SAE International™

SURFACE VEHICLE RECOMMENDED PRACTICE

SAE J2044 AUG2009

Issued 1992-06
Revised 2009-08

Superseding J2044 SEP2002

(R) Quick Connect Coupling Specification for Liquid Fuel and Vapor/Emissions Systems

RATIONALE

This revision is to encompass changes in fuel and emission technology and clarification of test procedures.

TABLE OF CONTENTS

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.

Copyright © 2009 SAE International

All rights reserved. No part of this publication may be reproduced, stored in a retrieval system or transmitted, in any form or by any means, electronic, mechanical, photocopying, recording, or otherwise, without the prior written permission of SAE.

TO PLACE A DOCUMENT ORDER: **Tel: 877-606-7323 (inside USA and Canada)**
Tel: 724-776-4970 (outside USA)
Fax: 724-776-0790
Email: CustomerService@sae.org
SAE WEB ADDRESS: http://www.sae.org

MASTER COPY
(Red Color Stamp)

1. SCOPE

This SAE Recommended Practice defines the minimum functional requirements for quick connect couplings used for supply, return, and vapor/emission fuel system connections. This document also defines standard male tube end form dimensions, so as to guarantee interchangeability between all connector designs of the same male tube end form size. This document applies to automotive and light truck applications under the following conditions:

a. Gasoline and diesel fuel delivery systems or their vapor venting or evaporative emission control systems.

b. Operating pressure up to 500 kPa, 5 bar, (72 psig).

c. Operating vacuum down to –50 kPa, –0.5 bar (–7.2 psi).

d. Operating temperatures from –40 °C (–40 °F) to 115 °C (239 °F).

Quick connect couplings function by joining the connector to a mating tube end form, then pulling back to assure a complete connection. The requirements stated in this document apply to new connectors in assembly operations unless otherwise indicated. For service operations, the mating tube should be lubricated with SAE 30-weight oil before re-connecting.

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

2. REFERENCES

2.1 Applicable Publications

The following publications form a part of this specification to the extent specified herein. Unless otherwise specified, the latest issue of SAE publications shall apply.

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.

SAE J526 Welded Low-Carbon Steel Tubing

SAE J527 Brazed Double Wall Low-Carbon Steel Tubing

SAE J1645 Fuel Systems and Components—Electrostatic Charge Mitigation

SAE J1681 Gasoline, Alcohol, and Diesel Fuel Surrogates for Materials Testing

SAE J1737 Test Procedure to Determine the Hydrocarbon Losses from Fuel Tubes, Hoses, Fittings, and Fuel Line Assemblies by Recirculation

SAE J2045 Performance Requirements for Fuel System Tubing Assemblies

SAE J2587 Optimized Fuel Tank Sender Closure

2.1.2 ASTM Publication

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 B 117 Method of Salt Spray (Fog) Testing

2.2 Related Publication

The following publication is provided for information purposes only and is not a required part of this specification.

2.2.1 SAE Publication

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.

SAE J30 Fuel and Oil Hoses

3. DEFINITIONS

3.1 Unexposed Coupling

One that has not been used or deteriorated since manufacture.

3.2 Lot

A group of couplings that can be traced to a single assembly set-up or material lot. No more than one week production in a lot.

3.3 Dimensions

Unless otherwise specified all dimensions are in millimeters (mm).

4. SIZE DESIGNATION

The size of quick connect couplings in this document are designated by three dimensions, and presented as ε x β x α, defined in Figure 1 below. Dimension ε designates the nominal male endform diameter. Dimension β designates the tubing or hose size suited for the stem end of the coupling. Dimension α designates the minimum straight length, of nominal diameter tubing, behind the male endform bead, required for proper installation and removal of the fitting.

EXAMPLE: 9.5 mm x 8 mm x 12 mm connector couples with a 9.5 mm male tube end, is inserted into an 8 mm flexible tube or hose and requires 12 mm clearance behind the bead on the tube end.

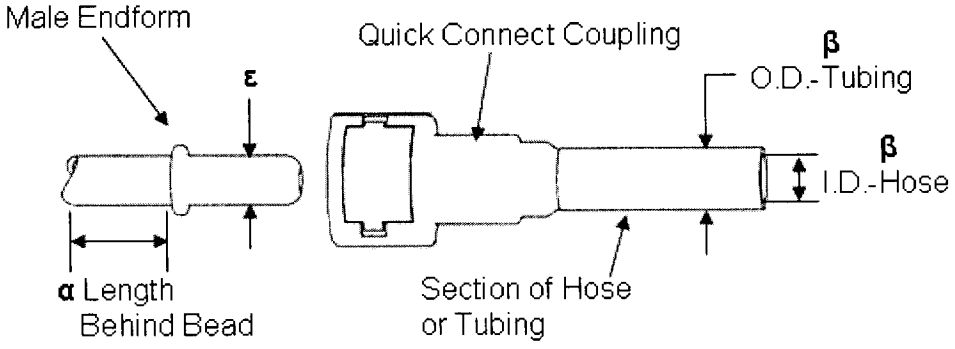


FIGURE 1 - CONNECTOR NOMENCLATURE

Details for standard coupling sizes and dimensions for standard tube end forms are shown in Table 1 and Figure 2.

NOTE: On metal or plastic tubing the OD is used to designate size. On flexible hose the ID is used to designate size.

5. TEST TEMPERATURES

Unless otherwise specified, all tests will be performed at room temperature 23 °C ± 2 °C (73.4 °F ± 4 °F).

6. FUNCTIONAL REQUIREMENTS

This section defines the minimum functional requirements for quick connector couplings used in flexible tubing fuel systems.

NOTE: New connector designs using the same materials as previously tested connectors may use the original results as surrogate data for 7.1 Corrosion, 7.2 Zinc Chloride Resistance, 7.3 External chemical and Environmental Resistance, and 7.4 Fuel Compatibility.

6.1 Leak Test (In-Process)

In accordance with stringent emissions regulations, including CARB PZEV, and safety regulations, quick connector couplings must be free of leaks and micro-leaks. Production leak testing is performed to assure conformance to the requirement. Compressed air leak testing is a proven technique which provides required leak sensitivity as well as a proof test for pressure resistance. Depending on the application, test conditions for Low Pressure (vapor), high pressure (liquid) and vacuum systems are described below.

NOTE: Leak test acceptance criteria for this document are in customary leak units of flow (cc/min) or mass flow (scc/min). In the fuel system industry, an alternate leak test criteria, based on units of equivalent channel dimension rather than flow rate, have been applied. For example, see SAEJ2587 for leak criteria for fuel pump module tank interface joint. The equivalent channel specification is especially appropriate for parts such as fuel tanks with large internal volume, with high deformation with applied pressure or vacuum and where use pressures are low. Leak tests for such parts include vacuum, pressure, and accumulation methods. It can be difficult to compare the indicated leak rates for various techniques, so an equivalent channel criteria is established. The equivalent channel dimension specification is based on test data indicating that fuel system micro-leaks will plug over time. Effectively, micro-leaks plug to a near zero hydrocarbon emission level. The high pressure leak tests defined in 6.1.3 have been demonstrated, with experiment and analysis, to satisfy an equivalent channel of 15 micron diameter and 3 mm length. No further testing is recommended to validate the equivalent channel criteria. Standard leak rate conditions are defined as 101.325 kPa (14.696 psia) and 293 K (20 C).

6.1.1 Low Pressure Leak Test Procedure

a. Insert leak test pin, shown in Figure 3, into the connector.

b. Pressurize between the seals (for single seal connectors, the stem must be capped or sealed) with suitable air leak test equipment to 69 kPa ± 7 kPa, 0.69 bar ± 0.07 bar (10 psig ± 1 psig).

6.1.2 Low Pressure Leak Acceptance Criteria

Maximum leak rate 2 scc/min (1.19 cc/min) at stabilization.

6.1.3 High Pressure Leak Test Procedure (Liquid Fuel Only)

a. Insert leak test pin, shown in Figure 3, into the connector.

b. Pressurize between the seals with suitable air leak test equipment to 1034 kPa ± 35 kPa, 10.34 bar ± 0.35 bar (150 psig ± 5 psig).

6.1.4 High Pressure Test Acceptance Criteria

Maximum leak rate 5 scc/min (0.45 cc/min) at stabilization.

NOTE: Appropriate safety precautions should be taken when testing with high-pressure air. Not required for vapor/emission quick connector couplings. Vapor connectors are not generally used for high pressure applications.

6.1.5 Vacuum Leak Test Procedure (Vapor Systems only at Customer's Request)

a. Insert leak test pin shown in Figure 3 into connector.

b. Apply a vacuum of 7 kPa (–1.02 psig) with suitable vacuum leak test equipment.

6.1.6 Vacuum Test Acceptance Criteria

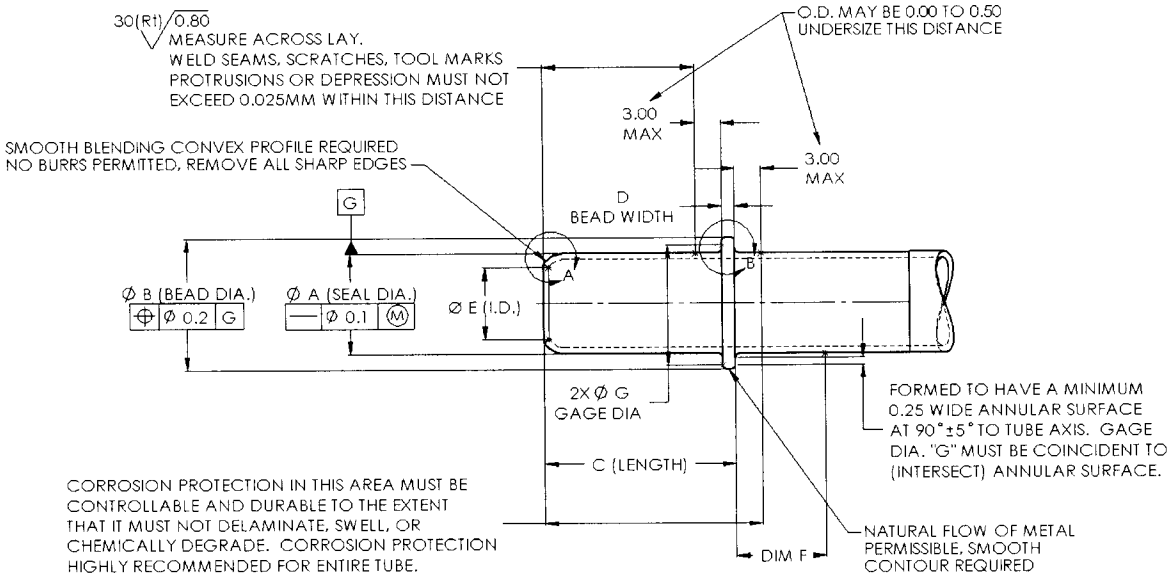
Maximum leak rate 2 scc/min (2.14 cc/min) at stabilization.

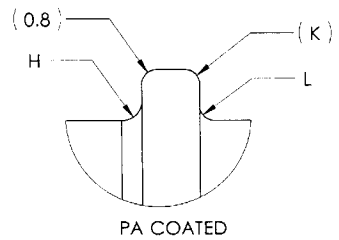
Stabilization can be determined by viewing a graphic output of actual leak rate. This will vary by connector size and leak test method. Permeation is not the same phenomenon as leaks. Permeation tests measure permeation rate.

TABLE 1 - STANDARD TUBE END-FORM DIMENSIONS

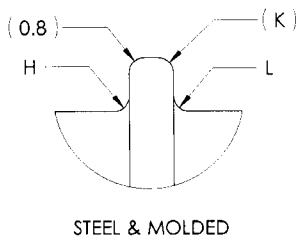
(NOMINAL) BASIC TUBE DIA.	A SEAL DIA.	B BEAD DIA.	C LENGTH	D BEAD WIDTH *•• See Note	E I.D.	F Clearance	G GAUGE DIA.	H TANGENT RADIUS	(K) BLEND RADIUS REFERENCE	L TANGENT RADIUS
3/16", 4.78 ±0.08	4.63 ±0.06	7.10 ±0.15	19.93 ±0.25	*1.57/1.93	2.20/2.70	6.9	6.08	0.5/1.0	0.5	0.3/0.5
1/4", 6.35 ±0.08	6.30 ±0.06	8.75 ±0.15	20.91 ±0.25	*1.57/1.93	3.60/4.10	9.5	7.75	0.5/1.0	0.6	0.4/0.8
5/16" 8mm, 7.94 ±0.08	7.89 ±0.06	10.98 ±0.15	21.12 ±0.25	*1.57/1.93	4.70/5.20	12.0	9.39	0.5/1.0	0.9	0.4/0.8
3/8", 9.53 ±0.08	9.49 ±0.06	12.94 ±0.21	21.12 ±0.25	*1.57/1.93	6.30/6.80	14.3	10.92	0.5/1.0	1.1	0.4/0.8
10mm ±0.08	9.89 ±0.06	13.42 ±0.21	24.74 ±0.25	** 2.34 / 2.74	6.60/7.10	15.0	11.34	0.5/1.0	1.2	0.4/0.8
7/16", 11.11 ±0.10	11.05 ±0.10	14.80 ±0.25	26.62 ±0.50	** 2.34 / 2.74	7.00/7.50	16.5	12.5	0.5/1.0	1.3	0.4/0.8
12mm ±0.10	11.80 ±0.10	16.51 ±0.25	26.62 ±0.50	** 2.34 / 2.74	7.50/8.00	18.0	13.25	0.5/1.0	1.6	0.4/0.8
1/2", 12.70 ±0.10	12.61 ±0.10	16.51 ±0.25	26.62 ±0.50	** 2.34 / 2.74	8.10/8.60	18.0	14.1	0.5/1.0	1.3	0.4/0.8
5/8", 15.88 ±0.10	15.82 ±0.10	19.18 ±0.25	26.62 ±0.50	** 2.34 / 2.74	11.10/11.90	24.0	17.27	0.5/1.0	1.1	0.4/0.8
3/4", 19.05 ±0.10	18.90 ±0.10	22.33 ±0.25	26.62 ±0.50	** 2.34 / 2.74	13.20/14.00	28.5	20.35	0.5/1.0	1.1	0.4/0.8
7/8", 22.23 ±0.15	22.70 ±0.15	25.7 ±0.5	29.50 ±0.50	** 2.34 / 2.74	16.00/16.80	33.0	24.15	0.5/1.0	1.2	0.4/0.8
1", 25.40 ±0.15	25.50 ±0.15	28.2 ±0.5	29.50 ±0.50	** 2.34 / 2.74	19.00/19.80	38.0	26.95	0.5/1.0	0.7	0.4/0.8
1 1/8", 28.58 ±0.15	28.42 ±0.15	32.3 ±0.5	42.50 ±0.50	** 2.34 / 2.74	22.70/23.70	43.0	29.87	0.5/1.0	1.3	0.4/0.8
PA Coated Endforms										
1/4", 6.35 ±0.08	6.30 ±0.06	8.75±0.15	21.31 ±0.25	*2.15 ±0.17	3.60/4.10	9.5	7.75	0.5/1.0	0.6	0.4/0.8
5/16" 8mm, 7.94 ±0.08	7.89 ±0.06	10.98±0.15	21.12 ±0.25	*2.15 ±0.17	4.70/5.20	12.0	9.39	0.5/1.0	1.1	0.4/0.8
3/8", 9.53 ±0.08	9.49 ±0.06	12.94±0.21	21.12 ±0.25	*2.15 ±0.17	6.30/6.80	14.3	10.92	0.5/1.0	0.9	0.4/0.8
10mm ±0.08	9.89 ±0.06	13.42±0.21	24.74 ±0.50	*2.15 ±0.17	6.60/7.10	15.0	11.34	0.5/1.0	1.2	0.4/0.8
12mm ±0.10	11.80 ±0.10	16.51±0.25	26.62 ±0.50	*2.15 ±0.17	7.50/8.00	18.0	13.25	0.5/1.0	1.7	0.4/0.8

NOTE: *Bead Width based on 0.028" (0.71 ± 0.08 mm) wall steel tubing for formed endforms. **Bead Width based on 0.042" (1.07 ± 0.102 mm) wall steel tubing. Formed metal tube bead width is dependant on tubing wall thickness. For formed metal tube wall thicknesses other than specified in Table 1; D= 2X wall +0.5/–0.0, bead width recommended. Nominal steel tube dimensions per SAE J526 and SAE J527. For material thicknesses other than specified in Table 1, see your Quick Connect supplier for compatibility. Molded plastic endform suitability with the various fitting types and applications, should be confirmed with the fitting manufacturer. See Appendix A for Bead Width measurement method.





PA COATED

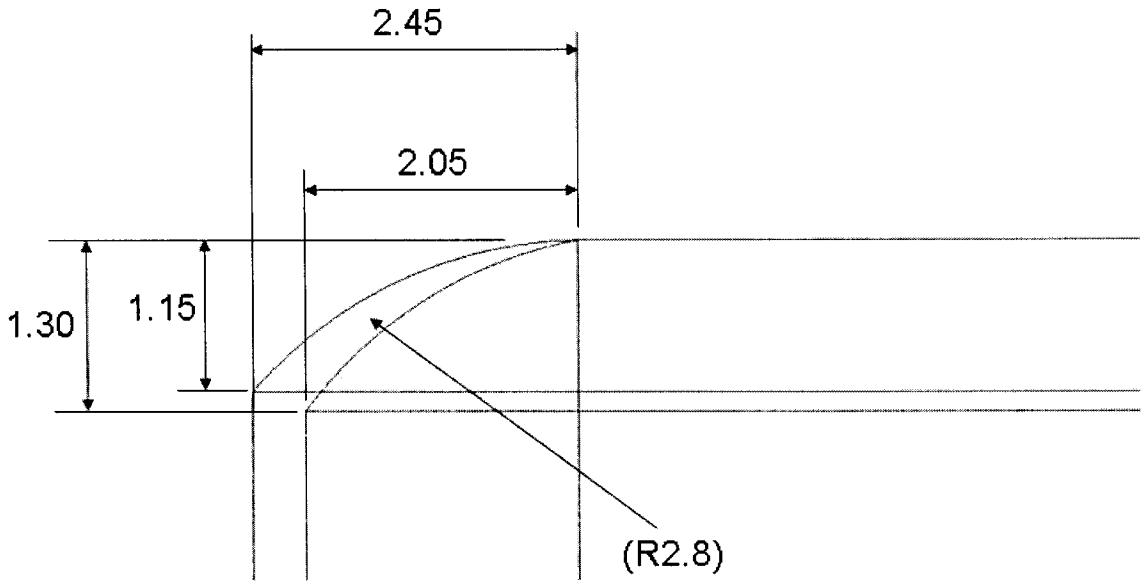


STEEL & MOLDED

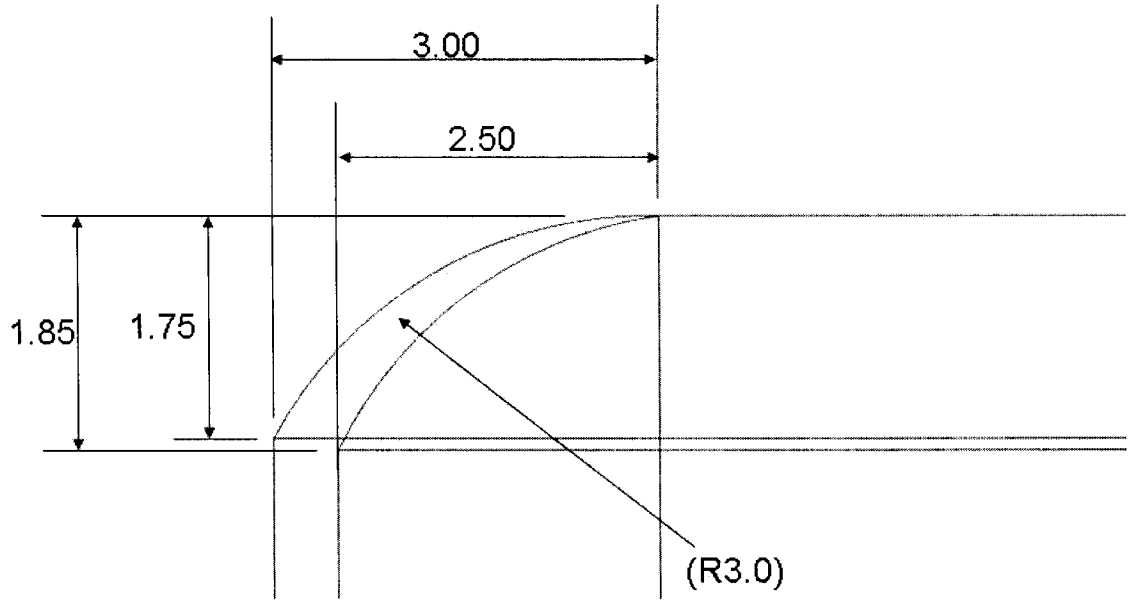
Note: Molded endforms with sharp (K) corner should be confirmed for serviceability.

NOTE: Dimension "F" is the distance from the rear of the Bead (the retaining surface side) to the tangent of a bend or a surface that may not deviate from the nominal tube diameter. This dimension may vary by coupling manufacturer to provide sufficient clearance for latching mechanisms, release tools, redundant latches or any circumstances required by the customer

FIGURE 2 - MATING TUBE END FORM



Tube sizes up to 10 mm (for overlay check)



Tube sizes greater than 10 mm (for overlay check)

FIGURE 2 - DETAIL A (CONTINUED)

NOTE: Nose shape must be smooth and allow insertion without seal damage. Also it must conform to the required minimum internal diameter in Table 1.

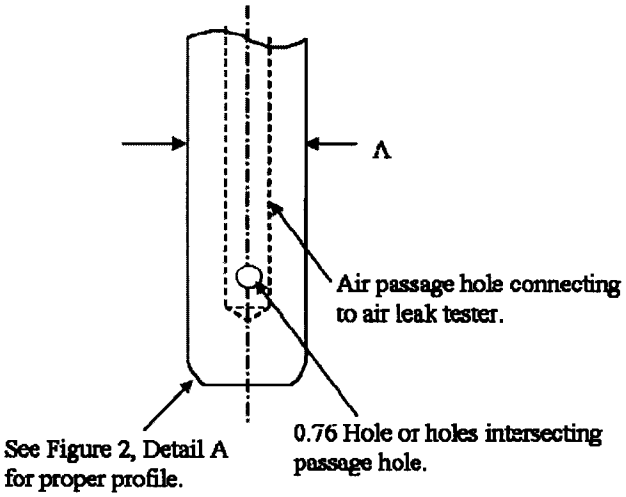


FIGURE 3 Basic Size	"A" Maximum	"A" Minimum
	mm	mm
4.78 mm (3/16 in)	4.57	4.55
6.35 mm (1/4 in)	6.24	6.22
7.94 mm (5/16 in)	7.83	7.81
9.53 mm (3/8 in)	9.43	9.41
10 mm	9.83	9.81
11.11 mm (7/16 in)	10.95	10.93
12 mm	11.70	11.68
12.70 mm (1/2 in)	12.51	12.49
15.88 mm (5/8 in)	15.72	15.70
19.05 mm (3/4 in)	18.80	18.78
22.23 mm (7/8 in)	22.55	22.53

FIGURE 3 - LEAK TEST PIN

NOTE: SAE J2044 rev 2002, test pins are acceptable for use.

6.2 Assembly Effort

Quick connect coupling assembly effort is the peak force required to fully assemble (latch or retain) the mating tube end into the connector. Use a suitable tensile/compression tester to verify conformance to this document.

6.2.1 Test Procedure (New Parts)

a. Test a minimum of 10 couplings.

b. Test the quick connect coupling as supplied. Do not add additional lubrication to the quick connect coupling or test pin.

c. Attach quick connect coupling to a suitable test fixture.

d. Wipe the test pins, before each test, with a clean lint-free cloth to prevent an accumulation of lubrication.

e. Insert assembly test pin, shown in Figure 4, into the quick connect coupling at a rate of 51 mm/min ± 5 mm/min (2 in/min ± 0.2 in/min) and measure assembly effort. (Simulated maximum tube end form)

6.2.2 Test Procedure (Connectors after Section 7 Exposure)

a. Allow samples to dry 48 h before insertion testing.

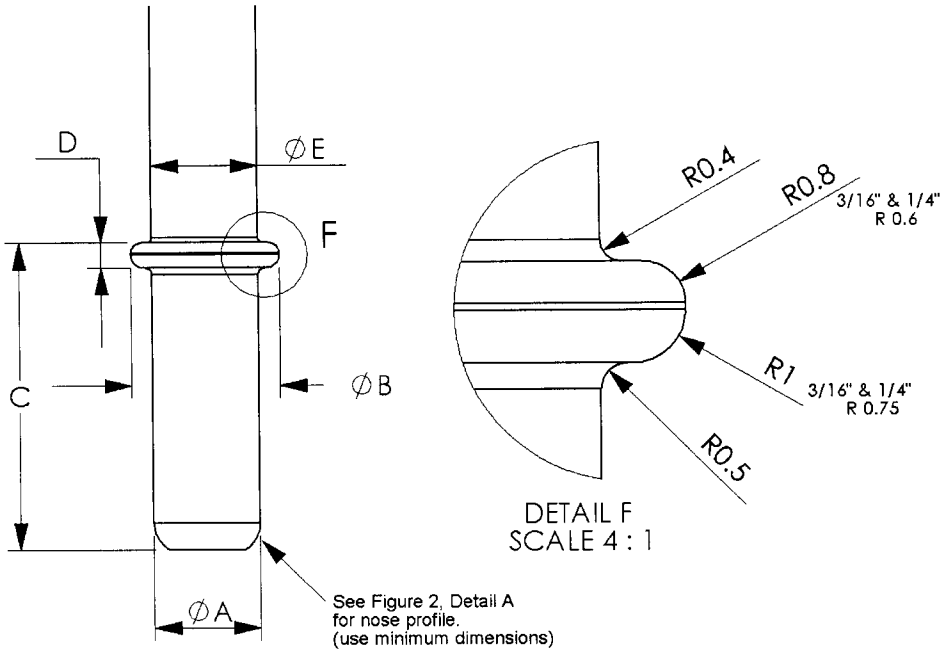
b. Lubricate test pin with SAE 30-weight oil by dipping the end in oil up to the retaining bead.

c. Insert assembly test pin, shown in Figure 4, into the quick connector at a rate of 51 mm/min ± 5 mm/min (2 in/min ± 0.2 in/min) and measure assembly effort.

6.2.3 Acceptance Criteria

a. Maximum first time assembly effort must not exceed 67 N (15 lb) for sizes <11 mm male tubes, and 111 N (25 lb) for sizes ≥11 mm male tubes.

b. Maximum assembly effort after Section 7 exposures must not exceed 111 N (25 lb) for <11 mm male tubes and 156 N (35 lb) for ≥11 mm male tubes.



	A +0.00 −0.01	B +0.00 −0.01	C +0.00 −0.05	D +0.00 −0.02	E +0.00 −0.05
4.78 mm (3/16 in)	4.69	7.25	20.18	1.93	4.76
6.35 mm (1/4 in)	6.36	8.90	21.16	1.93	6.35
8 mm (5/16 in)	7.95	11.13	21.37	1.93	7.94
9.53 mm (3/8 in)	9.55	13.15	21.37	1.93	9.53
10 mm	9.95	13.63	24.99	1.93	10.00
11.11 mm (7/16 in)	11.15	15.05	27.12	1.93	11.11
12 mm	11.90	16.76	27.12	1.93	12.00
12.70 mm (1/2 in)	12.71	16.76	27.12	1.93	12.70
15.88 mm (5/8 in)	15.92	19.43	27.12	2.74	15.88
19.05 mm (3/4 in)	19.00	22.58	27.12	2.74	19.05
22.23 mm (7/8 in)	22.85	26.20	30.00	2.74	22.23
PA COATED ENDFORMS					
6.35 mm (1/4 in) PA	6.36	8.90	21.16	2.32	6.35
8 mm (5/16 in) PA	7.95	11.13	21.37	2.32	7.94
9.5 mm (3/8 in) PA	9.55	13.15	21.37	2.32	9.53

FIGURE 4 - ASSEMBLY TEST PIN

NOTE: Dimensions represent Test Pin diameters @ Maximum Material Condition. Surface finish must be 30 RT or better. SAE J2044 rev 2002, test pins are acceptable for use.

6.3 Pull-Apart Effort

Quick connect coupling pull-apart effort is the peak force required to pull the mating tube end out of the quick connect coupling. Use a suitable tensile tester to verify conformance to this document. For hose pull-off, see SAE J2045.

6.3.1 Test Procedure

a. Attach the quick connector body stem to a fixture suitable for pulling axially through the centerline of the quick connector.

b. Use the pull-apart test pin shown in Figure 5. (Simulated minimum mating end form)

c. Apply a tensile load, at a rate of 51 mm/min ± 5 mm/min (2 in/min ± 0.2 in/min), until complete separation occurs.

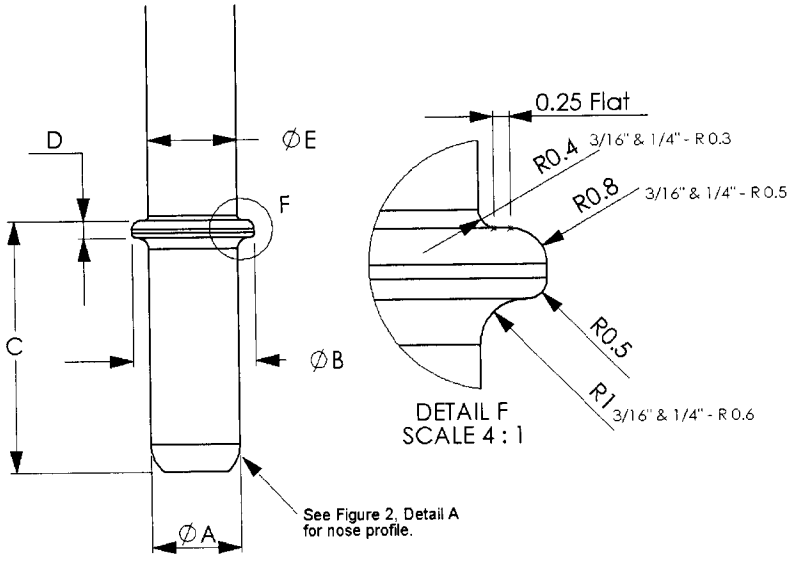
6.3.2 Acceptance Criteria

a. The Force required to separate unexposed liquid fuel quick connects from the test pin should be, 450 N minimum.

b. The Force required to separate exposed liquid fuel quick connects (after Section 7) from the test pin should be, 297 N minimum.

c. The Force required to separate unexposed vapor/emissions quick connects from the test pin should be, 222 N minimum.

d. The Force required to separate exposed vapor/emissions quick connects (after Section 7) from the test pin should be, 75 N minimum.



	A +0.01 −0.00	B +0.02 −0.00	C +0.05 −0.00	D +0.05 −0.00	E +0.05 −0.00
4.76 mm (3/16 in)	4.57	6.95	19.68	1.57	4.76
6.35 mm (1/4 in)	6.24	8.60	20.66	1.57	6.35
8 mm (5/16 in)	7.83	10.83	20.87	1.57	7.94
9.5 mm (3/8 in)	9.43	12.73	20.87	1.57	9.53
10 mm	9.83	13.21	24.49	1.57	10.00
11.1 mm (7/16 in)	10.95	14.55	26.12	1.57	11.11
12 mm	11.70	16.26	26.12	1.57	12.00
12.7 mm (1/2 in)	12.51	16.26	26.12	1.57	12.70
16 mm (5/8 in)	15.72	18.93	26.12	2.34	15.88
19 mm (3/4 in)	18.80	22.08	26.12	2.34	19.05
23 mm (7/8 in)	22.55	25.20	29.00	2.34	22.23
PA COATED ENDFORMS					
6.35 mm (1/4 in) PA	6.24	8.60	20.66	1.98	6.35
8 mm (5/16 in) PA	7.83	10.83	20.87	1.98	7.94
9.5 mm (3/8 in) PA	9.43	12.73	20.87	1.98	9.53

FIGURE 5 - PULL APART PIN

NOTE: Dimensions represent Test Pin diameters @ Minimum Material Condition. Surface finish must be 30 RT or better. SAE J2044 rev 2002, test pins are acceptable for use.

6.4 Side Load Capability

Quick connect couplings must be able to withstand side loads typical of what might be imposed by hose routing in a vehicle application as well as from having the hose pushed aside to reach other objects on the vehicle during service procedures. The connector side load capability is measured using a side load leak test and a side load fracture test.

6.4.1 Test Procedure

a. Insert quick connector into a length of flexible tubing or hose with the opposite end sealed.

b. Mount a sample in the fracture fixture (see Figure 6), side load quick connector at a rate of 12.7 mm/min ± 5 mm/min (0.5 in/min ± 0.2 in/min) until the specified force is applied or fracture of the quick connector occurs. Kinking of flexible tubing or hose is permitted

c. For liquid fuel quick connect couplings, pressurize the assembly with 1034 kPa ± 35 kPa, 10.34 bar ± 0.35 bar (150 psig ± 5 psig) air pressure.

d. For vapor/emission quick connect couplings, pressurize the assembly with 70 kPa ± 7 kPa, 0.7 bar ± 0.07 bar (10 psig ± 1 psig) air pressure.

e. Side load the quick connect to a load of 152 N, then stop the machine and perform the leak test. (For male tube endform sizes less than 8 mm (5/16") side load to 44.5 N and perform leak test.)

f. Continue side load to fracture (must exceed minimum requirement without damage to test equipment).

6.4.2 Acceptance Criteria (Side Load Leak Test)

a. Maximum leak rate is 8 scc/min (0.71 cc/min) at stabilization for liquid fuel quick connectors.

b. Maximum leak rate is 2 scc/min (1.19 cc/min) at stabilization for vapor/emission quick connects.

6.4.3 Acceptance Criteria (Side Load Fracture Test)

For stem sizes 5/16" and above, no fracture, rupture, or yield of the quick connector permitted below a minimum of 200N (45 lbf). For stem sizes less than 5/16", acceptance criteria is per agreement between fitting supplier and OEM.

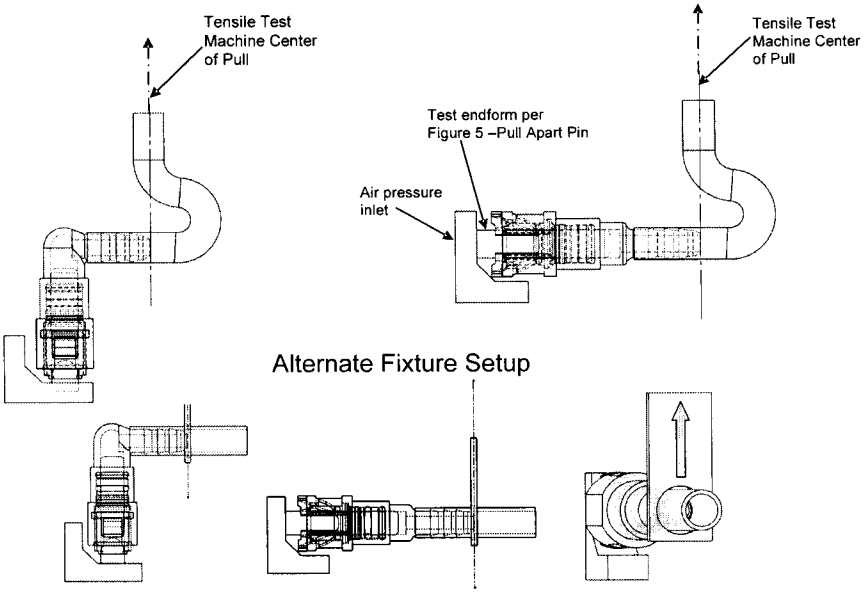


FIGURE 6 - SIDE LOAD TEST FIXTURE

6.5 Electrical Resistance

If required by the OEM, all connectors used in fuel system applications involving flowing liquid fuel must be sufficiently conductive and capable of creating an electrical connection with the flexible tubing into which they are inserted and with the tube end form that is inserted into them in order to prevent the buildup of harmful electrostatic charges.

6.5.1 Test Procedure

a. Test specimen is to consist of a coupling representative of the design as it will be installed in a vehicle application. The coupling is to be in the middle of the specimen. The length of both the flexible tubing or hose and rigid tubing must be 250 mm.

b. Expose the specimens in accordance with 7.4 Fuel Compatibility of this document, Fuel C only, then dry the exterior thoroughly (defer on fuel soak samples).

c. Test per SAE J1645 between the inner surfaces at each end of the specimen.

CAUTION: Measurement device may produce hazardous electrical charge, handle components with insulated means.

6.5.2 Acceptance Criteria

Acceptance criteria are specified in SAE J1645.

6.6 Resistance to Evaporative Emissions

Fuel line couplings are an integral part of the fuel system barrier to evaporative emissions. They are viewed as potential emissions or leak sites in the system. The evaporative losses from a single coupling are normally too small to measure accurately. While connector emissions have been estimated by testing 10 or more couplings concurrently, it is recommended that couplings be tested as a part of the fuel line assembly, per SAE J2045.

7. DESIGN VERIFICATION/VALIDATION TESTING

7.1 Corrosion

The corrosion test is performed to assure that the quick connector components will meet the functional requirements of the fuel system after exposure to the corrosion test.

7.1.1 Test Procedure

a. Insert design intent mating tube ends, shown in Figure 2, into the quick connect couplings.

b. Cap the mating tube ends and the stem ends of the quick connect couplings, so internal surfaces remain free of water and corrosion.

c. Perform salt spray test per ASTM B 117 for 500 h.

d. Rinse with water before functional tests.

7.1.2 Acceptance Criteria

The quick connect couplings shall be capable of meeting the functional requirements of 6.1 Leak Test, 6.2 Assembly Effort, and 6.3 Pull Apart Effort, after salt spray exposure. Appearance is not a functional requirement.

NOTE: New connector sizes using the same materials and architectural design as previously tested connectors may use the original results as surrogate data.

7.2 Zinc Chloride Resistance

Zinc chloride is an environmental stress-cracking agent to which some hygroscopic polymers are sensitive. This test is performed to assure that the quick connect couplings meet their functional requirements after exposure to zinc chloride.

7.2.1 Test Procedure

a. Insert mating tube ends, shown in Figure 2, into the quick connect couplings.

b. Cap the mating tube ends and stem ends of the quick connect couplings, so internal surfaces remain free of water and corrosion.

c. Immerse the couplings in a 50% aqueous solution (by weight) of zinc chloride for 200 h at 23 °C (room temperature). Cover or cap the container to prevent the solution from changing concentration significantly during the exposure. When in doubt, measure the concentration of ZnCl at the completion of the test.

d. When the exposure is complete, remove the quick connect couplings from the zinc chloride solution, do not rinse or clean.

e. The quick connect couplings must then be held at room temperature for 24 h.

f. Quick connect couplings are to be inspected after each exposure sequence for any evidence of cracking.

g. Rinse with water before functional tests.

7.2.2 Acceptance Criteria

a. No cracks or fractures of the quick connector or its components permitted.

b. The quick connect couplings shall be capable of meeting the functional requirements of 6.1 Leak Test, 6.2 Assembly Effort, and 6.3 Pull Apart Effort, after exposure to zinc chloride.

NOTE: New connector sizes using the same materials and architectural design as previously tested connectors may use the original results as surrogate data.

7.3 External Chemical and Environmental Resistance

Quick connect couplings may be exposed to a range of chemicals typical of the automotive environment. This chemical resistance test is performed to assure that the quick connect couplings will meet their functional requirements after exposure to typical automotive fluids.

7.3.1 Test Procedure, Fluid or Medium

See Table 2.

a Insert mating tube ends, shown in Figure 2, into the quick connect couplings.

b. Cap mating tube ends and stem ends of the quick connect couplings.

c. Submerge the quick connect coupling assemblies completely.

d. At the end of 60 days, dry connectors at room temperature for 48 h.

e. Rinse before functional tests. (See Table 2)

7.3.2 Acceptance Criteria

The quick connect couplings shall be capable of meeting the functional requirements of 6.1 Leak Test, 6.2 Assembly Effort, and 6.3 Pull Apart Effort, upon completion of the external chemical and environmental testing.

NOTE: New connector sizes using the same materials and architectural design as previously tested connectors may use the original results as surrogate data.

TABLE 2 - FLUID OR MEDIUM[1]

Fluid or Medium	Exposure Time	Procedure	Rinse with
Automatic Transmission Fluid	60 Days	Soak @ room temp	Mineral sprits
Motor Oil	60 Days	Soak @ room temp	Mineral sprits
Brake Fluid (Dot 3)	60 Days	Soak @ room temp	Water
Ethylene Glycol (50% Water)	60 Days	Soak @ room temp	Water
Propylene Glycol (50% Water)	60 Days	Soak @ room temp	Water
Diesel Fuel	60 Days	Soak @ room temp	Mineral sprits
Engine Degreaser (Soap based mixed with 50% Water)	60 Days	Soak @ room temp	Water

1. The fluids in Table 2 shall be considered generic or those that are common to the industry.

7.4 Fuel Compatibility

The fuel compatibility test is performed to assure that the quick connector will meet the functional requirements of the fuel system after exposure to specific fuel blends.

7.4.1 Test Procedure

a. Insert mating tube ends, shown in Figure 2, into the connectors.

b. The samples shall have fuel contact surfaces exposed to the fuels as specified in Table 3. Fittings to be used on the inside of a fuel tank must be totally submerged.

c. Replace the fuel every 7 days.

d. New samples must be used for each test.

7.4.2 Test Fuels

See Table 3 (reference SAE J1681).

TABLE 3 - TEST FLUIDS

Test Fluid	Exposure Time	Procedure
ASTM Reference Fuel C	60 Days	Soak @ 40 °C
SAE CE10 (Fuel C Plus 10% Ethyl Alcohol)	60 Days	Soak @ 40 °C
SAE CP (Auto-Oxidized Fuel 50 µmol/liter peroxide)	60 Days	Soak @ 40 °C

NOTE: Other fuels may be specified by the OEM.

7.4.3 Test Requirement

One-half the samples shall be tested immediately after removal from the test fuel and the remaining samples shall be tested after a 48 h dry-out period.

7.4.4 Acceptance Criteria

The quick connect coupling shall meet the functional requirements of 6.1 Leak Test, 6.2 Assembly Effort, and 6.3 Pull Apart Effort, after the completion of the fuel compatibility test.

NOTE: New connector sizes using the same materials and architectural design as previously tested connectors may use the original results as surrogate data.

7.5 Life Cycle

The life cycle test is performed to assure that the quick connector will meet the functional requirements of the fuel system when exposed to pressure, vibration, and temperature cycles typical of severe duty in automotive applications.

7.5.1 Test Procedure

a. Insert a connector into each end of a 500 mm (19.69 in) length of suitable flexible tubing (5 tube/QC assemblies).

b. Leak test the assembly per 6.1, except use mating tube end shown in Figure 2.

c. Connect the assembly to a test fixture, shown in Figure 8 using production intent tube endforms.

d. Test fluid (liquid fuel quick connect couplings)—Mobil Arctic 155 refrigerant oil or equivalent.

e. Test fluid (vapor/emission quick connect couplings)—Air.

NOTE: Use of flammable materials is not recommended. However, tests in fuel or fuel surrogates can produce better results at low temperatures.

7.5.2 Vibration Frequency

Continuously sweep the frequency from 7 Hz to 200 Hz, with 3 sweeps per hour.

7.5.3 Acceleration

See Table 4.

TABLE 4 - ACCELERATION(1)

Maintain Acceleration Load	From	To
18 m/s^2 (2 G)	7 Hz	25 Hz
90 (10 G)	25	50
182 (20 G)	50	75
163 (18 G)	75	100
145 (16 G)	100	125
127 (14 G)	125	150
109 (12 G)	150	175
90 (10 G)	175	200

1. This test may be interrupted or shut down for weekends at the end of any section.

7.5.4 Vibration Duration

Maintain vibration as specified in 7.5.8 (Test Cycles).

7.5.5 Fluid Pressure

a. For liquid fuel quick connect couplings during pressure portions of the test, alternate pressure between 0 and 1034 kPa ± 35 kPa, 10.34 bar ± 0.35 bar (150 psig ± 5 psig). Alternate pressure one time per minute (i.e., 1 min at each pressure).

b. For vapor/emission quick connect couplings during pressure portions of the test, alternate pressure between 0 and 69 kPa ± 2 kPa, 0.69 bar ± 0.02 bar (10 psig ± 0.3 psig). Alternate pressure one time minute (i.e., 1 min at each pressure).

NOTE: Pressure transition rate is to be as close to a square wave as practical but not so abrupt that pressure overshoot occurs. This may require several seconds. See Reference Pressure Cycle.

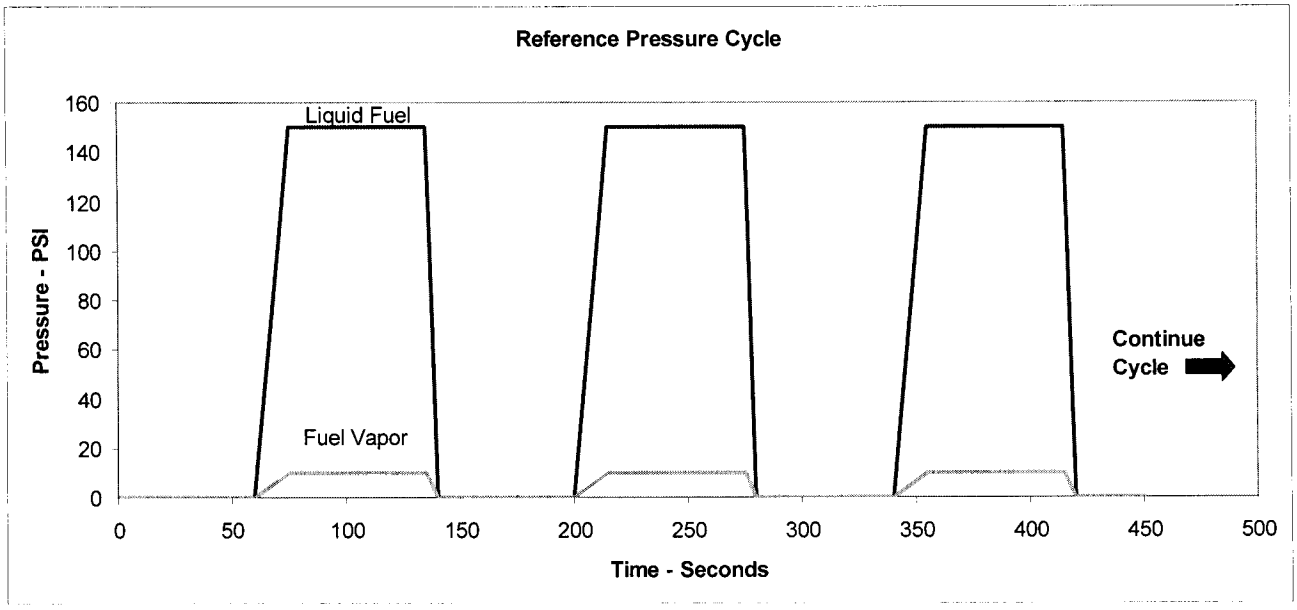


FIGURE 7 - REFERENCE PRESSURE CYCLE

NOTE: It is recommended that 10 pressure cycles be recorded to demonstrate pressure profile. Reference SAE J343, Figure 1 for reference pressure cycle description.

7.5.6 Fluid Flow (Liquid Fuel Quick Connect Couplings Only)

Flow rate during the specified test cycle is 1.33 Lpm ± 0.2 Lpm (0.46 gpm ± 0.07 gpm) through each quick connect coupling, or as required to maintain specified temperatures and pressures.

7.5.7 Test Duration

336 h (14 test cycles) (14 days)

7.5.8 Test Cycles

The test cycle consists of five sections to simulate hot operation, hot soak, hot operation after hot soak, cold soak, and cold operation. See Table 5.

NOTE: Included at the beginning of the hot and cold test sections are temperature transitions times of 1 h maximum.

7.5.8.1 Hot Operation Test

a. Length of Time—7 h

b. Chamber Temperature—125 °C ± 5 °C (257 °F ± 9 °F)

c. Fluid Temperature (liquid fuel quick connect couplings only)—66 °C ± 5 °C (151 °F ± 9 °F)

d. Fluid Pressure—yes

e. Fluid Flow—yes

f. Vibration—yes

7.5.8.2 Hot Soak

a. Length of Time—2 h

b. Chamber Temperature—125 °C ± 5 °C (257 °F ± 9 °F)

c. Fluid Temperature (liquid fuel quick connect couplings only)—Heat to chamber temperature

d. Fluid Pressure—yes

e. Fluid Flow—no

f. Vibration—no

7.5.8.3 Hot Operation after Hot Soak

a. Length of Time—7 h

b. Chamber Temperature—125 °C ± 5 °C (257 °F ± 9 °F)

c. Fluid Temperature (liquid fuel quick connect couplings only)—66 °C ± 5 °C (151 °F ± 9 °F)

d. Fluid Pressure—yes

e. Fluid Flow—yes

f. Vibration—yes

7.5.8.4 Cold Soak

a. Length of Time—7 h

b. Chamber Temperature— –40 °C (–40 °F)

c. Fluid Temperature (liquid fuel quick connect couplings only)—Cool to chamber temperature

d. Fluid Pressure—yes

e. Fluid Flow—no

f. Vibration—no

7.5.8.5 Cold Operation

a. Length of Time—1 h

b. Chamber Temperature— –40 °C (–40 °F)

c. Fluid Temperature (liquid fuel quick connect couplings only)—Cool to chamber temperature

d. Fluid Pressure—yes

e. Fluid Flow—yes

f. Vibration—yes

7.5.9 Acceptance Criteria

a. No fluid leaks permitted during or at completion of test.

b. The connector shall meet the functional requirements of 6.1 Leak Test, 6.2 Assembly Effort, and 6.3 Pull Apart Effort, after the completion of the life cycle test.

c. Perform visual inspection of connector and its components. No fractures, cracks, or unusual wear permitted.

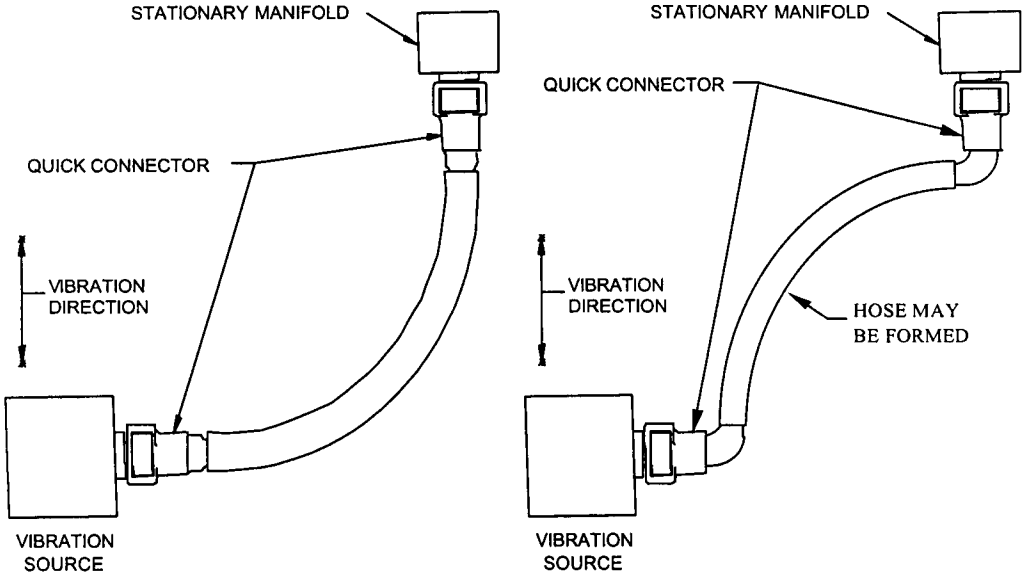


FIGURE 8 - LIFE CYCLE TEST SET UP

TABLE 5 - LIFE CYCLE TEST SCHEDULE

Section	Hour	Chamber Temperature (C°)	Fluid Temperature (C°)	Fluid Pressure	Fluid Flow	Vibration
7.5.8.1	1	125°[1]	125°[1]	Yes	Yes	Yes
	2	125°	66°	Yes	Yes	Yes
	3	125°	66°	Yes	Yes	Yes
	4	125°	66°	Yes	Yes	Yes
	5	125°	66°	Yes	Yes	Yes
	6	125°	66°	Yes	Yes	Yes
	7	125°	66°	Yes	Yes	Yes
7.5.8.2	8	125°	125°[1]	Yes	No	No
	9	125°	125°	Yes	No	No
7.5.8.3	10	125°	66°[1]	Yes	Yes	Yes
	11	125°	66°	Yes	Yes	Yes
	12	125°	66°	Yes	Yes	Yes
	13	125°	66°	Yes	Yes	Yes
	14	125°	66°	Yes	Yes	Yes
	15	125°	66°	Yes	Yes	Yes
	16	125°	66°	Yes	Yes	Yes
7.5.8.4	17	–40°[1]	–40°[1]	Yes	No	No
	18	–40°	–40°	Yes	No	No
	19	–40°	–40°	Yes	No	No
	20	–40°	–40°	Yes	No	No
	21	–40°	–40°	Yes	No	No
	22	–40°	–40°	Yes	No	No
	23	–40°	–40°	Yes	No	No
7.5.8.5	24	–40°	–40°	Yes	Yes	Yes

1. Temperature may be in transition.

7.6 Elevated Temperature Burst

The elevated temperature burst test is performed to assure that the quick connect coupling will withstand the pressure requirements of the fuel system at the maximum operating temperature. This test can be performed as part of the tube and hose assembly requirements of SAE J2045 or as follows.

7.6.1 Test Procedure

a. Insert a quick connector into each end of a 500 mm (19.69 in) length of tubing or reinforced fuel hose (5 tube/QC assemblies). Secure each end with a hose clamp if required, to prevent failure of the stem to hose interface.

b. Insert male tube ends, shown in Figure 2, into the quick connect couplings.

c. ttach assembly to a suitable, air or hydraulic, burst pressure source.

d. Place the assembly in a suitable environmental chamber and soak at 115 °C (239 °F) for 1 h.

e. Perform burst by pressurizing the assembly with a pulse free pressure, at a uniform rate of 7000 kPa/min (1000 psig/min), until burst or rupture occurs.

7.6.2 Acceptance Criteria

a. Minimum burst pressure for liquid fuel quick connect couplings 2000 kPa (290 psig).

b. Minimum burst pressure for vapor/emission quick connect couplings 138 kPa (20 psig).

NOTE: The burst test is for the quick connector only. Leakage or rupture of the hose is not a failure. If the hose fails below the minimum requirement; the test must be rerun with hose capable of higher pressure, if practical.

8. DESIGN VERIFICATION/VALIDATION AND IN-PROCESS TESTING MATRIX

(See Table 6.) This section describes the minimum requirements for quick connect couplings, mating tube ends, and attachment joints.

TABLE 6 - DESIGN VERIFICATION/VALIDATION AND IN-PROCESS TESTING MATRIX

Test	Section	Sample Size (QC's)	Design Verification Acceptance Criteria	Production Validation Acceptance Criteria	In-Process Minimum Samples(1)	In-Process Acceptance Criteria
Leak Test	6.1	10	No Failures	No Failures	100%	No Failures
Assembly Effort	6.2	10	< Maximum	< Maximum	5/lot	< Maximum
Pull-Apart Effort	6.3					
- Liquid		10	> Minimum	> Minimum	5/lot	> Minimum
- Vapor/Emission		10	> Minimum	> Minimum	5/lot	> Minimum
Side-Load Capability	6.4	10	> Minimum	> Minimum	10/year**	> Minimum
Electrical Resistance	6.5	10	< 10^6 Ohms	< 10^6 Ohms*	N/A	N/A
Resistance to Evaporative Emissions	6.6	N/A	N/A	N/A	N/A	N/A
Corrosion	7.1	10	No Failures	No Failures*	10/year for metal couplings	No Failures
Zinc Chloride Resistance	7.2	10	No Failures	No Failures*	N/A	N/A
External Chemical and Environmental Resistance	7.3	10 each	No Failures	No Failures*	N/A	N/A
Fuel Compatibility	7.4	10 each	No Failures	No Failures*	N/A	N/A
Life Cycle	7.5	10	No Failures	No Failures	N/A	N/A
Elevated Temperature Burst	7.6					
- Liquid		10	> 2000 kPa	> 2000 kPa	10/year**	> 2000 kPa
- Vapor		10	> 138 kPa	> 138 kPa	10/year**	> 138 kPa

1. N/A means annual re-testing is not required. Changes in materials, production tooling or processes will require re-testing.
*New connector designs using the same materials as previously tested connectors may use the original results as surrogate data for 7.1, 7.2, 7.3, and 7.4.
2. SAE J2044 rev 2002, test pins and in-process endforms have demonstrated to be acceptable for continued use if already installed.
3. **Same connector designs and sizes, using same materials and manufacturing process's as previously tested, may use surrogate data.

9. NOTES

9.1 Marginal Indicia

A change bar (I) located in the left margin is for the convenience of the user in locating areas where technical revisions, not editorial changes, have been made to the previous issue of this document. An (R) symbol to the left of the document title indicates a complete revision of the document, including technical revisions. Change bars and (R) are not used in original publications, nor in documents that contain editorial changes only.

PREPARED BY THE SAE FUEL SYSTEMS TECHNICAL STANDARDS COMMITTEE

APPENDIX A - PROCEDURE FOR MEASURING MATING TUBE ENDFORM BEAD WIDTH

A.1 PROCEDURE FOR MEASURING MATING TUBE ENDFORM BEAD WIDTH

A.1.1 Setup

a. From Seal Diameter (A) (ref. Figure 2) determine the centerline of the endform.

b. On either side of the bead, from the centerline find the point that is at ½ the Gauge Diameter (G).

A.1.2 Measurement

a. Measure and record the Bead Width (D), at four circumferentially evenly spaced points, at the specified Gauge Diameter.

A.1.3 Acceptance Criteria

a. Must meet the Bead Width dimension (D) at the specified Gauge Diameter dimension (G) as specified in Figure 2.

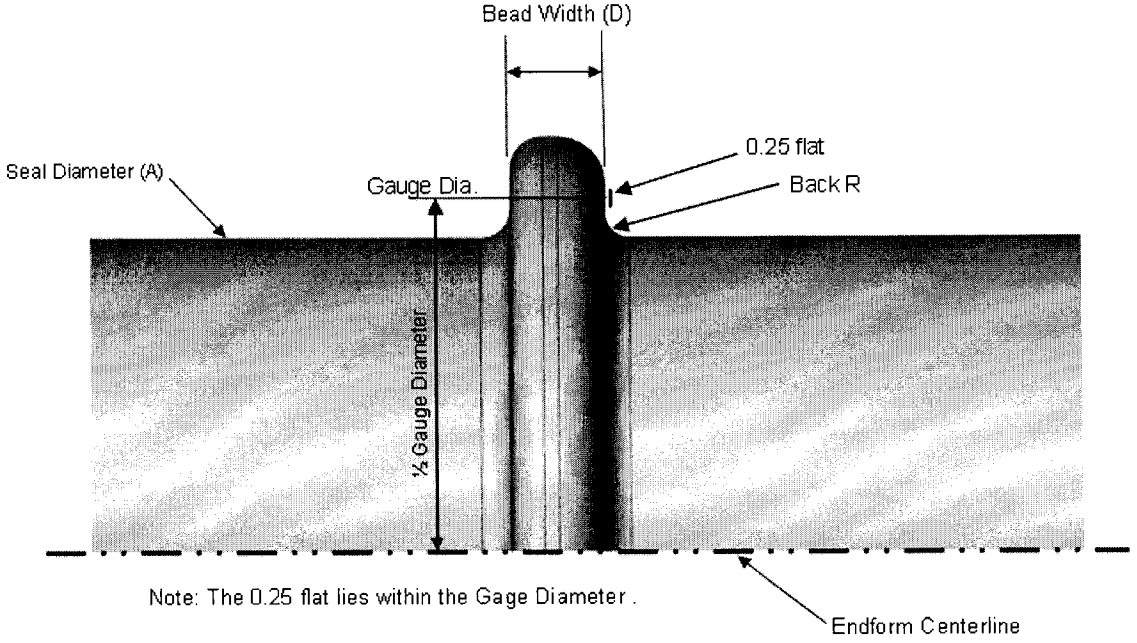


FIGURE A1 - BEAD WIDTH MEASUREMENT