



AEROSPACE RECOMMENDED PRACTICE

MAP2261

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Fluid Couplings for Spacecraft Servicing,
Preparation of Specification for, Metric

RATIONALE

MAP2261 has been reaffirmed to comply with the SAE five-year review policy.

1. SCOPE:

This SAE Metric Aerospace Recommended Practice (MAP) establishes the requirements for preparing a specification for fluid couplings for spacecraft servicing. The objective of this document is to provide design, development, verification, storage, and delivery requirement guidelines for the preparation of specifications for fluid couplings and the ancillary hardware for use with serviceable spacecraft designed for use in the space environment. The couplings shall be capable of resupplying storable propellants, cryogenic liquids, and gases to a variety of spacecrafts.

1.1 Product Classification:

The couplings shall be classified as follows:

- a. Type I: Tanker half
- b. Type II: Spacecraft half

1.1.1 The Type I coupling shall be attached to the supply tanker. This half shall contain the majority of the seals and mechanical/electrical complexity.

1.1.2 The Type II coupling shall be attached to the spacecraft. This half shall contain fewer seals and less mechanical/electrical complexity in order to maximize reliability.

1.2 Usage Classification:

The couplings shall be classified by usage such as robotic, automated, and manual.

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Documents

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2. REFERENCES:

2.1 SAE Publications:

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

AIR4728 References, Spacecraft and Servicing (Abbreviations, Acronyms, Definitions, Applicable Documents and Environmental Conditions)

SAE Technical Report Style Manual

2.2 Abbreviations and Acronyms:

Standard abbreviations and acronyms used in this document and frequently used in aerospace technical documents are given in AIR4728.

2.3 Definitions:

Definitions of terms used in this document and frequently used in aerospace technical documents are given in AIR4728.

3. REQUIREMENTS:

3.1 Preparation of Specifications:

A specification prepared in accordance with this MAP shall be presented using the rules given for specifications in the SAE Technical Report Style Manual (see Section 6 through 6.6.5).

3.2 Technical Requirements:

The following design requirements (physical/performance/environmental) statements shall be considered for inclusion and may be specified in a fluid coupling specification to support fluid servicing and space assembling in a space environment.

3.2.1 Examples of Physical Requirements: Following are physical requirements that shall be considered for listing in the specification. Only requirements applicable to the product and usage classification are to be included. Examples of wording for each paragraph are presented.

3.2.1.1 Envelope: The fluid coupling envelope shall conform to the applicable procuring agency dimensions.

3.2.1.2 Mounting: The fluid coupling shall be designed to engage and disengage with the system components as indicated on the part standard drawing.

- 3.2.1.3 Weight: As a design goal, the combined weight of both coupling halves shall not exceed the weight indicated by the procuring agency including any caps, covers, or unique supporting equipment, that must remain attached to the coupling or spacecraft/tanker.
- 3.2.1.4 Materials: The fluid coupling shall be constructed of materials that will not change the composition of, or be adversely affected by the fluid medium, environment, or service life specified.
- 3.2.1.5 Design and Construction: The configuration, dimensions, and other design details shall comply with the requirements in the part standard drawing. Mechanical units of the dimensions in the part standard drawing shall comply with the requirements and recommendations of the International System of Units (SI). Equivalent dimensions using units in accordance with the British Engineering System shall follow the SI dimensions and shall be enclosed in parentheses. The design objective shall be to obtain the smallest size and lightest weight commensurate with meeting performance requirements. The coupling design shall preclude occurrence of a catastrophic hazard. Structural integrity of the coupling design shall preclude cumulative creep or strain leading to rupture or permanent deformation that would affect the service life of the coupling.
- 3.2.1.6 Seals: All seals used in the coupling design shall be replaceable either independently or as a seal assembly unit, without cutting coupling or cover welds. All seals shall be designed and certified for full life without maintenance. Seal replacement is for contingency purposes only and not scheduled maintenance. All critical interface seals shall be located on the tanker half of the coupling to permit ease of checkout and replacement.
- 3.2.1.7 Interchangeability: Couplings of the same part number shall be interchangeable in accordance with the definition in MIL-STD-280. This includes like assemblies, subassemblies, and replaceable parts.
- 3.2.1.8 Protective Covers:
 - 3.2.1.8.1 Manual Coupling: If required by the part standard drawing, covers shall be required for each demated coupling half as a means of protecting all exposed critical surfaces, seals, etc. from damage and to minimize the entry of contaminants. Each cover shall be tethered to its respective half.
 - 3.2.1.8.2 Automated Coupling: Covers for automated couplings shall be provided by the host mechanism and are, thus, outside the scope of this document.
- 3.2.1.9 Filter Elements: If required by the part standard drawing, the fluid flow path of the tanker half (Type I) and the spacecraft half (Type II) shall incorporate filter elements. The filter elements shall be located to prevent the entry of contamination.
- 3.2.1.10 Filter Rating: The filter elements in the fluid flow path in either direction shall incorporate a micron particle rating as defined in the part standard drawing consistent with protecting the design of the coupling and system.

- 3.2.1.11 Launch Vehicle Safety: The coupling shall comply with the applicable safety requirements of launch and transportation vehicles in both the mated/demated positions, and during all operational phases associated with its use.
- 3.2.1.12 Fluid Flow Path: The coupling shall be designed to allow the maximum fluid flow in the direction of flow resulting in uniform flow area based on tube size and minimum turbulence.
- 3.2.1.13 Flow Control: As required by the specific application, flow through the fluid path shall be provided by flow control devices in each coupling half. Actuation of the flow control devices to the open position may be accomplished during the mating process or independent of the mating process. In either case, the flow control device must be actuated to the closed position prior to demating the interface seals and must not actuate to the open position prior to mating the interface seals or after separation of the Type I/Type II interface.
- 3.2.1.14 Engagement and Disengagement: As required by the specific application, the coupling shall be designed for either automatic or manual mating and demating. The engagement and disengagement processes shall require two separate phrases: first, latching to resist pressure separation, and second, opening to permit fluid flow.
- 3.2.1.15 Failure Tolerant:
- 3.2.1.15.1 Critical Hazards: Critical hazards shall be controlled such that no single failure or operator error can result in damage to launch equipment, a non disabling personnel injury, or the use of unscheduled safing procedures that affect operations.
- 3.2.1.15.2 Catastrophic Hazards: Catastrophic hazards shall be controlled such that no single or combination of two failures or operator errors can result in the potential for a disabling or fatal personnel injury or loss of the launch vehicle, ground facilities, or equipment.
- 3.2.1.16 Position Indicators: The coupling shall be designed with appropriate indicators to provide indication that the coupling has been fully coupled or decoupled and, consequently, shows the status of the fluid flow path.
- 3.2.1.17 Pressure Buildup: The coupling shall be designed to limit pressure buildup of trapped volumes of fluid medium between all seals and between all flow control devices during any stage of use whether mated/demated. The pressure buildup allowed before relief shall not degrade the performance of the coupling. Unless otherwise specified, no external venting to space shall be permitted.
- 3.2.1.18 Use of Standard Parts: Standard parts shall be used in the design of the fluid coupling to the greatest degree possible.
- 3.2.1.19 Indexing (Keying): The coupling shall incorporate an indexing feature to prevent mating with other coupling part numbers and/or with the same coupling part number for different fluids used at different locations.

3.2.1.20 Maintainability: The coupling shall be designed so that maintenance, overhaul, or adjustment during its operating life can be accomplished on the Type II spacecraft half.

3.2.1.21 Failure Deterrent: The coupling shall be designed such that:

- a. Built-in liquid traps, which would cause malfunction or failure, shall be eliminated.
- b. Blind pockets, where hidden corrosion could develop, shall be prohibited.
- c. Failure propagation protection shall be provided such that transient out-of-tolerance conditions or component failures shall not cause other component or subsystem failures.
- d. Positive locking on threaded parts and fasteners shall be incorporated to prevent loosening during service. The use of safety wire shall be prohibited.
- e. Backward or improper installation of unidirectional components or piece parts shall be prevented by use of nonsymmetry of configuration, different connecting sizes, or other comparable means.
- f. Sliding fits shall be designed to preclude frictional failures and/or binding.
- g. Fatigue failure resulting from flow-induced vibrations in flexible sections shall be prevented by proper design practices and material selection.

3.2.1.22 Protective Treatment: Materials subject to deterioration, when exposed to climatic and other environmental conditions as specified, shall be protected against such deterioration. The method of protection shall not prevent compliance with other requirements of the specification. The use of any protective coating that will crack, chip, scale, or erode during the required life when exposed to the extremes of climatic, environmental, or operational conditions specified, shall be prohibited.

3.2.1.23 Identification: Parts and assemblies shall be marked for identification in accordance with the specification.

3.2.1.24 Lubricants: The use of lubricants shall be discouraged. If their use is necessary, lubricants shall meet prior approval by the procuring agency.

3.2.1.25 Outgassing: Materials used shall be suitable for use in a space environment, exhibit low outgassing characteristics, and maintain their mechanical, physical, and electrical properties over the shelf and operational life times.

3.2.1.26 Workmanship: All parts and assemblies shall be designed, produced, and tested in a quality manner intended to produce defect-free hardware.