SAE Aerospace
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AEROSPACE RECOMMENDED PRACTICE

SAE ARP1709

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Coupling Assembly, Hydraulic Self Sealing, Quick Disconnect

RATIONALE

ARP1709 has been reaffirmed to comply with the SAE five-year review policy.

1. SCOPE:

1.1 This specification covers the requirements for aircraft, hydraulic, self sealing, quick disconnect couplings, for use in type II hydraulic systems (-65°F to +275°F temperature range) as defined by MIL-H-5440.

1.2 Classification: Hydraulic self sealing, quick disconnect couplings shall be of the following classes and types:

Class 1000: 1000 psi rated pressure.
Class 3000: 3000 psi rated pressure.
Class 4000: 4000 psi rated pressure.

Type I Quick Disconnects shall have a visual indication that they are completely connected and open to flow.

Type II Quick Disconnects shall have both a visual and touch indication that they are completely connected and open to flow.

2. APPLICABLE DOCUMENTS:

2.1 Issues of Documents: The following documents of the issue in effect on date of invitation for bids, or request for proposal, form a part of this specification to the extent specified herein:

TO PLACE A DOCUMENT ORDER: **Tel: 877-606-7323 (inside USA and Canada)**
Tel: +1 724-776-4970 (outside USA)
Fax: 724-776-0790
Email: CustomerService@sae.org
SAE WEB ADDRESS: **http://www.sae.org**

2.1.1 Military Specifications:

MIL-H-5440	Hydraulic Systems: Design, Installation and Test of Aircraft, (General Specification for)
MIL-H-5606	Hydraulic Fluid, Petroleum Base, Aircraft and Ordnance
MIL-H-8775	Hydraulic System Components, Aircraft and Missile, General Specification for
MIL-H-25579	Hose Assembly, Tetrafluoroethylene, High Temperature, Medium Pressure, General Requirements for
MIL-H-83282	Hydraulic Fluid, Fire Resistant Synthetic Hydrocarbon Base, Aircraft
MIL-P-83461	Packing, Preformed, Petroleum Hydraulic Fluid Resistant, Improved Performance at 275°F
MIL-R-8791	Retainer, Packing, Hydraulic and Pneumatic, Tetrafluoroethylene Resin

2.1.2 Military Standards:

MIL-STD-129	Marking for Shipment and Storage
MIL-STD-130	Identification Markings of U.S. Military Property
MIL-STD-810	Environmental Test Methods

2.2 Other Publications:

Society of Automotive Engineers (SAE)

AIR 1047	A Guide for the Selection of Quick Disconnect Couplings for Aerospace Fluid Systems
ARP 24	Hydraulic Pressure Drop Determination of
ARP 603	Impulse Testing of Hydraulic Hose Assemblies, Tubing, and Fittings
ARP 614	Hose Assemblies, Aircraft and Missiles, High Temperature (450°F), High Pressure (4000 psig)
ARP 868	Pressure Drop Test for Fuel System Components
AS 1339	Hose Assembly, Tetrafluoroethylene, Lightweight, High Temperature, High Pressure 3000 psi (20684 KPa) Hydraulic and Pneumatic

3. REQUIREMENTS:

3.1 Qualification: The couplings furnished under this specification shall be a product which has been tested, and has passed the qualification tests specified herein, and has been approved by the procuring agency or prime contractor.

3.2 General Specification: The requirements of MIL-H-8775 apply to this specification except as specified herein.

3.3 Materials: The coupling shall be constructed of materials that will not change the composition of or be adversely affected by hydraulic fluid conforming to MIL-H-5606 or MIL-H-83282. Other materials and fluids can be utilized for similar applications based on procuring agency requirements.

3.4 Design and Construction: The configuration, dimensions, and other details of design of the couplings shall conform to applicable Specification Control Drawings. The design objective shall be to obtain the smallest size and lightest weight commensurate with meeting performance requirements herein. When coupled, the coupling shall be such that it will permit fluid flow in either direction in accordance with the rated flow and pressure drop as specified in Table I. Flow shall not be blocked under surge conditions.

3.4.1 Temperature Range: Couplings shall be designed to operate throughout the temperature range of -65°F to +275°F (see para. 4.6.3).

3.4.2 Sealing and Fluid Loss: The couplings shall, when uncoupled, seal the ends of the disconnected lines at the point of disconnection and shall not permit external leakage during any phase of coupling or uncoupling. Fluid loss (spillage) as specified in Table II is not considered to be external leakage. Both halves of the coupling shall seal fluid under both low and high pressures (see para. 4.6.4).

3.4.3 Seals: Only MIL-P-83461 packing material and MIL-R-8791 retainer material shall be used with MIL-H-5606 hydraulic fluid. Packing and retainer material for other fluid shall be specified by the Procuring Agency.

Table I - Rated Flow and Pressure Drop

Dash No.	Equivalent Tube Size In Inches	Rated Flow GPM	Surge Flow GPM	Pressure Drop PSI (Max.)
-04	1/4	1.2	6	8
-06	3/8	3.5	17.5	8
-08	1/2	6.0	30	8
-10	5/8	10.5	52.5	8
-12	3/4	16.0	80	8
-16	1	29.0	87	8
-20	1 1/4	45.0	90	4
-24	1 1/2	60.0	120	4
-32	2	100.0	200	4

Table II - Air Inclusion and Fluid Loss

Dash No.	Equivalent Tube Size Inches	Air Inclusion Standard Cubic Centimeters ($in.^3$) (Max.)	Average Fluid Loss (Spillage) Per Operating Cycle Cubic Centimeter ($inches^3$) (Max.)
-04	1/4	0.10 (0.006)	0.05 (0.003)
-06	3/8	0.20 (0.012)	0.10 (0.006)
-08	1/2	0.40 (0.025)	0.20 (0.012)
-10	5/8	0.60 (0.037)	0.30 (0.018)
-12	3/4	1.00 (0.061)	0.50 (0.031)
-16	1	1.75 (0.110)	1.00 (0.061)
-20	1 1/4	2.00 (0.122)	1.20 (0.073)
-24	1 1/2	2.50 (0.153)	1.50 (0.092)
-32	2	3.00 (0.183)	2.00 (0.122)

3.4.4 Operation: The coupling shall be so designed that it can be coupled and uncoupled with a one handed simple motion and without special tools, while one half is held in a fixed mounting. It shall be possible to couple and uncouple with a static pressure, as shown in Table III, applied to both halves. The force, or torque, shall not exceed the values shown in Table III.

The Type I coupling shall have a clear and unmistakable visual indication that it is fully connected and open when viewed at 90° to the axis from any side.

The Type II coupling shall have a visual and touch feature to indicate the completely coupled condition, the touch feature shall be clear and unmistakable.

The coupling shall not inadvertently uncouple under a 20 G maximum load.

Table III - Coupling Forces With the Indicated Static Pressure Applied to Both Halves

Dash No.	Static Press. PSIG	Push-Pull Axial LBS.	Torque Rotation IN. LBS.
-04	60	30	15
-06	60	35	20
-08	60	40	25
-10	60	45	30
-12	50	50	40
-16	30	60	50
-20	20	60	60
-24	15	60	70
-32	10	60	80

3.5 Interchangeability: Couplings shall be interchangeable as a coupled assembly (not individual coupling halves). It shall be impossible to interconnect different tube sizes. Couplings of different pressure classes shall not be capable of cross coupling.

3.6 Performance: The self sealing couplings furnished under this specification shall perform satisfactorily when conforming to the following performance requirements.

3.6.1 Envelope, Weight, Materials: Each coupling half must conform to the applicable purchaser and supplier envelope dimensions, weight control, materials, and finishes.

3.6.2 Proof Pressure: Each coupling half must meet operational and leakage requirements after being subjected to proof pressure of 150% of operating pressure for a period of one minute (Ref. para. 4.6.2).

3.6.3 Extreme Temperature Functioning: Each coupling half shall show no malfunction during or after being subjected to extreme temperature testing from -65°F to 275°F (Ref. para. 4.6.3).

3.6.4 Leakage: Coupling halves shall meet specified leakage requirements at 30 inch static head of hydraulic fluid and at operating pressure (Ref. para. 4.6.4).

3.6.5 Vacuum: Each coupling half shall meet inward leakage requirements with no evidence of malfunction or degradation, with equivalent of 10 inches of Hg applied and lines closed for five minutes (Ref. para. 4.6.5).

3.6.6 Surge Flow: Coupling halves shall meet leakage, operational and pressure drop requirements after being subjected to five times (three times for -16, two times for -20, -24 and -32) the rated flow in each direction (Ref. para. 4.6.6).

3.6.7 Vibration: Each coupling half must be capable of withstanding the vibration environment specified without experiencing any malfunction or degradation. Couplings shall be pressurized with 15 psig pressure (Ref. para. 4.6.7).

3.6.8 Impulse: Coupling halves shall be capable of withstanding the impulse testing specified per ARP 603 without any indication of malfunction. Pressures, rate of rise and impulse form shall be per Table V and Figure 3 (Ref. para. 4.6.8).

3.6.9 Endurance: Each coupling half shall be capable of withstanding 200 endurance cycles without any evidence of malfunction or serious degradation, with 15 psig pressure applied to each half; size -32 shall have 10 psig pressure (Ref. para. 4.6.9).

3.6.10 Manual Operation: Coupling halves shall be capable of being tested in accordance with specified requirements with no evidence of coupling forces, leakage or spillage beyond the specified limits. Note: Both coupling halves shall be installed in systems capable of accommodating some fluid displacement without pressure rise. The coupling force/torque and applied pressures shall be per Table III (Ref. para. 4.6.10).

3.6.11 Air Inclusion: The air inclusion for all coupling halves shall be within specified limits per Table II and at 30 inches of oil pressure (Ref. para. 4.6.11).

3.6.12 Impact: Coupling halves shall withstand a 20 G impact test without evidence of disconnect, leakage or other malfunction. The test shall be performed per MIL-STD-810, Method 516.2 Procedure 1 (Ref. para. 4.6.12).

3.6.13 Pressure Drop: Each coupling shall indicate a pressure drop within the limits specified in Table I. The fluid temperature shall be 100° ± 10°F and test set-up shall be as shown in Figure 4 (Ref. para. 4.6.13).

3.6.14 Burst Test: Coupling halves shall be capable of withstanding 250% of operating pressure and 275°F temperature without fluid loss or rupture (Ref. para. 4.6.14).

3.7 Identification of Product: The coupling shall be marked for identification in accordance with MIL-STD-130. In addition, each coupling shall be permanently marked with the customer (NSN, MS, Purchaser Assigned) part number, manufacturer's part number and the manufacturer's name or code identification number. Class number (or operating pressure) shall be part of product identification. When available surface area precludes complete identification, a tag may be attached.

3.8 Workmanship: Workmanship shall be of the quality necessary to produce couplings free from all defects which would affect proper functioning in service.

4. QUALITY ASSURANCE PROVISIONS:

4.1 Inspection Responsibility: The supplier is responsible for the performance of all inspection requirements as specified herein. Except as otherwise specified, the supplier may utilize his own or any other inspection facilities and services acceptable to the procuring agency. Inspection records of the examination and tests shall be kept complete and available to procuring agency as specified in the contract or order. The government and/or procuring agency reserve the right to perform any of the inspections set forth in the specification where such inspections are deemed necessary to assure supplies and services conform to prescribed requirements.

4.2 Classification of Tests: The tests shall consist of qualification tests and acceptance tests (4.3 and 4.4 respectively).

4.3 Qualification Tests:

4.3.1 The qualification tests shall consist of the following tests and shall be conducted in the following order. All tests are described under 4.6. Unless otherwise specified, one test sample of each size shall be subjected to all indicated tests. Test samples shall be typical production units.

(a) Examination of Product	(4.6.1)
(b) Proof Pressure	(4.6.2)
(c) Extreme Temperature Functioning	(4.6.3)
(d) Leakage	(4.6.4)
(e) Vacuum	(4.6.5)
(f) Surge Flow	(4.6.6)
(g) Vibration	(4.6.7)
(h) Impulse	(4.6.8)
(i) Endurance	(4.6.9)
(j) Manual Operation	(4.6.10)
(k) Air Inclusion	(4.6.11)
(l) Impact	(4.6.12)
(m) Pressure Drop	(4.6.13)
(n) Burst Pressure	(4.6.14)

4.4 Acceptance Tests: The acceptance tests shall consist of the following tests. All tests are described under 4.6.

(a) Examination of Product	(4.6.1)
(b) Proof Pressure	(4.6.2)
(c) Leakage	(4.6.4)
(d) Manual Operation	(4.6.10)

4.5 Test Conditions:

4.5.1 Test Fluid: Unless otherwise specified, MIL-H-5606 shall be used for all qualification testing. Other fluids may be specified by the procuring agency, if required, for system compatibility.

4.5.2 Temperatures: Except where otherwise specified, the tests of this specification shall be conducted at a room temperature of 70° to 90°F and with a fluid temperature of 70° to 110°F, as measured within 12 inches of the test sample. The actual temperature of the fluid during the tests shall be recorded in the test reports.

4.5.3 Immersion: All couplings shall be immersed continuously in hydraulic fluid for a period of 72 hours at a fluid temperature of 275° ± 5°F, prior to conducting the qualification tests (see 4.3) specified herein. All internal parts of the coupling shall be in contact with the fluid during this immersion. After the 72 hours soak period, the coupling shall be subjected to the next test immediately or remain in the fluid at normal room temperatures until such test.

4.6 Test Methods:

4.6.1 Examination of Product: Visually inspect the unit to verify good workmanship and correct markings. Physically measure and record all dimensions noted on applicable assembly drawings to verify correct configuration, envelope, mounting requirements, interface dimensions and applicable dimensional tolerances. Record dry weight. Visually check finish and material usage. For acceptance tests only, dimensions are not required to be recorded, and weight is only required on a sampling basis.

4.6.2 Proof Pressure: The coupled coupling and the uncoupled halves shall be subjected to a proof pressure of 150 percent of the rated pressure for a period of one (1) minute at room temperature. There shall be no leakage greater than specified herein, nor any permanent distortion or other malfunctioning of the coupling. The coupling shall couple and uncouple normally and seal hydraulic fluid as required after having been subjected to this test. This test shall be repeated after all other tests required herein have been accomplished but just prior to the burst pressure test (4.6.14). This repeat test shall be conducted at 275° ± 5°F for a duration of five (5) minutes for qualification tests and at room temperature for a duration of one (1) minute for acceptance tests (4.3 and 4.4 respectively).

4.6.3 Extreme Temperature Functioning: The couplings shall withstand the following tests without malfunctioning or leakage in excess of the values specified herein (see 4.6.4).

4.6.3.1 High Temperature: After immersion (4.5.3) but before being uncoupled, the coupling shall be connected to a 30 inch static head of hydraulic fluid and subjected to a temperature of 275° ± 5°F for a period of 6 hours. There shall be no measurable leakage from the connected coupling during the 6 hour period. At the end of this time, the coupling shall be cooled to 140° ± 5°F and at least five cycles of coupling and uncoupling shall be completed. There shall be no binding during any cycle of disconnection and connection. The temperature of the uncoupled halves shall be raised to 225° ± 5°F and shall be subjected to the leakage at low pressure test and then at high pressure test (4.6.4).

4.6.3.2 Low Temperature: After completion of the high temperature tests (4.6.3.1) the couplings shall be connected to a 30 inch static head of hydraulic fluid, and subjected to a temperature not warmer than -65°F for a period of 4 hours after stabilization. There shall be no measurable leakage from the connected coupling during this period. At the end of this period, at least five cycles of coupling and uncoupling shall be completed. There shall be no binding during any cycle of disconnection and connection. The uncoupled halves shall be subjected to the leakage at low pressure test and then at high pressure test (4.6.4). It will be satisfactory for the temperature to rise to -40°F during this process.

4.6.3.3 Rapid Warmup: The coupled coupling while connected to a 30 inch static head of hydraulic fluid, shall be allowed to warm up rapidly from -65° to +40°F within a 5 minute period and shall be coupled and uncoupled at least five times during this period without waiting for the fluid, coupling, and ambient air temperature to stabilize. Temperature is to be measured at coupling outer surface. During the coupling and uncoupling process, the coupling shall be observed for any malfunction; there shall be none.

4.6.4 Leakage:

4.6.4.1 Leakage at Low Pressure: The connected coupling and the disconnected halves shall be subject to an internal pressure equal to a head of 30 inches of hydraulic fluid for 12 minutes. All external surfaces shall be dry at the beginning of this test. There shall be no evidence of any external leakage from the connected coupling. A waiting period of 2 minutes shall be allowed for the leakage rate to become constant from the disconnected halves. Following this waiting period, leakage shall be measured for the next 10 minutes and shall not exceed one drop.

For acceptance tests, the connected coupling and the disconnected halves shall be subjected to internal pressure equal to 30 inches of hydraulic fluid for 2 minutes. All external surfaces shall be dry at the beginning of this test. There shall be no evidence of leakage from either the coupled coupling or disconnected halves.

4.6.4.2 Leakage at High Pressure: Both the connected coupling and the disconnected halves shall be subjected to a hydraulic static pressure equal to the applicable operating pressure for 15 minutes. All external surfaces shall be dry at the beginning of this test. There shall be no evidence of any external leakage from the connected coupling. Leakage from the disconnected halves shall not exceed a trace (insufficient to form a drop in 10 minutes). Fluid loss (spillage), as specified in Table II, is not considered to be external leakage.

4.6.5 Vacuum: A vacuum shall be applied to the coupled coupling equivalent to 10 inches Hg. When the correct pressure has been attained, the lines shall be closed for a period of 5 minutes, during which time there shall be no change in pressure. Temperature shall be maintained constant within ±2°F, both fluid and ambient, during this test.

4.6.6 Surge Flow: The couplings shall be subjected to flow of five times (three times for -16, and two times for -20, -24 and -32 sizes) the rated flow for 3 seconds minimum duration in each direction. This surge flow pattern shall be repeated 100 times. There shall be no evidence of flow blocking or internal damage, and the disconnected halves shall pass the leakage tests (4.6.4) at the completion of the surge flow sequence.

4.6.7 Vibration: The couplings shall withstand the following tests without evidence of failure or leakage. During the vibration test, 15 psig pressure shall be applied.

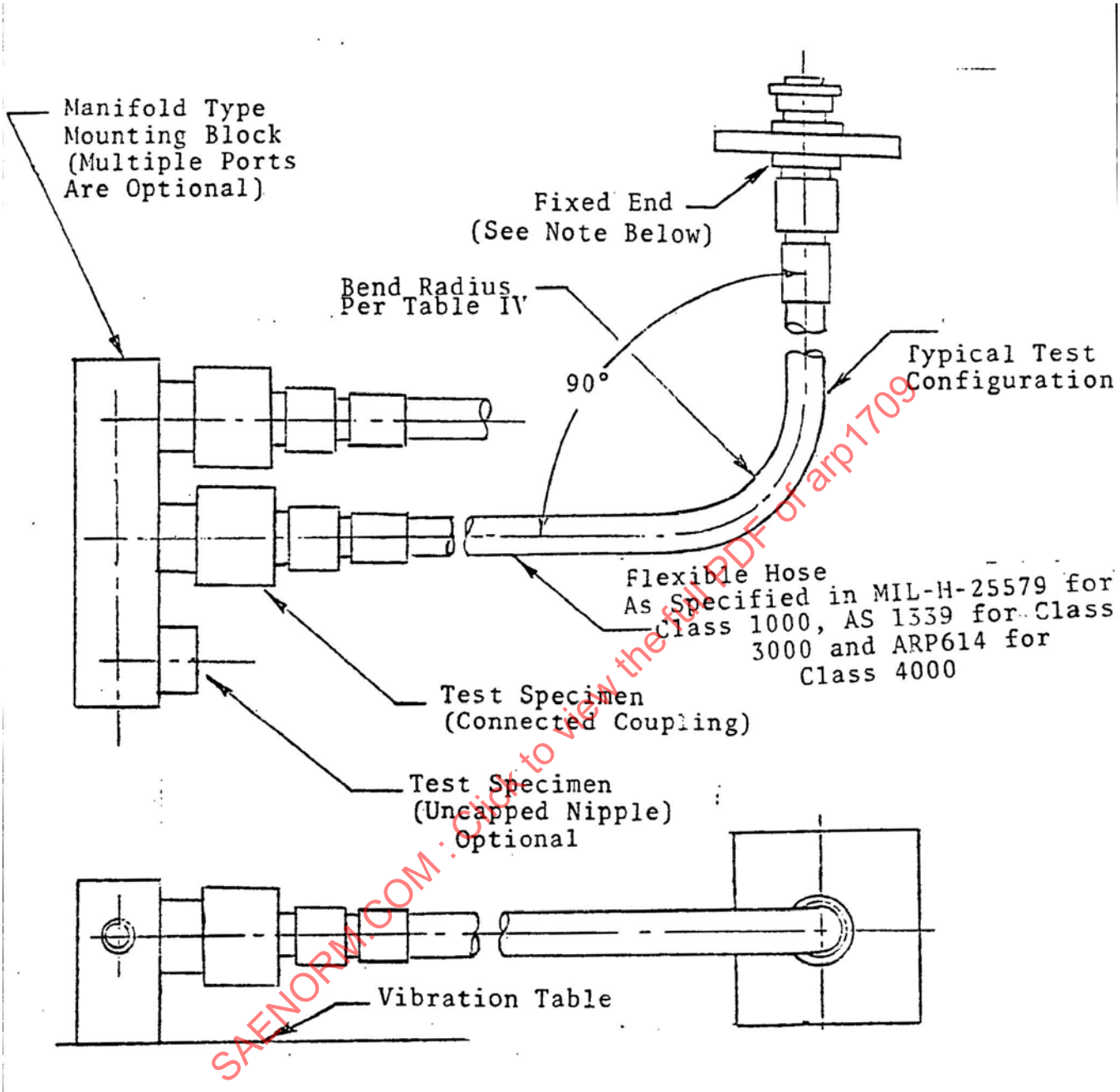
4.6.7.1 Resonance:

4.6.7.1.1 Resonance Search: The connected coupling and disconnected halves shall be pressurized to 15 psig pressure and a resonance search conducted, in directions parallel and perpendicular to the axis of the coupling (3 axes total), in accordance with Method 514.2 (para. 4.5.1.1) of MIL-STD-810. The test article temperature shall be 225° ± 5°F. Figure 1 shows test set-up.

4.6.7.1.2 Resonance Dwell: The test item shall be vibrated along each of the three axes, at the most severe resonant frequencies determined in para. 4.6.7.1.1, in accordance with Method 514.2 (para. 4.5.1.2) of MIL-STD-810. Conditions shall be as shown in Figure 2. The test time schedule (per axis) shall be in accordance with table 514.2-II for Procedure I, Part 1 of MIL-STD-810. The displacement vs frequency curve to be followed shall be in accordance with the composite curve, Figure 2. The test article temperature shall be 225° ± 5°F. Figure 2 represents the more severe of the airplane engine (L) and helicopter (M) curves in MIL-STD-810.

4.6.7.2 Cycling: The test article shall be vibrated for a total duration of 3 hours in each of the three axes in accordance with MIL-STD-810, para. 4.5.1.3 and the time schedule of table 514.2-II for Procedure No. I, Part 1, of Method 514.2. Test levels shall be as shown on the composite curve, Figure 2. The test article temperature shall be 225° ± 5°F.

4.6.8 Impulse: The mated coupling (and disconnected coupling halves with caps and plugs, if required) shall be subjected to impulse testing in accordance with the general requirements of ARP 603. Test conditions shall be per Table V in a setup per Figure 1. The impulse test machine shall produce dynamic pressure impulses, in the coupling, of the magnitude indicated by the graph shown in Figure 3. An oscilloscope photograph of the nature of the impulse shall be included in the test report.



NOTE: The end shall be fixed to allow equivalent length and bend radius shown on Table IV by clamping either the end fitting or the hose as required.

FIGURE 1

SET-UP FOR IMPULSE & VIBRATION TEST

DERIVED FROM MIL-STD-810

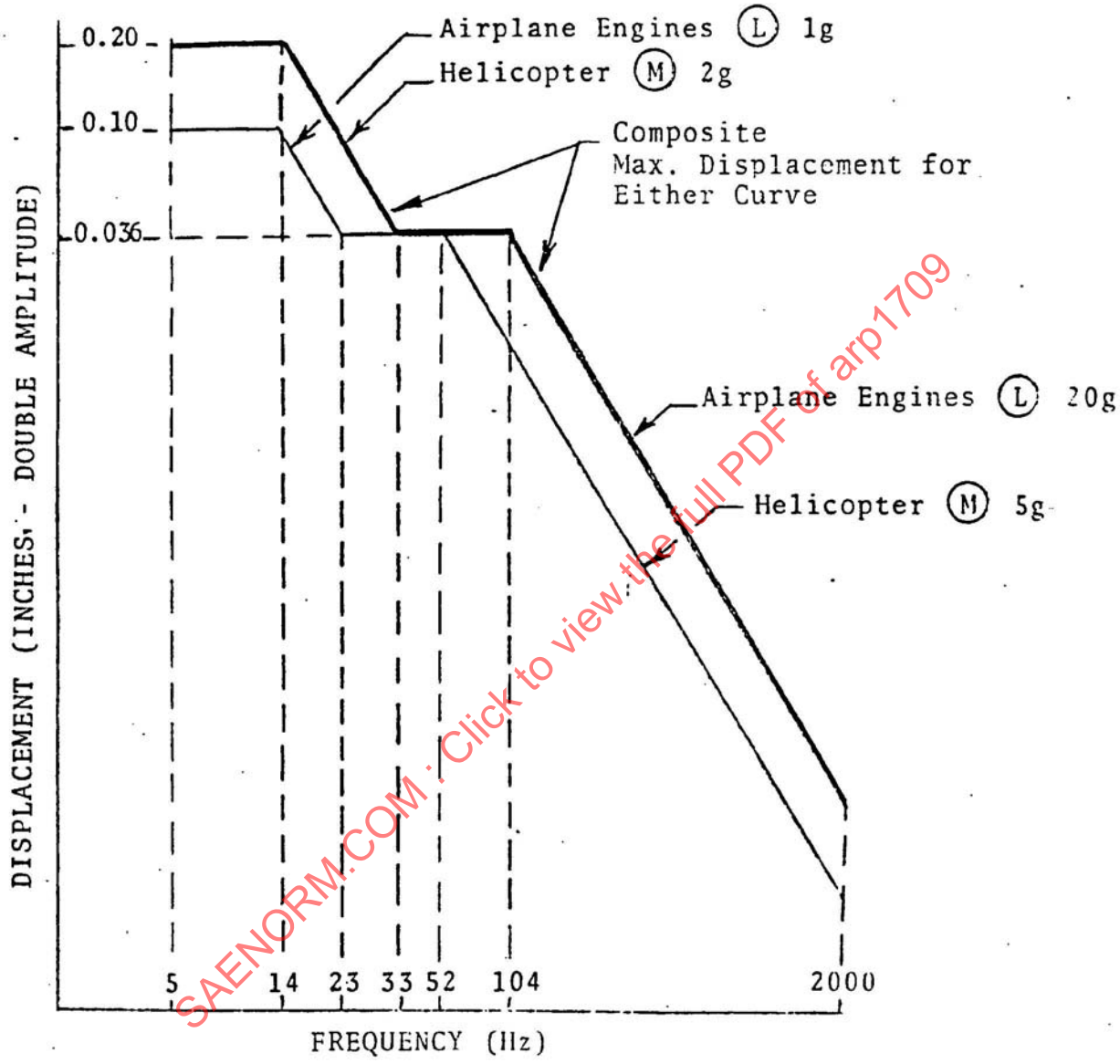


FIGURE 2

COMPOSITE
VIBRATION TEST CURVE FOR EQUIPMENT
MOUNTED ON HELICOPTERS OR AIRPLANE ENGINES

Table IV

Hose Lengths and Bend Radii

Class 1000 Based on MIL-H-25579*

Coupling Size	Equivalent Tube Size	Hose Length Flexible Section	Bend Radii Inches
-04	1/4	6.00	2.00
-06	3/8	9.75	4.00
-08	1/2	11.25	4.63
-10	5/8	13.00	5.50
-12	3/4	14.75	6.50
-16	1	17.25	7.38
-20	1 1/4	15.00	6.25
-24	1 1/2	18.00	7.50
-32	2	24.00	10.00

Class 3000 Based on AS 1339*

Coupling Size	Equivalent Tube Size	Hose Length Flexible Section	Bend Radii Inches
-04	1/4	5.50	1.50
-06	3/8	7.75	2.50
-08	1/2	8.50	2.88
-10	5/8	9.75	3.25
-12	3/4	10.75	4.00
-16	1	13.75	5.00

Class 4000 Based on ARP 614*

Coupling Size	Equivalent Tube Size	Hose Length Flexible Section	Bend Radii Inches
-04	1/4	10.00	3.00
-06	3/8	13.75	5.00
-08	1/2	15.50	5.75
-10	5/8	17.50	6.50
-12	3/4	19.00	7.75
-16	1	24.25	9.63

*Briefly describe hose construction in test report.

Table V

Impulse Test

	Class 1000	Class 3000	Class 4000
1. Operating Pressure	1000	3000	4000
2. Peak Pressure ± 5%	1500	4500	6000
3. Temperature	25% at 275°F and 75% at 225°F		
4. Cycle Rate (cpm)		70 ± 10	
5. Rate of Rise	Min. 10,000	45,000	60,000
PSI/SEC.	Max. 100,000	300,000	300,000
6. Number of Cycles	100,000	200,000	200,000

FIGURE 3

GRAPH OF PRESSURE IMPULSE CYCLE (PER ARP 603)