SAE Aerospace
An SAE International Group

AEROSPACE STANDARD

SAE AS5420D

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Superseding AS5420C

Hose Assembly, Heated, 125 psig, Lined Silicone, Potable Water, Procurement Specification

RATIONALE

Revised repeated freeze test to provide a more practical test and remove the drop while frozen requirement.

1. SCOPE

This SAE Aerospace Standard (AS) covers the requirements for a flexible, lightweight, low pressure, self-extinguishing, integrally heated silicone hose assembly. The hose has a fully fluorinated fluoropolymer inner liner and is primarily intended for use in aircraft potable water systems with an environmental operating temperature range of -65 °F (-54 °C) to +160 °F (+71 °C).

2. REFERENCES

2.1 Applicable Documents

The following publications form a part of this document to the extent specified herein. The latest issue of SAE publications shall apply. The applicable issue of other publications shall be the issue in effect on the date of the purchase order. In the event of a conflict between the text of this document and references cited herein, the text of this document takes precedence. Nothing in this document, however, supersedes applicable laws and regulations unless a specific exemption has been obtained.

2.1.1 SAE Publications

Available from SAE International, 400 Commonwealth Drive, Warrendale, PA 15096-0001, Tel: 877-606-7323 (inside USA and Canada) or 724-776-4970 (outside USA), www.sae.org.

AMS-QQ-A-225	Aluminum and Aluminum Alloy Bar, Rod, Wire, or special shapes, Rolled, Drawn or Cold Finished General Specification For
AMS-QQ-S-763	Steel, Corrosion Resistant, Bars, Wire, Shapes, and Forgings
AMS-STD-2219	Fusion Welding for Aerospace Applications
AMS2472	Anodic Treatment of Aluminum Alloys, Sulfuric Acid Process, Dyed
AMS2700	Passivation of Corrosion Resistant Steels
AMS4124	Aluminum Alloy, Rolled or Cold Finish Bars, Rods and Wire, 5.6Zn 2.5Mg 1.6Cu 0.23Cr (7075-T651) Solution and Precipitation Heat Treated

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AMS4771	Silver Alloy Brazing Filler Metal, 50Ag 16Cd 15.5Zn 15.5Cu 3.0Ni (BAg-3), 1170 to 1270 °F Solidus-Liquidus Range
AMS4772	Silver Alloy Brazing Filler Metal, 54Ag 40Cu 5.0Zn 1.0Ni (BAg-13), 1325 to 1575 °F Solidus-Liquidus Range
AMS4777	Nickel Alloy Brazing Filler Metal, 82Ni 4.5Si 7.0Cr 3.1B 3.0Fe (BNi-2), 1780 to 1830 °F Solidus-Liquidus Range
AMS4778	Nickel Alloy Brazing Filler Metal, 92Ni 4.5Si 3.1B (BNi-3), 1800 to 1900 °F Solidus-Liquidus Range
AMS5556	Steel, Corrosion and Heat Resistant, Seamless or Welded Tubing, 18Cr 11Ni 0.70Cb, Solution Heat Treated (S34700)
AMS5557	Steel, Corrosion and Heat Resistant, Seamless or Welded Hydraulic Tubing, 18.5Cr 10.5Ni 0.40Ti, Solution Heat Treated (S32100)
AMS5567	Steel, Corrosion and Heat Resistant, Seamless or Welded Hydraulic Tubing, 19Cr 10 Ni, Annealed (S30400)
AMS5570	Steel, Corrosion and Heat Resistant, Seamless Tubing, 18Cr 11Ni 0.40Ti, Solution Heat Treated (S32100)
AMS5571	Steel, Corrosion and Heat Resistant, Seamless Tubing, 18Cr 10.5Ni 0.70(Cb+Ta), Solution Heat Treated (S34700)
AMS5575	Steel, Corrosion and Heat Resistant, Welded Tubing, 18Cr 10.5 Ni 0.70(Cb+Ta), Solution Heat Treated (S34700)
AMS5636	Steel, Corrosion Resistant, Bars and Wire, 18Cr 9.0Ni, Solution Heat Treated and Cold Drawn, 100 ksi UTS (S30200)
AMS5637	Steel, Corrosion Resistant, Bars and Wire, 18Cr 9.0Ni, Solution Heat Treated and Cold Drawn, 125 ksi UTS (S30200)
AMS5638	Steel, Corrosion Resistant, Bars and Forgings, 0.14S 18Cr 9.5Ni 0.50Mo 0.80Al, Free Machining, Solution Heat Treated (S30345)
AMS5639	Steel, Corrosion Resistant, Bars, Wire, Forgings, Tubing and Rings, 19Cr 10Ni, Solution Heat Treated (S30400)
AMS5640	Steel, Corrosion Resistant, Bars, Wire, and Forgings, 18Cr 9Ni, Free Machining (S30300, S30310 and S30323)
AMS5645	Steel, Corrosion and Heat Resistant, Bars, Wire, Forgings, Tubing and Rings, 18Cr 10Ni 0.40Ti, Solution Heat Treated (S32100)
AMS5646	Steel, Corrosion and Heat Resistant, Bars, Wire, Forgings, Tubing and Rings, 18Cr 11Ni 0.60Cb, Solution Heat Treated (S34700)
AMS5647	Steel, Corrosion and Heat Resistant, Bars, Wire, Forgings, Tubing and Rings, 19Cr 9.5Ni, Solution Heat Treated (S30403)
AMS5648	Steel, Corrosion and Heat Resistant, Bars, Wire, Forgings, Tubing and Rings, 17Cr 12Ni 2.5Mo, Solution Heat Treated (S31600)

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AMS5685	Steel, Corrosion Resistant, Safety Wire, 18Cr 11.5Ni (S 30500) Solution Heat Treated, Cold Finish
AMS5688	Steel, Corrosion Resistant, Wire, 18Cr 9.0Ni, Spring Temper (S30200)
AMS5689	Steel, Corrosion Resistant, Wire, 18Cr 10.5Ni 0.40Ti, Solution Heat Treated (S32100)
AMS5690	Steel, Corrosion Resistant, Wire, 17Cr 12Ni 2.5Mo, Solution Heat Treated (S31600)
AMS5697	Steel, Corrosion Resistant, Wire, 19Cr 9.5Ni, Solution Heat Treated (S30400)
AS478	Identification Marking Methods
AS611	Hose Assembly and Tubing, Polytetrafluoroethylene, Cleaning Methods For
AS1073	Sleeve Hose Assembly, Heat Shrinkable
AS1650	Coupling Assembly, Threadless, Flexible, Fixed Cavity
AS1656	Fitting End Threadless Coupling - Ferrule or Sleeve, Design Standard
AS1708	Fitting End, Internal Flare Design Standard
AS1791	Wire, Retainer - Tube Coupling Nut
AS4370	Nut, Tube Coupling - Swivel
AS4375	Fitting End - External Thread, Flareless Design Standard
AS4395	Fitting End - Flared Tube Connection, Design Standard
AS4468	Hose Assembly, 125 psi, Lined Silicone, Potable Water
AS5272	Lubricant, Solid Film, Heat Cured, Corrosion Inhibiting
AS5421	Hose Assembly, Lined Silicone, Heated, Flareless, 125 psi, Potable Water
AS7003	National Aerospace and Defense Contractors Accreditation Program (NADCAP) Program Operation
AS7112	National Aerospace and Defense Contractors Accreditation Program Requirements for Fluid System Components
AS8879	Screw Threads - UNJ Profile, Inch
AS21921	Nut, Sleeve Coupling, Flareless
AS39029/31	Contacts, Electrical Connector, Pin, Crimp Removable
AS39029/32	Contacts, Electrical Connector, Socket, Crimp Removable

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2.1.2 U.S. Government Publications

Available from the Document Automation and Production Service (DAPS), Building 4/D, 700 Robbins Avenue, Philadelphia, PA 19111-5094, Tel: 215-697-6257, http://assist.daps.dla.mil/quicksearch/.

MIL-A-8625 Anodic Coating for Aluminum and Aluminum Alloys

MIL-STD-129 Military Marking for Shipment and Storage

MIL-STD-810 Environmental Engineering Considerations and Laboratory Tests

2.1.3 ASTM Publications

Available from ASTM International, 100 Barr Harbor Drive, P.O. Box C700, West Conshohocken, PA 19428-2959, Tel: 610-832-9585, www.astm.org.

ASTM A 269 Seamless and Welded Austenitic Stainless Steel Tubing for General Service

ASTM A 313/A 313M Chromium Nickel Stainless and Heat Resisting Steel Spring Wire

ASTM A 479/A 479M Stainless Steel Bars and Shapes for Use in Boilers and Other Pressure Vessels

ASTM D 570 Standard Method of Test for Water Absorption of Plastics

ASTM A 580/A 580M Stainless and Heat Resisting Steel Wire, Condition A

ASTM A 582/A 582M Specification for Free Machining Stainless and Heat Resistant Steel Bars, Hot Rolled and Cold Finished (S30300, S30310, S30323 and S30345)

ASTM A 632 Seamless and Welded Austenitic Stainless Steel Tubing (Small Diameter) for General Service

ASTM E 1417 Standard Practice for Liquid Penetrant Examination

2.1.4 NAS Publications

Available from Aerospace Industries Association, 1000 Wilson Boulevard, Suite 1700, Arlington, VA 22209-3928, Tel: 703-358-1000, www.aia-aerospace.org.

NAS847 Caps and Plugs, Protective, Dust and Moisture Seal

NAS1760 Fitting End, Flareless Acorn, Standard Dimension for

2.1.5 AWS Publications

Available from American Welding Society, 550 NW LeJeune Road, Miami, FL 33126, Tel: 1-800-443-9353, www.aws.org.

AWS A5.8/A5.8M Filler Metals for Brazing and Braze Welding

AWS A5.9 Rods and Wire, Welding, Corrosion and Heat Resistant Alloys

AWS A5.14/A5.14M Rods and Wire, Welding, Corrosion Resistant Alloys

AWS C3.6 Specification for Furnace Brazing

AWS D17.1 Specification for Fusion Welding for Aerospace Applications

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2.1.6 RTCA Publications

Available from Radio Technical Commission for Aeronautics Inc., 1828 L Street NW, Suite 805, Washington, DC 20036, Tel: 202-833-9339, www.rtca.org.

RTCA/DO-160 Environmental Conditions and Test Procedures for Airborne Equipment, Section 4 and 8

2.1.7 PRI Publications

Available from Performance Review Institute, 161 Thorn Hill Road, Warrendale, PA 15086-7527, Tel: 724-772-1616, www.pri-network.org.

PD2001 Qualified Product Management Council Procedures for Qualified Products Group

PD2101 Aerospace Quality Assurance, Product Standard, Qualification Procedures, Fluid Systems

2.1.8 Public Health Service Publication

Available from U.S. Department of Health and Human Services, 200 Independence Avenue, Washington, DC 20201, Tel: 877-696-6775, www.os.dhhs.gov.

USPHS No. 308 Handbook of Sanitation of Airlines (United States Public Health Service, Department of Health Education and Welfare)

3. REQUIREMENTS

3.1 Qualification

Hose assemblies supplied in accordance with this procurement specification shall be representative of products which have been subjected to and which have successfully passed the qualification tests specified in this specification.

3.1.1 Manufacturer Qualification

A manufacturer producing a product in conformance to this procurement specification shall be accredited in accordance with the requirements of PD2101, AS7003 and AS7112, and shall be listed in a Performance Review Institute (PRI) Qualified Manufacturers List (QML). See www.eAuditnet.com.

3.1.2 Product Qualification

All products shall conform to the requirements of this procurement specification and shall be approved in accordance with the requirements of PD2001 and PD2101 for listing in a Performance Review Institute (PRI) Qualified Parts List (QPL). See www.eAuditnet.com.

3.2 Materials

The hose assembly materials shall be uniform in quality, free from defects, suitable for the intended use, consistent with good manufacturing practices and shall conform to the applicable specifications and the requirements specified herein.

Materials used in these hose assemblies shall be selected from those listed in Table 1.

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TABLE 1 - Assembly Materials

Component	Material Designation	Material Specification	Material Finish
Nut (Coupling) AS21921, AS4370, or Equivalent	Type 300 Series Corrosion Resistant Steel	AMS5636, AMS5637, AMS5639, AMS5645, AMS5646, ASTM A 479 or AMS-QQ-S-763	Passivate per AMS2700, Method 1, Type 6 or 7 and Solid Film Lubricate per AS5272, Type I
	Type 2024 Aluminum Alloy	AMS-QQ-A-226/6	Anodize per AMS2472 or MIL-A-8625, Type II, Class 2, Color Optional and Solid Film Lubricate per AS5272, Type I
	Type 7075 Aluminum Alloy	AMS4124 or AMS-QQ-A-225/9	Anodize per AMS2472 or MIL-A-8625, Type II, Class 2, Brown Color and Solid Film Lubricate per AS5272, Type I
Hose (Inner Tube)	Fully Fluorinated Fluoropolymer Lined Silicone Inner Tube		As Manufactured
Heater Wire	Alloyed Metal	Commercial	As Manufactured
Hose (Wire Reinforcement)	Type 300 Series Corrosion Resistant Steel	ASTM A 313/A 313M, ASTM A 580/A 580M, AMS5688, AMS5689, AMS5690 or AMS5697	As Manufactured
Hose (Nonmetallic Braid, Reinforcement and/or Covering)	Aramid Fiber, Nylon, Polyester, Fire Resistant Composite Fiber Fiberglass or Similar Yarns	Commercial	Dark
Thermostat	Bi-Metal Type		As Manufactured
Insert Fitting (Nipple or Elbow)	Type 303 Series, 304, 304L, 316, 321 or 347 Corrosion Resistant Steel	AMS5648, AMS5556, AMS5557, AMS5567, AMS5570, AMS5571, AMS5575, AMS5638, AMS5640, AMS-QQ-S-763, ASTM A 582/A 582M, ASTM A 269 or ASTM A 632	Passivate per AMS2700, Method 1, Type 2, 6, or 7 as applicable
Socket (Collar)	Type 303 Series, 304, 304L, 316, 321 or 347 Corrosion Resistant Steel	AMS5648, AMS5556, AMS5557, AMS5567, AMS5570, AMS5571, AMS5575, AMS5638, AMS5640, AMS-QQ-S-763 or ASTM A 582/A 582M	Passivate per AMS2700, Method 1, Type 2, 6, or 7 as applicable
	Type 6061 Aluminum Alloy	AMS-QQ-A-225/8	Anodize per AMS2472 or MIL-A-8625, Type II, Class 2, Color Optional
Band (Identification)	Polyester Film or Polyolefin with Permanent Marking or Corrosion Resistant Steel		As Manufactured
Nut Retaining Wire AS1791 or Equivalent	Type 302, 304 or 305 Corrosion Resistant Steel, Condition A	ASTM A 313/A 313M, ASTM A 580/A 580M, AMS5688, AMS5689, AMS5690, AMS5697 AMS5697 or AMS5685	Passivate per AMS2700, Method 1, Type 2, 6, or 7 as applicable and Solid Film Lubricate per AS5272, Type I

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3.3 Design and Construction

The hose assembly shall consist of an integrally heated smooth inner tube with reinforcement braid or covering to meet the requirements of this document and as required for its intended use. Unless other fittings are specified, hose assemblies may have flared fittings per AS1708 or AS4395, flareless fittings per NAS1760 or AS4375 fitting ends or fixed cavity ends per AS1656-1 or AS1656-3. Hose end fittings shall be permanently attached to the hose.

3.3.1 End Fitting

3.3.1.1 Insert Fitting (Nipple and Elbow)

Inserts (nipples and elbows) shall be made of corrosion-resistant steel. They may be one-piece, welded or brazed construction assemblies. Only fusion welded butt joints or brazed lap joints shall be used.

3.3.1.2 Coupling Nuts

Coupling nuts shall be corrosion resistant steel or aluminum alloy as specified on part standard or drawing. Fitting nuts shall be dimensionally equivalent to AS21921 or AS4370. The nut threads and internal surfaces shall be solid film lubricated in accordance with AS5272, Type I. Solid film lubricant on external nut surfaces shall not be cause for rejection.

3.3.1.3 Sockets (Collars)

The sockets shall be corrosion resistant steel or aluminum alloy as specified on the part standard or drawing. Sockets shall be attached by crimping or swaging.

3.3.1.4 Screw Threads

All end fittings with threads shall be in accordance with AS8879, Class 3A or 3B as applicable. A 10% increase to the maximum thread tolerances is permissible after proof test.

3.3.1.5 Joining of End Fittings

Fusion welds shall be per AWS D17.1 Class C with 100% penetration. Filler wire, if required, shall be Type 347 per AWS A5.9 or AWS A5.14/A5.14M. Welds shall be penetrant inspected per ASTM E 1417. Brazed joints shall be per AWS C3.6, Class C, using a brazing alloy BNi12 per AWS A5.8/A 5.8M.

Brazing alloys AMS4777, AMS4778, AMS4772 and AMS4771 are optional. Brazing shall be accomplished without flux in a vacuum, inert or dry hydrogen atmosphere. All welds shall be penetrant inspected per ASTM E 1417 (water washable).

3.3.1.6 Fixed Cavity End Fittings

Hose assemblies with fixed cavity (threadless coupling) end fittings per AS1650 series standards shall have insert ends per AS1656-1 or AS1656-3.

3.3.1.7 The maximum allowable ID of AS1708 and NAS1760 style fittings may be in accordance with Table 2.

TABLE 2 - MAXIMUM FITTING I.D.

Size	I.D.
06	.319
08	.440
10	.567
12	.676
16	.927

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3.3.2 Hose

3.3.2.1 Inner Tube

The inner tube shall be fully fluorinated fluoropolymer lined silicone of seamless construction. It shall have a smooth inner surface, be free of cracks, and shall be nonshedding or particle producing. Only virgin materials shall be used for the inner tube.

3.3.2.1.1 Inner Tube Liner

The inner liner shall be a fully fluorinated fluoropolymer. It shall be free of splits or holes. There shall be no leakage during a 2 psig pneumatic proof pressure test of the fully fluorinated fluoropolymer inner liner, or visible defects when visually inspected against a light source. No rerun or reclaimed materials shall be used. The inner liner shall be clear, without carbon particles added. No material or combination of materials that are known to produce toxic effects when in contact with potable water, or after contact with mild cleaning agents shall be used. The hose shall not cause an objectionable odor or taste in potable water.

3.3.2.2 Reinforcement and Covering

The inner tube shall be reinforced with plies of nonmetallic material and/or metallic wires of sufficient number to meet the requirements of this document. The heating element shall be an integral part of the reinforcement and shall be sealed from the external environment. A nonmetallic reinforcement braid may be utilized as the hose outer cover.

3.3.3 Electrical Power Requirements

The required electrical power for each heated hose assembly configuration shall be determined by the following empirical equation:

$$P = \text{Power (Watts)} = (4a + 8.5) * b/12 + ca2 \pm 10\% \quad \text{(Eq. 1)}$$

where:

a = Hose size in inches

b = Assembly length in inches

c = 15 (when both end fittings are flared or flareless)

= 10 (when one end fitting is flared or flareless and the other is fixed cavity)

= 7.5 (when both end fittings are fixed cavity)

3.3.3.1 Resistance Values

The resistance (R) values shall be calculated based on the following equation:

$$R\ MIN = 1152/1.1\ P \quad \text{(Eq. 2)}$$

$$R\ MAX = 1152/0.9\ P \quad \text{(Eq. 3)}$$

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3.3.3.2 Current Draw Values

The current (A) draw values shall be calculated based on the following equation:

$$A\ MIN = 115/R\ MAX \quad \text{(Eq. 4)}$$

$$A\ MAX = 115/R\ MIN \quad \text{(Eq. 5)}$$

3.3.4 Service Life

The hose assembly shall be designed such that it will meet all the requirements of this document. Expected service life (no age limit or environmental degradation) is 20 years.

3.3.5 Corrosion Resistance

Materials (see Table 1) used shall not corrode or have detrimental effect on each other when the hose assembly is exposed to conditions normally encountered in service.

3.3.6 Public Health Service Compliance

All hose assembly materials (see Table 1) that are normally in contact with potable water shall comply with Public Health Service Publication 308. The supplier shall obtain Public Health Service approval for any material not already approved.

3.3.7 Temperature Compliance

Each hose assembly type shall be capable of operating at the environmental operating temperature range of -65 to +160 °F.

3.3.8 Lead Wire Terminations

The black lead wire shall terminate with a pin contact in accordance with M39029/31-229 and a plug connector as applicable. The white lead wire shall terminate with a socket contact per M39029/32-248 and a receptacle connector as applicable.

Socket contacts shall have a split four tine internal design with a napkin ring around the front end and have the front end enclosed in a hood. The napkin ring shall be located a minimum of 0.025 inch from the mating end of tines and shall have a minimum width of 0.040 inch. The material of the napkin ring shall be stainless steel per ASTM A 666, half hard or beryllium copper per ASTM B 194, ASTM B 196, or ASTM B 197.

Pin and socket contacts shall have plating resistive to oxidation when exposed to heat.

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3.4 Dimensions and Weights

3.4.1 Hose Dimensions

Minimum hose inside diameters, maximum outside diameters and bend radii shall be in accordance with Table 3.

TABLE 3 - HOSE DATA, DIMENSIONS, AND PERFORMANCE RATINGS

Hose Size Code	Hose ID MIN	Hose OD MAX	Minimum Inside Bend Radius Inch	Operating Pressure psig MAX	Proof Pressure psig MIN	Burst Pressure Psig MIN	Nominal Weight lb / in REF
06	0.355	0.66	1.13	125	250	500	0.0097
08	0.475	0.79	1.50	125	250	500	0.0122
10	0.600	0.94	1.88	125	250	500	0.0161
12	0.725	1.07	2.25	125	250	500	0.0194
16	0.975	1.32	3.00	125	250	500	0.0253

3.4.2 Fitting Dimensions

The basic fitting dimensions shall be as specified on the applicable standard or drawing.

3.4.3 Assembly Length

Hose assembly length designations shall be as specified on the applicable standard or drawing. Flareless hose assemblies with NAS1760 ends shall be measured from sealing gage point to sealing gage point. Flareless hose assemblies with combinations of NAS1760 to AS4375 end terminations shall be measured from the NAS1760 sealing gage point to the end of AS4375. Hose assemblies with AS1656 fixed cavity fitting ends shall be measured to the end of the fitting.

3.4.4 Weights

Nominal hose weights shall be in accordance with Table 3. Nominal weights of hose assemblies with standard end fittings shall be determined as shown in the applicable standard or drawing. Nominal weights of hose assemblies with nonstandard end fittings shall be listed on the supplier's drawing when submitted to purchaser for approval. Deviations from Nominal Weights shall not be cause for rejection.

3.5 Performance

The hose assembly dimensions and ratings, shown in Table 3, shall be verified by meeting or exceeding the requirements and quality assurance provisions specified herein.

3.5.1 Proof Pressure

The hose assembly shall withstand a room temperature proof pressure of 250 psig minimum for 1 min minimum, 5 min maximum without wetting, leakage or evidence of permanent deformation or malfunction when tested in accordance with 4.6.2.

3.5.2 Electrical Connections

The hose assembly shall be capable of meeting the operational requirements of 3.5.4 after the lead wires are subjected to a 12 lb pull test when tested in accordance with 4.6.3.

3.5.3 Electrical Requirements

3.5.3.1 Linear Resistance

The linear resistance of the hose assembly shall not be greater than 0.9 Ω per linear foot when tested in accordance with 4.6.4.1.

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3.5.3.2 Insulation Resistance

The insulation resistance of the hose assembly shall be not less than 200 MΩ when tested in accordance with 4.6.4.2.

3.5.3.3 Dielectric Strength

There shall be no arcing, sparking or leakage of current in excess of 2.0 mA for hose assemblies under 20 ft long or 3.0 mA for hose assemblies over 20 ft long when tested in accordance with 4.6.4.3, and the specimen shall pass the insulation resistance requirements of 3.5.3.2.

3.5.4 Operational Requirements

3.5.4.1 Thermostat Closing Temperature, Heater Wire Resistance and Current Draw

The thermostat contacts shall close on the temperature fall at +40 °F minimum and the measured resistance and current draw value shall be capable of generating the required power (see 3.3.3) with an applied 115 VAC input, when tested in accordance with 4.6.5.1.

3.5.4.2 Thermostat Opening Temperature

The thermostat contacts shall open on the temperature rise at +65 °F maximum when tested in accordance with 4.6.5.2.

The temperature differential between opening and closing temperatures shall be +7 °F minimum.

3.5.5 Hose Length and Diameter Change

The hose assembly shall not change length or diameter by more than plus or minus the percentage values shown in Table 4 when subjected to 125 psig ± 5 psig operating pressure for 30 min minimum. The hose assembly shall be tested in accordance with 4.6.6.

TABLE 4 - PERCENT CHANGE IN HOSE LENGTH, DIAMETER, AND FLATTENING

Hose Size Code	Length ± percent	Diameter ± percent	Flattening percent Max
06	2.0	4.0	11
08	2.0	4.0	12
10	2.5	4.0	13
12	3.0	4.0	13
16	5.0	5.0	14

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3.5.6 Repeated Freezing

The hose assembly shall pass the proof pressure test of 3.5.1 and shall pass the electrical tests of 3.5.3 after being subjected to a minimum of 20 repeated freeze cycles at -65 °F, when tested in accordance with 4.6.7.

3.5.7 Bend Radius

The hose assembly shall be capable of being bent a minimum of 180 degrees around a mandrel having a diameter equal to two times the minimum bend radius given in Table 3, without cracking or flattening of the hose cross section in excess of the flattening percentage of Table 4 of the original unbent and unpressurized hose outside diameter. The test shall be conducted at both the -20 and +160 °F environmental operating temperature in accordance with 4.6.8.

3.5.8 Hose Droop

The hose assembly shall not droop more than 0.25 in in 20 in when tested in accordance with 4.6.9.

3.5.9 Vacuum Strength

The hose assembly shall be capable of withstanding 22 in of mercury (Hg) vacuum at +160 °F while at the minimum bend radius per Table 3 for a minimum of 10 min without evidence of collapse and/or flattening of the hose cross section in excess of 10% of the flattening percentage of Table 4 of the original unbent and unpressurized hose outside diameter when tested in accordance with 4.6.10.

3.5.10 Tensile Strength

The hose assembly end fittings shall be capable of withstanding the tensile load specified in Table 5 without the end fitting pulling off or the hose parting when tested in accordance with 4.6.11.

TABLE 5 - TENSILE LOADS

Hose Size Code	06	08	10	12	16
Load (lb) ± 2%	75	100	125	160	250

3.5.11 High Temperature Compliance

The hose assembly shall be capable of withstanding +160 °F high environmental operating temperature and remain functional when tested in accordance with 4.6.12.

3.5.12 Low Temperature Compliance

There shall be no evidence of ice formation inside of the hose assembly at -40 °F when tested in accordance with 4.6.13. Upon completion of the low temperature test, the hose assembly shall meet the electrical requirements of 3.5.3.

3.5.13 Altitude

The hose assembly shall not fail or malfunction when tested in accordance with 4.6.14. Upon completion of the altitude test, the hose assembly shall meet the electrical requirements of 3.5.3 (Reference - Altitude and decompression requirements of RTCA/DO-160 Section 4).

3.5.14 Heating Efficiency

There shall be no ice formation inside of the hose assembly at -40 °F as evidenced by thermocouple readings when tested in accordance with 4.6.15. Upon completion of the low temperature test, the hose assembly shall meet the electrical requirements of 3.5.3.

3.5.15 Thermostat Electrical Function Verification

The electrical function of the hose assembly thermostat shall be verified when tested in accordance with 4.6.16. Upon completion of the thermostat electrical function test, the hose assembly shall meet the electrical requirements of 3.5.3.

3.5.16 Maximum Normal Operating Temperature

The hose assembly thermostat operation shall occur above the +40 °F minimum thermostat closing temperature when tested in accordance with 4.6.17.

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3.5.17 Fail Safe

The dry hose assembly shall not fail or produce an inside temperature in excess of +400 °F with a disabled thermostat when tested in accordance with 4.6.18. Upon completion of the fail safe test, the hose assembly shall meet the proof pressure test requirement of 3.5.1.

3.5.18 Thermostat Endurance

The thermostat manufacturer shall certify that the thermostat has been tested and shall be capable of 124 000 cycles of opening and closing (see 4.6.19).

3.5.19 Heater Element Endurance

The hose assembly shall be capable of continuous operation for 4800 h at maximum normal operating temperature when tested in accordance with 4.6.20.

3.5.20 Vibration

The hose assembly shall not fail or malfunction during preliminary frequency response and random vibration in two axes when tested in accordance with 4.6.21. Upon completion of the vibration test, the hose assembly shall meet the electrical requirements of 3.5.3 (Reference - Robust vibration requirements of RTCA/DO-160, Section 8).

3.5.21 Odor and Taste

The hose assembly shall not cause any objectionable odor or taste to potable water when tested in accordance with 4.6.22.

3.5.22 Humidity Resistance

The hose assembly shall not fail or malfunction when tested in accordance with 4.6.23.

3.5.23 Fungus Resistance

The hose assembly inner tube shall not show microscopic evidence of fungus growth that would affect performance of intended purpose when tested in accordance with 4.6.24.

3.5.24 Burst Pressure

The hose assembly shall not rupture and shall not show evidence of leakage at any pressure up to the minimum burst pressure specified in Table 3 and during the 5 min hold at minimum burst pressure when tested in accordance with 4.6.25.

3.5.25 Flammability

Flammability tests may be witnessed by the purchaser, FAA, or FAA Designated Engineering Representative (DER) as applicable.

3.5.26 Self Extinguishing

The hose material section, when tested vertically per 4.6.26, shall meet the following self-extinguishing requirements:

a. Average self-extinguishing time: 15 s maximum

b. Average burn length: 8 in maximum

c. Average extinguishing time for drippings: 5 s maximum

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3.5.27 Adhesion

There shall be no evidence of lifting or separation of the inner tube lining from the silicone inner tube when tested in accordance with 4.6.27. Shearing or tearing of the silicone inner tube shall be acceptable.

3.6 Identification of Hose Assembly

Hose assemblies shall have permanent identification marking on a permanent stainless steel or plastic band, not more than 1.0 in wide, or on the end fitting. The characters shall be 0.06 in high minimum. The band shall be so designed as to remain tight on the hose to prevent relative movement and resultant chafing, and be of sufficient strength to prevent removal by hand. After band installation, a 2.0 in length of clear polyolefin per AS1073 shall be heat shrunk to a tight fit over the band. Optional band material without the polyolefin is plastic (polyester or equivalent). The identification marking shall show the following as a minimum:

a. “SUITABLE FOR DRINKING WATER”

b. Manufacturer's name or trademark

c. Complete manufacturer's CAGE number and part number

d. Complete "AS" Standard number

e. Operating pressure 125 psig

f. Pressure test symbol “PT” or “FT”

g. Month and year of hose assembly manufacture

h. Serial Number

i. 115 VAC (Wattage)

Items (f) and (g) may be electro-etched on one hose end fitting socket (collar).

3.7 Workmanship

The hose assembly shall be constructed and finished to produce a product free from all defects that would affect functioning in service. Particular attention shall be given to thoroughness of assembly, alignment of parts, protective finish and removal of burrs and sharp edges.

3.7.1 Dimensions and Tolerances

All pertinent dimensions and tolerances, where interchangeability, operation or performance of the hose assembly may be affected shall be as specified on the applicable standard or drawing.

3.7.2 Cleaning

All hose assemblies shall be clean for use in potable water systems. Cleaning methods may be in accordance with AS611, Class I, except drying temperature shall not exceed +250 °F, or equivalent.

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4. QUALITY ASSURANCE PROVISIONS

4.1 Suppliers Responsibility

The supplier shall be responsible for performance of all quality assurance provisions and inspections specified herein. Accurate records of the testing shall be kept indefinitely by the supplier and shall be available to the purchaser on request. The supplier's test data, subject to purchaser approval, shall be considered adequate for product qualification. The purchaser reserves the right to perform any of the inspections and tests set forth in this document to ensure conformance to this document.

4.1.1 Rejection and Retest

Rejected hose or hose assemblies shall not be submitted for reinspection without furnishing full particulars concerning the previous rejection and measures taken to overcome the defects.

4.1.2 Defects on Items Already Accepted

If the investigation of the rejection indicates that the defect or defects causing the rejection may exist in hose assemblies previously supplied to the purchaser, the supplier shall advise the purchaser of this condition, the method for identifying these parts, and the recommended corrective action or disposition of the defective parts.

4.2 Purchaser's Responsibility

The purchaser shall establish adequate inspection procedures to ensure that all requirements of this document are met. Emphasis shall be placed on the following aspects:

a. Dimensional conformance

b. Material, finish and workmanship

c. Marking

d. Pressure test

e. Electrical test

4.3 Classification of Inspections

The examining and testing of the hose assemblies are classified as follows:

a. Qualification inspections

b. Quality conformance inspections

4.4 Qualification Inspections

The qualification inspections outlined herein are intended to qualify a manufacturer's hose construction and end fitting attachment method only. The configuration of the outlet ports shall be as described on the applicable standard or drawing. A number shall be assigned for each attachment method and hose construction used for qualification. The attachment method and hose shall be fully described in the test report by design standard drawings. All other end connections shall also be considered qualified, provided the hose and hose attachment method have not been altered.

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4.4.1 Test Specimens

Seven hose assemblies of each hose size shall be used for qualifying performance of the manufacturer's product except size code 08 shall have eight hose assemblies. Using flareless end fitting configurations, the Table 6 standard "AS series" hose assemblies shall be used for qualifying hose assemblies to this document.

TABLE 6 - TEST SPECIMEN CONFIGURATIONS

Specimen Number	Basic Part Number	Size Code 06	Size Code 08	Size Code 10	Size Code 12	Size Code 16
1 (STR-45°)	AS5421	G0180B2	H0180B2	J0180B2	K0220B2	M0290B2
2 (STR-90°)	AS5421	G0180C2	H0180C2	J0180C2	K0220C2	M0290C2
3 (STR-STR)	AS5421	G0180A1	H0200A1	J0200A1	K0240A1	M0240A1
4 (STR-STR)	AS5421	G0180A1	H0200A1	J0200A1	K0240A1	M0240A1
5 (STR-STR)	AS5421	G0480A1	H0480A1	J0480A1	K0480A1	M0480A1
6 (STR-STR)	AS5421	G0480A1	H0480A1	J0480A1	K0480A1	M0480A1
7 (STR-90°)	AS5421	G0700C2	H0700C2	J0700C2	K0700C2	M0700C2
8 (STR-STR)	AS5421	-	H0480A1	-	-	-

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4.4.2 Test Schedule and Sequence

The test specimens shall be subjected to qualification tests in the order indicated in Table 7.

TABLE 7 - TEST SCHEDULE AND SEQUENCE

Test Title	Paragraph Number	Specimen Number /1/ /4/ 1	Specimen Number /1/ /4/ 2	Specimen Number /1/ /4/ 3	Specimen Number /1/ /4/ 4	Specimen Number /1/ /4/ 5	Specimen Number /1/ /4/ 6	Specimen Number /1/ /4/ 7	Specimen Number /1/ /4/ 8
1. Examination of Product	4.6.1	X	X	X	X	X	X	X	X
2. Proof Pressure Test	4.6.2	X	X	X	X	X	X	X	X
3. Electrical Connection Test	4.6.3	X	X	X	X	X	X	X	X
4. Electrical Tests	4.6.4	X	X	X	X	X	X	X	X
5. Operational Test	4.6.5	X	X	X	X	X	X	X	X
6. Length and Diameter Change Test	4.6.6	X	-	-	-	-	-	-	-
7. Repeated Freeze Test	4.6.7	-	X	-	-	-	-	-	-
8. Bend Radius Test	4.6.8	-	-	-	-	X	-	-	-
9. Hose Droop Test	4.6.9	-	-	-	-	-	-	X	-
10. Vacuum Strength Test	4.6.10	-	-	X	-	-	-	-	-
11. Tensile Strength Test	4.6.11	-	-	-	X	-	-	-	-
12. High Temperature Compliance Test	4.6.12	-	-	-	-	-	X	-	-
13. Low Temperature Compliance Test	4.6.13	-	-	-	-	-	X	-	-
14. Altitude Test	4.6.14	-	-	-	-	X	-	-	-
15. Heating Efficiency Test	4.6.15	-	-	-	-	X	-	-	-
16. Thermostat Elec. Function Test	4.6.16	-	-	X	-	-	-	-	-
17. Max. Normal Operating Temp. Test	4.6.17	-	-	-	-	-	X	-	-
18. Fail Safe Test	4.6.18	-	-	-	-	X	-	-	-
19. Thermostat Endurance /2/	4.6.19	-	-	-	-	-	-	-	-
20. Heating Element Endurance Test /4/	4.6.20	-	-	-	-	-	-	-	X
21. Vibration Test	4.6.21	-	X /5/	-	-	-	-	-	-
22. Odor and Taste Test	4.6.22	-	-	X	X	-	-	-	-
23. Humidity Resistance Test	4.6.23	X	-	-	-	-	-	-	-
24. Fungus Resistance Test /3/	4.6.24	-	-	-	-	-	-	-	-
25. Burst Pressure Test	4.6.25	-	-	X	-	-	X	X	-
26. Flammability Test /3/	4.6.26	-	-	-	-	-	-	-	-
27. Adhesion Test /3/	4.6.27	-	-	-	-	-	-	-	-

/1/ See Table 6 for hose part number
/2/ Test to be performed by the thermostat manufacturer.
/3/ Bulk hose or specimen cut from hose assembly, lengths as specified by applicable test procedure.
/4/ Only size code 08 has 8 specimens.
/5/ Vibration test only on size -12.

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4.5 Quality Conformance Inspections

Quality conformance inspections shall consist of the following:

a. Individual tests (100% inspection)

b. Periodic control tests

4.5.1 Individual Tests (Acceptance Tests)

Each production hose assembly shall be subjected to the following:

a. Examination of product in accordance with 4.6.1

b. Proof pressure test in accordance with 4.6.2, except 1 min duration

c. Electrical connection test in accordance with 4.6.3

d. Electrical tests in accordance with 4.6.4

e. Thermostat closing, resistance and current draw tests of 4.6.5.1.1 and 4.6.5.2.1

4.5.2 Periodic Control Tests

The following tests shall be performed on three hose assemblies per size code selected at random from a production run. Periodic testing shall be performed every two years on each size of hose.

a. Individual tests of 4.5.1 (all hose assemblies)

b. Repeated freeze test per 4.6.7 (one hose assembly)

c. Bend radius test per 4.6.8 (one hose assembly)

d. Tensile test per 4.6.11 (one hose assembly)

e. Adhesion test per 4.6.27 (bulk hose only)

4.6 Test Methods

4.6.1 Examination of Product

All test specimens shall be examined to verify dimensional and material compliance with the applicable hose assembly standards or drawing.

4.6.2 Proof Pressure Test

All test specimens shall be subjected to a room temperature proof pressure test with clean tap water or compressed air while immersed under water to a proof pressure of 250 psig minimum. Pressure shall be maintained for a minimum of 5 min (see 3.5.1).

4.6.3 Electrical Connection Test

All test specimens shall be subjected to a lead wire pull test by applying a 12 lb load to the ends of the lead wire normal to the hose. Upon completion of the test, the test specimen shall be subject to examination of product in accordance with 4.6.1 and electrical test in accordance with 4.6.4 (see 3.5.2).

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4.6.4 Electrical Tests

All test specimens except bulk hose specimens.

4.6.4.1 Linear Resistance Test

The test specimen shall have the lead wires of an ohmmeter connected to each end fitting and the fitting to fitting resistance measured.

4.6.4.2 Insulation Resistance Test

The lead wires of the test specimen shall be connected together and attached to one lead of a high range megohmmeter. The other lead from the megohmmeter shall be connected to one of the fittings on the test unit. The instrument shall have an output voltage of 500 VDC. The instrument shall have scale divisions which will permit an accuracy of ±10% at the minimum specified value of insulation resistance.

Components or parts which are subject to possible damage from test voltages shall be electrically isolated before performing insulation-resistance tests (see 3.5.3.2).

4.6.4.3 Dielectric Strength Test

The lead wires of the test specimen shall be connected together and attached to one lead of a hypot. The other lead from the hypot shall be connected to one of the fittings on the test specimen. A voltage of 1500 VAC RMS ± 50 VAC 60 Hz shall be applied at the uniform rate of 250 to 500 VAC per second for a duration of 60 s maximum and the leakage current recorded. The insulation resistance test of 4.6.4.2 shall then be repeated (see 3.5.3.3). On any re-run of the dielectric strength test the voltage level shall be 80% of the previously used voltage levels.

4.6.5 Operational Tests

All test specimens except bulk hose specimens.

4.6.5.1 Thermostat Closing Temperature and Heater Wire Resistance

The test specimen shall be completely filled with tap water and both ends capped in an unpressurized condition. As shown in Figure 1, provisions shall be made for using three thermocouples for measuring the inside water temperature. Two thermocouples shall be placed inside the test specimen located between 1 and 2 in from each end of the hose assembly. The third thermocouple shall be placed inside of the test specimen within 1 in of the middle of the hose. A fourth thermocouple shall be attached onto the housing of the controlling thermostat on the test specimen to monitor the opening and closing temperatures.

The test specimen shall be placed into an environmental test chamber, as shown in Figure 1, and the test chamber temperature reduced at an approximate rate of 1 °F per minute to +35 °F ± 5 °F. The closing temperature of the controlling thermostat and the water temperature shall be shall be recorded at the moment a digital ohmmeter connected to the two leads of the test specimen registers a finite resistance value. The measured resistance of the test specimen shall be recorded (see 3.5.4.1).

4.6.5.1.1 Acceptance Test Method

The production hose assembly shall be placed in a cold chamber set at a maximum of +35 °F as shown in Figure 1, except no thermocouples shall be attached. After the thermostat closes, the measured resistance value of the hose assembly shall be recorded.

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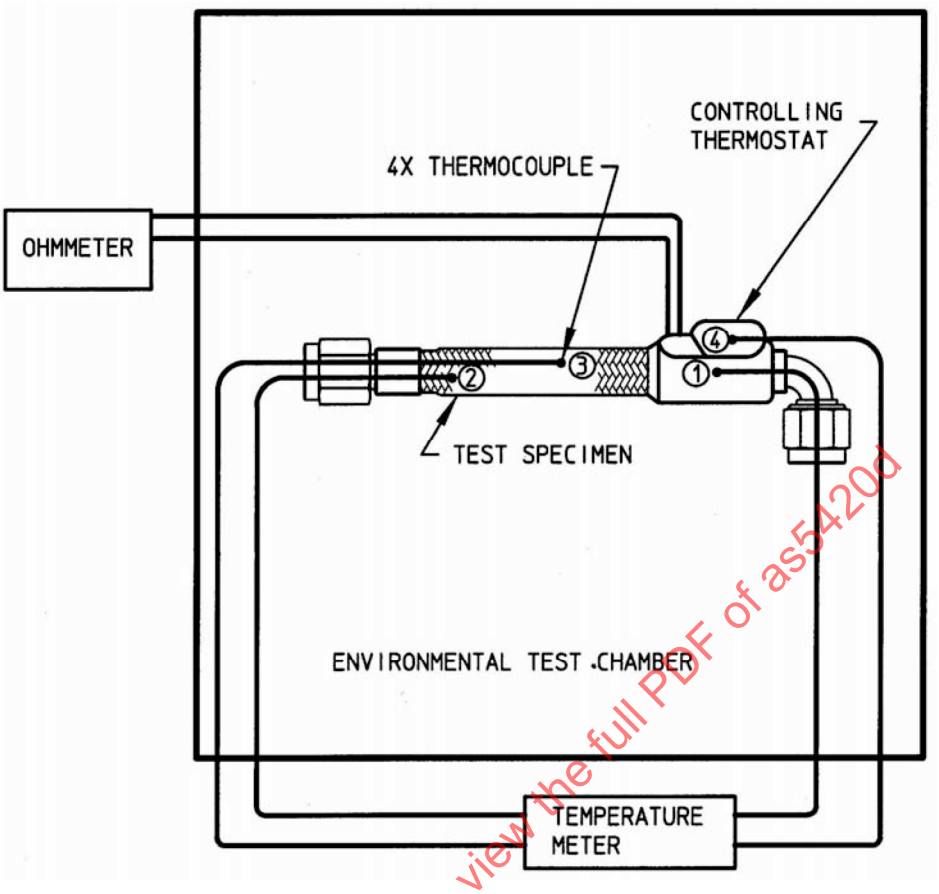

FIGURE 1 - TEST SET-UP FOR THERMOSTAT CLOSING TEMPERATURE AND HEATER WIRE RESISTANCE TESTS

4.6.5.2 Thermostat Opening Temperature

While still maintaining a test chamber temperature of +35 °F ± 5 °F the electrical leads of the test specimen shall be connected to a 115 VAC 60 Hz power supply with an ammeter connected in series as shown in the test setup on Figure 2. The test specimen shall be energized and the current draw shall be recorded. The test specimen shall then be de-energized and stabilized at +35 °F ± 5 °F. The lead wires of the test specimen shall be connected to a digital ohmmeter. The test chamber temperature shall be raised at an approximate rate of 1 °F per minute until the thermostat opens as evidenced by the resistance reading change shown by the ohmmeter. The thermocouple temperatures at the moment of change shall be recorded (see 3.5.4.2).

4.6.5.2.1 Acceptance Test Method

While still in the cold chamber of 4.6.5.1.1, the electrical leads of the hose assembly shall be connected to a 115 VAC 60 Hz power supply with an ammeter connected in series as shown in Figure 2. The hose assembly shall be energized and the current draw measured and recorded. The hose assembly shall be removed from the cold chamber and allowed to stabilize at ambient temperature and a digital ohmmeter connected to the hose assembly lead wires. The resistance reading shall be “OL” (∞) indicating that the thermostat has opened.

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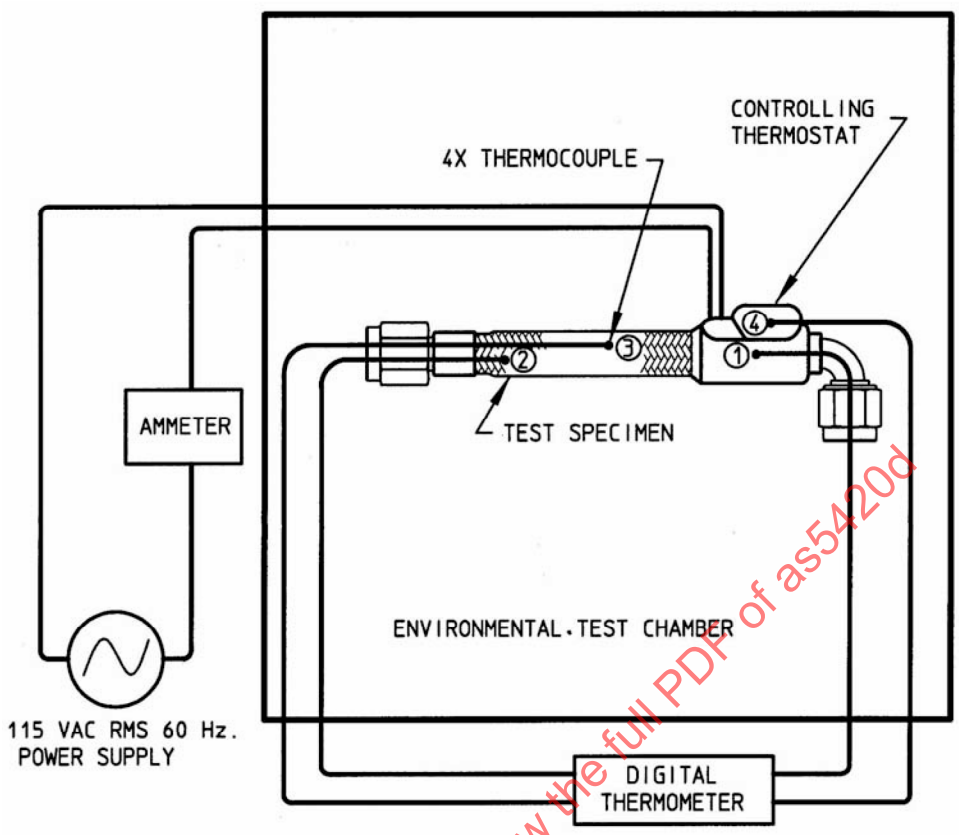

FIGURE 2 - TEST SET-UP FOR THERMOSTAT OPENING TEMPERATURE AND NORMAL OPERATING TEMPERATURE TESTS

4.6.6 Hose Length and Diameter Change Test

Test specimen No. 1 of each size code shall be placed in a straight unpressurized position. A standard 10.000 in ± 0.015 gage length shall be marked off on each hose and the actual length recorded. The hose diameter shall be measured at three locations randomly selected within the 10.000 in gage length and the measurements averaged.

The test specimens shall then be pressurized to 125 psig ± 5 psig with either tap water or compressed air for 30 min minimum after which, while pressurized, the hose diameter and gage length shall again be measured and the diameters averaged in the same locations as were the first measurements (see 3.5.5).

4.6.7 Repeated Freeze Test

The test specimen shall be filled with water and placed in a cold box stabilized at -65 °F ± 5 °F for a minimum period of 2 h. The hose assembly shall then be removed from the cold box, energized with 115.0 VAC RMS ± 0.5 VAC 60 Hz as shown in Figure 2A, and allowed to warm until the thermostat opens (+42 °F minimum), at which point the power shall be removed. A heated chamber set at 110 °F or lower may be used to hasten the thaw process. The water within the hose assembly shall be checked to assure no ice is present and makeup water shall be added where necessary to compensate for hose expansion. The entire freeze/thaw test sequence shall be repeated 20 times. After completion of the freeze/thaw cycles, the hose assembly shall then be proof pressure tested per 4.6.2 and subjected to the electrical tests of 4.6.4 (see 3.5.4).

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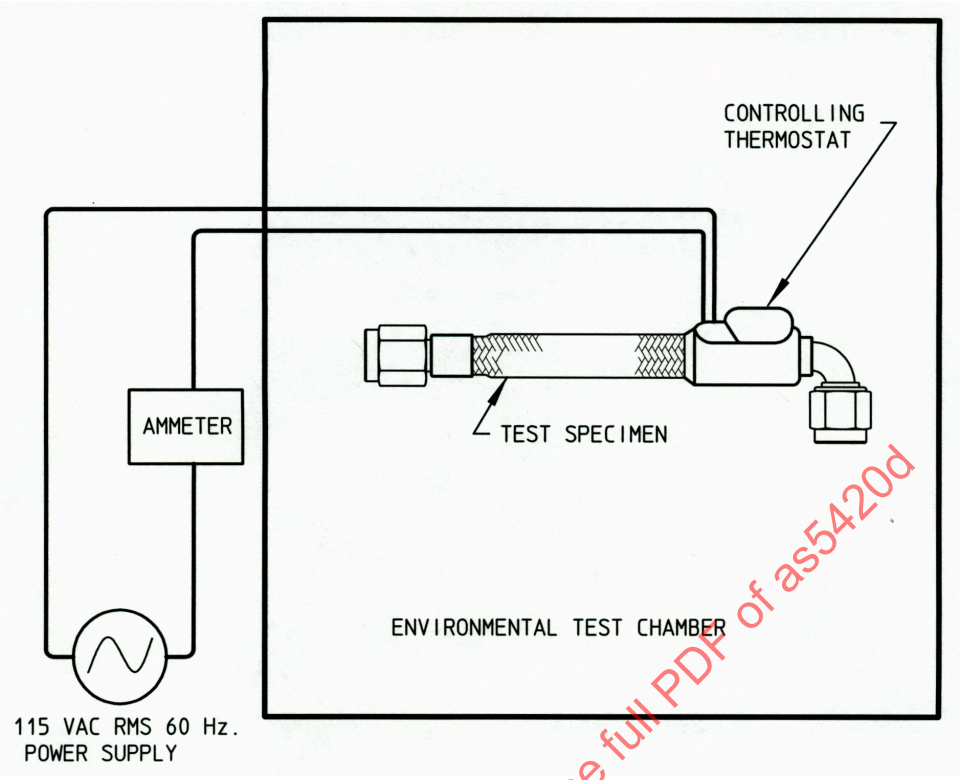

FIGURE 2A - TEST SET-UP FOR REPEATED FREEZE/THAW TEST

4.6.8 Bend Radius Test

Test specimen No. 5 of each size code shall have the hose OD measured in three places and the hose and the average diameter recorded. The test shall be conducted with the test specimen unpressurized.

4.6.8.1 The test specimen shall be placed into an environmental test chamber and allowed to soak for 4 h minimum at +160 °F ± 5 °F. Following the 4 h soak period, the test specimen shall be removed from the test chamber and, within 15 s of removal, the test specimen shall be bent a minimum of 180 degrees around a test mandrel having a diameter equal to two times the minimum bend radius given in Table 3. The test specimen shall then be straightened, rotated 180 degrees, and bent in the opposite direction for a minimum of 180 degrees around the test mandrel, still within 15 s of removal. The hose OD shall be measured in three places along the hose and the average diameter recorded.

4.6.8.2 The test specimen shall be placed into an environmental test chamber and allowed to soak for 4 h minimum at -20 °F ± 5 °F. Following the 4 h soak period, the bend test of 4.6.8.1 and the proof pressure test of 4.6.2 shall be repeated (see 3.5.7).

4.6.9 Hose Droop Test

Test specimen No. 7 of each size code shall be completely filled with tap water and both ends capped in an unpressurized condition. The test specimen shall be mounted horizontally and be supported at 20 in ± 0.25 in intervals with loop type support clamps. Without any external axial loads being applied to the test specimen the maximum hose droop between supports shall be measured as shown in Figure 3 (see 3.5.8).

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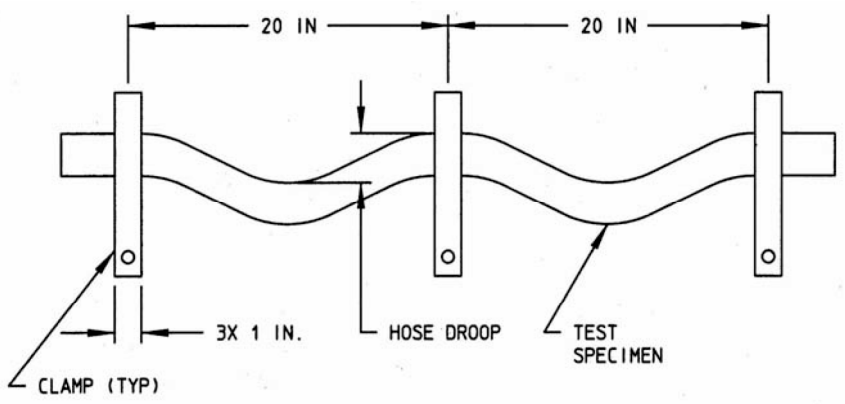

FIGURE 3 - HOSE DROOP TEST SET-UP

4.6.10 Vacuum Strength Test

Test specimen No. 3 of each size code shall be bent to the minimum bend radius specified in Table 3 and shall be maintained in this position during this test. The test specimen, with one end capped, shall be placed into an environmental test chamber and conditioned at +160 °F ± 5 °F for 10 min minimum. A suitable vacuum pump shall be used to evacuate the test specimen to a negative pressure equivalent to 22.00 in ± 0.25 in of mercury (Hg). Negative pressure shall be maintained for 10 min minimum and after the 10 min period, the hose OD shall be measured at three locations randomly selected along the hose within the 10.000 in gage length while maintaining the vacuum and the measurements averaged (see 3.5.9).

4.6.11 Tensile Strength Test

Test specimen No. 4 of each size code shall be held vertically from one hose end fitting. The applicable dead weight load of Table 5 shall be applied for 30 s at the opposite hose end fitting of the test specimen (see 3.5.10).

4.6.12 High Temperature Compliance Test

Test specimen No. 6 in size code 08 only shall be subjected to this test. The test specimen shall be completely filled with tap water and both ends capped in an unpressurized condition, and placed into an environmental test chamber. Two thermocouples shall be used to monitor the temperature of the test specimen. Provisions shall be made to place one thermocouple inside the test specimen within 1 in of the middle of the hose. The second thermocouple shall be placed outside the test specimen within 1 in of the thermostat. A third thermocouple shall be placed near the center of the test chamber to monitor the test chamber temperature.

The test chamber temperature shall be raised to +160 °F ± 5 °F. After test specimen temperature stabilization, the thermocouple readings shall be recorded and the test chamber temperature shall be maintained for a duration of 48 h minimum. Upon completion of the 48 h soak duration the test specimen shall be returned to room temperature and allowed to stabilize for 1 h minimum and subjected to the operational test of 4.6.5. The test specimen shall be non-operating throughout the 48 h soak duration (see 3.5.11).

4.6.13 Low Temperature Compliance Test

Test specimen No. 6 in size code 08 only shall be subjected to this test. The test specimen shall be connected to an upper and lower hose assembly. The upper and lower hose connected to the test specimen shall be of the same hose size and watt density as the test specimen. The test assembly shall be arranged in such a way that the test specimen shall be the middle section of the three connected hose assemblies and shall maintain a constant 4° ± 1° slope while coiled, as shown in Figure 4. The hose assemblies shall be completely filled with tap water and both ends capped in an unpressurized condition, and placed into an environmental test chamber without being in contact with the walls of the chamber. Provisions shall be made for using three thermocouples for measuring the inside water temperature. Two thermocouples shall be placed inside the test specimen, between 1 and 2 in from each end of the hose assembly. The third thermocouple shall be placed inside the test specimen within 1 in of the middle of the hose. A fourth thermocouple shall be placed near the center of the environmental test chamber.

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The test chamber temperature shall be lowered to -70 °F ± 5 °F. After test specimen temperature stabilization is reached, the test chamber temperature shall be maintained for a duration of 24 h minimum. Upon completion of the 24 h soak duration the test chamber temperature shall be adjusted to -40 °F ± 5 °F and the test specimen stabilized at -40 °F. The test specimen and the connecting hose assemblies shall then be energized with 115.0 VAC RMS ± 0.5 VAC 60 Hz. The temperature at which the internal water stabilizes shall be recorded along with the test chamber temperature.

Upon completion of the low temperature test, the test specimen shall be returned to room temperature and allowed to stabilize for 1 h minimum and subjected to the electrical test of 4.6.4 (see 3.5.12).

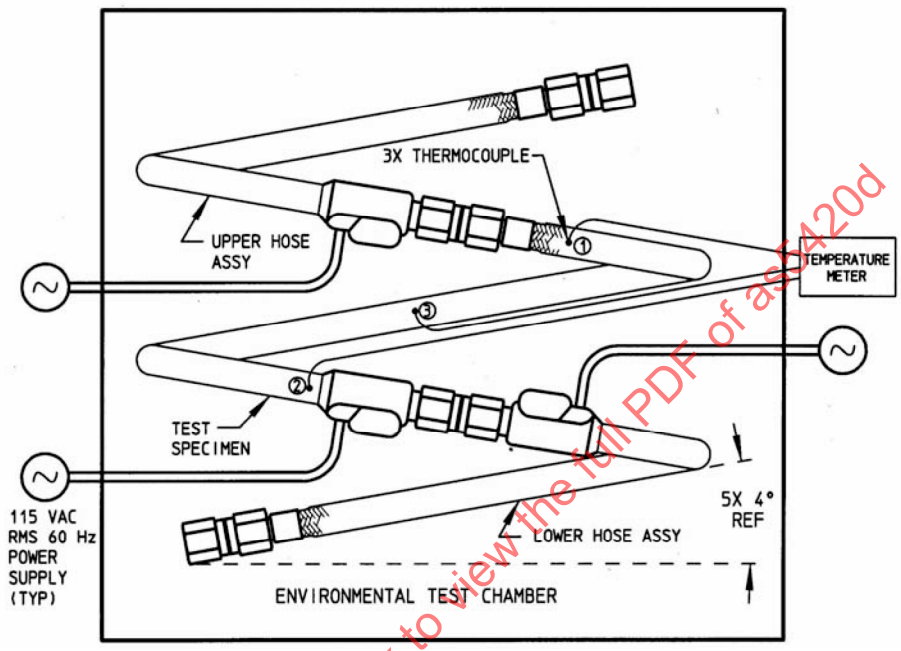

FIGURE 4 - LOW TEMPERATURE COMPLIANCE TEST SET-UP

4.6.14 Altitude Test

Test specimen No. 5 in size code 08 only shall be subjected to this test. The test specimen shall be completely filled with tap water and the ends capped. The electrical leads of the test specimen shall be connected to a 0 to 140 VAC 60 Hz variable power supply with an ammeter connected in series as shown in the test setup on Figure 5. Provisions shall be made for using three thermocouples for measuring the inside water temperature. Two thermocouples shall be placed inside the test specimen, between 1 and 2 in from each end of the hose assembly. The third thermocouple shall be placed inside of the test specimen within 1 in of the middle of the hose. A fourth thermocouple shall be attached onto the housing of the controlling thermostat on the test specimen to monitor the opening and closing temperatures. The test specimen shall then be placed inside the environmental test chamber set at -40 °F ± 5 °F and allowed to stabilize for 2 h minimum at standard atmospheric pressure. The test shall be conducted in the following sequence:

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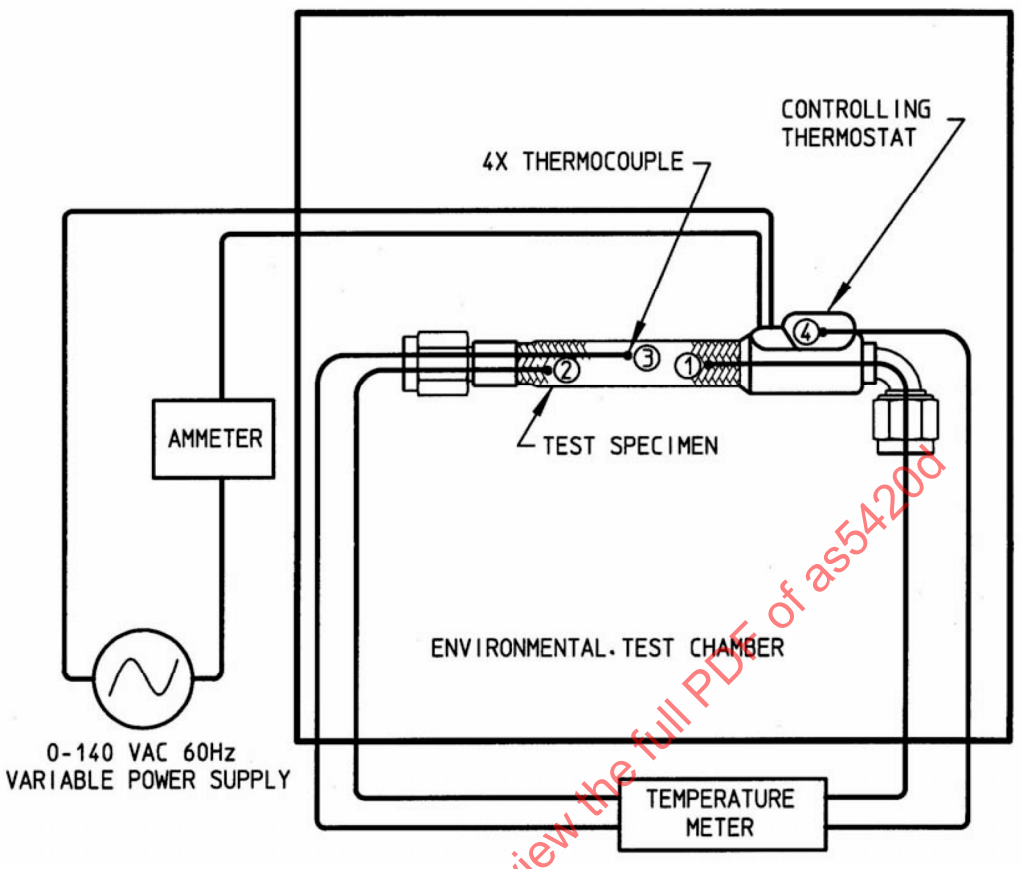

FIGURE 5 - TEST SET-UP FOR ALTITUDE, HEATING EFFICIENCY AND THERMOSTAT ELECTRICAL FUNCTION TESTS

a. The test specimen shall be energized at 122.0 VAC RMS ± 0.5 VAC 60 Hz. Following a warm-up time not exceeding 15 min, a reading of the current draw shall be recorded. The test specimen shall be allowed to stabilize for 1 h minimum while energized and with the environmental test chamber temperature maintained at -40 °F. The test specimen temperature shall be recorded.

b. The test chamber pressure shall be reduced to 8.28 psia ± 0.50 psia to simulate an altitude of 15 000 ft. Upon reaching the chamber pressure of 8.28 psia, the test specimen current draw shall be recorded. The test chamber pressure shall be maintained for 2 h minimum. The test specimen temperature shall be recorded.

c. The test specimen shall be de-energized and removed from the test chamber. The test specimen shall be allowed to stabilize at room temperature for 1 h minimum. The test specimen shall be subjected to examination of product of 4.6.1 and electrical test of 4.6.4 (see 3.5.13).

4.6.15 Heating Efficiency

Test specimen No. 5 of each size code shall be completely filled with tap water and both ends capped in an unpressurized condition. Provisions shall be made for using three thermocouples for measuring the inside water temperature. Two thermocouples shall be placed inside the test specimen, between 1 and 2 in from each end of the hose assembly. The third thermocouple shall be placed inside of the test specimen within 1 in of the middle of the hose. A fourth thermocouple shall be attached onto the housing of the controlling thermostat on the test specimen to monitor the opening and closing temperatures as shown in Figure 5.

After the test chamber temperature reaches -40 °F ± 5 °F, the test specimen shall then be placed inside the environmental test chamber and energized with 104.0 VAC RMS ± 0.5 VAC 60 Hz. The test chamber temperature shall be lowered to -40 °F ± 5 °F. The test specimen shall be allowed to stabilize for 1 h minimum. The test specimen temperatures shall be recorded (see 3.5.14).

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4.6.16 Thermostat Electrical Function Verification

Test specimen No. 3 of each size code shall be completely filled with tap water and both ends capped in an unpressurized condition. Provisions shall be made for using three thermocouples for measuring the inside water temperature. Two thermocouples shall be placed inside the test specimen, between 1 and 2 in from each end of the hose assembly. The third thermocouple shall be placed inside of the test specimen within 1 in of the middle of the hose. A fourth thermocouple shall be attached onto the housing of the controlling thermostat on the test specimen to monitor the opening and closing temperatures as shown in Figure 6. The test specimen shall then be placed inside the environmental test chamber set at +35 °F ± 5 °F.

The test specimen shall be energized at 133.5 VAC RMS ± 0.5 VAC 60 Hz. The test chamber temperature shall be maintained at +35 °F until the thermostat closes, and the amount of current draw shall be recorded. The test chamber temperature shall then be raised to the minimum thermostat closing temperature of +40 °F and maintained at this temperature for 24 h. The test specimen temperatures shall be recorded. Upon completion of the 24 h test duration the test specimen shall be removed from the test chamber and allowed to stabilize at room temperature. The test specimen shall be subjected to the electrical test of 4.6.4. The results shall be recorded. The resistance of the test specimen shall be recorded before and after the electrical power requirement test (see 3.5.15).

4.6.17 Maximum Normal Operating Temperature

Test specimen No. 6 of each size code shall be completely filled with tap water and both ends capped in an unpressurized condition. Provisions shall be made for using three thermocouples for measuring the inside water temperature. Two thermocouples shall be placed inside the test specimen, between 1 to 2 in from each end of the hose assembly. The third thermocouple shall be placed inside of the test specimen within 1 in of the middle of the hose. A fourth thermocouple shall be attached onto the housing of the controlling thermostat on the test specimen to monitor the opening and closing temperatures as shown in Figure 2. The test specimen shall then be placed inside the environmental test chamber set at +35 °F ± 5 °F.

After the test specimen temperature stabilizes at +35 °F the test specimen shall be energized at 115.0 VAC RMS ± 0.5 VAC 60 Hz. The test chamber temperature shall be raised at a rate of 5 °F per minute to the minimum thermostat closing temperature of +40 °F. The test specimen thermostat shall be allowed to cycle "on" and "off" for two cycles before increasing the test chamber temperature by 1 °F over the minimum thermostat closing temperature. The sequence shall be repeated until the test specimen fails to cycle "on" and "off". The maximum test chamber temperature setting at which the thermostat fails to cycle "on" and "off" shall be recorded along with the maximum test specimen temperature readings for each cycle at each thermocouple location (see 3.5.16).

4.6.18 Fail Safe Test

Test specimen No. 5 of each size code shall be subjected to a fail safe test. A section of the controlling thermostat housing shall be removed on each of the test specimens to expose the lead wire connections of the thermostat. The thermostat leads shall be connected together disabling the thermostat. The test specimens shall be completely dry. Provisions shall be made for using three thermocouples for measuring the inside hose temperature. Two thermocouples shall be placed inside the test specimen, between 1 and 2 in from each end of the hose assembly. The third thermocouple shall be placed inside of the test specimen within 1 in of the middle of the hose. The test specimen shall then be placed inside the environmental test chamber set at +160 °F ± 5 °F.

After the test specimen temperature stabilizes at +160 °F the test specimen shall be energized at 115.0 VAC RMS ± 0.5 VAC 60 Hz until the test specimen temperature stabilizes.

The thermocouple readings shall be recorded. The test specimen shall then be allowed to return to room temperature. Upon completion of the fail safe test, the test specimen shall be subjected to the electrical test of 4.6.4 and the proof pressure test of 4.6.2 (see 3.5.17).

The dielectric strength test of 4.6.4.3 shall be performed with the test specimen submerged in 95% tap water and 5% sodium chloride solution by weight, except for the section where the thermostat housing was removed.

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4.6.19 Thermostat Endurance Test

The thermostat manufacturer shall provide test data demonstrating that the thermostat has been tested and complies with the 124 000 cycles of opening and closing requirement (see 3.5.18).

4.6.20 Heater Element Endurance Test

Test specimen No. 8 in size code 08 only shall be subjected to this test. The test specimen shall be subjected to continuous operation for 4800 h minimum at maximum normal operating temperature. The heater elements shall be energized at 115.0 VAC RMS ± 0.5 VAC 60 Hz with an ammeter connected in series, by-passing the thermostat. The test specimens shall be energized continuously at room temperature and in an open environment. The test specimen temperatures shall be monitored using two thermocouples. One thermocouple shall be placed inside of the test specimen within 1 in of the middle of the hose. The second thermocouple shall monitor the outside surface temperature of the test specimen and shall be placed within 1 in of the middle of the hose.

The test specimen shall be connected to a 90 degree elbow tube fixture as shown in Figure 6 and suspended horizontally. The test specimen and apparatus shall be completely filled with tap water prior to being energized. The temperature and current draw of the test specimen shall be recorded weekly to insure proper operation of the heating element. The test specimen may be connected in series with a MS or AN type union or tested separately. The water inside the test specimen may be circulated or water may be added during the 4800 h test.

The test unit shall be subjected to examination of product in accordance with 4.6.1 along with resistance readings before and after the heater element endurance test (see 3.5.19).

4.6.21 Vibration Test

Test specimen No. 2 in size code 12 only shall be subjected to this test.

4.6.21.1 General

The test specimen shall be completely filled with tap water in an unpressurized condition and shall be non-operating at all times. All vibration testing shall be performed using the test fixturing of Figure 7. The test specimen as shown in Figure 7 shall be subjected to the vibration test in accordance with RTCA/DO-160, Section 8, Robust Vibration for Fuselage mounted equipment, except only the X and Y axes shall be used and the test specimen shall be non-operating.

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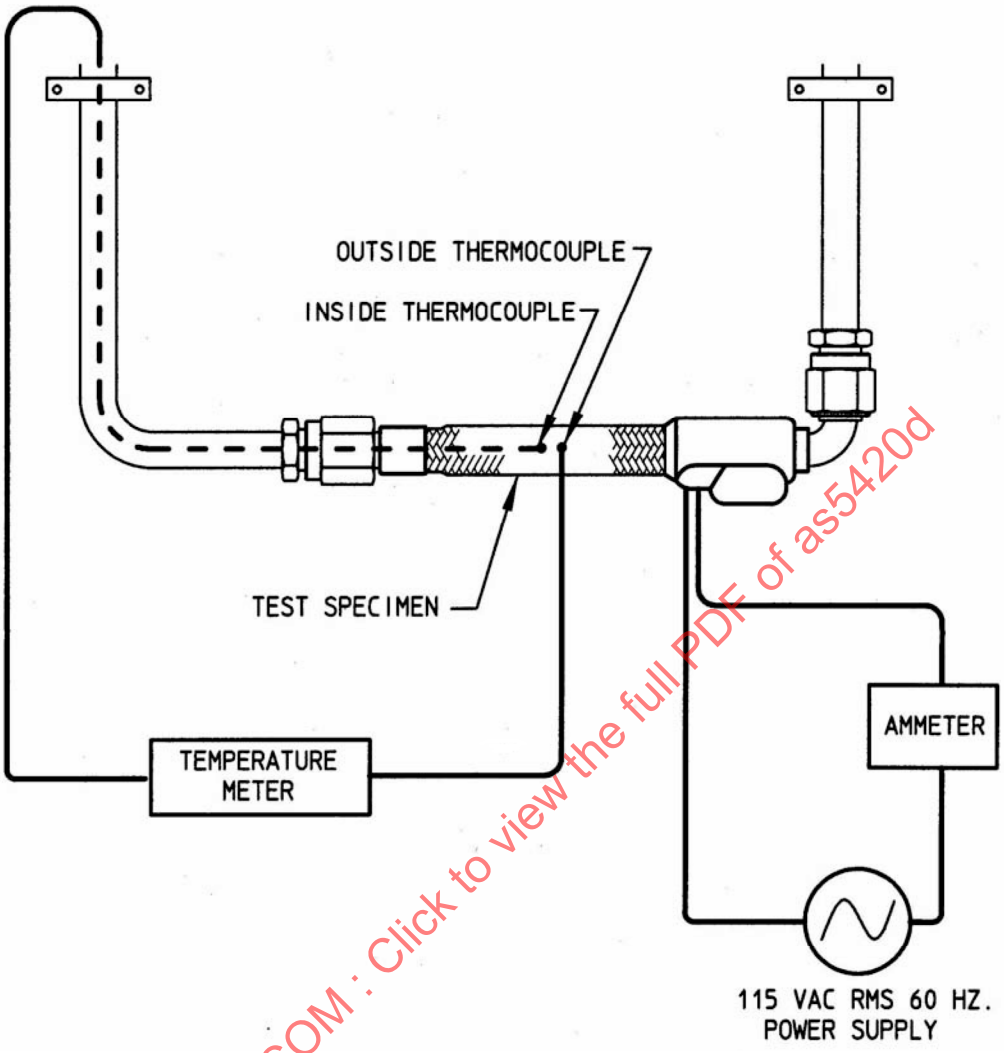

FIGURE 6 - HEATING ELEMENT ENDURANCE TEST SET-UP

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