

SURFACE VEHICLE RECOMMENDED PRACTICE

Submitted for recognition as an American National Standard

SAE J2044

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SAE QUICK CONNECTOR SPECIFICATIONS FOR LIQUID FUEL SYSTEMS

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1. Scope—This SAE Recommended Practice defines minimum functional requirements for quick connectors used in supply and return, liquid lines, for flexible tubing fuel systems. The document applies to automotive and light truck gasoline and diesel fuel systems, with operating pressures up to 500 kPa, 5 Bar, (72.5 psig), and the fuel lines and connectors routed such that continuous operating temperature exposure is less than 115 °C (239 °F). These tests apply to new fittings in assembly operations: for service operations, the male tube should be lubricated with engine oil before coupling.

Vehicle O.E.M. fuel system specifications may impose additional requirements beyond the scope of this general SAE document. In those cases, the O.E.M. specification takes precedence over this document.

2. References

2.1 Applicable Documents—The following publications form a part of this specification to the extent specified herein. The latest issue of SAE publications shall apply.

2.1.1 SAE PUBLICATIONS—Available from SAE, 400 Commonwealth Drive, Warrendale, PA 15096-0001.

SAE J2045—Flexible Hose Assemblies for Gasoline Fuel Injection Fuel Supply Systems

2.1.2 ASTM PUBLICATIONS—Available from ASTM, 1916 Race Street, Philadelphia, PA 19103.

ASTM B 117—Method of Salt Spray (Fog) Testing

ASTM D 1171-68—Test Method for Rubber Deterioration—Surface Ozone Cracking Outdoors or Chamber Triangular Specimens)

ASTM G 23—Practice for Operating Light- and Water-Exposure Apparatus (Carbon-Arc Type) for Exposure of Nonmetallic Materials

3. Size Designation—For this document, the quick connector size designation consists of two numbers. The first number designates the OD of the mating tube end, and the second number designates the tubing size suited to the stem. (See Figures 1 to 5.)

NOTE—On nylon and metal tubing, the OD is used to designate size; rubber and P.T.F.E. hose use the I.D. to designate size.

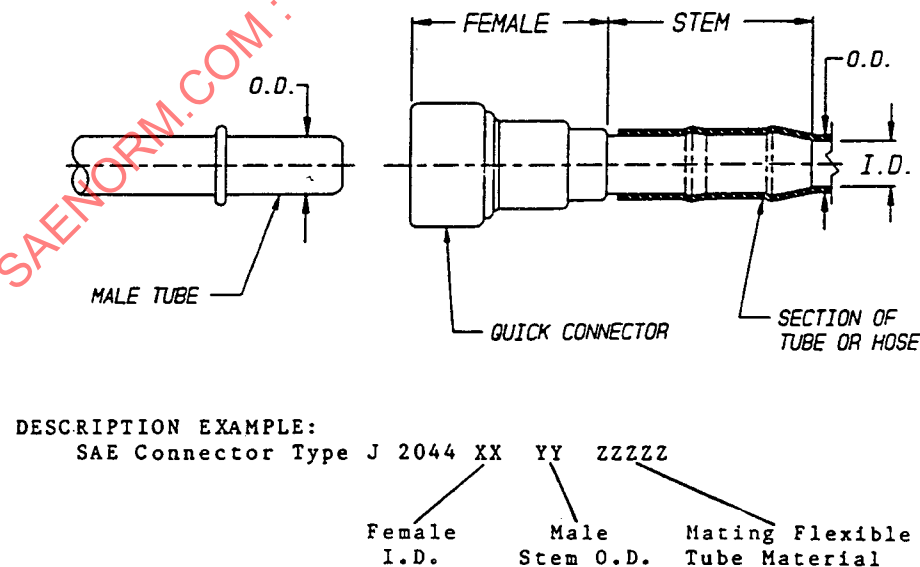
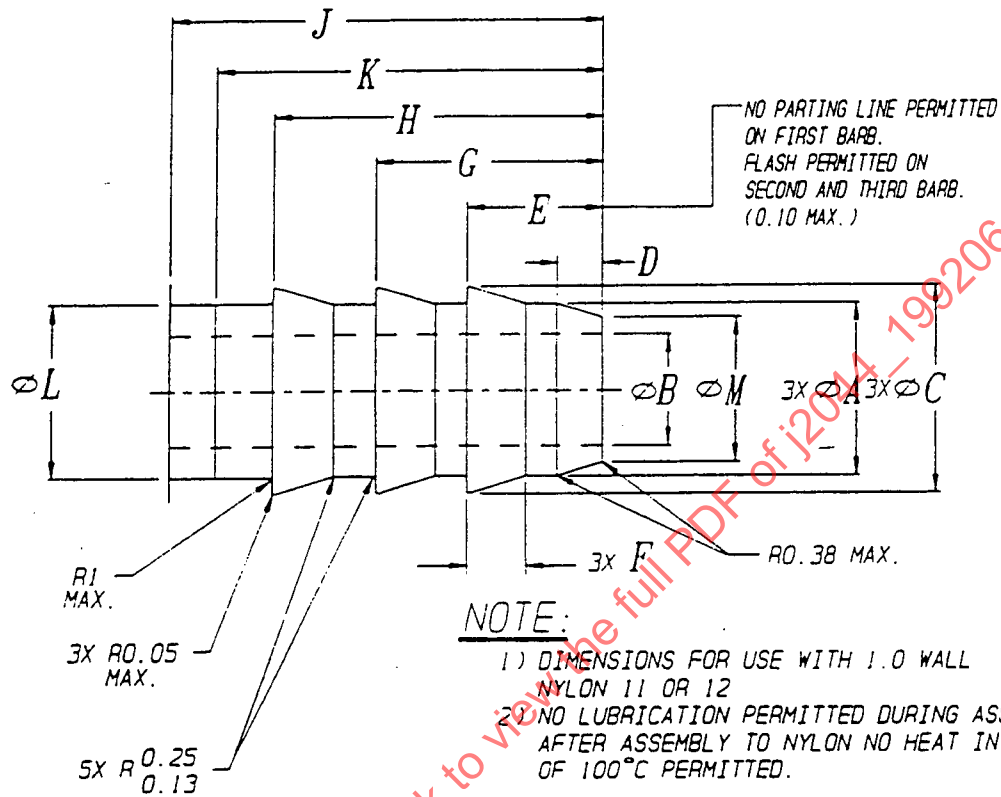


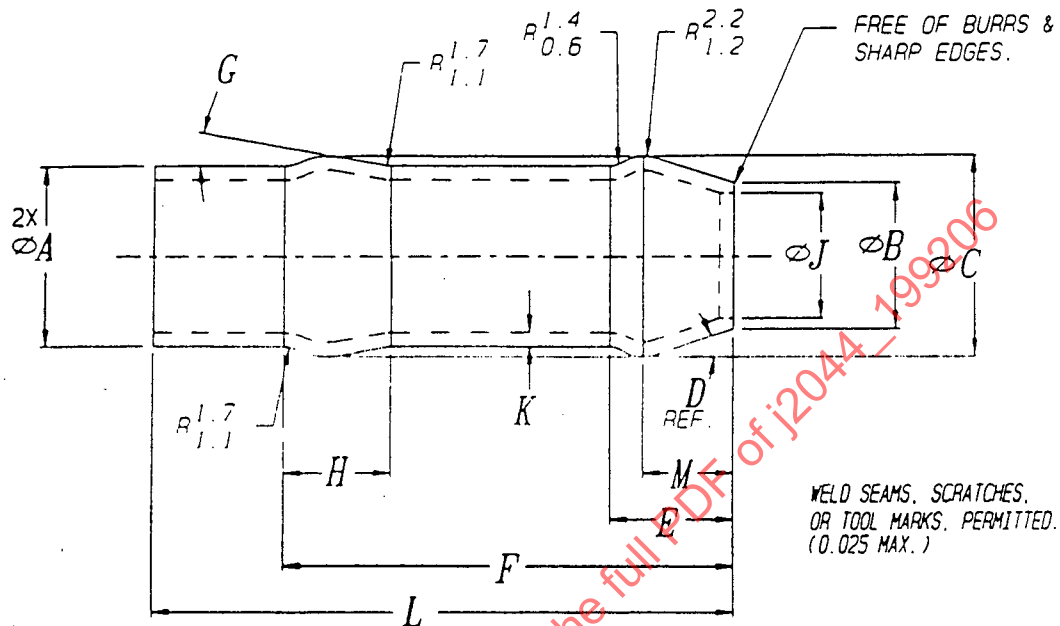
FIGURE 1—SIZE DESIGNATION



SIZE	A Ø O.D.	B I.D.	C BARB O.D.	D CHAMFER	E 1ST BARB	F BARB WIDTH	G 2ND BARB	H 3RD BARB	J LENGTH	K NYLON INTERFACE	L SHAFT O.D.	M LEAD O.D.
1/4" (6.35)	N/A	N/A	N/A	3.1 2.5	6.13 5.86	2.72 2.46	10.14 9.88	14.64 14.37	18.6 MIN.	17 MIN.	N/A	N/A
5/16" (7.93)	7.52 7.27	4.83 4.67	9.10 8.70	2.25 1.75	6.25 5.75	2.85 2.35	10.25 9.75	14.75 14.25	19.0 MIN.	17 MIN.	8.25 7.75	6.25 6.09
3/8" (9.53)	9.44 9.29	6.08 5.88	11.12 10.60	2.25 1.75	6.25 5.75	2.85 2.35	10.25 9.75	14.75 14.25	19.5 MIN.	19 MIN.	9.85 9.29	7.87 7.67
1/2" (12.7)	12.45 12.30	9.34 9.08	14.65 14.50	2.25 1.75	6.25 5.75	2.75 2.25	10.25 9.75	14.75 14.25	20.0 MIN.	20 MIN.	N/A	10.70 10.55
8mm (.315")	7.52 7.27	4.83 4.67	9.10 8.70	2.25 1.75	6.25 5.75	2.85 2.35	10.25 9.75	14.75 14.25	19.0 MIN.	17 MIN.	8.25 7.75	6.25 6.09
10mm (.394")	9.92 9.77	6.56 6.36	11.60 11.08	2.25 1.75	6.25 5.75	2.85 2.35	10.25 9.75	14.75 14.25	19.5 MIN.	19 MIN.	9.92 9.77	8.35 8.15

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FIGURE 2—TYPICAL MOLDED OR MACHINED STEM CONFIGURATION FOR PLASTIC TUBING

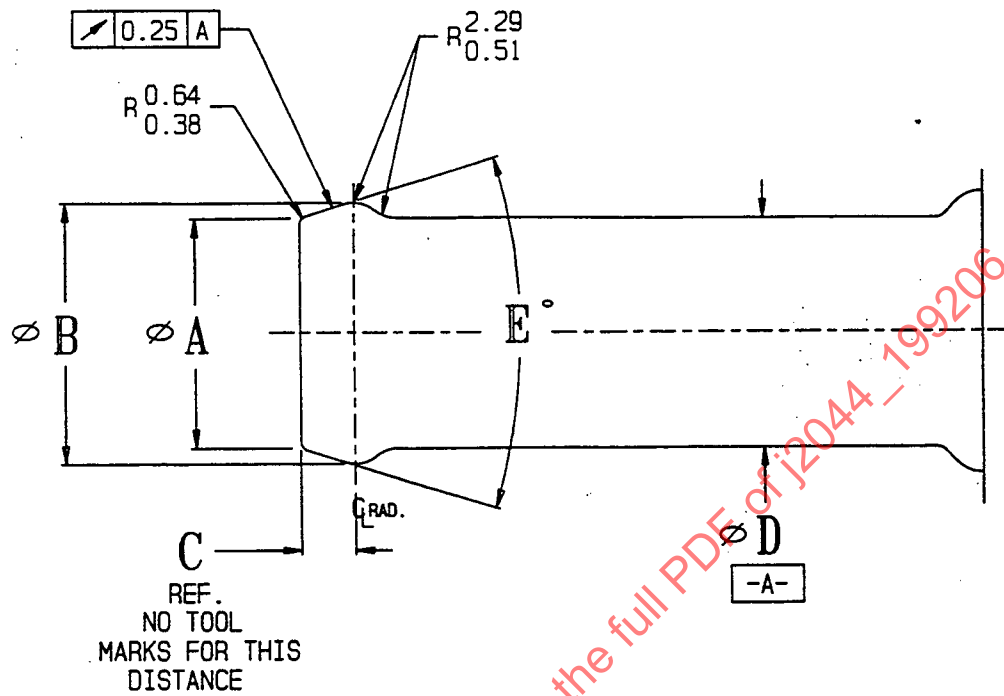
**NOTE:**

- 1) DIMENSIONS FOR USE WITH 1.0 WALL NYLON 11 OR 12
- 2) NO LUBRICATION PERMITTED DURING ASSEMBLY. AFTER ASSEMBLY TO NYLON NO HEAT IN EXCESS OF 100°C PERMITTED.

SIZE	A TUBE DIA.	B TUBE END	C BEAD DIA.	D REF. CHAMFER	E BEAD LENGTH	F LENGTH	G BEAD ANGLE	H BEAD WIDTH	J I.D.	K WALL THICK	L NYLON INTERFACE	M LENGTH
1/4" (6.35)	6.35	N/A	N/A	N/A	N/A	19.15 17.65	9°11'	5.0 4.5	3.84 MIN.	.62 MIN.	30.0 MIN.	N/A
5/16" (7.92)	7.92	6.60 6.10	8.89 8.64	15°	7.11 5.84	20.05 19.55	9°11'	5.0 4.5	4.67 MIN.	.62 MIN.	30.0 MIN.	4.0
3/8" (9.53)	9.53	8.12 7.62	10.41 10.16	17°	7.36 6.09	21.35 20.85	9°11'	5.0 4.5	5.90 MIN.	.62 MIN.	33.0 MIN.	4.5
1/2" (12.7)	12.70	N/A	N/A	N/A	N/A	19.15 17.65	9°11'	5.0 4.5	9.33 MIN.	.62 MIN.	33.0 MIN.	N/A
8mm (.315")	7.57	6.25 5.75	8.54 8.29	15°	7.11 5.84	20.05 19.55	9°11'	5.0 4.5	4.32 MIN.	.62 MIN.	30.0 MIN.	4.0
10mm (.394")	10.00	8.60 8.10	10.89 10.64	17°	7.36 6.09	21.35 21.85	9°11'	5.0 4.5	6.38 MIN.	.62 MIN.	33.0 MIN.	4.5

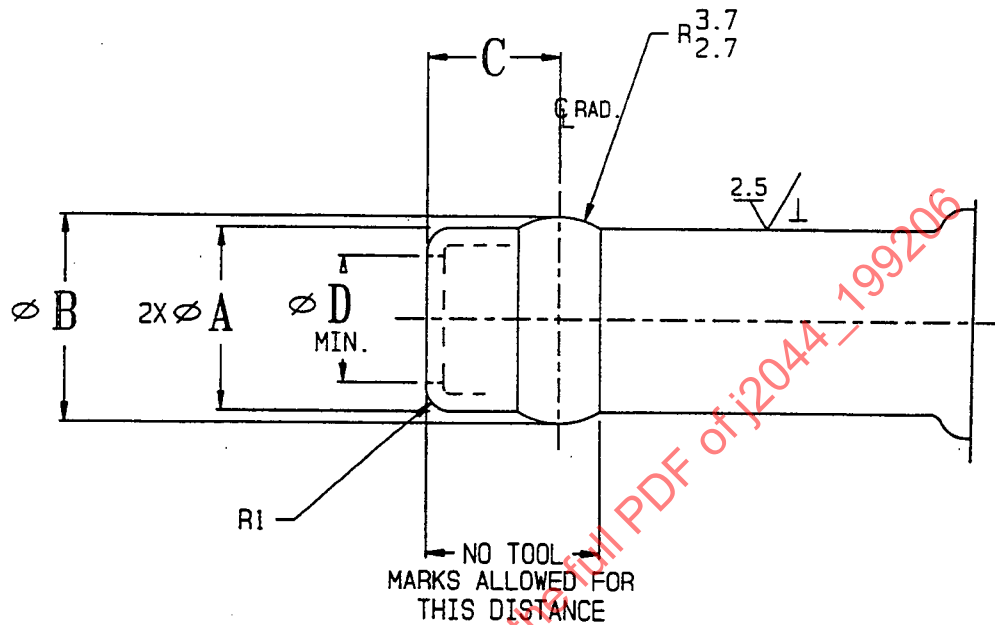
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FIGURE 3—TYPICAL STEEL TUBE STEM CONFIGURATION FOR PLASTIC TUBING



SIZE	A END O.D.	B BARB O.D.	C BARB CENTER LINE	D STEM O.D.	E BARB ANGLE
1/4" (6.35)	6.20	7.37	2.54	6.35	30° 26°
5/16" (7.93)	7.78	9.14	2.54	7.93	30° 26°
3/8" (9.53)	9.38	10.92	2.54	9.53	30° 26°
1/2" (12.70)	12.55	14.22	3.05	12.70	30° 26°
8mm (.315")	7.85	9.14	2.54	8.0	30° 26°
10mm (.394")	9.85	11.14	2.54	10.0	30° 26°

FIGURE 4—TYPICAL MOLDED OR MACHINED END CONFIGURATION FOR RUBBER HOSE



SIZE	A END O.D.	B BARB O.D.	C BARB CENTER LINE	D MIN. I.D.
1/4" (6.35)	6.35	7.34	5.08	4.11
5/16" (7.94)	7.94	8.92	5.46	5.60
3/8" (9.53)	9.53	10.52	5.84	7.11
1/2" (12.70)	12.70	13.72	6.22	10.49
8mm (.315")	8.00	8.56	5.46	5.13
10mm (.394")	10.00	10.99	5.84	7.51

FIGURE 5—TYPICAL MOLDED OR MACHINED END CONFIGURATION FOR P.T.F.E. TUBE

4. Test Temperatures—Unless otherwise specified all tests will be performed at room temperature $23^{\circ}\text{C} \pm 2^{\circ}\text{C}$ ($73.4^{\circ}\text{F} \pm 4^{\circ}\text{F}$).

5. Functional Requirements—This section defines the minimum functional requirements for quick connectors used in flexible tubing fuel systems.

5.1 Leak Test—Fuel system quick connectors shall meet the leak test requirements of this document. In order to provide a production compatible process, all leak testing should be performed using compressed air to insure the connectors will not leak fuel.

5.1.1 TEST PROCEDURE—Insert leak test pins, shown in Figure 6, into the quick connectors and pressurize between the O-ring seals with suitable air leak test equipment.

5.1.2 LOW PRESSURE— $69\text{ kPa} \pm 7\text{ kPa}$, $0.69\text{ bar} \pm 0.07\text{ bar}$ ($10\text{ psig} \pm 1\text{ psig}$).

5.1.3 ACCEPTANCE CRITERIA—2 cc/minute, Maximum

5.1.4 HIGH PRESSURE— $1034\text{ kPa} \pm 35\text{ kPa}$, $10.34\text{ bar} \pm 0.35\text{ bar}$ ($150\text{ psig} \pm 5\text{ psig}$).

5.1.5 ACCEPTANCE CRITERIA—5 cc/minute, Maximum

5.2 Connector Assembly Effort—Connector assembly effort is the force required to fully insert (latch or retain) the male tube end into the quick connector. Use a tensile/compression tester suitable to verify conformance of this document.

5.2.1 TEST PROCEDURE—For New Parts

- a. Test the connector as supplied. Do not add additional lubrication to the connector or test pin.
- b. Attach quick connect fitting to suitable test fixture.
- c. Wipe the test pins, before each test, with a clean lint free cloth to prevent an accumulation of lubrication.
- d. Insert assembly test pin, shown in Figure 7, into the connector at a rate of $51\text{ mm/min} \pm 5\text{ mm/min}$ ($2\text{ in/min} \pm 0.2\text{ in/min}$) and measure assembly effort.

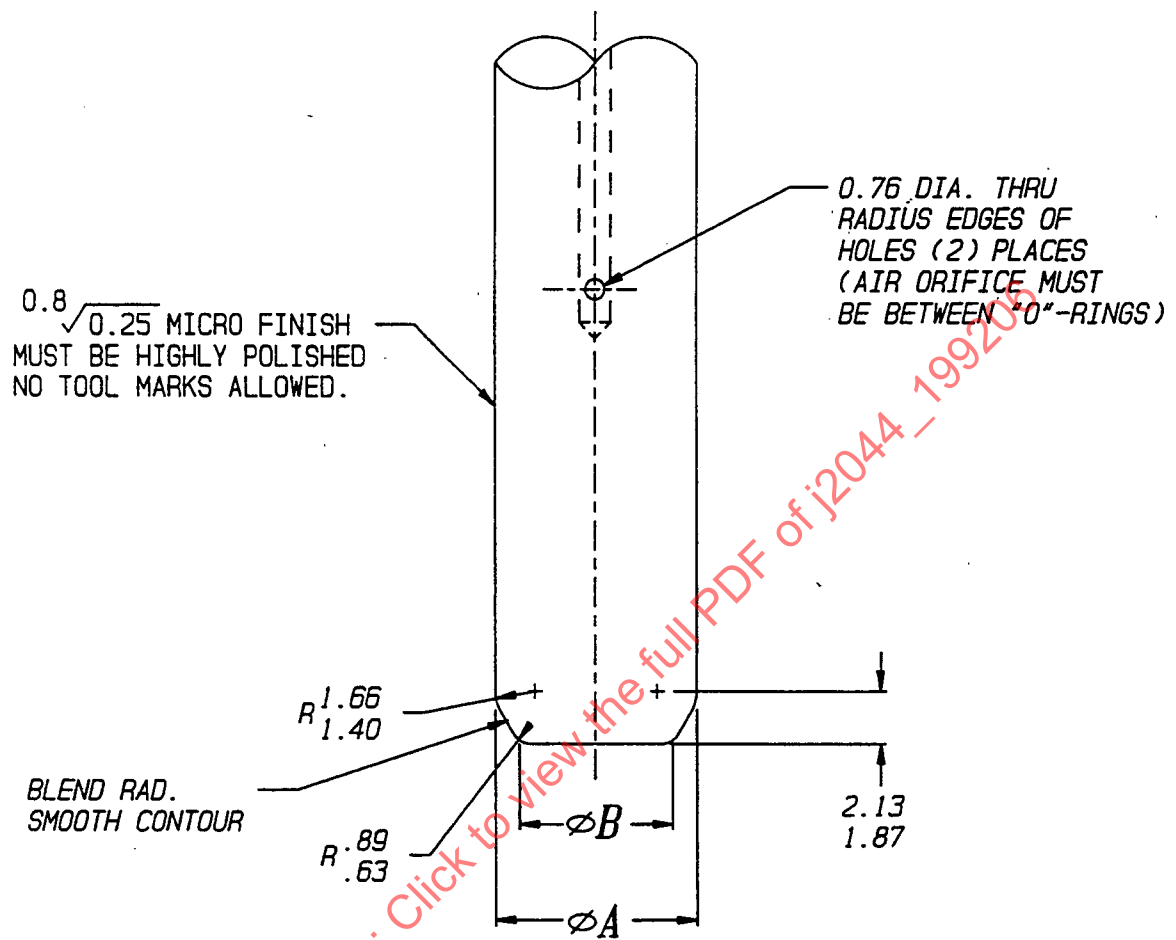
5.2.2 TEST PROCEDURE—For Fittings Exposed To Fuel (Per 6.5), or Corrosion (Per 6.1)

- a. Allow samples to dry 48 h before insertion testing.
- b. Lubricate test pin with SAE 30 weight oil.
- c. Insert assembly test pin, shown in Figure 7, into the connector at a rate of $51\text{ mm/min} \pm 5\text{ mm/min}$ ($2\text{ in/min} \pm 0.2\text{ in/min}$) and measure assembly effort.

5.2.3 TEST REQUIREMENT

- a. First time assembly effort must not exceed 67 N (15 lb).
- b. Assembly effort after fuel compatibility test must not exceed 111 N (25 lb).
- c. Assembly effort after corrosion test must not exceed 111 N (25 lb).

5.3 Quick Connector Pull-Apart Test—Quick connector pull apart is the force required to pull the mating tube end out of the quick connector. Use a suitable tensile tester to verify conformance to this document.



SIZE	A	B
1/4"	6.26 6.25	4.06 3.56
5/16"	7.84 7.83	5.66 5.16
3/8"	9.44 9.43	7.24 6.74
1/2"	12.55 12.54	10.41 9.91
8mm	7.84 7.83	5.65 5.15
10mm	9.84 9.83	7.65 7.15

FIGURE 6—CONNECTOR LEAK TEST PIN

5.3.1 TEST PROCEDURE

- Attach the connector body stem to a fixture suitable for pulling axially through the centerline of the connector.
- Use the pull apart test pin shown in Figure 8 of this document.
- Apply a pull apart load, at a speed of 51 mm/min $\pm$ 5 mm/min (2 in/min $\pm$ 0.20 in/min), until complete separation occurs.

5.3.2 TEST REQUIREMENTS—The force required to separate the tube end from the connector must exceed 450 N (101 lb).

5.4 Connector Side Load Capability—Connector side load capability consists of a side load leak test and a side load fracture test.

The fuel quick connector must meet the side load and air leak test requirements of this document.

5.4.1 TEST PROCEDURE

- Insert fitting stem into a 200 mm length design intent hose with the opposite end sealed.
- Attach the connector to a suitable fixture shown in Figure 9 of this document.
- Internally pressurize the connector between the O-ring seals with 1034 kPa $\pm$ 35 kPa, 10.34 bar $\pm$ 0.35 bar (150 psig $\pm$ 5 psig) air pressure.

NOTE—Appropriate safety precautions should be taken when testing with high pressure air.

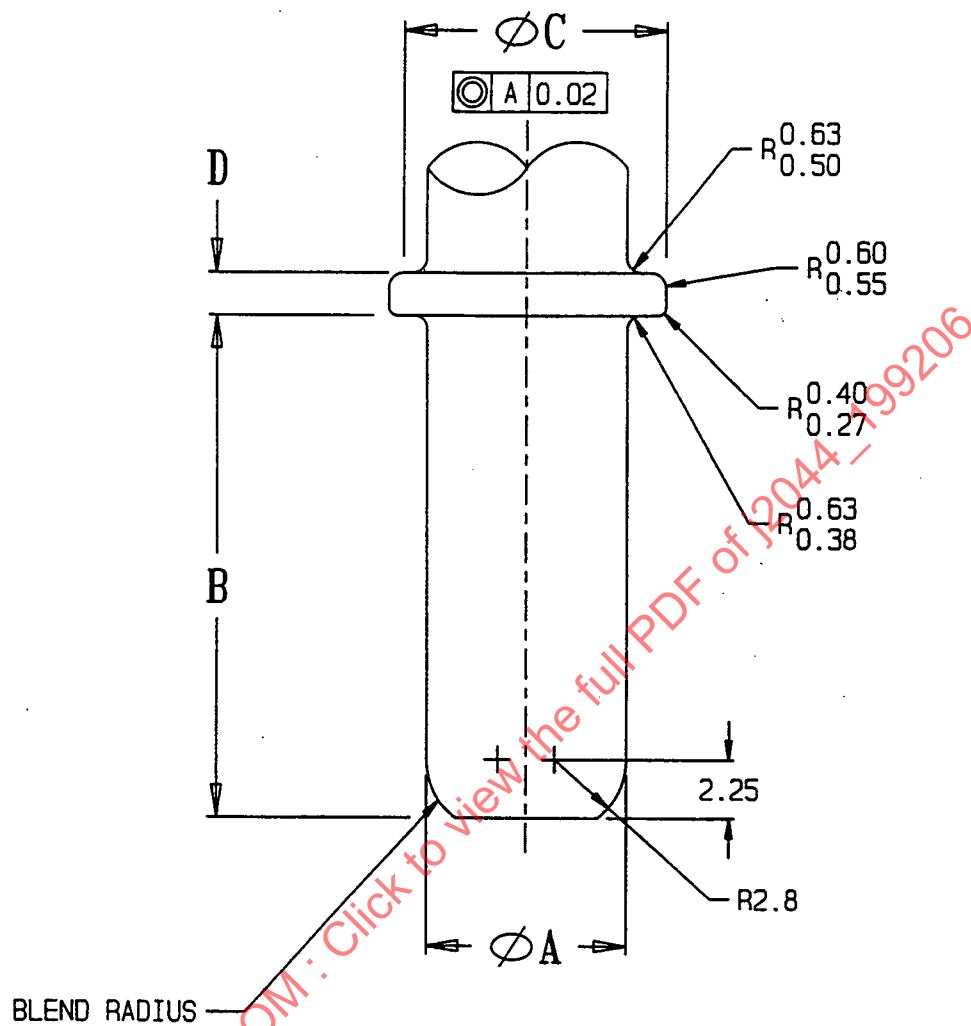
- Side load the connector, at a rate of 12.7 mm/min $\pm$ 0.5 mm/min (0.50 in/min $\pm$ 0.02 in/min) to the specified force and perform the leak test. At the end of the leak test, increase the side load force until fracture or kinking of the connector occurs. Kinking of the stem is permitted if no rupture results.

5.4.2 TEST REQUIREMENTS

- Side Load Air Leak Test. (See Table 1.)

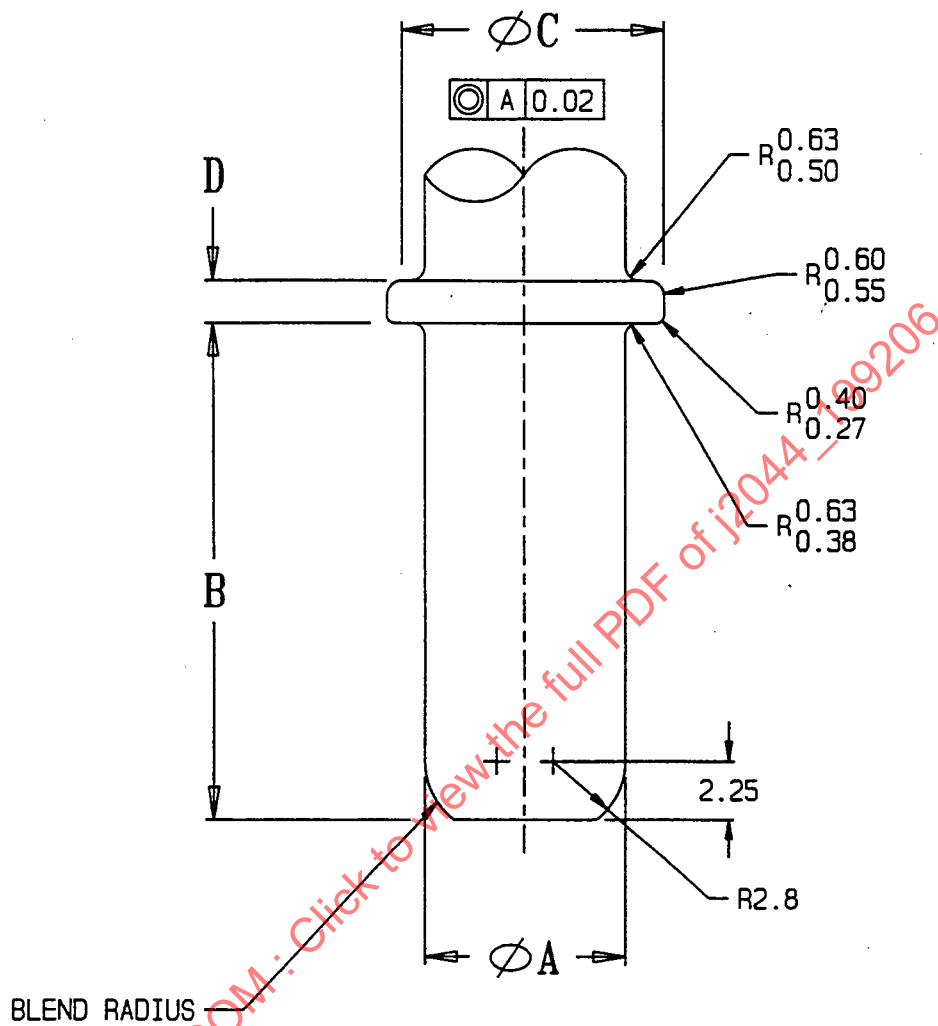
TABLE 1—SIDE LOAD AIR LEAK TEST

Connector Size (Stem OD)	Side Load Force
1/4 in	111 N $\pm$ 9 N (25 lb $\pm$ 2 lb)
5/16 in	138 N $\pm$ 9 N (31 lb $\pm$ 2 lb)
3/8 in	187 N $\pm$ 9 N (42 lb $\pm$ 2 lb)
1/2 in	249 N $\pm$ 9 N (56 lb $\pm$ 2 lb)
8 mm	138 N $\pm$ 9 N (31 lb $\pm$ 2 lb)
10 mm	200 N $\pm$ 9 N (45 lb $\pm$ 2 lb)



SIZE	A	B	C	D
1/4"	6.26 6.25	19.58 19.56	8.90 8.89	1.92 1.91
5/16"	7.95 7.94	19.77 19.75	11.13 11.12	1.92 1.91
3/8"	9.55 9.54	19.77 19.75	13.15 13.14	1.92 1.91
1/2"	12.68 12.67	24.37 23.35	16.76 16.75	2.74 2.73
8mm	7.95 7.94	19.77 19.75	11.13 11.12	1.92 1.91
10mm	9.95 9.94	19.77 19.75	13.63 13.62	1.92 1.91

FIGURE 7—CONNECTOR ASSEMBLY TEST PIN



BLEND RADIUS

SIZE	A	B	C	D
1/4"	6.26	19.10	8.61	1.61
	6.25	19.06	8.60	1.60
5/16"	7.84	19.31	10.84	1.61
	7.83	19.27	10.83	1.60
3/8"	9.44	19.31	12.74	1.61
	9.43	19.27	12.73	1.60
1/2"	12.55	24.90	16.27	2.51
	12.54	23.86	16.26	2.50
8mm	7.84	19.31	10.84	1.61
	7.83	19.27	10.83	1.60
10mm	9.84	19.31	13.22	1.61
	9.83	19.27	13.21	1.60

FIGURE 8—CONNECTOR PULL APART TEST PIN

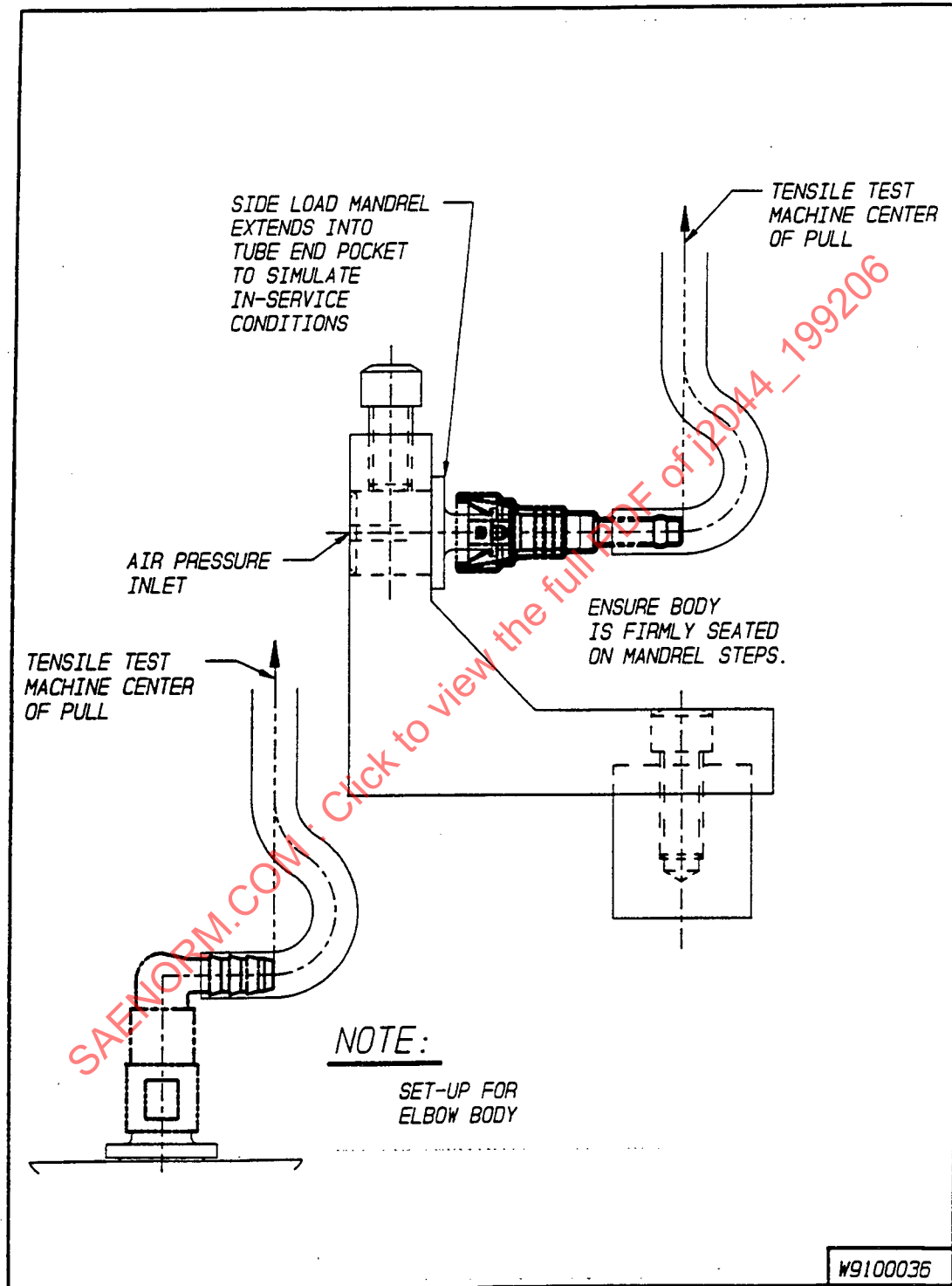


FIGURE 9—SIDE LOAD TEST FIXTURE

5.4.3 ACCEPTANCE CRITERIA

- a. No fracture or rupture of the component permitted. Air leak not to exceed 8 cc/min at 10.34 bar ± 0.34 bar (150 psig ± 5 psig).
- b. Side load force to fracture or kink test. (See Table 2.)

TABLE 2—SIDE LOAD FORCE TO FRACTURE OR KINK TEST

Connector Size (Stem OD)	Side Load Force Minimum
1/4 in	200 N (45 lb)
5/16 in	245 N (55 lb)
3/8 in	311 N (70 lb)
1/2 in	403 N (90 lb)
8 mm	245 N (55 lb)
10 mm	350 N (79 lb)

6. Design Verification/Validation Testing

6.1 Corrosion Test—The corrosion test is performed to assure the quick connector will meet the functional requirements of the fuel system after exposure to the corrosion test.

6.1.1 TEST PROCEDURE

- a. Insert a mating tube end, shown in Figure 10, into the quick connectors.
- b. Cap the mating tube end and stem end of the connector so that internal surfaces remain free of water and corrosion.
- c. Perform salt spray test per ASTM B 117.

6.1.2 TEST REQUIREMENTS

- a. The connectors shall be capable of meeting the functional requirements of Section 5 after 500 h salt spray. Appearance is not a functional requirement.

6.2 Zinc Chloride Resistance—The zinc chloride resistance test is performed to assure the quick connector meets the functional requirements of the fuel system after exposure to the zinc chloride test.

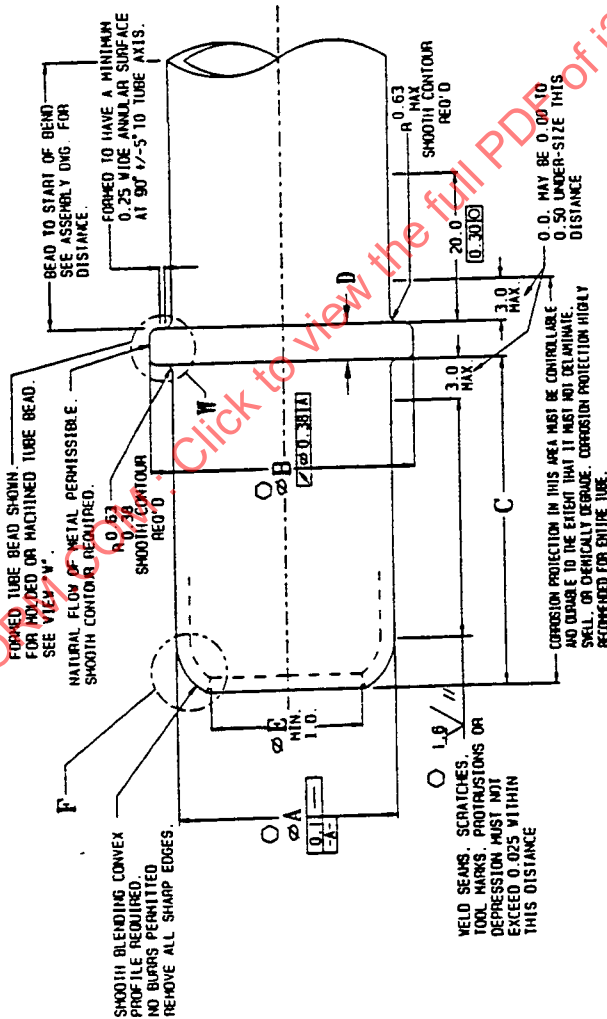
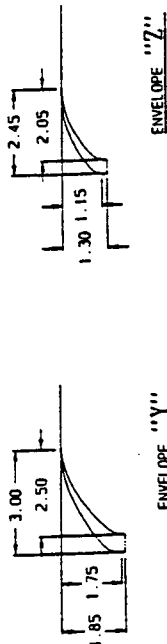
6.2.1 TEST PROCEDURE

- a. Insert a mating tube end, shown in Figure 10, into the quick connectors.
- b. Cap the mating tube end and stem end of the connector so that internal surfaces remain free of water and corrosion.
- c. The connector shall be immersed in a 50% aqueous solution (by weight) of zinc chloride for 200 h at 60 °C (140 °F). The solution may change percentage during the exposure.
- d. The connectors then must be removed from solution, do not rinse or clean.
- e. The connectors must then be exposed to heated air at 60 °C (140 °F) for 200 h.
- f. Samples are to be inspected after each exposure sequence and any evidence of cracking recorded.

TUBE NOSE CHECKING ENVELOPE (10 X SIZE)

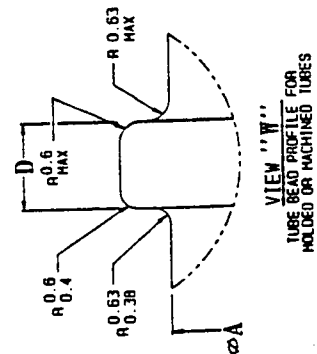
EXTERIOR CONTOUR OF TUBE NOSE TO FALL WITHIN ENVELOPE AS SHOWN. TUBE NOSE ENVELOPE 2 10 BE USED AS A TEMPLATE ON AN OPTICAL COMPARATOR.

ORIGINAL FILE NO.	A NO. OF DIA.	B NO. OF DIA.	C NO. OF DIA.	D NO. OF DIA.	E NO. OF DIA.	F NO. OF DIA.
1/4	6.30.37	0.75	19.31	19.31	3.50	2
5/16	7.03.17-06	10.98	19.52	19.52	4.73	2
One	7.03.17-06	10.98	19.52	19.52	4.73	2
3/8	9.49	22.94	21	22.94	6.30	2
10mm	9.03.17-06	13.42	22.24	22.24	6.30	2
1/2	12.01.17-07	16.51	22.24	22.24	8.10	2



NOTE:

- NOTE:
1.) THE O.E.M. RELEASE ENGINEER IS RESPONSIBLE TO VERIFY THAT THE RECOMMENDED TUBE END IS SUITABLE FOR THE INTENDED APPLICATION.
- 2.) ALL DIMENSIONS & MICRO FINISH ARE AFTER PLATING, COATING OR FINISH OPERATIONS.
- 3.) $\bigcirc$ DIMENSIONS, S.P.C. REQUIRED
- 4.) TRANSITION TO LARGER OR SMALLER PIPE SIZE PERMITTED BEYOND START OF BEND DIMENSION. SELECT WALL THICKNESS TO SUIT BEND DETAIL..
- 5.) CONNECTOR DESIGN & VALIDATION TESTING IS BASED UPON USE OF TUBE PROFILE DEFINED ON TUBE CHART.



VIEW IN CIRCLE "F"
SUGGESTED TOOLING RADII FOR NOSE PROFILE.
FINISHED TIRE PROFILE TO FALL WITHIN CHECKING ENVELOPE.

TUBE NOISE ENVELOPE	DIH. N MEAN	DIH. S RAD.
Y	2.75	3.0
Z	2.25	2.8

FIGURE 10—FUEL QUICK CONNECTOR STANDARD MALE TUBE END

6.2.2 ACCEPTANCE CRITERIA

- a. No cracks or fractures of connector components permitted.
- b. The connectors shall be capable of meeting the functional requirements of Section 5 after exposure to zinc chloride.

6.3 External Chemical and Environmental Resistance—The external chemical resistance test is performed to assure the quick connectors will meet the functional requirements of the fuel system after exposure to typical automotive fluids.

6.3.1 TEST PROCEDURE

- a. Insert a mating tube end, shown in Figure 10, into the quick connector.
- b. Cap the mating tube end and stem end of the connector.
- c. The connector shall be immersed in the fluids, specified in 6.3.2, at room temperature, unless otherwise specified.
- d. Perform functional tests specified in Section 5.

6.3.2 FLUIDS OR MEDIUM—(See Table 3.)**TABLE 3—FLUIDS OR MEDIUM**

Fluid or Medium	Exposure Time	Procedure
Automatic Transmission Fluid	30 day	Soak
Brake Fluid	30 day	Soak
Ethylene Glycol (Coolant)	30 day	Soak
Ozone	144 hr	ASTM D 1171-68
Ultraviolet Rays	30 day	ASTM G 23
Diesel Fuels	30 day	Soak
Motor Oil	30 day	Soak
Windshield Washer Fluid	30 day	Soak
Lacquer Thinner - Used in Assembly Plants	30 day	Soak
Car Wash Detergent	30 day	Soak
Engine Degreasers	30 day	Soak
Vehicle Undercoating	30 day	Soak

The materials in Table 3 shall be considered generic and those that are common to the industry.

6.3.3 ACCEPTANCE CRITERIA—The connectors must be capable of meeting the functional requirements of Section 5 at completion of the external chemical and environmental testing.

6.4 Fuel Compatibility—The fuel compatibility test is performed to assure the quick connector will meet the functional requirements of the fuel system after exposure to specified fuel blends. Not all connector materials may be suitable for all fuels.

6.4.1 TEST PROCEDURE—Completely submerge the samples, with male tubes installed (see Figure 10), for 30 days in a covered container with the fuel as specified in 5.4.2. New samples must be used for each test. Agitate the container every 10 days.

6.4.2 TEST FUELS (REF. SAE GASOLINE/METHANOL MIXTURES FOR MATERIALS TESTING #90-0868EG)

- a. ASTM reference fuel "C"
- b. SAE CE15 (ASTM reference fuel "C" plus 15% ethyl alcohol)
- c. SAE CM30 (ASTM reference fuel "C" plus 30% methyl alcohol)
- d. SAE CP (Auto-Oxidized Fuel)

6.4.3 TEST REQUIREMENTS—The quick connector shall meet the functional requirements of Section 5 after completion of the fuel compatibility test, half of the samples tested immediately and the remaining half tested after 48 h dry-out.

6.5 Life Cycle Test—The life cycle test is performed to assure the connector will meet the functional requirements of the fuel system when exposed to pressure/vibration/temperature cycles.

6.5.1 TEST PROCEDURE

- a. Attach a quick connector to each end of a 500 mm (19.69 in) length of suitable tubing.
- b. Air pressure leak test the assembly per 5.1, except use a male tube as shown in Figure 10.
- c. Connect the assembly to a test fixture as shown in Figure 11.
- d. Test Fluid-Mobile Arctic 155 refrigerant oil or equivalent.

NOTE—USE OF FLAMMABLE MATERIALS IS NOT RECOMMENDED.

6.5.2 VIBRATION FREQUENCY—Continuously sweep the frequency from 7 HZ to 200 HZ at a rate of 0.3 HZ/s (approximately 3 sweeps/h).

6.5.3 G LOAD—(See Table 4.)

TABLE 4—G LOAD

Maintain G Load	From	To
2 G	7 HZ	25 HZ
10	25	50
20	50	75
18	75	100
16	100	125
14	125	150
12	150	175
10	175	200

6.5.4 VIBRATION DURATION—Maintain vibration as specified in the test cycles.

6.5.5 FLUID PRESSURE—During pressure portions of the test alternate pressure between 0 and 413 kPa $\pm$ 34 kPa, (60 psig $\pm$ 5 psig) alternate pressure one time per minute. (One minute at each pressure.)