is to be open for the test.

11.2.3 The tank mentioned in 11.2.2 is to be provided with a burst diaphragm at one end and an inlet for the mixture at the other end.

11.2.4 The burst diaphragm is to be made of 0.0015- to 0.010-inch (0.038- to 0.2540-mm) thick cellulose acetate film, polyester film, polyethylene terephthalate film, or the equivalent.

11.2.5 The mixture is to be introduced into the tank and is to be ignited by a pilot flame or spark plug at the outlet of the flame arrester. The mixture may be reignited as necessary during the test.

11.2.6 Temperatures are to be measured on the surface of the protected side of the arrester element at its center, at its edge, and halfway between the center and the edge.

11.2.7 The concentration and the flow rate of the mixture are to be varied while maintaining a flame on the surface of the arrester for at least 2 hours or until the temperature on the protected side has a temperature rise of at least 100°C (180°F). After 2 hours or a 100°C rise, the procedure is to be continued until the highest obtainable temperature is reached on the protected side of the arrester.

11.2.8 The highest obtainable temperature is identified as being reached when the temperature rise does not exceed 0.5°C (0.9°F) per minute over a 10-minute period, regardless of the concentration and flow rate.

11.2.9 The highest obtainable temperature is to be maintained for 10 additional minutes without additional temperature rise after which the flow is to be stopped. Observation is to be made to determine if flashback occurs.

11.3 Continuous flame test

11.3.1 The flame arrester is to be subjected for 1 hour (or longer at the manufacturer's request) to the flame of a continuously burning mixture of gasoline vapor and air at a concentration of 1.9 ± 0.05 percent by volume. The total burning time in this test until flashback occurs or the test is discontinued shall be used for the marking in 24.1(e).

11.3.2 The flame arrester is to be connected as intended for installation:

- a) Using the maximum length of pipe intended, if marked on the arrester in accordance with 24.1(a) and not less than 5 feet (1.5 m);
- b) Discharging directly to the atmosphere when intended for such use; or
- c) Connected to the specific vent-valve intended, with the valve open for the test.

11.3.3 The mixture is to be introduced into the inlet (tank) end of the test installation at the rate specified in Table 11.1 and is to be burned at the outlet face of the arrester.

Table 11.1
Rate of flow of gasoline vapor-air mixture

Pipe size ANSI B36.10 nominal inches	Rate of flow	
	Cubic feet per hour	Cubic meters per hour
3/4	5	0.14
1	9	0.26
2	35	0.99
2-1/2	55	1.56
3	80	2.27
4	120	3.40
6	235	6.65
8	408	11.55
10	716	20.28
12	1030	29.17

11.3.4 The mixture composition is to be continuously monitored during the test.

11.3.5 The flow of the mixture into the inlet is to be stopped for 15 seconds every 10 minutes after initiation of the test. There shall be no flashback, as determined visually, at any time during the test, including the 15 seconds following the final 10-minute burning interval.

12 Explosion and Flashback Tests

12.1 General

12.1.1 A flame arrester shall not permit the passage of sparks or flame from the outlet (vent) end to the inlet (tank) end of the arrester. Tests as described in either 12.2.1 – 12.2.11, at the manufacturer's request, or 12.3.1 – 12.3.12 are to be conducted to determine if passage of sparks or flame can ignite the explosive mixture in the tank when the arrester is subjected to a series of explosions.

12.2 Explosion tests

12.2.1 The flame arrester is to be subjected to explosion tests as described in 12.2.2 – 12.2.11 using propane-air mixtures at atmospheric pressure over the range specified in 12.2.2.

12.2.2 A series of at least 10 tests are to be conducted over the flammable range, which involves testing at 3.0, 3.5, 4.0, 4.2, 4.5, 5.0, 5.5, 6.0, 6.5 and 7.0 percent propane by volume in air.

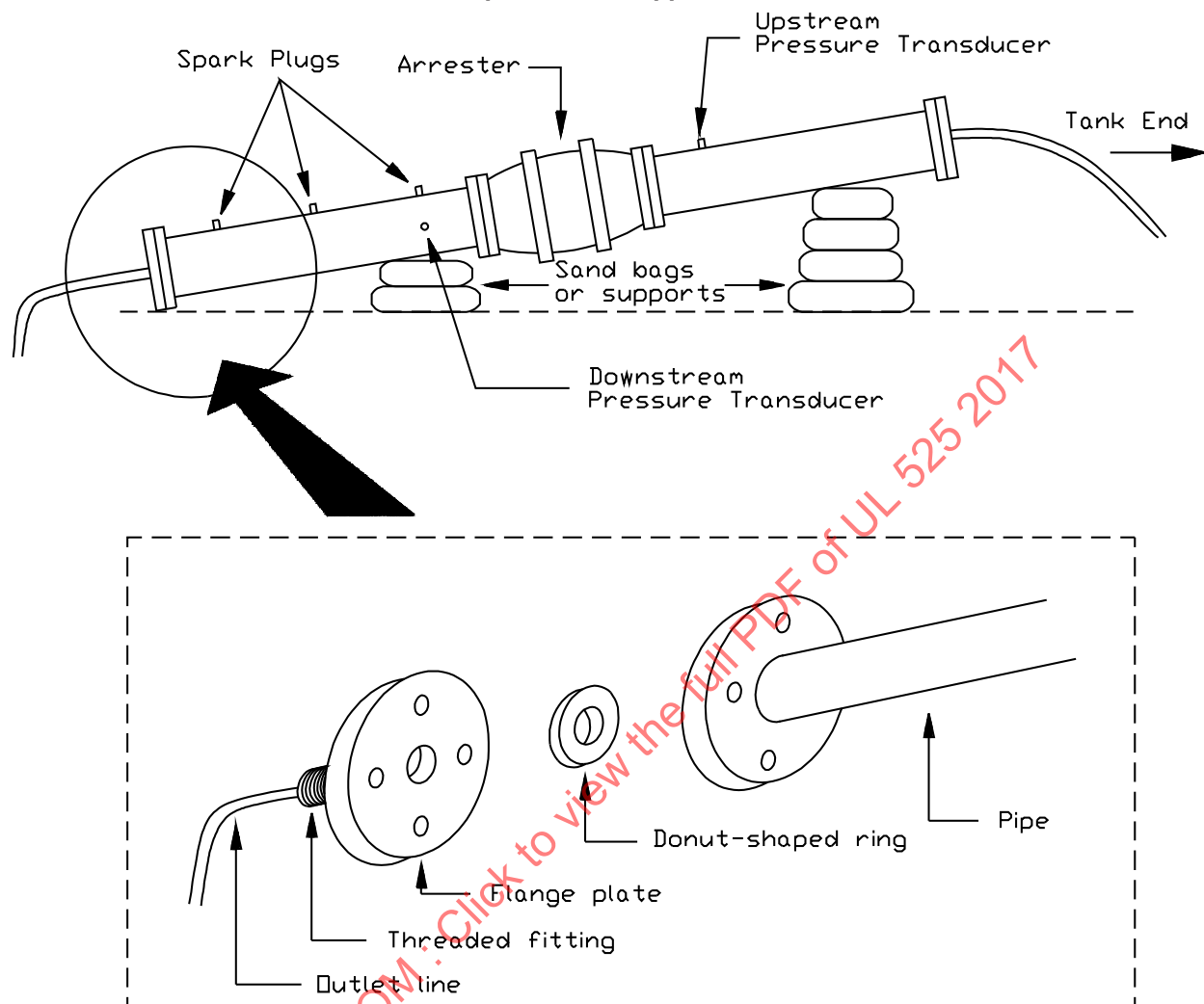
12.2.3 The flame arrester is to be installed in a pipeline of the diameter for which it is designed. The pipe connected to the inlet (tank end) is to be at least 5 feet (1.5 m) long. The outlet of the flame arrester, based upon the intended use, is to be connected to:

- a) A vent line of the maximum length of pipe intended, if marked on the arrester in accordance with 24.1(a);
- b) A 5-foot length of pipe, when it is intended to open directly to the atmosphere; or
- c) The intended vent valve, with the valve open for the test.

12.2.4 The test installation, including the axes of the inlet and outlet pipes, is to be inclined from the horizontal with the inlet end higher than the outlet end unless the flame arrester is specifically designed for vertical use only, in which case the flame arrester is to be tested in that position. The angle of inclination of the test installation shall be such that the bottom edge of the opening of the tank end of the inlet pipe is above the top edge of the opening of the tank end of the flame arrester.

12.2.5 The diameter of each pipe's open end is to be reduced by a donut-shaped ring loosely inserted into the pipe. The ring is to have a hole the size of the inlet or outlet line for the flammable mixture. After inserting the ring, each end is to be closed by a pipe flange plate with a reduced opening threaded for the inlet or outlet line carrying the explosive mixture. The lines are to be attached to the fittings. See Figure 12.1.

Figure 12.1
Explosion test apparatus



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12.2.6 A device for recording peak explosion pressure is to be connected in the inlet end and another recording device in the outlet end of the test installation. Three spark plugs are to be provided in the outlet end for ignition of the mixture; one 6 inches (152 mm) from the arrester, one 6 inches from the outlet, and the third at the midpoint between the other two.

12.2.7 The mixture is to be prepared by auxiliary equipment capable of preparing and maintaining predetermined concentrations within the limits specified in 12.2.2.

12.2.8 The mixture is to be introduced into the test installation until the original air is entirely displaced. The mixture is to be continuously monitored.

12.2.9 When the mixture is as specified in 12.2.2, the lines and pipe flanges plates are to be removed from both inlet and outlet pipes, and the openings are to be immediately plugged with a fire-resistant, cotton-like cloth. The mixture is then to be ignited in the outlet side of the test installation.

12.2.10 During each test, the installation is to be observed for propagation of flame through the flame arrester.

12.2.11 At the conclusion of each test, the installation is to be purged of residual gases with a stream of air.

12.3 Flashback tests

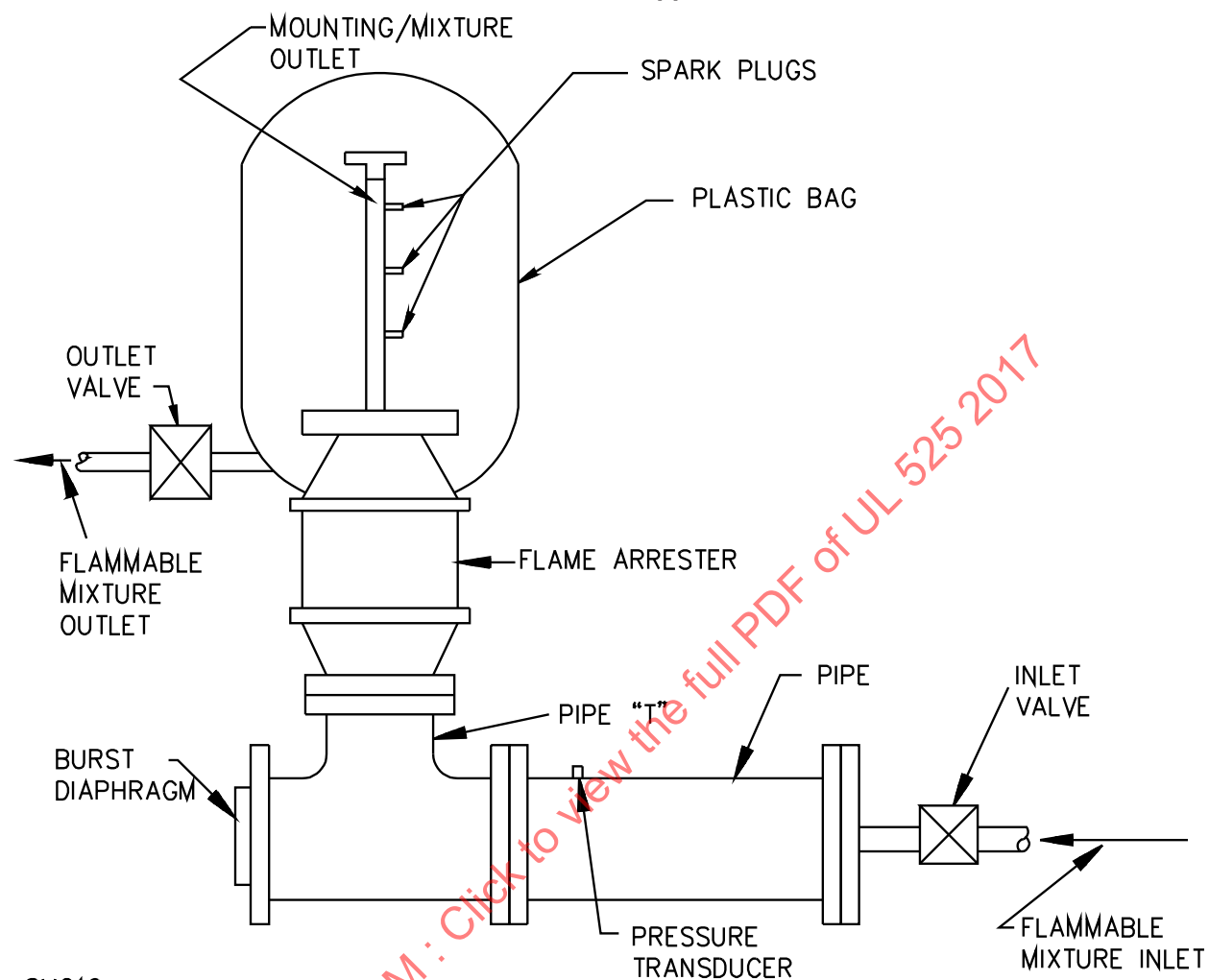
12.3.1 The flame arrester is to be tested as described in 12.3.2 – 12.3.12 using a 4.2 percent mixture by volume of propane in air.

12.3.2 When a flame arrester is to be provided with cowls, weatherhoods, deflectors, and similar components, it is to be tested in each configuration in which it is to be provided.

12.3.3 The flame arrester is to be installed on a tank as shown in Figure 12.2 (the tank may consist of a fitting and a length of pipe as shown).

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Figure 12.2
Flashback test apparatus



SM216

12.3.4 The tank is to be provided with a burst diaphragm at one end and an inlet for the mixture at the other end.

12.3.5 The burst diaphragm is to be made of 0.0015- to 0.010-inch (0.038- to 0.254-mm) thick cellulose acetate film, polyester film, polyethylene terephthalate film, or the equivalent.

12.3.6 The flame arrester is to be enclosed in a 0.002-inch (0.05-mm) thick nominal, transparent plastic bag. The dimensions of the bag are dependent on the dimensions of the flame arrester, but the nominal dimensions are:

- a) 68 inches (1727 mm) in circumference by 98 inches (2489 mm) long, or
- b) 80 inches (2032 mm) in circumference by 100 inches (2540 mm) long.

12.3.7 The plastic bag surrounding the flame arrester is to be provided with an outlet for the mixture.

12.3.8 Three spark plugs for ignition of the mixture are to be located within the plastic bag; one close to the flame arrester, one as far away from the flame arrester as possible, and the third at the midpoint between the other two.

12.3.9 The test installation is to be filled with the mixture. The mixture flow is to be adjusted to cause the plastic bag to inflate. The flow is to continue for at least 10 minutes so that all air originally present in the test installation has been displaced.

12.3.10 The mixture within the plastic bag is then to be ignited by the three spark plugs in succession, one during each of three tests.

12.3.11 Between each of the three tests, the installation is to be purged with air for at least 5 minutes.

12.3.12 During each test, the installation is to be observed for propagation of flame through the flame arrester. If propagation occurs, the mixture within the tank will ignite, bursting the diaphragm. There will also be emission of flame.

13 Hydrostatic Pressure Test

13.1 Except as noted in 13.2, a casing or housing of a flame arrester shall withstand a hydrostatic pressure of 250 psi (1725 kPa) for 1 minute without rupture or permanent distortion.

13.2 The casing or housing of a flame arrester intended to open and vent directly to the atmosphere or through not more than 7 feet (2.1 m) of open pipe shall withstand a hydrostatic pressure of 125 psi (860 kPa) for 1 minute without rupture or permanent distortion.

13.3 The hydrostatic pressure within the enclosure is to be gradually increased until the required internal pressure is reached. Gaskets or other means may be employed if necessary to prevent leakage of water during application of pressure.

14 Corrosion Test

14.1 A flame arrester intended for marine use shall be subjected to the salt spray test described in 14.2. After the test, all movable parts shall operate as intended and there shall be no corrosion deposits that cannot be washed off.

14.2 Each threaded opening of the arrester is to be provided with at least 6 inches (152 mm) of pipe. The assembly is then to be exposed for 240 hours to a 20 ± 1 percent sodium chloride solution spray at a temperature of $25^{\circ}\text{C} +2^{\circ}$, -3° ($77^{\circ}\text{F} +3.6^{\circ}$, -5.4°). Following the exposure, the assembly is to be allowed to dry for 48 hours.

IN-LINE DETONATION FLAME ARRESTERS

15 Samples

15.1 Only one sample of each model of in-line detonation flame arrester being tested shall be used for the Endurance Burn and Continuous Flame Tests, Section 17, and the Detonation and Deflagration Tests, Section 18.

Exception No. 1: Additional samples may be used to map or chart unstable (overdriven) and stable detonations prior to beginning the series of 30 detonation and deflagration tests specified in Section 18.

Exception No. 2: Two samples, or one sample for each direction, may be used for the detonation and deflagration tests on an asymmetrical bidirectional in-line detonation flame arrester. When two samples are used, each sample shall also be used for the Endurance Burn and Continuous Flame Tests, Section 17.

16 Flow Capacity

16.1 The flow capacity of a flame arrester shall be determined at the operating pressure specified for the arrester by the manufacturer.

17 Endurance Burn and Continuous Flame Tests

17.1 General

17.1.1 A Type I flame arrester shall be subjected to the Endurance Burn Test described in 11.2.1 – 11.2.9 and there shall be no flashback or passage of flame, both during the test and when the gas valve is closed at the conclusion of the test.

17.1.2 A Type II flame arrester shall be subjected to the Endurance Burn Test described in 11.2.1 – 11.2.9 and shall also be subjected to the Continuous Flame Test specified in 17.2.1 – 17.2.5. The arrester shall be marked in accordance with 25.1(c).

17.2 Continuous flame

17.2.1 The flame arrester is to be connected for the installation that it is intended.

17.2.2 The flammable mixture is to be introduced into the inlet (protected) end of the test installation at the concentration and rate used to obtain the highest temperature during the Endurance Burn Test. The mixture is to be burned at the outlet face of the arrester.

17.2.3 The mixture is to be continuously monitored during the test.

17.2.4 The flow of the mixture into the inlet is to be stopped for 15 seconds every 10 minutes after initiation of the test. There shall be no flashback, as determined visually, at any time during the test, including the 15 seconds following the final 10-minute burning interval.

17.2.5 The test is to be continued until passage of flame occurs or for the length of time specified by the manufacturer. The total burning time in this test until flashback occurs or the test is discontinued shall be used for the marking in 25.1(c).

18 Detonation and Deflagration Tests

18.1 General

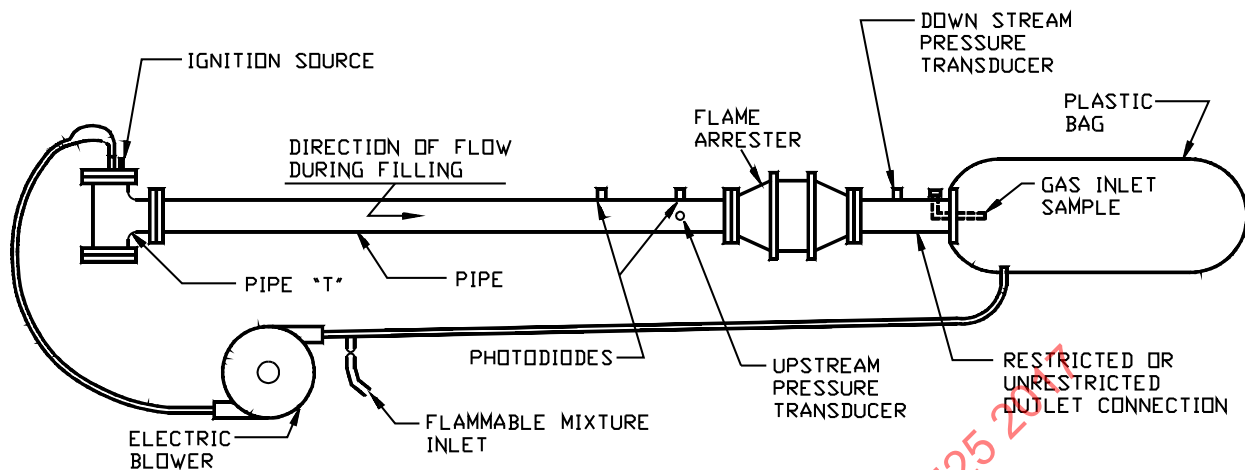
18.1.1 A flame arrester shall be subjected to the Detonation Tests described in 18.2.1 – 18.2.5 and the Deflagration Tests described in 18.3.1 – 18.3.3. There shall be no passage of flame through the arrester during the tests.

18.1.2 The flammable mixture for the tests is to be a 4.2 percent mixture by volume of propane in air.

18.1.3 The flame arrester is to be provided with lengths of pipe on the upstream (inlet) and downstream (outlet) sides as shown in Figure 18.1.

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Figure 18.1
Detonation and deflagration test apparatus



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18.1.4 The upstream length of pipe is to be provided with:

- a) A fitting at the outer end with an opening for inlet to the mixture and means for mounting an ignition source for the deflagration tests and a high energy ignition source for the detonation tests, and
- b) A high frequency pressure transducer for measuring the explosion pressures, with the transducer located not more than 8 inches (203 mm) from the arrester inlet.

18.1.5 The downstream pipe is to be of the same diameter as the upstream pipe, with a length at least ten times the diameter. The pipe is to be provided with:

- a) Means for obtaining a sample of the mixture,
- b) A pressure transducer located not more than 8 inches (203 mm) from the arrester outlet, and
- c) A plastic bag as described in 12.3.6 or a burst diaphragm, provided over the outer open end.

18.1.6 The flammable mixture is to be circulated through the test setup filling it to a test pressure equal to or greater than the maximum operating pressure of the arrester. A method which meets the intent of the requirement, is the use of a blower, the outlet of which is connected to the fitting on the end of the upstream length of pipe. The inlet of the blower is connected to the auxiliary equipment that produces the flammable mixture and the outlet is in the plastic bag on the downstream length of pipe. The auxiliary equipment is to be capable of maintaining predetermined concentrations of flammable mixtures.