



AEROSPACE STANDARD

AS1650™**REV. F**

Issued 1992-03
Reaffirmed 2005-06
Revised 2018-10

Superseding AS1650E

Coupling Assembly, Threadless, Flexible,
Fixed Cavity, Self-Bonding, Procurement Specification

RATIONALE

Revise pressure surge test fixture in Figure 7 and clarify allowable leakage description for the vibration test in 4.6.3.3.3.

1. SCOPE

This SAE Aerospace Standard (AS) defines the requirements for a threadless, flexible, self-bonding coupling assembly which, when installed on machined fixed-cavity ferrules, provides a flexible connection for joining tubing and components in aircraft fuel, vent, or other systems. This assembled coupling, hereafter referred to as the assembly, is designed for use from -65 to +400 °F and at 125 psig nominal operating pressure.

AS1650 was not designed for the new certification requirements for flammable leakage zones and fuel tanks for lightning protection and assembly redundancy. As such, their use and installation may require additional efforts and equipment to support new FAA CFR compliance. The AS7510 flexible coupling should be the preferred coupling for use in flammable leakage zones and fuel tanks that require service life and functionality for lightning protection and part redundancy.

1.1 Product Classification

The coupling assemblies shall be of the integral electrical bonding type.

2. REFERENCES

2.1 Applicable Documents

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

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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 +1 724-776-4970 (outside USA), www.sae.org.

AMS3331	Elastomer: Fluorosilicone Rubber (FVMQ), Fuel and Oil Resistant, 65 - 75 Shore A Hardness, for Products in Fuel Systems/Lubricating Oils
AMS-WW-T-700	Tube, Aluminum and Aluminum Alloy, Drawn, Seamless, General Specification for
AMS-WW-T-700/6	Tube, Aluminum Alloy, Drawn, Seamless, 6061
AS568	Aerospace Size Standard for O-Rings
AS1651	Assembled Coupling, Threadless - Flexible, Fixed Cavity, Self-Bonding, Envelope Dimensions
AS1652	Coupling Assembly, Threadless - Flexible, Fixed Cavity, Self-Bonding
AS1653	Male Ferrule, Threadless - Flexible, Fixed Cavity, Self-Bonding, Swaged
AS1654	Sleeve, Threadless - Flexible, Fixed Cavity, Self-Bonding
AS1655	Coupling Body, Threadless - Flexible, Fixed Cavity, Self-Bonding
AS1656	Fitting End, Threadless - Flexible, Fixed Cavity, Self-Bonding, Male and Female Design Standard
AS4060	Tube Fitting Swaged Joint, Roller Expander Manual Process, Requirements for
AS4734	Male Ferrule, Threadless - Flexible, Fixed Cavity, Self-Bonding, Butt Welded
AS4735	Female Ferrule, Threadless - Flexible, Fixed Cavity, Self-Bonding, Swaged
AS4736	Female Ferrule, Threadless - Flexible, Fixed Cavity, Self-Bonding, Butt Welded
AS25281	Clamp, Loop, Plastic, Wire Support
ARP9013	Statistical Product Acceptance Requirements

2.1.2 U.S. Government Publications

Copies of these documents are available online at <http://quicksearch.dla.mil>.

MIL-HDBK-831	Preparation of Test Reports
MIL-PRF-680	Degreasing Solvent (Stoddard Solvent)
MIL-PRF-7024	Calibrating Fluids, Aircraft Fuel System Components
MIL-R-25988/1	Rubber, Fluorosilicone Elastomer, Oil & Fuel Resistant, O-Rings, Class 1, Grade 70
MIL-STD-129	Military Marking for Shipment and Storage
MIL-STD-130	Identification Marking of U.S. Military Property

MIL-STD-464	Electromagnetic Environmental Effects Requirements for Systems
MIL-STD-810	Environmental Engineering Considerations and Laboratory Tests
MIL-STD-889	Dissimilar Metals
VV-P-236	Petrolatum, Technical

2.1.3 NAS Publications

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

NAS1787	Clamp, Tube Mounting
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2.1.4 Uniform Classification Committee Publications

Available from Uniform Classification Committee, 202 Chicago Union Station, Chicago, IL 60606.

Uniform Freight Classification Rules

2.1.5 ASTM Publications

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

ASTM B117	Standard Practice for Operating Salt Spray (Fog) Apparatus
ASTM D471	Standard Test Method for Rubber Property – Effect of Liquids
ASTM D1193	Standard Specification for Reagent Water
ASTM D6211	Standard Specification for Fully-Formulated Propylene Glycol-Base Engine Coolant for Heavy-Duty Engines

2.1.6 PRI Publications

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

AC7112	Nadcap Requirements for Fluid System Components
AC7112/3	Nadcap Audit Criteria for Couplings and Formed Sheet Metal Products
PD1100	Nadcap - Program Requirements
PD2001	Qualified Product Management Council Procedures for Qualified Products Group
PD2101	Aerospace Quality Assurance, Product Standard, Qualification Procedures, Fluid Systems

2.1.7 ANSI Accredited Publications

Copies of these documents are available online at <http://webstore.ansi.org/>.

ANSI/ASQ Z1.4	Sampling Procedures and Tables for Inspection by Attributes
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2.1.8 American Welding Society Publications

Available from American Welding Society, 8669 NW 36 Street, #130, Miami, FL 33166-6672, Tel: 800-443-9353, www.aws.org.

AWS D17.1/D17.1M Specification for Fusion Welding for Aerospace Applications

2.2 Definitions

ASSEMBLED COUPLING: The completed coupled connection, utilizing the clamshell coupling body, sleeve, and O-rings to connect two ferrules attached to two ducts.

COUPLING ASSEMBLY: The connecting device consisting of the clamshell body and sleeve which constrains the ferrules and provides a pressure seal and electrical continuity path across the ferrules.

3. TECHNICAL REQUIREMENTS

3.1 Qualification

Assemblies furnished under this specification shall be products which are qualified by meeting all of the requirements covered by this document. Manufacturers choosing to produce only a part or parts of the assembled coupling shall qualify the part or parts by complying with the requirements and performing all tests of this specification. The test specimens for qualification of a part or parts shall be tested with a qualified part or parts made by other qualified manufacturers.

3.1.1 Manufacturer Qualification

A manufacturer producing a product in conformance to this procurement specification shall be accredited in accordance with the requirements of PD1100, PD2101, AC7112, and AC7112/3, and shall be listed in a Nadcap Qualified Manufacturer's List (QML).

3.1.2 Product Qualification

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

3.2 Materials and Finishes

Materials and finishes for the components shall be those designated on the applicable AS standard drawing. The assembly materials and finish shall be uniform in quality, free from defects, suitable for service, consistent with good manufacturing practice, and in conformance with the applicable specifications and requirements stated herein.

3.2.1 Dissimilar Materials

Materials shall possess adequate corrosion resistance characteristics or shall be suitably protected by the use of finishes to resist corrosion caused by such conditions as dissimilar metal combinations, moisture, salt spray, and high-temperature deterioration. Dissimilar materials are defined by MIL-STD-889.

3.3 Design and Fabrication

The assembly shall be a lightweight flexible connection for fuel, vent, and other system lines using the basic principles of O-ring sealing. It shall be capable of a 125 psig nominal operating pressure at temperatures from -65 to +200 °F with aluminum components, and -65 to +400 °F with CRES and titanium components. The assembly shall function at a maximum angular misalignment of 4 degrees or a maximum axial gap of 0.250 inch or, in combination, a minimum axial gap of 0.063 inch at a maximum angular misalignment of 3 degrees. If a component uses an AS1656-2-(size) sleeve end, the maximum angular misalignment is 2 degrees or a maximum axial gap of 0.250 inch. The AS1656-3-(size) sleeve end is intended for hose end applications with no angular misalignment or axial gap except for clearances required to permit assembly.

3.3.1 Assembled Coupling Components

The assembled coupling shall consist of ferrules, O-ring seals, and a coupling assembly as specified in the following standards (refer to AS1651):

Table 1

Quantity	Description	AS Standard Number
2	Ferrule	AS1653 or AS4734, ends per AS1656-1-(Size)
2	O-ring seal	User-defined compound, sizes per AS568
1	Coupling assembly	AS1652

3.3.2 Ferrule

Ferrules shall contain the fixed O-ring cavity. The design of the O-ring groove shall be in accordance with AS1656-1-(size) for standard sizes, as specified in Table 2. Attachment of the ferrule to the tubing shall be by mechanical roller swaging, draw bar swaging, or welding. Roller swaging shall conform to AS4060. Ferrule material shall be compatible with the tubing to which it is attached and shall comply with MIL-STD-889.

3.3.3 Coupling Assembly

Coupling assemblies (refer to AS1652) are provided to simplify drawing callouts. Ferrules are not considered integral to the coupling assembly because they are usually specified on tubing fabrication drawings and vary according to the attachment method.

3.3.3.1 Sleeve

The sleeve shall conform to AS1654 and is designed principally for hoop stresses and to effect sealing when constrained by the AS1655 coupling body. A portion of the sleeve outside surfaces shall be circumferentially grooved or knurled to facilitate gripping by hand during installation and removal.

Table 2 - Physical requirements

Dash Size Ref	Tube Size Inches Ref	Operating Pressure Nominal Negative (-) in Hg	Operating Pressure Nominal Positive (+) psig	Proof Pressure Minimum Negative (-) in Hg	Proof Pressure Minimum Positive (+) psig	Burst/ Rupture Pressure Minimum psig	AS568 O-Ring Dash Size Ref
-08	0.500	24	125	28	250	375	-015
-10	0.625	24	125	28	250	375	-017
-12	0.750	24	125	28	250	375	-117
-16	1.000	24	125	28	250	375	-214
-20	1.250	24	125	28	250	375	-218
-24	1.500	24	125	28	250	375	-222
-28	1.750	24	125	28	250	375	-224
-32	2.000	24	125	28	250	375	-226
-36	2.250	10	125	12	250	375	-228
-40	2.500	10	125	12	250	375	-230
-48	3.000	10	125	12	250	375	-234
-56	3.500	10	125	12	250	375	-238
-64	4.000	10	125	12	250	375	-242

3.3.3.2 Coupling

The coupling shall automatically lock when manually closed and shall be structurally capable of withstanding both the axial and bending moment loads transmitted by the system tubing when using the tubing wall thickness as specified in Table 3. The closure shall have clear indication of a locked condition both visually and by feel. Quick connect or disconnect action of the latch shall be utilized to allow assembly and removal with one hand. The coupling assembly shall provide electrical bonding means which will produce a maximum of 1 Ω resistance from tube to tube across the coupling assembly. The coupling assembly is allowed to rotate around the ferrules when installed.

3.3.4 Seals

O-ring seals are not considered a part of this specification except for coupling qualification test requirements. Sizes in accordance with AS568 are given in Table 2.

3.3.5 Dimensions

The assembly envelope dimensions shall be as specified in AS1651. Part dimensions shall be as specified in applicable AS part standards.

3.3.6 Weights

The individual components of the coupling shall meet the weight requirements listed on the applicable AS part standards.

Table 3 - Tube size and wall thickness

Coupling Dash Size Ref	Tube Size in Ref	Tube Wall Thickness /1/ Inch
08	0.500	0.035
10	0.625	0.035
12	0.750	0.035
16	1.000	0.035
20	1.250	0.035
24	1.500	0.035
28	1.750	0.035
32	2.000	0.035
36	2.250	0.042 or 0.049
40	2.500	0.042 or 0.049
48	3.000	0.042 or 0.049
56	3.500	0.049
64	4.000	0.049

/1/ Aluminum drawn tubing, 6061-T6 in accordance with AMS-WW-T-700/6.

3.4 Performance

The assembled coupling shall meet the following performance requirements.

Previous qualification testing to previous revisions of this specification provides acceptable qualification test data to the current revision. Suppliers shall identify the previous specification revision level used for the previous testing in their qualification test report.

3.4.1 Proof Pressure

The assembled coupling shall meet the negative and positive proof pressures listed in Table 2 without leakage as specified or evidence of other malfunction. Testing is specified in 4.6.2.

3.4.1.1 Negative Pneumatic Leakage

The assembled coupling shall not exhibit a decrease in negative pressure exceeding 0.5 in Hg within a period of 5 minutes when subjected to the Table 2 negative proof pressure. Testing is specified in 4.6.2.1.

3.4.1.2 Positive Pneumatic Leakage

The assembled coupling shall withstand pneumatic pressure equal to the Table 2 positive proof pressure for 3 minutes at room temperature without any visible bubbles starting after 1 minute at proof pressure. Testing is specified in 4.6.2.2.

3.4.1.3 Positive Hydraulic Leakage

The assembled coupling shall withstand hydraulic pressure equal to the Table 2 positive proof pressure for 3 minutes at room temperature without external wetting from any point of the assembly. Testing is specified in 4.6.2.3.

3.4.2 Vibration

The assembled coupling shall show no evidence of malfunction or structural failure and no leakage in excess of 3.4.1.3 after exposure to vibration levels in accordance with 4.6.3. The electrical resistance across the assembled coupling shall not exceed 1 Ω .

3.4.3 Repeated Assembly

There shall be no evidence of deformation, damage, or degradation in latching ability, and the assembled coupling shall show no evidence of leakage in excess of 3.4.1.3 when subjected to the proof pressure requirements of 3.4.1 following 100 repeated assembly operations. The electrical resistance across the assembled coupling shall not exceed 1 Ω . Testing is specified in 4.6.4.

3.4.4 Salt Fog

The assembled coupling shall show neither evidence of excessive corrosion, peeling, chipping, or blistering of the finish, nor exposure of base metal under plated surfaces after being subjected to the salt fog test. The assembled coupling shall show no evidence of leakage in excess of 3.4.1.3 when subjected to the Table 2 positive proof pressures. The electrical resistance across the assembled coupling shall not exceed 1 Ω . Testing is specified in 4.6.5.

3.4.5 Flexure

The assembled coupling shall withstand Table 2 proof pressure without evidence of leakage in excess of 3.4.1.3 with no binding or galling of parts after being subjected to 28800 flexure cycles with the assembled coupling at an offset of 3 degrees. Testing is specified in 4.6.6.

3.4.6 Pressure Surge

The assembled coupling shall withstand pressure surge cycles as defined in Table 4 and Figures 1 and 2, for the appropriate tube size, without evidence of malfunction or leakage in excess of 3.4.1.3. Testing is specified in 4.6.7.

Table 4 - Pressure surge cycles by dash size

Coupling Dash Size	Pressure Cycles	Pressure Surge Curve
08 through 16	100000	Figure 1
20 through 36	100000	Figure 2
40	60000	
48 through 64	100000	

Figures 1 and 2 define the performance pressure surge requirements of the assembled couplings. Each pressure pulse shall be within the envelope upper and lower limits defined in Figure 1 for sizes -08 through -16, and Figure 2 for sizes -20 through -64.

The suppliers shall perform qualification of -08 through -16 size to Figure 1 with the initial pressure spike exceeding 180 psi and the entire pulse profile shall be within the defined boundaries of the figure. For sizes -20 through -64, each pressure pulse shall have a portion of the profile that shall meet or exceed 150 psi. Pressure trace recordings shall be made at the start, middle, and end of each run of 50000 pressure surge cycles, or each run of 30000 pressure surge cycles for -40.

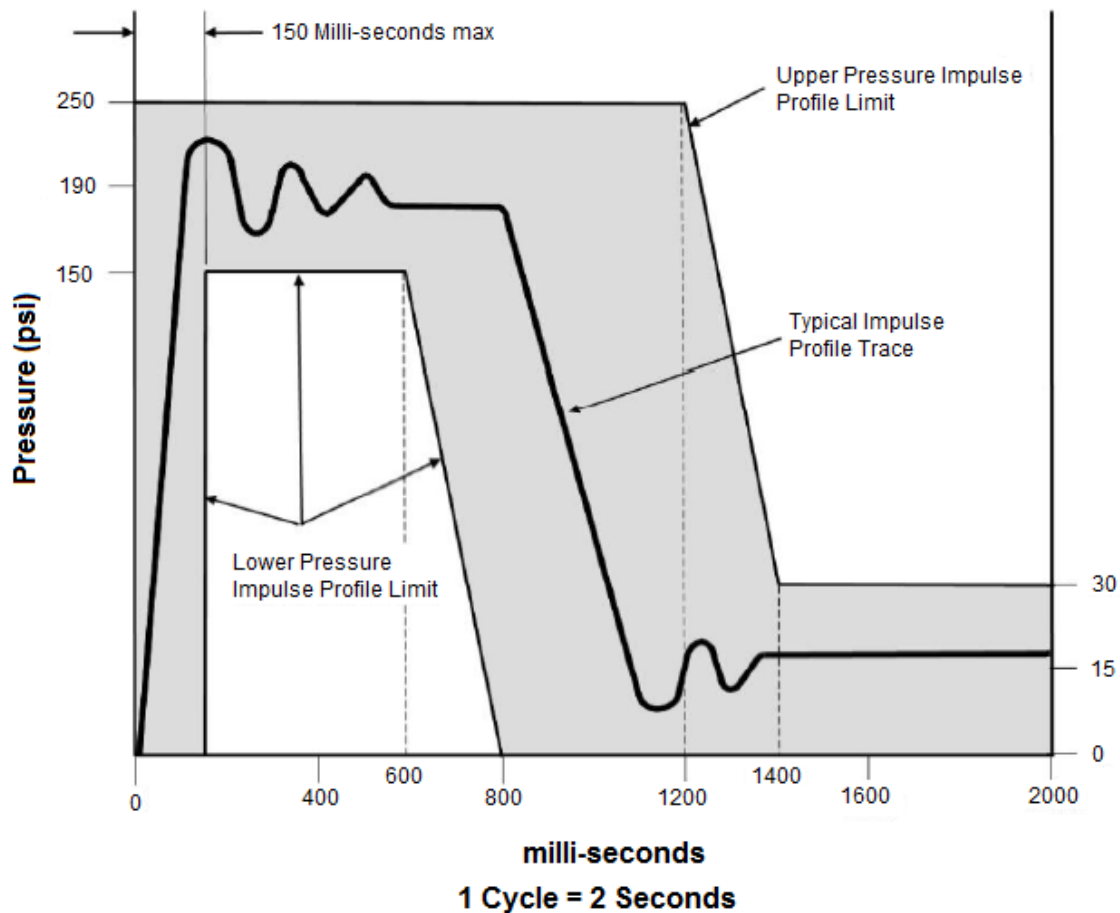


Figure 1 - Pressure surge curve for sizes -08 through -16

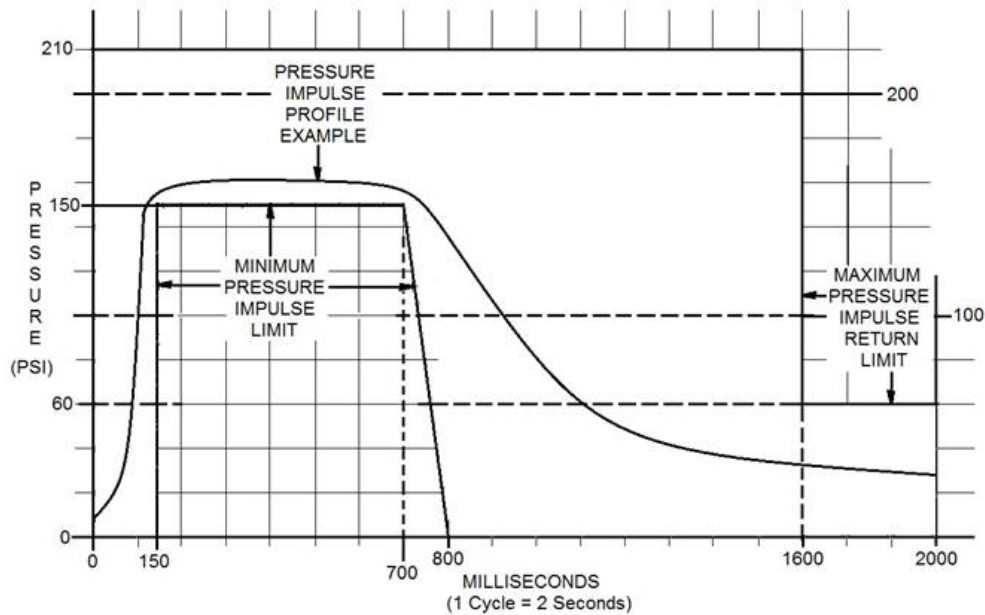


Figure 2 - Pressure surge curve for sizes -20 through -64

3.4.7 Burst/Rupture

The assembled coupling shall neither rupture, nor show evidence of leakage in excess of 3.4.1.3 at any pressure up to the Table 2 burst/rupture pressures. Testing is specified in 4.6.8.

3.4.8 Electrical Bonding

The electrical resistance of the assembled coupling, when measured from tube to tube, shall not exceed 1 Ω at any time. Testing is specified in 4.6.9.

3.5 Identification of Product

Coupling assembly parts and ferrules shall be marked for identification in accordance with MIL-STD-130, as specified on the applicable AS standard or drawing.

3.6 Workmanship

Coupling components shall be manufactured and finished in accordance with commercially accepted practices and processes.

3.7 Cleanliness

The coupling components as supplied shall be free of oil, grease, dirt, or any other foreign material both internally and externally.

4. QUALITY ASSURANCE PROVISIONS

4.1 Responsibility for Inspection

Unless otherwise specified in the contract or purchase order, the supplier is responsible for the performance of all inspection and test requirements as specified herein. Except as otherwise specified, the supplier may utilize his/her own facilities or any commercial laboratory acceptable to PRI for the performance of the inspection and test requirements. PRI reserves the right to witness any of the inspections and tests set forth in the specification, where such inspections and tests are deemed necessary to assure that supplies and services conform to prescribed requirements.