ETSO-2C75
Date: 24.10.03

European Aviation Safety Agency

European Technical Standard Order

Subject: HYDRAULIC HOSES ASSEMBLY

1 - Applicability

This ETSO gives the requirements which static hydraulic hoses assembly that is manufactured on or after the date of this ETSO must meet in order to be identified with the applicable ETSO marking.

2 - Procedures

2.1 - General

Applicable procedures are detailed in CS-TSO Subpart A.

2.2 - Specific

None.

3 - Technical Conditions

3.1 - Basic

3.1.1 - Minimum Performance Standard

Standards set forth in the attached „Federal Aviation Administration Standard, Hydraulic Hoses Assemblies“dated December 15, 1962, except as mentioned in paragraph 3.2 below.

3.1.2 - Environmental Standard

As stated in the Federal Aviation Administration Standard.

3.1.3- Computer Software

None

3.2 - Specific

Proof of pressure: 2Pw as specified in CS-25 Appendix J.

4 - Marking

4.1 - General

Marking is detailed in CS-ETSO Subpart A paragraph 1.2; in addition to the markings required by this paragraph, the hoses must be marked:

- if suitable for use with synthetic base fluids: letter „S“ immediately following the type designation.
- if suitable for use with petroleum base fluids: letter „P“ immediately following the type designation.
- if suitable for use with both synthetic base and petroleum base fluids: letters „S/P“ immediately following the type designation.
- if complying with the fire resistant requirements: letter „F“ immediately following the type and fluid designation.

4.2 - Specific

None.

5 - Availability of Referenced Document

See CS-ETSO Subpart A paragraph 3

FAA Standard associated with ETSO–2C75

DECEMBER 15, 1962

Federal Aviation Agency Standard
For
Hydraulic Hose Assemblies

1.0 ***Purpose.*** To specify minimum airworthiness requirements for hydraulic hose assemblies intended for use on civil transport category aircraft.

2.0 ***Scope.*** This specification covers minimum airworthiness requirements for the following types of hydraulic hose assemblies:

Type	*Pressure*	*Temperature*
IA	Medium [1][1]	160° F.
IB	High [2][2]	160° F.
IIA	Medium	275° F.
IIB	High	275° F.
IIIA	Medium	400° F.
IIIB	High	400° F.

3.0 ***General Requirements.***

3.1 *Materials.* Materials shall be uniform in quality and suitable for the purpose intended. The suitability of the materials shall be determined on the basis of satisfactory service experience or substantiating qualification test.

3.2 *Workmanship.* Workmanship shall be of the quality necessary to produce hose assemblies free from all defects which may adversely affect proper functioning in service.

3.3 *Qualification Tests, General.*

3.3.1 *Performance.* There shall be no evidence of leakage, wicking, imperfections or damage of the hose or end fittings when the assembly is subjected to the tests specified herein.

3.3.2 *Test Assemblies.* A sufficient number of each type and size hose assembly to be qualified shall be selected at random and satisfactorily tested to the applicable provisions specified herein.

3.3.3 *Fluid Aging.* In all the tests involving fluid aged assemblies, the assemblies shall be filled with a suitable test fluid[3] and soaked for 7 days in an air oven at the applicable temperature specified in paragraph 2.0.

3.3.4 *Air Aging.* In all the tests involving air aged assemblies, the assembly shall be aged for 7 days in air at the applicable temperature specified in paragraph 2.0.

3.3.5 *Test Pressures.* Unless otherwise noted, all pressures specified herein are hydraulic pressures and shall not be less than the applicable pressure shown in paragraph 7.1.

3.3.6 *Test Temperatures.* Unless otherwise specified, the fluid and ambient temperatures shall be room temperatures.

3.3.7 *End Fitting Design.* If an end fitting incorporates a minor variation from the design of a similar fitting in a previously qualified hose assembly of the same type, then the hose assembly need not be retested . It is the responsibility of the manufacturer to determine that such a variation will not adversely affect the airworthiness of the hose assembly.

3.3.8 *Corrosion.* The design and manufacture of the hose assemblies shall be such that corrosive tendencies in any component part shall be effectively minimized.

4.0 ***Test Requirements, Type IA, IIA, IB, and IIB Hose Assemblies.***

4.1 *Proof Pressure.* Hose assemblies shall be subjected, for at least 30 seconds, to a proof pressure test of at least 1.5 times the applicable pressure shown in paragraph 7.1.

4.2 *Bending and Vacuum.* A hose assembly shall be fluid aged in accordance with paragraph 3.3.3. It shall then be proof pressure tested in accordance with paragraph 4.1. The unfilled assembly shall then be bent over a form so that the radius and length shall conforrn to Table I except that, for –16 and larger size hoses, the length shall be 30 inches. The hose shall not flatten or deform at any section to an amount greater than 10 percent of the outside diameter of the hose. While still bent in this radius, a vacuum of 28 inches of mercury shall be applied and held for 5 minutes during which time the hose shall be checked for additional flattening. Application of the 28-inch Hg vacuum shall not result in more than a 20 percent reduction in OD at any section for all sizes up to and including -24 and a 35 percent reduction for size -32. After the vacuum is released, and the hose is dissected longitudinally, there shall be no evidence of ply separation, blistering, collapse, or other damage.

4.3 *Hydraulic Leakage.* An unaged hose assembly, not less than 12 inches in length, shall be subjected to 70 percent of the hydraulic burst pressure specified in paragraph 4.4 for 5 minutes. The pressure shall then be reduced to zero, after which it shall be raised to 70 percent of the specified burst pressure for another 5-minute period. The outer surface of the hose assembly shall be carefully checked after this period for conformance with paragraph 3.3.1. After completion of the hydraulic leakage test, the hose assembly shall be subjected to the Room Temperature Burst Pressure test specified in paragraph 4.4.

4.4 *Room Temperature Burst Pressure.* An unaged hose assembly of the applicable length specified in Table I shall be subjected to a burst pressure of 4.0 times the applicable pressure shown in paragraph 7.1. The rate of pressure rise shall be

[1] The term „medium“ is used herein to mean anominal operating pressure of 1,500 p.s.i. or less.

[2] The term „high“ pressure means a nominal operating pressure greater than 1,500 p-s.i. and up to and including 3,000 p.s.i.

[3] A suitable test fluid is one which is representative of that to be used with the applicable hose assembly in civil transport category aircraft operation.

20,000±5,000 p.s.i. per minute until the burst pressure is obtained.

4.5 *Hydraulic Impulses.* A fluid aged, air aged, and unaged hose assembly of lengths not less than those applicable lengths specified in Table I shall be proof pressure tested in accordance with paragraph 4.1 and then be connected to a manifold installed in an impulse test machine. The temperature of the test fluid shall be measured at the test manifold and shall be maintained at 120°±10° F. Hose assemblies of the -3 through -12 sizes shall be installed with the applicable bend radius shown in Table I and both ends shall be connected to a rigid support. Size -16 through -32 hose assemblies shall be installed straight with one end left free. Electronic measuring devices shall be used to measure the impulse pressures in the inlet manifold. Impulse cycling in accordance with Figure I shall be as follows:

Type	*Size*	*No of Cycles*
IA and IIA	-3 through -16	100,000
IA and IIA	-20 through -32	50,000
IB and IIB	-4 through -6	100,000
IB and IIB	-8	75,000
IB and IIB	-10	50,000
IB and IIB	-12	35,000
IB and IIB	-16	45,000
IIIA	all sizes	100,000
IIIB	all sizes through -8	250,000
IIIB	sizes -10 and -12	100,000
IIIB	-16	45,000

The following assemblies need not be subjected to any peak pressure greater than the applicable operating pressure:

Type	*Size*
IA and IIA	-20 through -32
IB, IIB and IIIB	-16
IIIA	-20 and -24

4.6 *Cold Temperature Flexing.* A fluid aged and an air aged hose assembly (reference paragraphs 3.3.3 and 3.3.4 respectively) shall be filled with a suitable test fluid and placed, for a 72-hour period in a cold chamber which is controlled to -65° to -70° F. While at this temperature, the assemblies shall be bent through 180°, in opposite directions, to the applicable radius specified in Table I, within a 4-second period. After removal from the cold chamber, the assemblies shall be subjected to the applicable proof pressure test. Dash l6 and larger size assemblies may be tested at -40° F. in lieu of the above specified temperature.

5.0 ***Test Requirements, Type IIIA Hose Assemblies.***

5.1 *Room Temperature Burst Pressure.* Same as paragraph 4.4.

5.2 *Bending and Vacuum.*

a. An unaged assembly shall be filled with test fluid and cold soaked at -65° to -70° F. for 24 hours and then bent to the applicable bend radius, through 180°, in opposite directions. Five complete cycles shall be conducted at the rate of approximately one cycle in 4 seconds. The assembly shall then be subjected to the applicable proof pressure test while still at –65° to –70°F.

b. The assembly shall be emptied and heat soaked at 400°±10° F. for 4 hours while bent to the applicable bend radius and while being subjected to the following negative pressure:

28 inches of mercury for the -4 through -12 size.

18 inches of mercury for the -16 and -20 size.

14 inches of mercury for the -24 size.

The assembly shall then be cooled to room temperature while the negative pressure is maintained.

c. After this test and after the hose is dissected longitudinally and inspected, there shall be no evidence of damage or breakdown.

5.3 *Hydraulic Leakage.* A hose assembly of the applicable length specified in Table I shall be subjected to the hydraulic leakage test specified in paragraph 4.3 after it has been pressurized, while at room temperature, to 25 p.s.i. for at least 5 minutes.

5.4 *High Temperature Burst Pressure.* An assembly, of the applicable length specified in Table I shall be filled with test fluid at 50 p.s.i. and heat soaked for l-hour wherein ambient and fluid temperatures are 400°±10° F. The pressure shall then be increased to the rated operating pressure and held for 5 minutes. The pressure shall then be raised to three times the applicable pressure shown in paragraph 7.1 at a rate of 20,000±5,000 p.s.i.. During this test, one end of the assembly shall be free.

5.5 *Hydraulic Impulses.* Same as paragraph 4.5 except that the fluid and ambient temperatures shall be at 400°±10° F.

6.0 ***Test Requirements, Type IIIB Hose Assemblies.***

6.1 *Hydraulic Leakage.* Same as paragraph 5.3.

6.2 *Hydraulic Impulse.* Same as paragraph 4.5 except that, in addition, the assembly shall be temperature cycled from room temperature to the specified ambient and fluid temperature, and back to room temperature, for at least 2 cycles. This test shall be programmed so that at least 80 percent of the impulses shall be at 400° F. ambient and fluid temperatures.

6.3 *Thermal Shocks.*

a. The test assembly shall be air aged in accordance with paragraph 3.3.4 and after aging shall be subjected to the applicable proof pressure for a minimum of 5 minutes.

b. The test assemblies shall then be mounted, empty, in a controlled temperature test set-up (typical set-up shown in Figure II) and the ambient temperature reduced to -67°±2° F. for a minimum of 2 hours. At the end of this period, while still at this temperature, high temperature test fluid at a temperature of 400° F. shall be suddenly introduced at a minimum pressure of 50 p.s.i. Immediately after

the hot fluid has filled the assembly, the pressure shall be raised to the applicable proof pressure for a minimum of 5 minutes. Not more than 15 seconds shall elapse between the introduction of the high temperature fluid at 50 p.s.i. and the raising of the pressure to proof pressure.

c. The assembly shall then be subjected to the High Temperature Burst Pressure test specified in paragraph 5.4.

6.4 *Flexing.* The assembly shall be mounted in the flex set-up as illustrated in Figure III, shall be filled with test fluid and subjected to the following test sequence. The temperatures indicated are both fluid and ambient. Flexing shall occur at a rate of 70±10 cycles per minute during portions c. d. and e.

a. The test assemblies shall be soaked, with no pressure or flexing at a temperature of -67°±2° F. for a minimum of one hour.

b. With no flexing, the test assemblies shall be pressurized to the proof pressure with the temperature still at -67° F. for a minimum of 5 minutes (first cycle only).

c. Flexing shall begin while the test assemblies are pressurized to the operating pressure with the temperature still at -67° F. for a minimum of 4,000 cycles.

d. With the pressure reduced to zero p.s.i., flexing shall continue for 1,000 cycles at -67° F.

e. Increase the temperature to 400° F. and flex for 1,000 cycles with the pressure at zero p.s.i. The pressure shall then be increased to the operating pressure with the temperature held at 400° F. Flexing shall continue until an accumulated total of 80,000 cycles is reached.

f. Steps a. c. d. and e. shall be repeated for a total of 5 test sequences, i.e., 400,000 flexing cycles.

g. After completion of step f. and with no flexing, the test assemblies shall be pressurized to the proof pressure with the temperature still at 400° F. for a minimum of 5 minutes (last cycle only).

7.0 *Fire-Resistant Hose Assemblies.* Fire-resistant hose assemblies which are intended to be used in locations within fire zones shall comply with the applicable requirements specified herein and in addition shall also comply with the fire test described in FAA report entitled, „Standard Fire Test Apparatus and Procedure“ revised March 1961. The use of a protective sleeve over the hose and/or end fittings is permitted to facilitate compliance with the fire test requirements. Sleeve or protective covers shall be secured to the hose assembly so that fire-resistant properties will be maintained.

7.1 *Fire Test Parameters.*

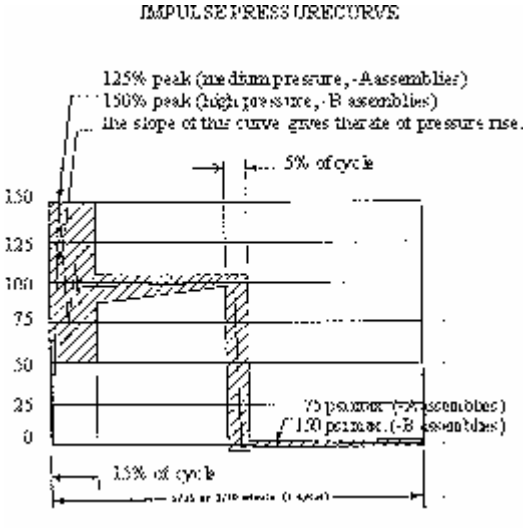
Type Hose Assembly	*Hoze Size*	*Maximum Operating Pressure*	*Flow Rate GPM*
IA and IIA	-3	1,500	7 x (ID) [2]
	-4	1,500	"
	-5	1,500	"
	-6	1,500	"
	-8	1,500	"
	-10	1,500	"
	-12	1,000	"
	-16	800	"
	-20	600	3 x (ID) [2]
	-24	500	1 x (ID) [2]
IB and IIB	All	3,000	1 x (ID) [2]
IIIA	-3 to -10	1,500	1 x (ID) [2]
	-12	1,000	"
	-16	1,250	"
	-20	1,000	"
	-24	750	"
IIIB	All	3,000	"

7.2 *Criteria for Acceptability.* The hose assembly shall be considered acceptable if it successfully withstands the applicable fire test for a period of 5 minutes without evidence of leakage.

TEST LENGTH AND MINIMUM BEND RADIUS

SIZE NUMBER	LENGTH OF TEST ASSEMBLY INCHES				MINIMUM BEND RADIUS AT INSIDE OF BEND INCHES			
	Type Hose Assemblies				Type Hose Assemblies			
	IA and IIA	IB and IIB	IIIA	IIIB	IA and IIA	IB and IIB	IIIA	IIIB
-3	14	—	—	—	3	—	—	—
-4	14	16	14	16	3	3	2	3
-5	16	18	16	—	3?	3?	2	—
-6	18	21	18	21	4	5	4	5
-8	21	24	21	24	4?	5¾	4?	5¾
-10	23½	30	23½	30	5½	6½	5½	6½
-12	27½	33	27½	33	6½	7¾	6½	7¾
-16	18	24	18	24	7?	9?	7?	9?
-20	18	—	18	—	9	—	11	—
-24	18	—	18	—	11	—	14	—
-32	18	—	—	—	13¼	—	—	—

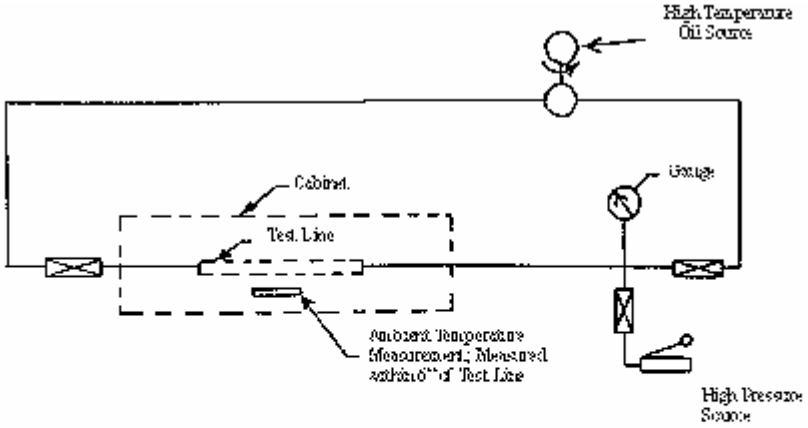
TABLE I



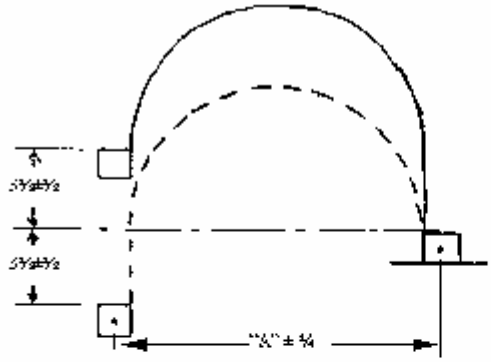
The curve shown above is the approximate pressure-time cycle determined to be of proper severity for impulse testing of hose assemblies. The pressure-time curve shall be confined to the shaded area indicated.

NOTE : Cycling tolerance = 35±5 or 70±10 cycles per minute.

FIGURE I



Typical Setup for High Temperature Pressure Testing
Figure II



Hose Size	"A" Inches	Assem Length Inches
-4	5½	20
-6	10 7/	27
-8	12¾	30
-10	14	33
-12	16 7/	37
-16	20¾	45

Assembly Flex Test Setup
Figure III