

Submitted for recognition as an American National Standard

HOSE, AIR DUCT, FLEXIBLE, NONMETALLIC, AIRCRAFT

1. SCOPE:

This document covers flexible and semiflexible, reinforced and unreinforced air hoses fabricated from laminated and impregnated fabric, intended for use in aircraft heating, air conditioning, ventilating, defrosting and/or deicing systems.

1.1 Classifications:

Hoses furnished under this document shall be of the following operating temperature classifications and constructions shown in Table 1.

TABLE 1 - Operating Temperature Range and Construction

Type	Operating Temperature Range	Construction
I	-65 to +250 °F	Chloroprene rubber impregnated fiberglass
II	-65 to +500 °F	Silicone rubber impregnated fiberglass
III	-65 to +176 °F	Polyurethane rubber impregnated nylon cloth
IV	-65 to +250 °F	Silicone rubber impregnated fiberglass
V	-65 to +250 °F	Chloroprene rubber impregnated Meta-Aramid cloth
VI	-65 to +500 °F	Silicone rubber impregnated Meta-Aramid cloth

NOTE: Hoses with nonmetallic wire shall not be used over 250 °F.

1.2 Grades:

Grades shall be designated by a letter code as shown in Table 2, and utilized as required on standards and drawings to differentiate hose operating pressures, and to specify hose classification.

SAE Technical Standards Board Rules provide that: "This report is published by SAE to advance the state of technical and engineering sciences. The use of this report is entirely voluntary, and its applicability and suitability for any particular use, including any patent infringement arising therefrom, is the sole responsibility of the user."

SAE reviews each technical report at least every five years at which time it may be reaffirmed, revised, or cancelled. SAE invites your written comments and suggestions.

1.3 Forms:

The hose shall be wire reinforced in one of the following forms:

- a. Form 1: Helical - wire (metallic or nonmetallic) reinforcement which can be axially compressed, but not elongated beyond its free length.
- b. Form 2: Helical convoluted - Wire (metallic) reinforcement if specified which can be axially compressed and elongated.
- c. Form 3: Annular convoluted - Wire ring reinforcement if required for pressure, which can be axially compressed and elongated.
- d. Form 4: Sleeve - No reinforcement other than fabric which cannot be axially compressed or elongated.

2. REFERENCES:

2.1 Applicable Documents:

The following publications, of the issue in effect on the date of invitation for bids or request for proposal, form a part of this document to the extent specified herein.

2.1.1 SAE Publications: Available from SAE, 400 Commonwealth Drive, Warrendale, PA 15096-0001.

- AS1241 Fire Resistant Hydraulic Fluid for Aircraft
- AS1502 Hose, Air Duct, Flexible, Helical, Metallic Wire Supported (Exposed), Self Extinguishing
- AS1503 Hose, Air Duct, Flexible, Helical, Metallic Wire Supported (Covered), Self Extinguishing
- AS1504 Hose, Air Duct, Flexible, Helical, Nonmetallic Wire Supported (Exposed), Self Extinguishing
- AS1505 Hose, Air Duct, Flexible, Annular Convoluted, Self Extinguishing
- AS1506 Hose, Air Duct, Semiflexible, Sleeve Section, Unreinforced, Self Extinguishing
- AS1541 Hose, Air Duct, Flexible, Helical Convoluted, Metallic Wire Supported (Covered), Self Extinguishing
- AS1542 Hose, Air Duct, Flexible, Helical Convoluted, Self Extinguishing
- AS1543 Hose, Air Duct, Semiflexible, Sleeve Section Unreinforced, Self Extinguishing, Nomex
- AS1544 Hose, Air Duct, Flexible, Helical, Nonmetallic Wire Supported (Covered), Silicone Rubber, Self Extinguishing
- AS1591 Hose, Air Duct, Flexible, Polyurethane Coated Nylon Fabric, External Nylon Helix, Self Extinguishing
- AS4546 Hose, Air Duct, Flexible, Silicone Coated Fabric, External Nylon Helix, Self extinguishing

2.1.2 ASTM Publications: Available from American Society for Testing and Materials, 1916 Race Street, Philadelphia, PA 19103.

- (R) ASTM A 853 Wire, Steel, Carbon (Round, Bare, and Coated)
- ASTM B 194 Copper-Beryllium Alloy Plate, Sheet, Strip and Rolled Bar (Copper Alloy Numbers 170 and 172)
- ASTM B 117 Salt Spray (Fog) Testing, Method of Test for (ANSI Z118.1-74)
- (R) ASTM A 313 Chromium Nickel Stainless and Heat Resisting Steel, Spring Wire

2.1.3 AIA Publication: Available from Aerospace Industries Association, 1250 Eye Street NW, Washington, DC 20005.

NAS1922 Clamp, Hose, Band, Tangential Worm, Lightweight

2.1.4 U.S. Government Publications: Available from Standardization Documents Order Desk, 700 Robbins Avenue, Building 4D, Philadelphia, PA 19001.

- FAR 25.853 Federal Aviation Regulation, Volume III, Part 25
- QQ-P-35 Passivation Treatments for Corrosion-Resisting Steel
- QQ-A-250/4 Aluminum Alloy, Plate and Sheet, 2024
- QQ-P-416 Plating, Cadmium (Electrodeposited)
- TT-I-735 Fluid, Anti-Icing (Isopropyl Alcohol)
- TT-S-735 Standard Test Fluids, Hydrocarbon
- MIL-Y-1140 Yarn, Cord, Sleeving, Cloth, and Tape-Glass
- MIL-P-5425 Plastic, Sheet Acrylic, Heat Resistant
- MIL-H-5606 Hydraulic Fluid, Petroleum Base; Aircraft, Missile, and Ordnance
- MIL-T-5624 Turbine Fuel, Aviation, Grades JP-4 and JP-5
- MIL-L-6082 Lubricating Oil, Aircraft Reciprocating Engine (Piston)
- MIL-L-6085 Lubricating Oil, Aircraft Instrument, Low Volatility
- MIL-L-7808 Lubricating Oil, Aircraft Turbine Engine, Synthetic Base
- MIL-S-18729 Steel Plate, Sheet and Strip, Alloy 4130, Aircraft Quality
- MIL-L-23699 Lubricating Oil, Aircraft Turbine Engine, Synthetic Base
- DOD-STD-100 Engineering Drawing Practices
- MIL-STD-129 Marking for Shipment and Storage
- MIL-STD-130 Identification Marking of U.S. Military Property
- MIL-STD-810 Environmental Test Methods
- MS21920 Clamp, Hose (Flat Band, 500 °F)
- MS33660 Tubing End, Hose Connection, Standard Dimensions For
- MS35842 Clamp, Hose: Low Pressure, Type "F"

3. REQUIREMENTS:

3.1 Qualification:

Any hose assembly furnished under this document shall be a product identical in construction to the specimens which have been tested and passed the qualification tests specified herein.

3.2 Materials:

The hose assembly materials shall be uniform in quality, free from defects, suitable for its intended use, consistent with good manufacturing practices, and in conformance with the applicable specifications and requirements specified herein. Materials used in these hose assemblies shall be selected from those listed in Table 3.

3.3 Design and Construction:

Hose furnished under this document shall be in accordance with requirements of AS1502, AS1503, AS1504, AS1505, AS1506, AS1541, AS1542, AS1543, AS1544, AS1591, and AS4546 and shall comply with the grades of construction and forms of manufacture as specified on the individual standards.

3.3.1 Soft End Couplings (Cuffs): Soft end couplings (cuffs) shall be formed by omitting the reinforcement wire (metallic or nonmetallic) from the end portion of the hose. See 3.3.3 for termination of wire ends. The inner layer of fabric of the hose shall be continuous for the entire length of the hose and couplings. The soft ends shall have sufficient resilience for a snug fit over a rigid tube end conforming to Type A of MS33660 but shall be resistant to flow deformation to prevent clamp loosening and hose blow-off during service.

3.3.1.1 Cuff External Configuration: For high pressure hose assemblies, a bead shall be added to the soft ends when specified on applicable standard or drawing. The width of the bead shall be 0.12 or 0.19 in for hose diameters 4.00 in and smaller and 0.25 to 0.38 in for hose diameters 4.25 in and larger. Height of the bead shall be 0.04 in minimum above the cuff with shape optional.

3.3.1.2 Cuff Internal Configuration: Internally molded seal rings shall be added to soft ends when specified on standard or drawing to reduce joint leakage.

3.3.2 Cut Ends: Cut or plain ends shall be the same as the hose body. Reinforcement wire (metal or nonmetallic) ends shall be crimped and/or terminated in such a manner as to prevent damage to the hose. Cut ends shall be used to a minimum extent possible and shall be used in lower pressure systems and where higher joint leakage can be tolerated.

(R) TABLE 2 - Hose Assembly Data

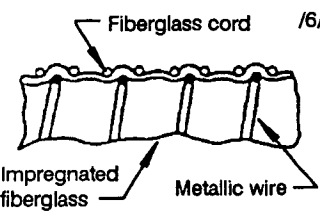
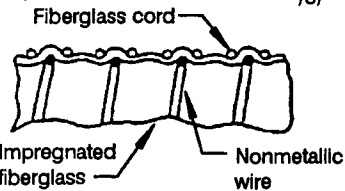
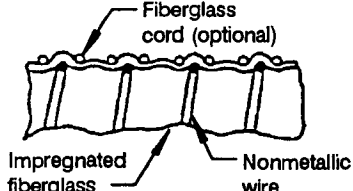
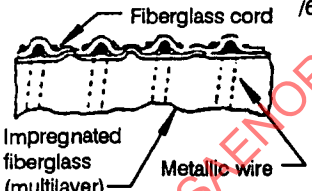
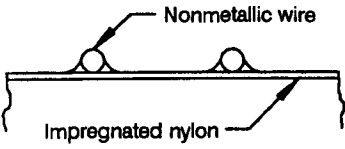
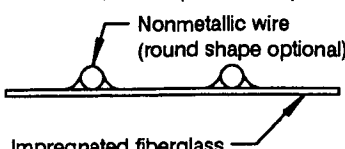
Construction	Maximum weight, lb/ft/in dia	Minimum inside bend radius, in	Crush resistance	Maximum hose leakage, SCFM/ft/in dia	Maximum total joint leakage, SCFM/in hose dia	/3/	/4/	Available types
Form 1, helical (ref. AS1502) 	0.10 Grades A and B	0.50 x hose ID	N/A	0.02	0.20	6	N/A	I & II
Form 1, helical (ref. AS1504) (3.25-in ID and over) 	0.07 Grades A and B	2.0 x hose ID	/5/	0.02	0.10	6	N/A	I
Form 1, helical (ref. AS1504) (3.00-in ID and under) 	0.07 Grades A and B	1 x hose ID	/5/	0.02	0.10	6	N/A	I
Form 1, helical (ref. AS1503) 	0.16 Grades A and B 0.12 Grades C and D 0.20 Grades E and F	1 x hose ID	N/A	0.01 0.02 0.02	0.10	6	N/A	I & II
Form 1, helical (ref. AS1591) 	0.0035 Grade A	0.75 x dia	/5/	0.015	0.10	6	N/A	III
Form 1, helical (ref. AS4546) 	0.004 Grade A	0.75 x dia	/5/	0.015	0.10	6	N/A	II

TABLE 2 (Continued)

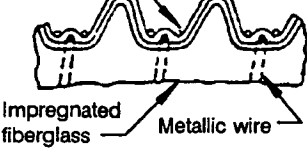
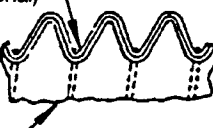
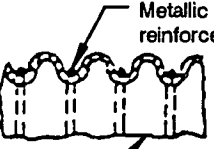
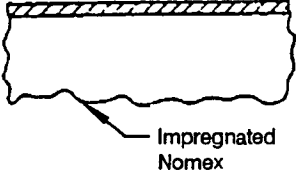
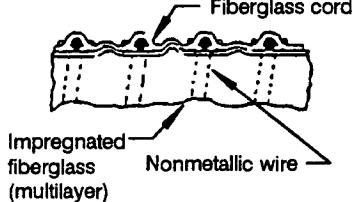
Construction	Maximum weight, lb/ft/in dia	Minimum inside bend radius, in	Crush resistance	Maximum hose leakage, SCFM/ft/in dia	Maximum total joint leakage, SCFM/in hose dia	/3/	/4/	Available types
Form 2, helical (ref. AS1541) Fiberglass cord (optional) /6/  Impregnated fiberglass Metallic wire	0.17 Grades A and B	1.5 x hose ID	N/A	0.01	0.10	6	6	I & II
Form 2, helical (ref. AS1542) Fiberglass cord (optional) /6/  Impregnated fiberglass (multilayer)	0.09 Grade A	1 x hose ID (3-in ID and under) 2 x hose ID (3.25-in ID and over)	N/A	0.02	0.20	20	20	II
Form 3, annular convoluted (ref. AS1505)  Metallic reinforcement ring Impregnated fiberglass /8/	0.24 Grade A	2 x hose ID	N/A	0.01	0.10	6	6	II
Form 3, annular convoluted (ref. AS1505)  Impregnated fiberglass	0.12 Grades C and D	0.75 x hose ID	N/A	0.015	0.10	10	10	I & II
	0.18 Grade B	1.0 x ID	N/A	0.01	0.10	10	10	II
Form 4, sleeve (semi-rigid) (ref. AS1506)  Impregnated fiberglass	0.075 Grades C and D	N/A	/7/	0.02	0.10	N/A	N/A	I & II
	0.10 Grades A and B			0.01	0.10			

TABLE 2 (Continued)

Construction	Maximum weight, lb/ft/in dia	Minimum inside bend radius, in	Crush resistance	Maximum hose leakage, SCFM/ft/in dia	Maximum total joint leakage, SCFM/in hose dia	/3/	/4/	Available types
Form 4, sleeve (semi-rigid) (ref. AS1543) 	0.045 Grade B	N/A	/7/	0.02	0.20	N/A	N/A	II
	0.07 Grade A			0.01	0.10			
Form 1, helical (ref. AS1544) /6/ 	0.10 Grade A	1.0 x hose ID (2.75-in ID and under) 2.0 x hose ID (3.00-in ID and over)	N/A	0.02	0.10	6	N/A	I

/1/ Maximum operating pressure (psi) specified on "AS" standards or drawings varies with hose construction and diameter.

/2/ Inside diameter range shall be in accordance with "AS" standard or drawing.

(R) /3/ Compressibility percentage = $\Delta L/L \times 100$. (Where L is the convoluted length less 1.50 in for wire termination.)

(R) /4/ Extensibility percentage = $\Delta L/L \times 100$. (Where L is the convoluted length less 1.50 in for wire termination.)

/5/ The hose shall be able to be flattened a minimum of 50% of its diameter over its entire length without damage or permanent set. The hose shall return to its full diameter after removal of deforming force and without being pressurized.

/6/ Twisted.

/7/ Sleeve-type hose shall be deformable without permanent set.

/8/ Wire ring reinforced rings shall be butt welded or brazed with a smooth joint and shall fit snug to hose convolutions. One ring per convolution except none adjacent to soft end.

TABLE 3 - Hose Assembly Materials

Component	Material Description	Specification	Finish
Coated Fabric	Fiberglass, chloroprene rubber impregnated	MIL-Y-1140 (fabric only)	As manufactured unless specified otherwise
	Fiberglass, silicone rubber impregnated		
	Meta-aramid, silicone rubber impregnated		
	Nylon, polyurethane impregnated		
Cordage	Fiberglass	MIL-Y-1140	
Reinforcement	Carbon steel hard drawn	ASTM A 853	Coppered per ASTM A 853, Finish 2
			Tinned per ASTM A 853, Finish 3
			Zinc-coated per ASTM A 853, Finish 5, Class 2
			Cadmium-plated per QQ-P-416, Type II, Class 2
	300 series cres.	ASTM A 313	Passivate per QQ-P-35
	Nonmetallic material meeting requirements of 3.5.8		Cadmium-plated per QQ-P-416, Type II, Class 2
			As manufactured unless specified

- 3.3.3 Wire Reinforcement (Metal or Nonmetallic) and Cordage: Wire helical reinforcement shall be inside the hose for one ply construction, except for AS1591 and AS4546 ducts, and between layers for a multilayered hose. The nonmetallic reinforcement wire shall be flame retardant to meet requirements of 3.5.8. For multilayered hoses and where bonding of layers is critical, the fiberglass cordage shall be placed tight to both sides of the reinforcement wire when specified on applicable standard or drawing. The reinforcement wire shall be securely bonded to the fabric over its entire length. Wire ends shall be secured and shall be terminated between layers at the soft ends to prevent piercing or damage to the hose. When specified on the standard or drawing, external fiberglass cordage (single or multicord) shall be securely bonded for its entire length and shall follow helical troughs formed by wire.

- 3.3.3.1 Nonmetallic Wire Heat Resistance: The helix reinforcement shall retain its spring characteristic following exposure to the applicable maximum hose operating temperature specified plus 100 °F. When tested as specified in 4.5.3.1, the helix reinforcement shall be within 40% of the original length without load, and within 60% of original length when tested with load.
- 3.3.3.2 Metallic Wire Corrosion Resistance: External metallic wire and duct constructions with embedded metal wire shall show no evidence of corrosion after it is exposed to saltwater testing. The testing is specified in 4.5.3.2.
- 3.3.4 Coatings: The surface of the hoses may be coated with a self-extinguishing and/or temperature-resistant material to conform to the requirements of this document or procurement drawing. Hoses may also be coated with a resin to decrease effusion rates and to provide additional rigidity, except that no resin shall be applied over the attachment areas, unless specified on the procurement drawing. The coating material shall not be detachable from the hose surface by the airstream and shall not emit a noxious odor when subjected to any temperature within the design range.
- 3.3.5 Coated Fabric Abrasion Resistance: There shall be no evidence of fabric exposure in excess of 10% of the abraded area after experiencing abrasion equivalent to the levels defined in 4.5.3.3. Fabric shall not appear abraded to the naked eye.
- 3.4 Dimensions and Weights:
- 3.4.1 Hose Diameter: The hose diameter is determined by the hose inside diameter and corresponds to the outside diameter or the rigid tube to which it attaches. The tolerance of the inside diameter of convoluted hose assemblies, the hose soft ends, and the sleeve type hoses shall be -0.01 to +0.03 in. The hose outside diameter at the convolution crest for convoluted hose assemblies shall be specified on applicable standard (or drawing).
- 3.4.2 Hose Length: The hose length shall be measured in increments and tolerance as specified on standards and drawings. The length shall be measured as described under 4.5.1.1, when the hose is in an undistorted condition and shall include soft and coupling lengths.
- 3.4.3 Weight: Hose weight shall be kept to a minimum, consistent with good design practices and shall comply with maximum weights specified on applicable standards (or drawings).

3.5 Performance:

The hose assembly minimum bend radius, leakage and operating, proof and burst pressure ratings shall be verified by demonstration of meeting or exceeding the following performance requirements through qualification testing specified herein. Confidence in hose assembly performance shall be maintained by adherence to the quality assurance provisions as specified herein. Hose assemblies shall not show evidence of failure, delamination, cracking, collapse in bending, collapse under vacuum, or permanent deformation during demonstration of performance requirements in accordance with 3.5.2, 3.5.3, 3.5.4, 3.5.6, and 3.5.7 as follows:

a. Notes

- (1) Failure: Any discrepancy that precludes a hose assembly from meeting performance requirements specified herein.
- (2) Delamination: A bubble of fabric separation exceeding 0.1 in² area in any portion of the hose assembly except immediately adjacent to the reinforcement wire of a multilayered hose assembly or a bubble or fabric separation that grows with continued working of hose material.
- (3) Cracking: Internal or external separation of hose surface that grows with continued working of hose material.
- (4) Collapse: Any ovality of the hose that causes a reduction in hose cross sectional area of 5% or greater as defined in 3.5.3.
- (5) Permanent Deformation: Any change in size or shape in excess of the envelope parameters defined by standard or drawing.
- (6) Operating Pressure: Specified on part standards.

3.5.1 Examination of Product: Each hose assembly must conform dimensionally and materially to its applicable standard (or drawing) and to all applicable requirements of this document. Examination is specified in 4.6.1.

3.5.2 Proof Pressure: The hose assembly shall withstand a room temperature (Reference 70 °F) proof pressure of twice the operating pressure specified on its applicable standard (or drawing) without failure. Testing is specified in 4.6.2.

- 3.5.3 Bend Radius: The hose assembly (except Form 4 sleeves) shall bend uniformly to the minimum inside bend radius specified in Table 2. There shall be no indication of segmented bending, buckling, collapse, reduction in cross sectional area in excess of 5%, delamination, or any other indication of failure. Duct material between wire reinforcements shall not move inward into the duct to obstruct flow. Reduction in area shall be determined by:

$$1 - \frac{D_{(max)} \times D_{(min)}}{D^2 (FREE)} \times 100 \leq 5\% \quad (Eq.1)$$

where:

D = hose assembly outside diameter

Testing is specified in 4.6.3.

- 3.5.4 Leakage: The hose assembly shall not exceed the maximum allowable leakage rates specified in the applicable standard (or drawing) at room temperature. Testing is specified in 4.6.4.
- 3.5.5 Blow Off: The hose assembly shall not blow off of a MS33660 beaded rigid tube nor show any evidence of the hose creeping from under the clamp at two times specified applicable standard (or drawing) operating pressure at maximum operating temperature. Testing is specified in 4.6.5.
- 3.5.6 Burst Pressure: The hose assembly shall not burst nor show evidence of failure at three times the operating pressure specified in the applicable standard (or drawing) at any temperature between the minimum and the maximum operating temperatures. Testing is specified in 4.6.6.
- 3.5.7 Flexure and Pressure Cycling: Hose assembly shall show no evidence of delamination, cracking, or deterioration and shall satisfactorily pass proof pressure test, 3.5.2, after flexure as stated in 4.6.7.
- 3.5.8 Self-Extinguishing: The hose assemblies, when tested vertically, shall meet the self-extinguishing requirements of Federal Aviation Regulation, FAR 25-32, paragraph 25.853 (b), as follows:
- Self-extinguishing: 15 s average
 - Maximum burn length: 8.0 in average
 - Drippings self-extinguishing time: 5 s average
- Testing is specified in 4.6.8.
- 3.5.9 Odor and Fungus: This hose assembly shall not be a nutrient to fungi, contain any substance which is injurious to the skin, health, or emit a toxic or unpleasant odor when subjected to any temperature within the applicable operating temperature range. Testing is specified in 4.6.9.

- 3.5.10 Fluid Resistance: The hose assembly shall show no evidence of delamination, wicking, tackiness or structural degradation when exposed to Table 4 fluids. Testing is specified in 4.6.10.

TABLE 4 - Test Fluids

Fluid	Specification
Standard test fluids, hydrocarbon	TT-S-735, Types I and II
Anti-icing (isopropyl alcohol)	TT-I-735
Hydraulic fluid, petroleum base	MIL-H-5606
Hydraulic fluid, phosphate ester	AS1241, high and low density
Fuel	MIL-T-5624, Type JP-5
Lubricating oil, engine	MIL-L-6082
Lubricating oil, instrument	MIL-L-6085
Lubricating oil, turbine engine	MIL-L-7808 or MIL-L-23699
Water	3.51 NaCl solution

(R)

- 3.5.11 Plexiglass Polycarbonate Crazing: Plasticizer, extracted from hose material(s) shall not craze plexiglass or polycarbonates conforming to MIL-P-5425. Testing is specified in 4.6.11.
- 3.5.12 Corrosion: Polished metal samples shall show no evidence of corrosion when in contact with hoses. Testing is specified in 4.6.12.

3.6 Hose Clamp:

The hose clamp and torque requirements must be specified on installation drawing and/or specification. See design note below. For hose qualification testing, hose installation and clamping shall be in accordance with Figure I and Table 5.

DESIGN NOTE: Allowable hose pressure and hose end leakage are dependent on type clamp used, clamp torque and stiffness and configuration of rigid hose end.

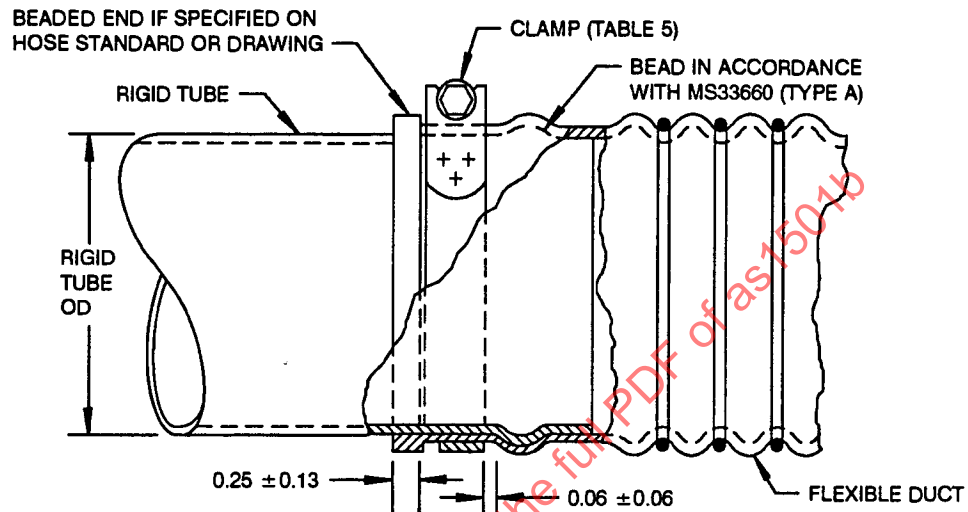


FIGURE 1 - Hose Clamp Installation

TABLE 5 - Tightening Torques

Clamp	Torque in-lb	Specimen /1/ Diameter in
MS21920	20 - 25	2.50 and 10
MS35842	18 - 22	2 thru 7
NAS1922	18 max	2 thru 10

/1/ For larger hose diameters assemble in tandem two or more clamps to obtain the required size.

3.7 Part Numbering of Interchangeable Parts:

All parts having the same manufacturer's part number shall be functionally and dimensionally interchangeable. The item identification and part number requirements of DOD-STD-100 shall govern the manufacturer's part number and changes thereto.

3.8 Identification of Product:

Each hose assembly shall be durably and legibly marked with an oil-resistant marking fluid in no less than two suitable places, size permitting or tagged in accordance with MIL-STD-130, with the following information:

- a. Cage code number/manufacturer's part number
- b. Manufacturer's name or trademark
- c. Complete standard, specification control, or drawing number
- d. Date of hose manufacture expressed in terms of month and year

3.9 Workmanship:

The hose assembly shall be free of defects and shall be constructed and finished in a thoroughly workmanlike manner.

4. QUALITY ASSURANCE PROVISION:

4.1 Supplier's Responsibility:

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

4.2 User's Responsibility:

The purchaser should establish adequate inspection procedures to ensure that all requirements of this document are met. Receiving inspections should consist of, but are not limited to, the following verifications:

- a. Dimensional conformance
- b. Material, finish and workmanship
- c. Marking
- d. Pressure and leakage 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 are intended to qualify the manufacturer's design, materials, and manufacturing processes to produce a hose that meets the performance requirements of this document. The purchaser shall be notified at least 14 days prior to the start of test and shall reply within 7 days prior to start of test of intent to witness the test. Any changes in the manufacturing process, parts or materials that affect the quality assurance provisions of this document shall have prior approval from the purchaser.

- 4.4.1 Test Specimens: Seven hose assemblies of each grade (defining type, weight, and construction) as specified by each applicable standard (or drawing) shall be used for qualifying performance of the manufacturer's product. The assemblies shall be fabricated according to the manufacturer's production procedures and drawing and shall be the length and diameter specified on Table 6.

TABLE 6 - Specimen Diameter and Length (inches)

Specimen Number	1	2	3	4	5	6	7	8	9	10	11
Hose Diameter	2	2	2	4	4	6	6	10	10	14	14
Hose Length (Form 1)	19	12	12	36	16	50	20	82	24	113	28
Hose Length (Form 2)	19	6	6	36	9	50	12	82	18	113	24
Hose Length (Form 3)	19	6	6	36	9	50	12	82	18	113	24
Hose Length (Form 4)	16	N/R	6	6	N/R	15	6	6	N/R	6	N/R

4.4.2 Test Schedule and Sequence:

- 4.4.2.1 Hose Assembly Test: Test specimens shall be subjected to qualification tests in the order indicated in Table 7 (from top to bottom)
- 4.4.2.2 Materials Test: The material test of 4.5.3 shall be performed on representative samples of the hose materials.

4.5 Quality Conformance Inspections:

Quality conformance inspections shall consist of the following inspections:

- Individual tests (100% inspection except as noted) (4.5.1).
- Sampling tests (4.5.2).
- Material tests (4.5.3).

TABLE 7 - Test Schedule and Sequence for Qualification Testing

Hose Assembly Qualification Test	Specimen Number 1	Specimen Number 2	Specimen Number 3	Specimen Number 4	Specimen Number 5	Specimen Number 6	Specimen Number 7	Specimen Number 8	Specimen Number 9	Specimen Number 10	Specimen Number 11
Examination of Product (4.6.1)	X	X	X	X	X	X	X	X	X	X	X
Leakage Rate Test (4.6.4) /2/	X	X	X	X	X	X	X	X	X	X	X
Proof Pressure Test (4.6.2)	X	X	X	X	X	X	X	X	X	X	X
Bend Radius Test (4.6.3) /1/	X			X		X		X		X	
Leakage Rate Test (4.6.4) /2/	X			X		X		X		X	
Proof Pressure Test (4.6.2)	X			X		X		X		X	
Blow Off Test (4.6.5)	X			X		X		X		X	
Burst Pressure Test (4.6.6)	X			X		X		X		X	
Flexure and Pressure Cycling Test (4.6.7) /1/		X			X		X		X		X
Leakage Rate Test (4.6.4) /1/ /2/		X			X		X		X		X
Proof Pressure Test (4.6.4) /1/		X			X		X		X		X
Self-Extinguishing Test (4.6.8)						X					
Odor and Fungus Test (4.6.9)				X							
Hydraulic Fluid and Water Resistance Test (4.6.10)		X									
Plexiglass and Polycarbonate Crazing Test (4.6.11)							X				
Corrosion Test (4.6.12)							X				

/1/ Not required for sleeve type (Form 4) hose assemblies.

/2/ Leakage test may be performed in conjunction with proof pressure test.

4.5.1 Individual Tests (Functional Tests): All production hoses shall be tested as follows:

- a. Examination of product (4.5.1.1).
- b. Leakage and proof pressure test (4.5.1.2).
- c. Bend radius test (4.5.1.3).

4.5.1.1 Examination of Product: Each hose shall be inspected to assure dimensional conformance and product construction in accordance with the applicable standard (or drawing). Lengths shall be measured on a smooth horizontal surface with a 1 lb tensile load applied to the end of the duct. One hose out of each production run shall be weighed to ensure compliance with the weight requirement.

4.5.1.2 Leakage and Proof Pressure Test: One hose assembly out of each production run of hose assemblies having the same diameter, material, and construction shall be tested at room temperature. A leakage test in accordance with 4.6.4 and a proof pressure test in accordance with 4.6.2 shall be conducted. Operations may be combined to facilitate testing. A hose failure to pass either or both of the tests, or collapse in negative pressure testing, is reason for 100% testing (prior to shipment to the purchaser) of the remaining hose assemblies having the same diameter, material, and construction as the failed item in the production run.

4.5.1.3 Bend Radius Test: One hose out of each production run of hose assemblies of the same diameter, material, and construction shall be tested in accordance with 4.6.3 except at room temperature without prior conditioning and length permitting. A hose failure to pass the bend radius test is reason for 100% testing of the remaining hose assemblies of the same diameter, material, and construction as the failed item in the production run.

4.5.2 Sampling Test: In a period of time not exceeding 2 years, a self-extinguishing test in accordance with 4.6.8 shall be conducted for each type and form hose assembly constructed by the manufacturer in accordance with this document. The hose assembly to be tested shall be selected at random from production hose assemblies.

4.5.3 Material Tests:

4.5.3.1 Nonmetallic Reinforcement, Heat Resistance Test: Heat resistance tests shall be conducted as follows:

- a. Measure a test length in vertical position
- b. Apply a load to extend test length to 4x free length, record weight
- c. Subject reinforcement to operating temperature plus 100 °F for 50 h
- d. Following heat soak, allow reinforcement to stabilize at room temperature
- e. Measure free length without weight in vertical position
- f. Measure extended length with same load as used before 50 h heat soak

Testing shall be conducted in intervals not exceeding 5 years.

4.5.3.2 Metal Wire, Salt Spray Test: Samples of externally installed metal wire, and of duct material with embedded wire, as constructed in the duct, shall be subjected to salt spray test for 100 h in accordance with ASTM B 117. Testing shall be conducted in intervals not exceeding 5 years.

4.5.3.3 Abrasion Resistance Test: Samples for this test shall be 4 in x 12 in and shall be of the material representative of the outside surface of the hoses. Type I material shall be subjected to a minimum of 2500 cycles on a Tabor Abrader using a H-22 Calibrase Wheel under a log of 1 kg. (An alternate of 20 000 cycles minimum under a 1 kg load using a CS-17 Calibrase Wheel. Testing shall be conducted in intervals not exceeding 5 years.

4.6 Test Method:

The following notes are applicable as indicated to the qualification tests contained in this paragraph of the document:

- a. Note 1: Specimen shall be mounted in a straight line position on test mounts similar to the mount shown in Figure 2 except that both ends shall be rigidly fixed in respect to each other so hose can neither lengthen nor shorten during test. This note is applicable to tests, 4.6.2, 4.6.4, 4.6.5, and 4.6.6.
- b. Note 2: Temperatures, pressures, and other test specifications shall be within +10, -0% of specified values.
- c. Note 3: Specimens must be conditioned to $70^{\circ}\text{F} \pm 5$ and at $50\% \pm 5$ relative humidity until moisture equilibrium is reached or for 24 h. Only one specimen at a time may be removed from the conditioning environment immediately before subjecting to tests, 4.6.8.

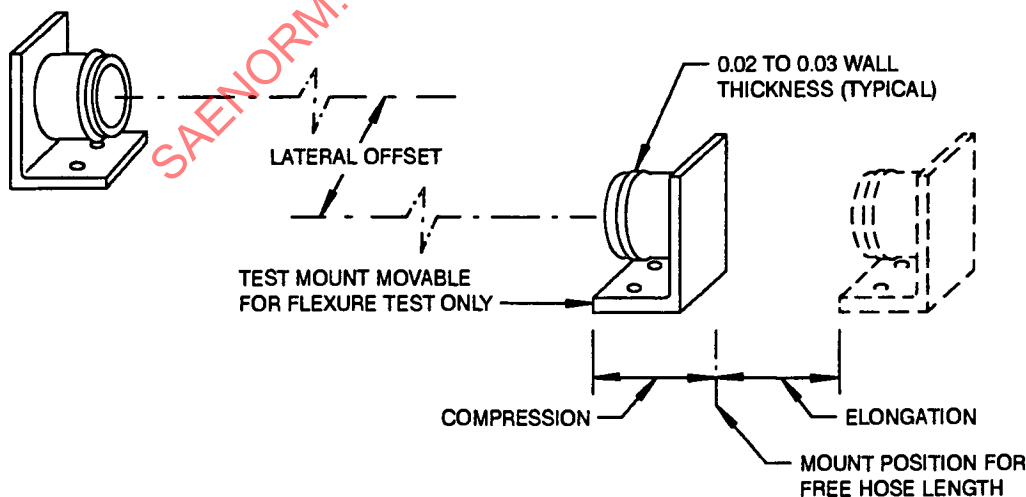


FIGURE 2 - Test Mounts for Flexure and Other Test

- 4.6.1 Examination of Product: Each hose assembly shall be examined to determine compliance with this document with respect to material, size, workmanship, dimensions, weight, and bending characteristics.
- 4.6.2 Proof Pressure Test: Hose assemblies shall be subjected to a proof pressure test as described. Tests shall be conducted at room temperature. Clamps securing the end plugs shall be selected from Table 5 and shall be torqued to the specified value in Table 5. Continuous pressurization (or evacuation) shall be maintained to compensate for hose leakage. Hose shall be tested for 5 min without evidence of failure. A suitable vacuum pump shall be used to evacuate hose for negative pressures.
- 4.6.2.1 Proof Pressure Test, Positive Pressure: Hose assemblies shall be subjected to a proof pressure test of twice the operating pressure for hose diameter specified by the applicable standard (or drawing).
- 4.6.2.2 Proof Pressure Test, Negative Pressure: Hose assemblies rated for negative pressures between 0 psi and -0.9 psi shall be proof tested at 2x rated negative pressure. Hose assemblies rated for negative pressures - 1 psi and lower shall be proof tested at 1 psi lower than the rated negative pressure.
- 4.6.3 Minimum Bend Radius Test:
- 4.6.3.1 Maximum Operating Temperature Conditions: Hose assemblies shall be maintained at the maximum operating temperature for type hose being tested for a period of $72 \text{ h} \pm 2$. At the end of the conditioning period, one hose assembly at a time shall be removed from oven and shall be flexed six times for 90° to minimum bend radius specified by the applicable standard (or drawing). After flexing the hose, it shall be bent 180° to minimum specified bend radius; then reduction in cross sectional area, if any, shall be measured.
- 4.6.3.2 Minimum Operating Temperature Conditions: Hose assemblies shall be maintained at the minimum operating temperature for type hose being tested for a period of $24 \text{ h} \pm 2$. At the end of the conditioning period, one hose assembly at a time shall be removed and shall be tested as described in 4.6.3.1. Hose assembly shall withstand proof pressure test in accordance with 4.6.2 and leakage test in accordance with 4.6.4.
- 4.6.4 Leakage Test: The leakage test shall be conducted as illustrated in Figure 5 at room temperature while pressurized to the applicable operating pressure specified on the standard drawing. Clamps securing the end plugs shall be selected from Table 5 and shall be torqued to the specified value in Table 5. A suitable flow meter will be used to measure leakage and in all cases the leakage volume shall be corrected to standard cubic feet per minute (SCFM). Maximum allowable leakage rates are specified in Table 2 and on the part standards.
- (R)