UL 428A

STANDARD FOR SAFETY

Electrically Operated Valves for Gasoline and Gasoline/Ethanol Blends with Nominal Ethanol Concentrations Up to 85 Percent (E0 – E85)

UL Standard for Safety for Electrically Operated Valves for Gasoline and Gasoline/Ethanol Blends with Nominal Ethanol Concentrations Up to 85 Percent (E0 – E85), UL 428A

Second Edition, Dated June 7, 2022

Summary of Topics

This new edition of ANSI/UL 428A dated June 7, 2022 includes the following:

– Deletion of redundant requirements

– Operations Test

The new and revised requirements are substantially in accordance with Proposal(s) on this subject dated March 18, 2022.

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UL 428A

Standard for Electrically Operated Valves for Gasoline and Gasoline/Ethanol Blends with Nominal Ethanol Concentrations Up to 85 Percent (E0 – E85)

Prior to the first edition, the requirements for the products covered by this standard were included in the Outline of Investigation for Electrically Operated Valves for Gasoline and Gasoline/Ethanol Blends with Nominal Ethanol Concentrations Up to 85 Percent (E0 – E85), UL 428A.

First Edition – June, 2015

Second Edition

June 7, 2022

This ANSI/UL Standard for Safety consists of the Second Edition.

The most recent designation of ANSI/UL 428A as an American National Standard (ANSI) occurred on June 7, 2022. 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 electrically operated general purpose and safety valves rated 600 volts or less and intended for the control of the fluids specified in 1.2. Electrically operated valves, other than automotive fuel valves, covered by these requirements are intended to be used in other than hazardous locations as defined in accordance with the National Electrical Code, NFPA 70.

1.2 Electrically operated valves are intended for use with the following:

a) Gasoline formulated in accordance with the Standard Specification for Automotive Spark Ignition Fuel, ANSI/ASTM D4814; and

b) Gasoline/ethanol blends with nominal ethanol concentrations up to 25 percent ethanol (E25), consisting of gasoline formulated in accordance with the Standard Specification for Automotive Spark Ignition Fuel, ANSI/ASTM D4814, when blended with denatured fuel ethanol formulated to be consistent with the Standard Specification for Denatured Fuel Ethanol for Blending With Gasoline For Use as Automotive Spark Ignition Engine Fuel, ANSI/ASTM D4806; or

c) Gasoline/ethanol blends with nominal ethanol concentrations above 25 percent formulated in accordance with the Standard Specification in (b) or formulated in accordance with the Standard Specification for Ethanol Fuel Blends for Flexible-Fuel Automotive Spark Ignition Engines, ANSI/ASTM D5798, as applicable.

1.3 These requirements do not cover valves for use with fluids other than as specified in 1.2.

1.4 These requirements do not cover valves employing electrical parts, including coils, switch contacts and resistance elements, located in the flammable gas containing compartment of a valve. Valves constructed as such shall comply with the requirements in the Standard for Intrinsically Safe Apparatus and Associated Apparatus for Use in Class I, II, and III, Division 1, Hazardous (Classified) Locations, UL 913.

2 Glossary

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

2.2 BLENDING OPTION – Dispensing devices may be provided with an option that blends two specific fuels into one fuel to be dispensed. This blending occurs at the dispenser level and can be in two forms:

a) Fixed blending – Blending at the dispenser level that blends two specific fuels into one fuel to be dispensed, and that fuel to be dispensed is fixed. For example, fixed blending includes blend options where gasoline and denatured fuel ethanol can be blended to achieve E85, which is the actual dispensed fuel.

b) Variable blending – Blending at the dispenser level that blends two specific fuels into the fuel to be dispensed, but the fuel to be dispensed can be any of a number of previously set points. For example, variable blending includes blend options where gasoline and E85 can be blended to achieve E40, E60, and E85 as the actual dispensed fuel.

2.3 GASOLINE/ETHANOL BLENDS – Blended fuels composed of a gasoline component and an ethanol component. The numerical value corresponding to the ethanol component determines the blend rating (such as E85 for 85 % ethanol, 15 % gasoline).

2.4 MAXIMUM OPERATING PRESSURE DIFFERENTIAL– The maximum difference between the pressure at an inlet port and the pressure at an outlet port against which an electrically operated valve is intended to operate.

2.5 MAXIMUM RATED PRESSURE – The maximum pressure to which the valve assembly may be subjected as specified by the manufacturer.

2.6 MINIMUM OPERATING PRESSURE DIFFERENTIAL – The minimum difference between the pressure at an inlet port and the pressure at an outlet port required for operation of the valve.

2.7 SEALS, DYNAMIC – A seal that is subject to mechanical movement or other applied forces that result in movement or flexing of the seal under normal use conditions.

2.8 SEALS, STATIC – A seal that is not subject to mechanical movement or other applied forces other than compression forces that are applied during installation and maintained during normal use conditions.

2.9 SWITCH – A contact device actuated by the valve mechanism and intended to control electrical loads that are internal or external to the valve.

a) Safety Switch – A switch that opens and closes a safety-control circuit, or one intended for use as an interlock in a safety-control circuit.

b) Nonsafety Switch – A switch not associated with a safety-control circuit.

2.10 WATERTIGHT ENCLOSURE– An enclosure that, when subjected to the application of a hose stream does not permit water to enter the enclosure.

CONSTRUCTION

3 General

3.1 Electrically operated valves for gasoline/ethanol blends with nominal ethanol concentrations up to 85 percent (E0 – E85) shall be constructed to comply with the following:

a) The requirements defined in the Standard for Electrically Operated Valves, UL 429, and

b) The requirements in this Standard.

3.2 Fluid confining parts, except gaskets and seals, shall be constructed of metallic materials.

4 Materials

4.1 Metallic materials

4.1.1 General

4.1.1.1 A metallic part, in contact with the fuels anticipated by these requirements, shall be resistant to the action of the fuel if degradation of the material will result in leakage of the fuel or if it will impair the function of the device. For all fuel ratings, see Corrosion due to fluid, 4.1.2.1. For valves rated for gasoline/ethanol blends with nominal ethanol concentrations greater than 40 %, see Metallic materials – system level, 4.1.3.

4.1.1.2 Metallic parts in contact with the fuels anticipated by these requirements shall not be constructed of lead, or materials that are substantially lead. In addition, no coatings or platings containing lead shall be used, such as terne-plated steel.

4.1.2 Metallic materials – material level

4.1.2.1 Corrosion due to fluid

4.1.2.1.1 All metallic materials used for fluid confining parts shall be resistant to corrosion caused by the fuels anticipated by these requirements. In addition, metallic materials, used internally in fluid confining parts, that are required to operate in some manner to address safety (e.g. plunger on a valve) shall be resistant to corrosion caused by these fuels. Compliance is verified by the Long Term Exposure Test, Section 6.

4.1.2.1.2 A coating or plating, applied to a base metal, shall be resistant to the action of the fuels anticipated by these requirements as determined by the Long Term Exposure Test, Section 6.

4.1.3 Metallic materials – system level

4.1.3.1 Combinations of metallic materials in products rated for use with gasoline/ethanol blends with nominal ethanol concentrations greater than 40 % shall be chosen to reduce degradation due to galvanic corrosion in accordance with 4.1.3.2 – 4.1.3.4.

4.1.3.2 Table 4.1 shows the galvanic series for metallic materials exposed to a conductive solution of sea water. The most active material in a given combination will experience increased levels of corrosion, while the most passive material in the combination will experience reduced levels of corrosion. The greater the separation of the materials are in the galvanic series of Table 4.1, the more pronounced the effects would be. Table 4.1 serves as a guide in selecting the appropriate test conditions based on manufacturer specified material combinations.

Table 4.1
Galvanic Series of Metal Materials

Most passive	Platinum
	Gold
–	Graphite
–	Silver
–	Stainless Steel Type 316 (Passive)
–	Stainless Steel Type 304 (Passive)
–	Titanium
–	13 % Chromium Stainless Steel (Passive)
–	76 Ni – 16 Cr – 7 Fe Alloy (Passive)
–	Nickel (Passive)
–	Silver Solder
–	M-Bronze
–	G-Bronze
–	70:30 Cupro Nickel
–	Silicon Bronze
–	Copper

Table 4.1 Continued on Next Page

Table 4.1 Continued

–	Red Brass
–	Aluminum Brass
–	Admiralty Brass
–	Yellow Brass
–	60 Ni – 30 Mo – 6 Fe – 1 Mn
–	76 Ni – 16 Cr – 7 Fe Alloy (Active)
–	Nickel (Active)
–	Manganese Bronze
–	Tin
–	Stainless Steel Type 316 (Active)
–	Stainless Steel Type 304 (Active)
–	13 % Chromium Stainless Steel (Active)
–	Cast Iron
–	Wrought Iron
–	Mild Steel
–	Aluminum 2024
–	Cadmium
–	Alclad
–	Aluminum 6053
–	Aluminum 1100
–	Galvanized Steel
–	Zinc
–	Magnesium Alloys
Most active	Magnesium
Note – Reprinted with permission from NACE. Based on table titled "Galvanic Series of Metals Exposed to Seawater" from NACE Corrosion Engineer's Reference Book, Third Edition ©NACE International 2002, page 127.	

4.1.3.3 Platings, such as nickel plating, can be used to reduce or eliminate dissimilar metal contact areas, as long as the plating material complies with 4.1.3.2 as the contact metal. If used, the plating shall comply with the Long Term Exposure Test, Section 6.

4.1.3.4 Gaskets or nonmetallic spacers used to reduce or eliminate dissimilar metal contact areas, where permitted, shall be subjected to the applicable requirements for static seals in Nonmetallic materials, 4.2, when they are in contact with the fluid.

4.2 Nonmetallic materials

4.2.1 General

4.2.1.1 A nonmetallic part in contact with the fuels anticipated by these requirements, shall be resistant to the action of the fuel if degradation of the material will result in leakage of the fuel, or if it will impair the function of the device.

4.2.1.2 Gaskets or seals shall be designated as dynamic and/or static seals. See 2.7 and 2.8 respectively. If the type of seal cannot be determined, then the material shall be treated as both a static and a dynamic seal.

4.2.1.3 Gaskets and seals shall comply with the requirements as outlined in Nonmetallic materials – material level, 4.2.2 and Nonmetallic materials – system level, 4.2.3.

4.2.1.4 Nonmetallic materials in contact with the fuels anticipated by these requirements shall not be constructed of the following:

a) Polysulfide rubber;

b) Ethylene propylene diene monomer (EPDM) rubber;

c) Methyl-Methacrylate;

d) Polyvinyl Chloride (PVC);

e) Nylon 6/6; or

f) Polyurethane.

4.2.2 Nonmetallic materials – fluid compatibility – material level

4.2.2.1 Static seals

4.2.2.1.1 Static seals shall be evaluated in accordance with the Standard for Gaskets and Seals, UL 157, modified as indicated in 4.2.2.1.2 – 4.2.2.1.4. If a specific material complies with these requirements, the material can be considered to be qualified for system testing.

4.2.2.1.2 A static seal shall be constructed of a material that is acceptable in accordance with the scope of Standard for Gaskets and Seals, UL 157.

4.2.2.1.3 Static seals shall be subjected to the Volume Change and Extraction Test in accordance with the Standard for Gaskets and Seals, UL 157, except for the following modifications:

a) The test duration shall be 1000 hours;

b) The applicable test fluids shall be as described in Supplement SB; and

c) For all materials, the average volume change shall not exceed 40 % swell (increase in volume) or 1 % shrinkage (decrease in volume). In addition, the weight loss shall not exceed 10 %. For coated fabrics, alternate limits can be used with the average volume change not exceeding 60 % swell or 5 % shrinkage, and the weight loss shall not exceed 20 %. There shall be no visual evidence of cracking or other degradation as a result of the exposure for any material including coated fabrics.

4.2.2.1.4 Static seals shall be subjected to the Compression Set Test in accordance with the Standard for Gaskets and Seals, UL 157, except for the following modifications:

a) The test duration shall be 1000 hours.

b) The samples shall be immersed, at room temperature, in the test fluids (see item c) while compressed for the entire test duration. No oven conditioning is required.

c) The applicable test fluids shall be as described in Supplement SB.

d) The recovery period shall consist of removing the sample from the compression device and immersing it in the applicable test fluid for 30 minutes at room temperature. The sample shall not be allowed to dry out due to exposure to air. The 30-minute immersion should use the same fluid as the test fluid for each sample.

e) For all materials, the average compressions set is calculated and shall not exceed 35 percent. For coated fabrics, alternate limits can be used with the average compression set not exceeding 70 %.

Exception: This requirement does not apply to composite gasket materials as defined in accordance with the Standard for Gaskets and Seals, UL 157.

4.2.2.2 Dynamic seals

4.2.2.2.1 Dynamic seals shall be evaluated in accordance with the Standard for Gaskets and Seals, UL 157 modified as indicated in 4.2.2.2.2 – 4.2.2.2.4. If a specific material complies with these requirements, the material can be considered to be qualified for system testing.

4.2.2.2.2 A dynamic seal shall be constructed of a material that is acceptable in accordance with the scope of the Standard for Gaskets and Seals, UL 157.

4.2.2.2.3 Dynamic seals shall be subjected to the Volume Change and Extraction Test in accordance with the Standard for Gaskets and Seals, UL 157, except for the following modifications:

a) The test duration shall be 1000 hours;

b) The applicable test fluids shall be as described in Supplement SB; and

c) For all materials, the average volume change for a gasket or seal material shall not exceed 40 % swell (increase in volume) or 1 % shrinkage (decrease in volume). In addition, the weight loss shall not exceed 10 %. For coated fabrics, alternate limits can be used with the average volume change not exceeding 60 % swell or 5 % shrinkage, and the weight loss shall not exceed 20 %. There shall be no visual evidence of cracking or other degradation as a result of the exposure for any material including coated fabrics.

4.2.2.2.4 Dynamic seals shall be subjected to the Tensile Strength and Elongation Test in accordance with the Standard for Gaskets and Seals, UL 157, except for the following modifications:

a) The test duration shall be 1000 hours;

b) The applicable test fluids shall be as described in Supplement SB; and

c) For all materials, the average tensile strength and the average elongation of materials shall not be less than 60 percent of the as-received values. For coated fabrics, alternate limits can be used with the average tensile strength and the average elongation not less than 30 % of the as-received values.

4.2.3 Nonmetallic materials – fluid compatibility – system level

4.2.3.1 For all materials, gaskets and seals that have been shown to comply with the applicable requirements for static seals in the Standard for Gaskets and Seals, UL 157, or with the requirements under material level tests shall be subjected to the system level tests for the applicable component after the Long Term Exposure Test, Section 6.

4.3 Casting impregnation materials

4.3.1 Material level fluid compatibility

4.3.1.1 The material shall be subjected to an infrared spectrum analysis in accordance with the Standard for Polymeric Materials – Short Term Property Evaluations, UL 746A.

4.3.2 System level fluid compatibility

4.3.2.1 The casting impregnation material, applied as intended to a casting, shall comply with the Long Term Exposure Test, Section 5. The casting shall not show indications of porosity leakage at any point during or after this test.

4.4 Internal parts – fluid compatibility

4.4.1 Nonmetallic parts located internally to a fluid confining part, degradation of which would not directly result in leakage, is not required to comply with Nonmetallic materials, 4.2. The part shall be tested in accordance with 4.4.2.

4.4.2 Internal nonmetallic parts shall be tested during the Long Term Exposure Test, Section 5. During this test, the part shall not degrade to the extent that visible particles can be observed in the fluid.

4.5 Blending options

4.5.1 Valves intended for use with dispensing equipment that provides for a variable blending option, at gasoline/ethanol blends with nominal ethanol concentrations above 25 percent, shall be subjected to the Blending Cycling Test, Section 11.

4.5.2 Valves intended for use with dispensing equipment that provides for a fixed blending option, as gasoline/ethanol blends with nominal ethanol concentrations above 25 percent, shall be evaluated in accordance with (a) or (b):

a) If intended to be located after the blending option such that the valve is only subjected to the final blended fuel, then the Blending Cycling Test is not required.

b) If intended to be located at or before the blending option such that it is subjected to a different gasoline/ethanol blend levels, the valve shall be subjected to the Blending Cycling Test, Section 11.

4.5.3 Valves intended for use with dispensing equipment that provides for a variable or fixed blending of gasoline/ethanol blends with nominal ethanol concentrations below 25 percent are considered acceptable without further evaluation for the blending option.

PERFORMANCE

5 General

5.1 Except as otherwise indicated, representative commercial sample(s) of a valve are to be subjected to the applicable tests described herein. The order of tests, as far as applicable, is to be as indicated in the specific test sequence shown in 5.6. In addition, except as noted in 5.2 or 5.3, the various tests are to be conducted at rated frequency and at the voltage indicated in Table 5.1. Additional samples of internal parts, such as diaphragms, seats, and the like, may be required for separate tests.

Table 5.1
Test Voltages

Test	Voltage range[a,b,c]				
	110 – 120	220 – 240	257 – 277	440 – 480	550 – 600
All tests	120	240	277	480	600

[a] If a 60-hertz rated coil has a voltage rating that does not fall within any of the indicated voltage ranges, it shall be tested at its rated voltage.

[b] If coils rated for 60 hertz are supplied for various voltage ratings within a specified range (for example, 110, 115, or 117 volts), and if a coil is available for the maximum voltage rating of that range (120 volts), tests may be conducted on representative coils based on the marked voltage ratings of the coils selected for testing. If a coil is not available for the maximum voltage rating of that range, tests shall be conducted on all coils at the test potential indicated in this table.

[c] If a coil is direct current (DC) or 50 hertz rated, the test voltage shall be based on the rated voltage. See 5.2 and 5.3.

5.2 If a valve is rated at 50 hertz only, or 50/60 hertz, the input, temperature, overvoltage, undervoltage, and burnout tests may be conducted, with the concurrence of those concerned, at a frequency of 60 hertz and at a test voltage calculated as specified in 5.4.

5.3 If a valve is rated at 50/60 hertz, and the test voltage calculated in accordance with 5.4 is less than or equal to the 60-hertz test voltage specified in Table 5.1, the input, temperature, overvoltage, undervoltage, and burnout tests are to be conducted at the higher voltage.

5.4 With reference to 5.2, the test voltage is to be based on increasing the current through the valve coil in accordance with the ratio of the impedance at the two frequencies for which the valve is rated. The test voltage is to be calculated from the following formula:

$$V_T = \frac{1.2\ V_R\ V_M\ I_M}{\sqrt{(V_M\ I_M)^2 + 0.44\ P_M{}^2}}$$

in which:

V_T is the test voltage;

V_R is the rated voltage at 50 hertz;

V_M is the rated voltage at 60 hertz, or 1.091 V_R if the valve has a frequency rating of 50 hertz only;

I_M is the input current measured at V_M at 60 hertz; and

P_M is the input power measured at V_M and 60 hertz.

5.5 All tests shall be performed using the test fluids specified for that test. No substitution of test fluids in allowed. When the test indicates that CE25a, CE40a or CE85a are to be used, the test fluid shall be prepared as described in Supplement SB.

5.6 The tests in the given sequence are to be performed on samples that were subjected to the Long Term Exposure Test, Section 6. One sample of the valve is required for each applicable test fluid, and that sample shall then be subjected to the sequence.

a) Long Term Exposure Test, Section 6;

b) External Leakage Test, Section 8;

c) Operation Test, Section 7;

d) Endurance Test, Section 9;

e) External Leakage Test, Section 8;

f) Operation Test, Section 7; and

g) Hydrostatic Strength Test, Section 10.

5.7 To reduce the effects of seal dry out due to removal of the test fluid after specific tests, the tests in the given sequence in 5.6, shall be started within 4 hours of removal of the previous test fluid. If necessary to coordinate testing, the sample may be left filled with the most recent test fluid at room temperature until the next test is initiated. If the previous test used an aerostatic or hydrostatic source, the sample shall be filled with kerosene.

5.8 A valve that must be mounted in a definite position in order to function as intended is to be tested in that position if directions for mounting in the correct position are given on the valve or in an instruction sheet supplied with the valve.

6 Long Term Exposure Test

6.1 General

6.1.1 The test outlined in 6.2 – 6.4 is to be performed on one or two samples of the valve. If the product is rated for use with gasoline or a gasoline/ethanol blend with a nominal ethanol concentration of up to 25 percent (E0 – E25), then the test shall be performed using the CE25a test fluid on one sample. If the product is rated for use with gasoline or a gasoline/ethanol blends with a nominal ethanol concentration of up to 40 percent (E0 – E40), then the test shall be performed using both the CE25a and CE40a test fluids. If the product is rated for use with a gasoline/ethanol blend with a nominal ethanol concentration of up to 85 percent, then the test shall be performed using both the CE25a and CE85a test fluids with one fluid per sample. See Supplement SB for the test fluids.

6.2 Samples

6.2.1 A sample of a complete valve is to be tested. All inlet and outlet openings of the samples shall be sealed in accordance with 6.2.3.

6.2.2 If platings or coatings are used internal to the device, additional samples may be used. See 6.4.2.

6.2.3 Closures shall be provided to seal off inlet and outlet openings of all samples in accordance with 6.2.1. These closures shall be fabricated of materials as specified in 6.2.4. The closures shall be provided with a 1/4 inch NPT opening for connection to the test apparatus. All closures shall be installed by the manufacturer and provided with a torque rating. There will be no other adjustment to connections for the duration of the test.

6.2.4 Material combinations at the product and closure interface will be as specified by the manufacturer. All closures for valves rated for gasoline/ethanol blends with nominal ethanol concentrations up to 25 or 40 percent shall be fabricated of suitable materials. All closures for valves rated for gasoline/ethanol blends with nominal ethanol concentrations above 25 percent shall be fabricated of the materials representing permitted material to which the device may be connected; such as aluminum closures representing aluminum tubing. Table 4.1 shall be used to determine the worst case material interactions based on the materials specified by the manufacturer. Materials specified by the manufacturer but not included in Table 4.1 shall be tested as necessary to represent worst case conditions.

6.2.5 Any o-rings, gaskets, or other sealing materials, shall be provided and installed by the manufacturer. These dynamic sealing devices shall be the same as those that will be used in the final product installation. Static seals shall be representative of the seals being used in the final product installation. If the sealing device or material is not considered part of the component under test, but will be provided in an end product at the time of installation, a representative seal shall be provided for the test.

6.3 Method

6.3.1 The sample is to be exposed to the applicable test fluid in accordance with 6.1.1. The test fluids shall be prepared using the instructions in Supplement SB.

6.3.2 A quick connect device is connected to the 1/4 inch NPT connection at the inlet, and is used to fill the samples with the applicable test fluids. A source of pressure may be used to assist in filling or draining the samples, however, the pressure shall not exceed the rated pressure of the valve under test. Once the samples are filled to exclude all air, they are closed off and sealed. The samples are then placed in the test chamber.

6.3.3 The chamber temperature is increased to 60 ±2 °C (140 ±4 °F). When the chamber reaches this temperature, the exposure period begins. The samples are exposed to the applicable test fluid at 60 ±2 °C for approximately 168 hours. At the end of this duration, the exposure period is halted and the chamber is allowed to cool. The samples are subjected to a 50 psi (347 kPa) pressure for one minute. The fluid is then drained from the samples and observed in accordance with 6.4.2. After this observation, the fluid is discarded. The samples are then immediately refilled with new test fluid and the chamber temperature is allowed to increase to 60 ±2 °C again. The total duration of the test shall equal 1008 hours of exposure at 60 ±2 °C.

6.3.4 At the end of the total exposure duration, the test fluid is left in the samples and the samples are removed from the chamber. The samples are then subjected to the test sequence as outlined in 5.6 and in accordance with 5.7. Prior to the initiation of the test sequence, the Long Term Exposure test fluid is to be drained and discarded.

6.3.5 If the device contains any parts or surfaces that are plated or coated, if the device uses casting impregnation materials to eliminate porosity leakage, or if the device contains internal nonmetallic parts, the plating, coating, impregnation, or internal parts are tested both during and after this exposure. See 6.4.2 and 6.4.4.

6.4 Results

6.4.1 There shall be no leakage during this test. If leakage is observed at any point during the test, the test is to be stopped.

6.4.2 For platings or coatings, there shall be no softening of the plating or coating material. Compliance is checked by observance of the drained test fluid. There shall be no evidence of visible flaking or material. In addition, there shall be no substantial discoloration of the test fluid when observing the drained fluid. Discoloration is an indication of chemical attack on the plating or coating internal to the device. In order to determine that the base metal is not exposed, visual inspections shall be made. If the visual inspection requires examination of internal surfaces, the samples shall be cut open to determine compliance. If this is necessary, additional samples can be used to determine compliance with this requirement, such that the remaining test sequence will not be disturbed by cutting open samples. However, both the samples to be cut open and the samples to be used for the test sequence are required to complete the Long Term Exposure Test.

6.4.3 For casting impregnation materials, the sample shall not show evidence of porosity leakage during or after the fluid exposure duration.

6.4.4 For internal nonmetallic parts, there shall be no visible evidence of this material in the drained test fluid.

7 Operation Test

7.1 A valve shall handle a kerosene or Soltrol 170 at the maximum rated operating pressure differential. The test is to be repeated at the minimum rated operating pressure differential if the valve is so rated.

7.2 A valve rated for use in ambient temperatures greater than 25 °C (77 °F) or for handling a fluid at temperatures greater than 25 °C, or both, is to be tested in accordance with 6.3, at the maximum rated temperatures.

7.3 The inlet of the valve is to be connected to a suitable system that can deliver the test fluid under pressure. The valve shall be in an open position with the fluid flowing. The valve shall then be closed and the outlet shall be observed for signs of fluid flow. There shall be no continued flow of fluid from the valve outlet.

8 External Leakage Test

8.1 A valve shall not leak externally when tested hydrostatically at a pressure of one and one-half times the maximum rated pressure but not less than 1/2 psig (3.5 kPa) with the valve in the open position and the outlet closed for a period of 1 hr.

8.2 The inlet of the valve is to be connected to a hydrostatic source capable of supplying the specified test pressure. The outlet of the valve is to be sealed. Any bypass or other openings not essential to the operation of the valve during this test are to be sealed unless this discharge in the main fluid stream before the outlet of the valve. The test fluid is to be admitted and maintained at the specified test pressure. In the case of diaphragm elements which, in intended usage, are subjected to pressure on both sides of the diaphragm, the test pressure is to be applied to both sides of the diaphragm slowly and without shock.

9 Endurance Test

9.1 A valve intended for use with the fuels anticipated by these requirements, shall be subjected to 100,000 cycles of open and close action at the maximum rated operating pressure differential. At the end of the 100,000 cycles, the valve shall operate as intended and shall not leak externally.

9.2 The endurance test is to be conducted at a rate not faster than six operations per minute. However, a rate greater than six operations per minute may be used if requested by the manufacturer.

9.3 A valve is to be tested with kerosene or Soltrol 170 as the test fluid. This test is to be performed after the Long Term Exposure Test, Section 6, in accordance with 5.6.

9.4 The appropriate tests for operation and external leakage are to be conducted before and after the endurance test in accordance with the test sequence shown in 5.6.

10 Hydrostatic Strength Test

10.1 All parts of a valve, except a diaphragm, that are subjected to pressure during intended operation shall be tested hydrostatically to determine that the strength of the parts is sufficient to withstand, without rupture, a pressure equivalent to five times the maximum rated pressure of the valve.

10.2 The valve is to be tested by connecting the inlet to a hydraulic system. With the outlet of the valve sealed and the valve in the open position, the pressure is to be raised slowly to the required test pressure

and held for a period of 1 minute. In the case of a diaphragm valve, the test pressure is to be applied on both sides of the diaphragm slowly and without shock to avoid excessively stressing the diaphragm.

10.3 External leakage observed during this test is acceptable provided the test pressure can be maintained for the entire test duration, and if, following the hydrostatic test, the valve complies with the requirements for external leakage specified in Section 8.

11 Blending Cycling Test

11.1 One complete sample of the valve is to be used for this test. The sample shall be fully assembled with all gaskets and seal materials in place as intended.

11.2 The sample shall be provided with closures to seal off inlet and outlet openings. The main inlet and outlet closures shall be provided with a 1/4 inch NPT opening for connection to the test apparatus. All closures shall be installed by the manufacturer and there shall be no further adjustments to these closures during this test.

11.3 Suitable materials shall be used for the closures in 11.2.

11.4 A quick connect device is to be connected to the 1/4 inch NPT connection at the inlet and outlet, and is used to facilitate the filling and draining of the applicable test fluids. A source of pressure may be used to assist in filling and draining the samples, however the pressure shall not exceed the rated pressure of the device under test. Once the samples are filled, they are to be closed off and sealed.

11.5 The sample is to be filled with CE85a test fluid as described in Supplement SB. Once filled and closed off in accordance with 11.2 – 11.4, the sample is allowed to remain at rest for 85 ±0.5 hours at an ambient temperature of 23 ±2 °C (73 ±4 °F). The sample is then drained and immediately refilled with CE25a test fluid as described in Supplement SB. Once filled, the sample is allowed to remain at rest for 85 ±0.5 hours at an ambient temperature of 23 ±2 °C. This constitutes one cycle. The sample shall be subjected to a total of 4 cycles. At the end of each of the first three cycles, the sample shall be subjected to the External Leakage Test, Section 8, at rated pressure, but not less than 50 psi (347 kPa). After the fourth cycle, the sample shall be subjected to the External Leakage Test, Section 8, at 1.5 times rated pressure, but not less than 75 psi (518 kPa). There shall be no leakage during any of these tests or during the exposures.

11.6 At the end of the four cycles, the device under test shall be subjected to the Hydrostatic Strength Test, Section 10.

MARKING

12 Details

12.1 The following information shall appear on each valve, unless indicated otherwise.

12.2 Valves shall be marked to indicate the fuel rating for which they are intended. The marking shall be "Gasoline" for valves rated for gasoline only, shall be "E25" for valves rated for gasoline and gasoline/ethanol blends with nominal ethanol concentrations up to 25 percent ethanol (E0 – E25) shall be "E40" for valves rated for gasoline and gasoline/ethanol blends with nominal ethanol concentrations up to 40 percent ethanol (E0 – E40), or shall be "E85" for valves rated for gasoline and gasoline/ethanol blends with nominal ethanol concentrations up to 85 percent ethanol (E0 – E85). This marking shall be prominently displayed to identify the valve.

SUPPLEMENT SA – MARINE USE ELECTRICALLY OPERATED SHUT-OFF VALVES FOR GASOLINE AND GASOLINE/ETHANOL BLENDS WITH NOMINAL ETHANOL CONCENTRATIONS UP TO 85 PERCENT (E0 – E85)

SA1 Scope

SA1.1 The requirements in this supplement cover electrically operated shut-off valves rated 50 volts or less intended to be used on boats with the fuels anticipated by these requirements.

SA1.2 The products covered by the requirements in this supplement are intended for installation in accordance with the manufacturer's instructions and the applicable requirements of the Fire Protection Standard for Pleasure and Commercial Motor Craft, NFPA 302; the applicable requirements of the American Boat and Yacht Council (ABYC); and the applicable requirements of the United States Coast Guard (USCG).

SA1.3 A product intended for marine use shall comply with the requirements in Sections 3 – 7, as applicable, except as modified or superseded by the requirements in this supplement.

SA2 Installation and Operating Instructions

SA2.1 The manufacturer shall provide complete installation and operating instructions with each valve. The instructions shall include recommendations relative to the use of thread compound, recommendations on proper wire size and fusing, mounting instructions and any other data necessary for the proper installation and operation of the valve.

SA2.2 The operating instruction shall specifically cover the operation of any manual by-pass valve and shall include the statement "Caution – Risk of Fire," and the following or equivalent statement, "The electric valve will not function as a shut-off valve with the by-pass open." In addition, the manufacturer shall provide the following operating data for gasoline, diesel oil, or other liquids for which the valve is intended to be used:

a) The maximum operating pressure.

b) The flow capacity in gallons per minute or hour, as related to the pressure differential or pressure differential or pressure drop between the inlet and outlet, for specific liquids.

SA3 General

SA3.1 A valve intended to be used in the fuel feed system to propulsion engines shall be equipped with a manual emergency by-pass.

SA3.2 A valve used in the fuel feed lines to non-vital equipment, such as heater, auxiliary generator, and the like, shall not incorporate a manual by-pass.

SA3.3 A diaphragm type valve shall be constructed so that a damaged diaphragm will not cause external leakage.

SA3.4 A valve shall be provided with means for mounting independent of the fuel line.

SA3.5 A valve shall be constructed so that it will unseat before the pressure on the valve outlet exceeds 1000 psi (6895 kPa) in order to prevent pressure from building up in trapped sections of the fuel line due to heat. See the Fire Test, Section SA11.

SA3.6 A valve shall be capable of operating in any orientation without leakage or malfunction.

SA4 Materials

SA4.1 All materials shall comply with the requirements in Materials, Section 4.

SA4.2 A metallic part shall be formed from AISI 300 or 400 Series stainless steel or other material having at least equivalent resistance to the corrosive effects of salt spray as determined by the Standard Practice for Operating Salt Spray (Fog) Apparatus, ASTM B117.

SA5 Electrical Connections

SA5.1 An electrical connection for low-voltage DC circuits operating at less than 32 volts shall be made by means of a two prong plug, two insulated terminals, or by means of a pigtail for use with an external junction box or block.

SA5.2 Exposed uninsulated terminals shall not be used.

SA5.3 A pigtail lead, if used for field wiring, shall be at least 16 AWG (1.3 mm^2) stranded copper wire and no less than 8 inches (203 mm) in length.

SA5.4 An actuating coil shall be constructed for a two wire system without an electrical ground.

SA6 General

SA6.1 The same sample is to be used for the Vibration Test, the Shock Test, and the Ignition Protection Test, Sections SA7 – SA9, respectively.

SA6.2 The same sample used for the Long Term Exposure Test, Section 6, is to be used for the Fire Test, Section SA10.

SA7 Vibration Test

SA7.1 A valve shall function as intended without increasing the risk of fire or explosion following the vibration conditioning specified in SA7.2 – SA7.4. There shall not be evidence of leakage, and there shall not be fluid flow due to vibration.

SA7.2 The valve specified in SA6.1, with tubing sections connected in accordance with the manufacturer's instructions, is to be rigidly mounted directly to the surface of a vibration table in its normal operating position. The valve is to be subjected to a pressure of 10 psi (69 kPa) on the valve inlet when the valve is closed during the conditioning.

SA7.3 The assembly specified in SA7.2 is to be subjected to variable frequency vibration along each of three rectilinear orientation axes (horizontal, lateral, and vertical) for 4 hours in each plane (12 hours total) at a peak-to-peak amplitude of 0.060 ±0.001 inches (1.5 ±0.025 mm). The frequency of vibration is to continuously varied, at a uniform rate, from 10 to 60 to 10 Hz every 4 minutes.

SA7.4 During the first hour of conditioning in each separate plane, the valve is to be energized. The valve is to be unenergized during the last three hours of conditioning; except for the last ten minutes in which the valve is to be randomly cycled on and off to check for leakage.

SA8 Shock Test

SA8.1 The same valve used for the Vibration Test, Section SA7, shall function as intended without increasing the risk of fire or explosion following the conditioning specified in SA8.2 – SA8.4. There shall not be evidence of leakage and no fluid flow due to shock.