MS-15

FEDERAL AVIATION AGENCY
FLIGHT STANDARDS SERVICE
Washington 25, D. C.

April 26, 1962

REGULATIONS OF THE ADMINISTRATOR DRAFT RELEASE NO. 62-21

SUBJECT: Technical Standard Order C75 "Hydraulic Hose Assemblies"

The Flight Standards Service of the Federal Aviation Agency has under consideration an amendment to Part 514 of the Regulations of the Administrator to add a new Technical Standard Order TSO-C75 "Hydraulic Hose Assemblies." The reasons therefor are set forth in the explanatory statement of the attached proposal which is being published in the Federal Register as a notice of proposed rule making.

The Flight Standards Service desires that all persons who will be affected by the requirements of this proposal be fully informed as to its effect upon them and is therefore circulating copies in order to afford interested persons ample opportunity to submit comments as they may desire.

Because of the large number of comments which we anticipate receiving in response to this draft release, we will be unable to acknowledge receipt of each reply. However, you may be assured that all comment will be given careful consideration.

It should be noted that comments should be submitted, preferably in duplicate, to the Docket Section of the Federal Aviation Agency, and in order to insure consideration must be received on or before June 18, 1962.

Acting Director
Flight Standards Service

FEDERAL AVIATION AGENCY

FLIGHT STANDARDS SERVICE

(14 CFR 514)

[Regulatory Docket No. 1183; Draft Release No. 62-21]

TECHNICAL STANDARD ORDERS FOR AIRCRAFT MATERIALS PARTS, PROCESSES AND APPLIANCES

NOTICE OF PROPOSED RULE MAKING

Pursuant to the authority delegated to me by the Administrator (14 CFR Part 405) notice is hereby given that the Federal Aviation Agency has under consideration a proposal to amend Part 514 of the Regulations of the Administrator by adopting a new Technical Standard Order. This Technical Standard Order establishes minimum performance standards for hydraulic hose assemblies to be used on civil aircraft of the United States.

Interested persons may participate in the making of the proposed rule by submitting such written data, views or arguments as they may desire. Communications should be submitted in duplicate to the Docket Section of the Federal Aviation Agency, Room C-226, 1711 New York Avenue, N. W., Washington 25, D. C. All communications received on or before June 18, 1962, will be considered by the Administrator before taking action on the proposed rule. The proposals contained in this notice may be changed in light of the comments received. All comments submitted will be available in the Docket Section for examination by interested persons at any time.

This amendment is proposed under the authority of Sections 313(a) and 601 of the Federal Aviation Act of 1958 (72 Stat. 752, 775; 49 U.S.C. 1354(a), 1421).

In consideration of the foregoing it is proposed to amend Part 514 as follows:

By adding the following section 514.81:

§ 514.81 Hydraulic hose assemblies - TSO-C75--(a) Applicability--(1) Minimum performance standards. Minimum performance standards are hereby established for hydraulic hose assemblies which are to be used on civil aircraft of the United States. New models of hydraulic hose assemblies, manufactured on or after the effective date of this section which are to be used on civil aircraft of the United States shall meet the standards specified in Federal Aviation Agency Standard, "Hydraulic Hose Assemblies", dated March 15, 1962.1/ Hydraulic hose assemblies approved prior to the effective date of this section may continue to be manufactured under the provisions of their prior approval.

(b) Marking. The markings required are specified in § 514.3 with the following exceptions:

(1) Trademark may be used in lieu of name, and manufacturer's address is not required.

(2) Size, type, and maximum operating pressure of the hose assembly shall be shown in lieu of the weight in paragraph (d)(3) of § 514.3.

(3) Part number shall be shown.

1/ Copies may be obtained upon request addressed to: Publishing and Graphics Branch, Inquiry Section, MS-158, Federal Aviation Agency, Washington 25, D. C.

(4) Date of manufacture in terms of month and year is to be shown and serial number omitted.

(5) In lieu of paragraph (d)(2) of § 514.3 hose assemblies suitable for use with synthetic base fluids shall be marked with the letter "S" immediately following the type designation. Assemblies suitable for use with petroleum base fluids shall be marked with the letter "P". Assemblies suitable for use with both synthetic and petroleum base fluids shall be marked with "S/P", i.e., Type II-B-S, Type II-B-P, or Type II-B-S/P.

(6) Hose assemblies complying with the fire resistant requirements shall be identified by the letter "F" immediately following the type and fluid designation, i.e., Type II-B-S/P-F.

(c) Data requirements. (1) Six copies of a tabulation containing the following data shall be furnished to the Chief, Engineering and Manufacturing Division, Flight Standards Service, Federal Aviation Agency, Washington 25, D. C., with the statement of conformance:

(i) Type.

(ii) Size.

(iii) Maximum operating pressure.

(iv) Part number.

Acting Director
Flight Standards Service

Issued in Washington, D. C., on April 26, 1962.

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FAA Standard - Hydraulic Hose Assemblies

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

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

Type	Pressure	Temperature
I-A	Medium 1/	160° F.
I-B	High 2/	160° F.
II-A	Medium	275° F.
II-B	High	275° F.
III-A	Medium	450° F.
III-B	High	450° 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 tests.

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 hose assemblies of each type and size shall be tested to establish and certify compliance with this technical standard order.

1/ The term "medium" is used herein to mean a nominal 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.

3.3.3 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 specified, all test pressures shall be hydraulic pressures and shall have a tolerance of ± 3 percent.

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.

Test Requirements, Type I-A, II-A, I-B and II-B Hose Assemblies.

4.1 Hydraulic Fluid Circulation. A hose assembly shall be subjected to the following tests at the applicable pressure shown in Paragraph 7.1. Hose assembly sizes up to the -24 size shall have 9 inches of free-length hose between the end fittings. For the -24 size and larger size assemblies, the ratio of free-length hose between end fittings to nominal hose size in inches shall be 6 - 1. The following sequence of tests shall be used:

(a) The assembly shall be installed on a vibrating machine in a temperature controlled chamber. The temperature of the ambient air shall be reduced to -40° ± 5°F and held for a minimum of 1 hour. The

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3/ A suitable test fluid is one which is representative of that to be used in aircraft operation.

assembly shall then be vibrated with a total amplitude of 1/4 inch at a frequency of 1750 to 2000 c.p.m. when the fluid is at the applicable operating pressure and the minimum flow rate is 3 gpm.

(b) The ambient air temperature shall then be increased to 140° ± 10°F and the fluid temperature shall be increased to the applicable temperature shown in Paragraph 2.0.

(c) Circulation and vibration shall be continued for a minimum of 20 hours at which time the above cycle shall be repeated. The assembly shall be subjected to 10 such cycles to obtain a minimum of 200 hours fluid circulation and vibration.

(d) The assembly shall then be proof pressure tested as shown in Paragraph 4.2.

4.2 Proof Pressure. The assembly to be impulse tested 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.

4.3 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 4.2. The unfilled assembly shall then be bent over a form so that the radius and length shall conform 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.

4.4 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 4.5 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 4.5.

4.5 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 20,000 ± 5,000 p.s.i. per minute until the burst pressure is obtained.

4.6 Hydraulic Impulse. A fluid aged, air aged, and unaged hose assembly of lengths not less than those applicable lengths specified in Table II shall be proof pressure tested in accordance with Paragraph 4.2 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. The test fluid and ambient temperatures shall be maintained at the applicable temperature specified in Paragraph 2.0. 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 & IIA	-3 through -16	100,000
IA & IIA	-20 through -32	50,000
IB & IIB	-4 through -10	100,000
IB & IIB	-12 through -16	55,000
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 & IIA	-20 through -32
IB, IIB & IIIB	-16
IIIA	-20Z

4.7 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 degrees, in opposite directions, to the applicable radius specified in Table I, within a four second period. After removal from the cold chamber, the assemblies shall be subjected to the applicable proof pressure test. Dash 16 and larger size assemblies may be tested at -40°F in lieu of the above specified temperature.

5.0 Test Requirements, Type III-A Hose Assemblies.

5.1 Hydraulic Fluid Circulation and Vibration. At least two hose assemblies shall be subjected to the following tests in the sequence as shown below. The length of the assembly shall be that required for bending it through 180° over a mandrel having a radius, as applicable, shown in Table I.

(a) The assemblies shall be filled with the test fluid and placed in a cold chamber for 16 hours at a temperature of -65° to -70°F. After the 16 hour cold soak, and while still at -65° to -70°F, the assembly shall be subjected to the applicable operating pressure. The pressure shall be held for 5 minutes and then released. After 5 minutes at no pressure, the specified operating pressure shall again be applied for 5 minutes. This sequence shall continue for a total of 10 pressure applications.

(b) The assemblies shall then be installed on vibration equipment in an approximately straight position. The fluid and ambient temperature shall be maintained at 450° ± 10°F. With one end of the assembly fixed, the other end shall be vibrated at a frequency of

55 ± 2 cycles per second and a double amplitude of 0.060 inches for 168 hours, while test fluid is circulated through the assembly in sufficient quantity to maintain a constant fluid temperature. Pressure shall be maintained at 60 psi except that once every 24 hours, the pressure shall be increased to the applicable operating pressure for a minimum of 5 minutes. At the end of 168 hours the applicable proof pressure shall be applied for a minimum of 5 minutes while maintaining the temperature specified above.

(c) The empty assemblies shall then be cold soaked for 24 hours at -65° to -70°F. Test fluid at 450° ± 10°F shall then be suddenly introduced at a minimum pressure of 50 psi. Within 15 seconds after introduction of the hot fluid, the pressure shall be raised to the applicable proof pressure for at least 5 minutes.

(d)(1) One of the assemblies shall then be subjected to the Room Temperature Burst Pressure Test specified in Paragraph 4.5.

(2) The other assembly shall be subjected to the Bending and Vacuum Test specified in Paragraph 5.2.

5.2 Bending and Vacuum. (a) The assembly referenced in Paragraph 5.1(d)(2) and an unaged assembly of equal length 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 degrees, in opposite directions. Five complete cycles shall be conducted at the rate of approximately one cycle in 4 seconds. The assemblies shall then be subjected to the applicable proof pressure test while still at -65° to -70°F.

(b) The assemblies shall be emptied and heat soaked at 450° ± 10°F for four 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.
20 inches of mercury for the larger sizes.

The assemblies 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 4.4 after it has been pressurized, while at room temperature, to 25 psi 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 psi and heat soaked for 1 hour wherein ambient and fluid temperatures are 450° ± 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 psi. During this test, one end of the assembly shall be free.

5.5 Hydraulic Impulse. Same as Paragraph 4.6.

6.0 Test Requirements, Type III-B Hose Assemblies.

6.1 Hydraulic Leakage. Same as Paragraph 5.3.

6.2 High Temperature Burst Pressure. Same as Paragraph 5.4.

6.3 Hydraulic Impulse. Same as Paragraph 4.6 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% of the impulses shall be at 450°F.

6.4 Thermal Shock. (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 450°F shall be suddenly introduced at a minimum pressure of 50 psi. 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 psi 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.

6.5 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 below are both fluid and ambient. Flexing shall occur at a rate of 35 ± 5 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 2000 cycles.

d. With the pressure reduced to zero psi, flexing shall continue for 500 cycles at -67°F.

e. Increase the temperature to 450°F and flex for 500 cycles with the pressure at zero psi. The pressure shall then be increased to the operating pressure with the temperature held at 450°F. Flexing shall continue until an accumulated total of 40,000 cycles is reached.

f. Steps a, c, d, and e shall be repeated for a total of 10 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 450°F for a minimum of 5 minutes (last cycle only).

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

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. Sleeves 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	Hose Size	Maximum Operating Pressure	Flow Rate GPM
IA and IIA	-3	1500	$7 \times (ID)^2$
	-4	1500	"
	-5	1500	"
	-6	1500	"
	-8	1500	"
	-10	1500	"
	-12	1000	"
	-16	800	"
	-20	600	$3 \times (ID)^2$
	-24	500	$1 \times (ID)^2$
IB and IIB	All	3000	$1 \times (ID)^2$
IIIA	-3 to -10	1500	$1 \times (ID)^2$
	-12	1000	"
	-16	1250	"
	-20	1000	"
	-24	750	"
IIIB	All	3000	"

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

TEST LENGTH AND MINIMUM BEND RADIUS

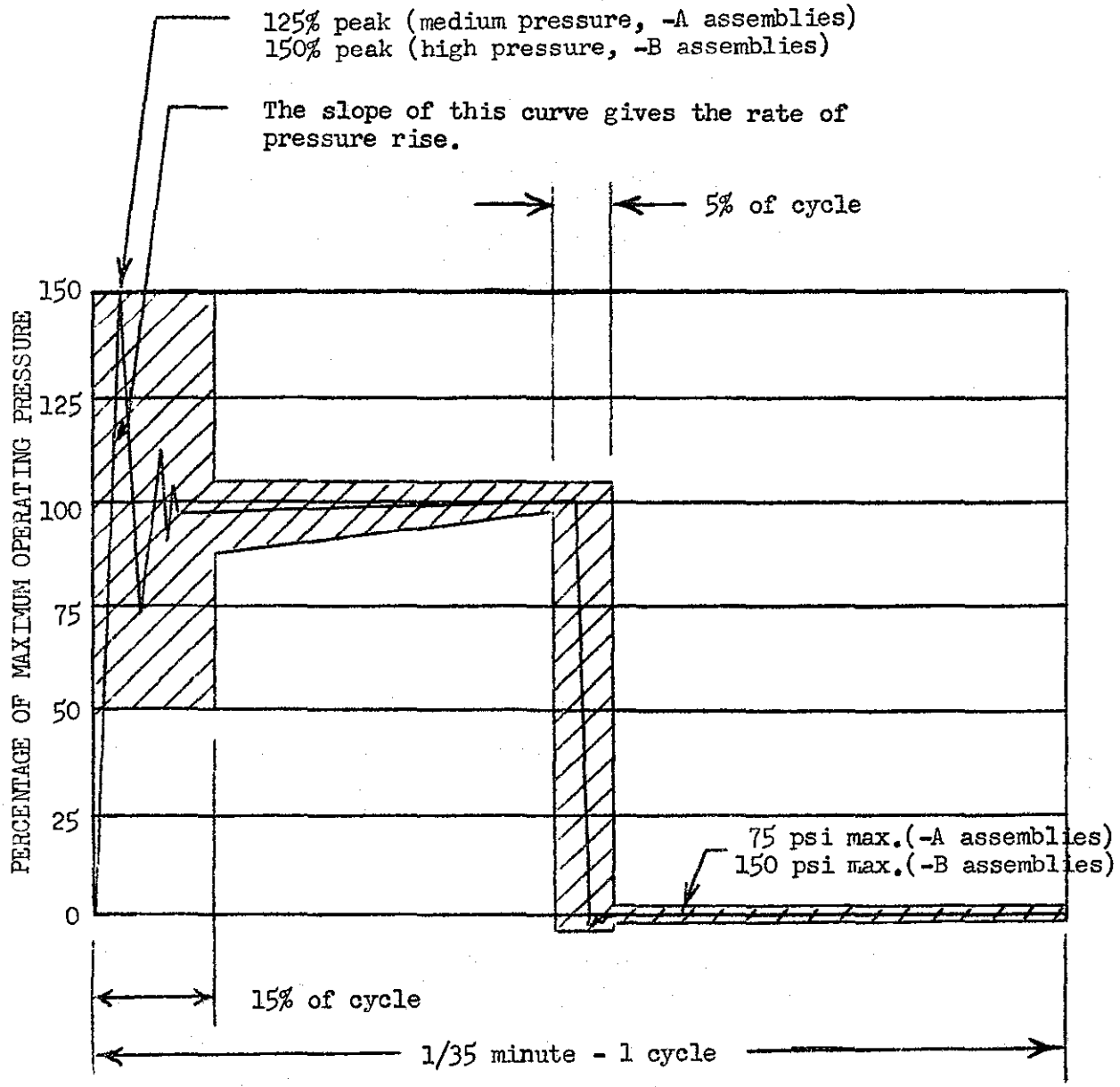
Size Number	Length of Test Assembly 1/ Inches				Minimum Bend Radius at Inside of Bend, Inches			
	Type Hose Assemblies				Type Hose Assemblies			
	IA & IIA	IB & IIB	IIIA	IIIB	IA & IIA	IB & IIB	IIA	IIB
-3	14	--	--	--	3	--	--	--
-4	14	16	14	16	3	3	2	3
-5	16	18	16	--	3 3/8	3 3/8	2	--
-6	18	21	18	21	4	5	4	5
-8	21	24	21	24	4 5/8	5 3/4	4 5/8	5 3/4
-10	23 1/2	30	23 1/2	30	5 1/2	6 1/2	5 1/2	6 1/2
-12	27 1/2	33	27 1/2	33	6 1/2	7 3/4	6 1/2	7 3/4
-16	18	24	--	24	7 3/8	9 5/8	--	9 5/8
-16 2/	--	--	18	--	--	--	7 3/8	--
-20	18	--	--	--	9	--	--	--
-20 2/	--	--	18	--	--	--	11	--
-24	18	-	--	--	11	--	--	--
-32	18	--	--	--	13 1/4	--	--	--

TABLE I

1/ Line lengths may be varied from those lengths shown in the table when such a variation is necessary in conducting the required tests

2/ Two wire braids incorporated for added strength

IMPULSE PRESSURE CURVE

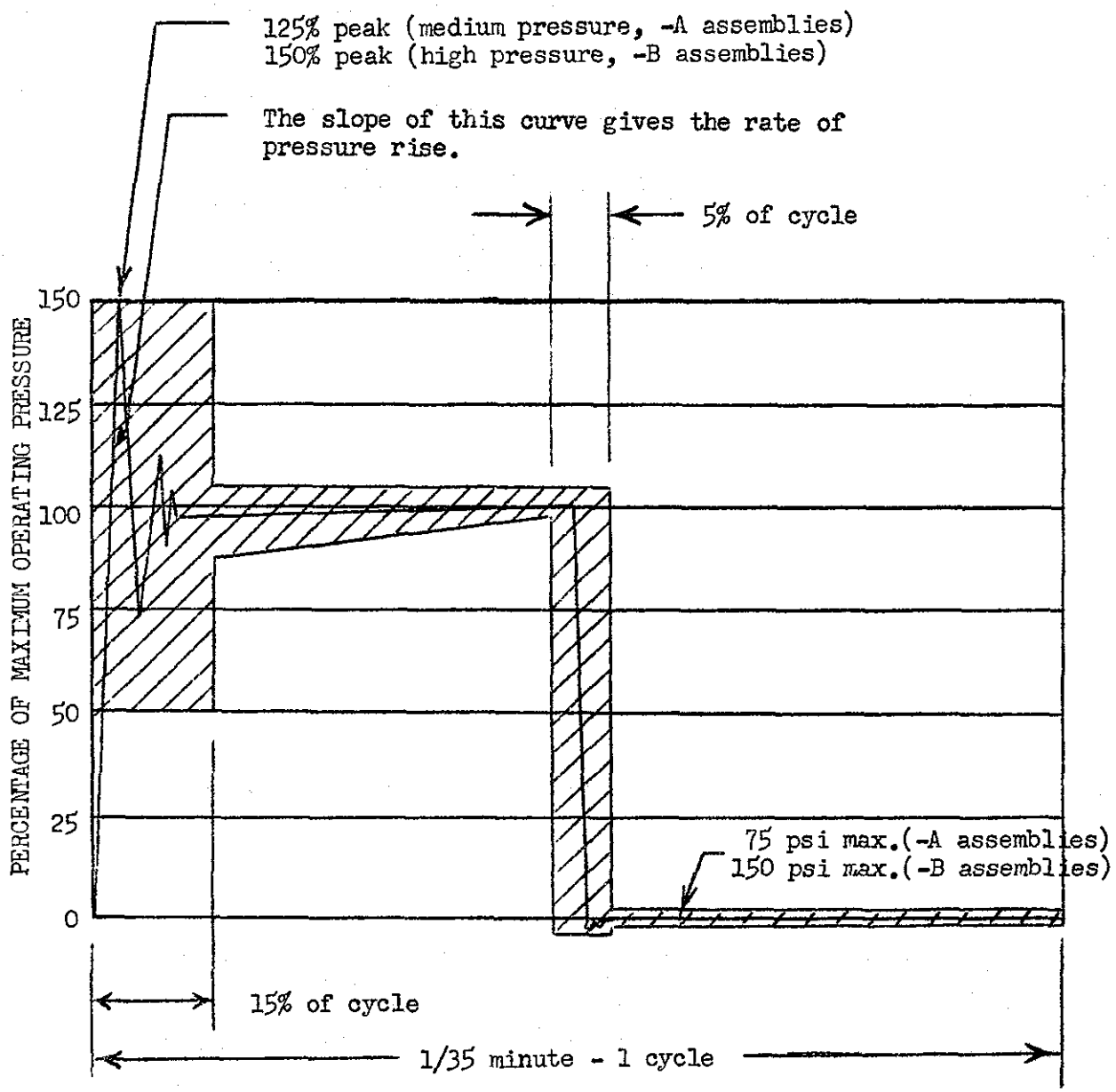


The curve shown above is the approximate pressure-time cycle determined to be of proper severity for impulse testing of hose assemblies. The pressure-time curve shall be confined to the shaded area indicated.

Note: cycling tolerance = 35 ± 5 cycles per minute

FIGURE 1

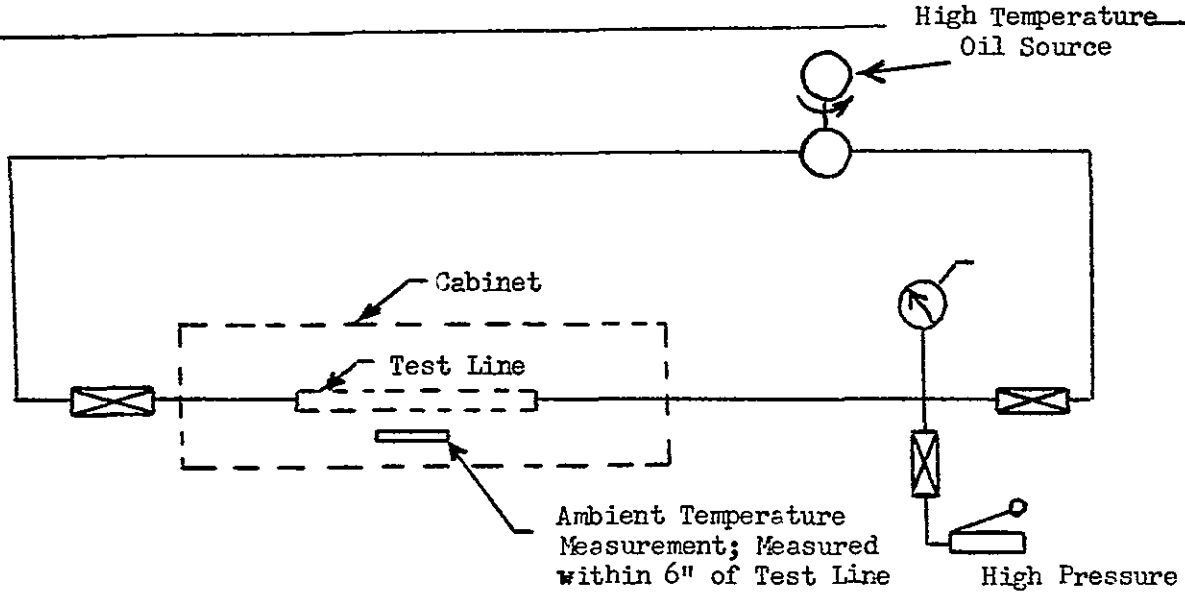
IMPULSE PRESSURE CURVE



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.

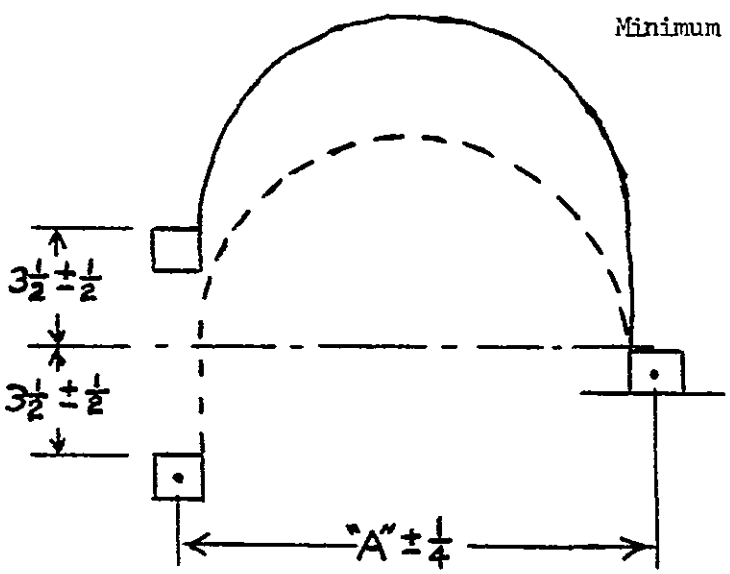
Note: cycling tolerance = 35 ± 5 cycles per minute

FIGURE 1



TYPICAL SETUP FOR HIGH TEMPERATURE PRESSURE TESTING

FIGURE II



Hose Size	"A" Inches
-4	6 1/2
-6	10 5/8
-8	12 1/4
-10	14
-12	16 5/8
-16	20 3/4

ASSEMBLY FLEX TEST SETUP

FIGURE III