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Superseding ARP820

Physical & Performance Tests for Type II (-65 to 275 F) O-ring Packings, 3000 psi Hydraulic Service

RATIONALE

This document has been determined to contain basic and stable technology which is not dynamic in nature.

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1. PURPOSE - This document outlines proposed test methods for the qualification of 0-ring packings intended for use in aircraft hydraulic systems utilizing MIL-H-5606 fluid at rated service pressures up to 3000 psi and temperatures ranging from -65 to 275 F. It will also serve as the basis for the future preparation of a complete packing specification after basic elastomer types have been established by capability of performance.

2. REFERENCE DOCUMENTS

MIL-P-5514
MIL-P-25732
MIL-H-8788
MIL-H-5606 - low swell
ASTM D 329-58T
ASTM D 395-55
Federal Test Method Standard 601
SAE ARP 568

3. REQUIREMENTS

3.1 The items utilized in the tests covered in this specification shall be fabricated from materials appropriate for use in MIL-H-5606 hydraulic fluid. These materials shall contain no substance which, when in contact with the fluid, will adversely affect the properties of the fluid or the packings.

3.2 The packing material shall be homogenous to insure uniformity of characteristics as determined by the physical properties.

4. DESIGN AND CONSTRUCTION - Shape and Dimensions - The general shape and dimensions of hydraulic packings shall conform to ARP 568.

5. QUALIFICATION TESTS

5.1 Sampling Instructions - Qualification test samples shall consist of 0-ring packing sizes per ARP 568 dash numbers 116, 216, and 325 plus three ASTM Hardness Test Discs, 1/4 inch thick by 1 inch diameter and three ASTM Compression-Set Plugs, 1/2 inch thick by 1.129 inch diameter. The quantity of packings to be used is shown in Table 1.

5.2 Any readings taken from plied-up samples are to be considered as indicative and not definite.

Table I

Test Samples Required For Qualification Testing

Original physical property tests	No. of samples per ARP 568 Dash No. -116	-216	-325
Specific Gravity			2
Tensile Strength, Ult. Elongation and Modulus		6	6
Permanent Set	2		
Temperature Retraction		2	
Endurance or Performance Tests	16	8	
Hardness* - 3 plugs Compression Set* - 3 plugs			
Total	18	16	8

*Hardness and compression set testing to be performed on plugs as specified in Paragraphs 5.1., 6.3., and 6.6.

NOTE: The original and final physical properties as well as the performance tests are of prime importance. Additional testing related to corrosion and adhesion as specified in MIL-P-25732 and the physical properties after aging are to be developed as becomes necessary. The sizes and numbers of O-ring test samples may be changed as details of test fixtures are finally developed.

6. TEST METHODS

6.1 The qualification tests of hydraulic packings shall consist of tests to determine the following properties:

a. Specific Gravity
b. Tensile Strength
c. Ultimate Elongation
d. Tensile Stress (Modulus)
e. Permanent Set in Tension
f. Permanent Set in Compression
g. Temperature Retraction
h. Hardness

6.2 The physical properties listed in Table I shall be determined from unaged samples by the methods described in the following paragraphs. The manufacturers shall report all values for each size sample. This shall be done during qualification tests only.

6.3 Hardness - Hardness of the compound shall be determined in accordance with Federal Test Method Standard No. 601 - Method 3021, except as follows:

6.3.1 Test samples shall be compression-molded, 1/4 inch in thickness and no smaller than 1 inch in diameter.

6.3.2 Hardness checks shall not be made upon actual packings nor on plied-up samples.

6.3.3 These hardness checks shall be made with the sample at room temperature 70 $\pm$ 5 F and 275 $\pm$ 5 F.

6.4 Tensile Strength, Ultimate Elongation, Tensile Stress (Modulus) and Permanent Set for the material shall be conducted on actual qualification samples submitted for test. The quantities and sizes of the samples to be tested shall be as specified in Table I.

6.4.1 Tensile Strength shall be determined in accordance with Federal Test Method Standard No. 601, Method 4111.

6.4.2 Ultimate Elongation shall be determined in accordance with Federal Test Method Standard No. 601, Method 4121.

6.4.3 Tensile Stress (Modulus) shall be determined in accordance with Federal Test Method Standard No. 601, Method 4131.

6.5 Permanent Set (in Tension) shall be determined in the manner described in paragraph 4.5.2.3 of MIL-P-25732. Samples to be examined for defects while in the stretched condition.

6.6 Permanent Set (Compressive) shall be determined in the manner described in ASTM D 395-55.

6.7 Specific Gravity shall be determined from the finished 0-ring samples in accordance with Federal Test Method Standard No. 601, Method 14011.

6.8 Temperature Retraction Tests on samples are to be conducted in accordance with ASTM D 329-58T modified as described in MIL-P-25732, paragraph 4.5.4.1. Packing sizes to be as specified in Table I.

7. <u>PERFORMANCE TESTING</u> - The performance tests shall consist of the test sequences as outlined in the following paragraphs. All of these tests shall be performed with the sample packings assembled in test fixtures similar in design and construction to those shown in Figures 1 and 2. The temperatures of the packing test fixtures shall be determined by the suitable placement of thermocouples.

7.1 Static Seal Applications - The test fixture utilized shall be of a configuration as shown in Figure 1. The cylinder body to be approximately 4 inches long, with a piston or plug having glands for the 0-rings at each end. These glands shall be in conformance with MIL-P-5514 for the -116 0-ring size. The piston is to be retained in the cylinder body by two end caps as shown. The cylinder bore shall have a surface finish no rougher than 32 micro-inches, but not finer than 8 micro-inches. Diametral clearance between the bore and the plug or piston shall be no greater than .0025 considering all geometrical errors in both parts. Surface finish of the grooves is to be within the limits specified in MIL-P-5514.

7.2 Preliminary Low Temperature Leakage Test - Install test samples in fixture (Figure 1) and conduct a low temperature leakage test in accordance with paragraph 7.6.

7.3 Elevated and Room Temperature Aging - All of the components of the fixture shall be submerged in a container of low-swell MIL-H-5606 prior to assembly. Any entrapped air or that which clings to the surfaces of any part shall be removed. The 0-rings shall then be installed in the grooves and the piston or plug inserted into the sleeve or cylinder while submerged in the fluid. Sufficient fluid must be present in the container to prevent entrance of air to test fixture during assembly and soak period. The container holding the test fixture and fluid will then be placed in an aging oven and temperature cycled in accordance with the following schedule. One cycle to be as follows:

Temperature	Time
70 ± 5F	48 hours (2 days)
275 ± 5F	168 hours (7 days)
Aging Time - Total	216 hours (9 days)

7.3.1 The above cycle shall be conducted for a total of 5 times until a total of 1080 hours of exposure has been attained; 240 hours at room temperature and 840 hours at 275 F.

7.3.2 At the conclusion of the thermal aging period, the end caps are to be installed on the test fixture and the assembly connected to a variable hydraulic pressure source utilizing MIL-H-5606 fluid.

7.4 Low Temperature Test - The test fixture while connected to the pressure source is then placed in a test chamber and the temperature of the fixture reduced to -65 F. Allow the test block or fixture and fluid contained therein to stabilize at -65 F. At such time as the fixture and its fluid have stabilized a 24-inch (2-foot) head of fluid pressure shall be applied and the leakage rate for each seal shall be observed and recorded over a one-hour period. (The maximum allowable leakage to be no greater than 5 drops per minute per seal.) The fluid pressure shall then be increased to 3000 psi for a one-hour period and seal leakage observed and recorded. (The maximum leakage to be no greater than 5 drops per minute per seal.)

7.5 The block and fluid temperature shall be increased to -30 F, stabilized, and the applied pressure cycled from a low range of from 0-75 psi to 3000 ± 50 psi for 160,000 cycles. (The maximum allowable leakage to be one drop per hour per seal.)

One cycle to be of 17-second duration

8.5 seconds @ 3000 psi

8.5 seconds @ 0/75 psi

The pressure schedule and envelope to be in accordance with MIL-H-8788.

8. PERFORMANCE TEST (Ref. Figure 3)

8.1 Dynamic Seal Applications

8.1.1 Two seals (-116 size) and two seals (-216 size) shall be assembled in each test-cylinder insert of the test fixture shown in Figure 2. The cylinder shall be assembled filled with hydraulic fluid and aged at 275 F for 100 hours at atmospheric pressure. The assembled test fixture is placed in the test chamber and the temperature decreased to -65 F and held until stabilized. A 24-inch (2-foot) head of fluid pressure will then be applied and the leakage of each seal observed and recorded for a one-hour period. (The maximum allowable leakage, 5 drops per minute per seal.)

8.1.2 The fluid pressure is then increased to 50 psi and leakage over a one-hour period observed and recorded. (The maximum leakage again to be 5 drops per minute per seal.) The temperature of the test block should be increased to and stabilized at -30 F. Applying 50 psi pressure to the seals, side load the rod and record leakage for one hour. (Maximum allowable leakage, 1 drop per hour per seal.) Increase the pressure to 3000 psi and again observe and record leakage for one hour. (Maximum allowable leakage, 1 drop per hour per seal.)

8.1.3 Reduce the seal pressure to 50 psi, reverse the side load using the opposite loading piston, and observe and record leakage for one hour. (Maximum allowable leakage, 1 drop per hour per seal.)

8.1.4 Repeat at 3000 psi. (Leakage limitations to be the same.)

8.1.5 Place the test fixture assembly in a thermal chamber with 5 to 10 psi pressure on each seal and conduct a consecutive series of 10 thermal cycles from 75 to 275 F. Insure that the fluid temperature attains the extremes of this range. The leakage rate shall not exceed 1 drop per hour per seal. The time for each thermal cycle shall not be less than 1/2 hour (30 minutes) nor more than 2 hours.

8.1.6 The fixture temperature shall be raised to 275 F and cycled in accordance with the following schedule.

No. of Cycles	10,000
Stroke	4 inches, minimum
Rate	50 cpm
System pressure	3000 psi operating - impulse at mid-stroke, with pressure envelope per MIL-H-8788

8.1.7 At the conclusion of the above run, allow the fixture to soak at 275 F for 200 hours.

8.1.8 The foregoing dynamic seal test sequence (paragraphs 8.1.1 thru 8.1.6) shall then be repeated at the conclusion of the 200-hour soak period except that the number of cycles shall be reduced to 1,000 cycles. After each repeat test, the test unit shall be subjected to -65 F for 5 hours, then the temperature increased to -30 F and the unit cycles 15 times through a 1-inch stroke at 50 cpm with 3000 psi applied system pressure.

8.1.9 These tests shall be repeated until a total of 1000 hours of operation (including soak periods) have been completed.

9. CHEW TEST

9.1 Twelve sample 0-rings (-116 size) shall be used. Six of the rings shall be aged in MIL-H-5606 fluid for seven days at 160 F. The rings shall be lubricated with MIL-H-5606 fluid and installed in a test fixture similar to that shown in Figure 2. They shall then be subjected to 5000 short stroke cycles (total travel .156 inch per cycle) at a rate of 300 cpm while under a constant 3000 psig hydraulic pressure at room temperature (70 ± 5 F). Leakage need not be measured.

9.2 The minimum average abrasion value and chew rating shall not be less than 85 based on the procedures outlined in paragraph 9.3.

9.3 Each sample shall be assigned an abrasion value ranging from 0 to 100 where 100 represents no abrasion loss and 0 represents a 50% loss in projected cross section. In assigning the abrasion value a magnified shadowgraph projection shall be used. It shall be adjusted so that the best coincidence of the most abraided cross section outline and a reference circle is obtained.

Chew rating is determined by the following formula:

R = Mean chew + $(D_a - D_b)$ where:

R = Chew resistance rating

Mean Chew = Obtained from chew values of individual samples (as described in 9.3.)

$D_a = 1 \sqrt{\sum FD^2}$ = total deviation above 90

$D_b = 1 \sqrt{\sum FD^{2.25}}$ = total deviation below 90

1 = Size of interval (one in the case)

= Summation of

F = Distribution frequency

D = The deviation of each individual sample chew value above or below 90

Example:

Assume that the following values were obtained from six sample runs: 95, 95, 92, 85, 85, 87. The first three values are above 90 and the last three below 90; therefore, the formulae for D_a and D_b are used, respectively.

Sample	Chew Value	D	D^2
1	95	95-90 = 5	25
2	95	95-90 = 5	25
3	92	95-90 = 2	4

$$D_a = \sqrt{2(25) + 1\ (4)}$$

$$D_a = \sqrt{54}$$

$$D_a = 7.4$$

Sample	Chew Value	D	$D^{2.25}$
4	85	90-85 = 5	37.2
5	85	90-85 = 5	37.2
6	87	90-87 = 3	11.8

$$D_b = \sqrt{2(37.2) + 1(11.8)}$$

$$D_b = \sqrt{86.2}$$

$$D_b = 9.3$$

Mean Chew = 95 + 95 + 92 + 85 + 85 + 87 all divided by 6.

$$= \frac{539}{6}$$

Mean Chew = 89.8

Substituting in R - Mean chew + (D_a - D_b)

$$R = 89.8 + (7.4 - 9.3)$$

$$= 89.8 - 1.9$$

$$R = 87.9 \text{ or } 88$$

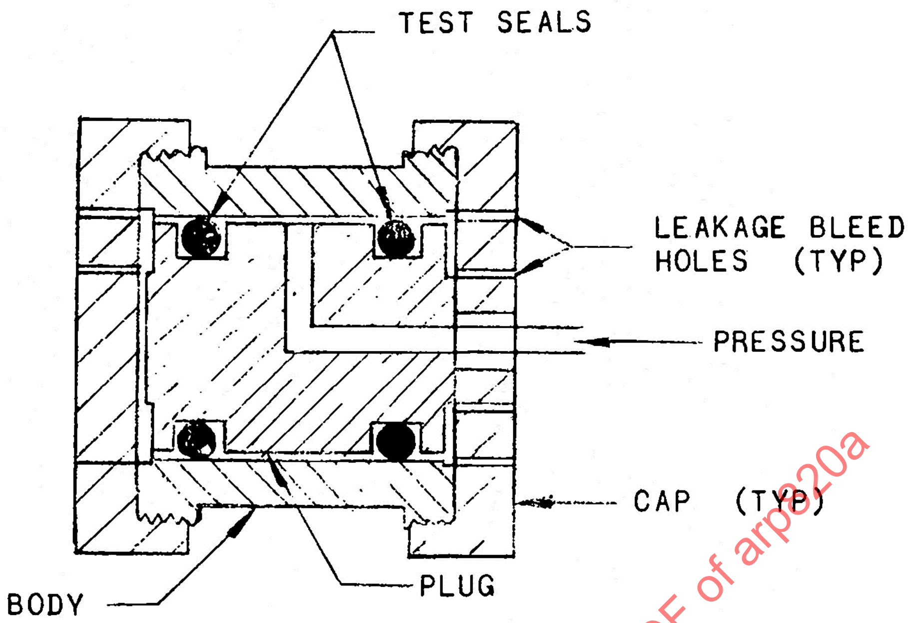
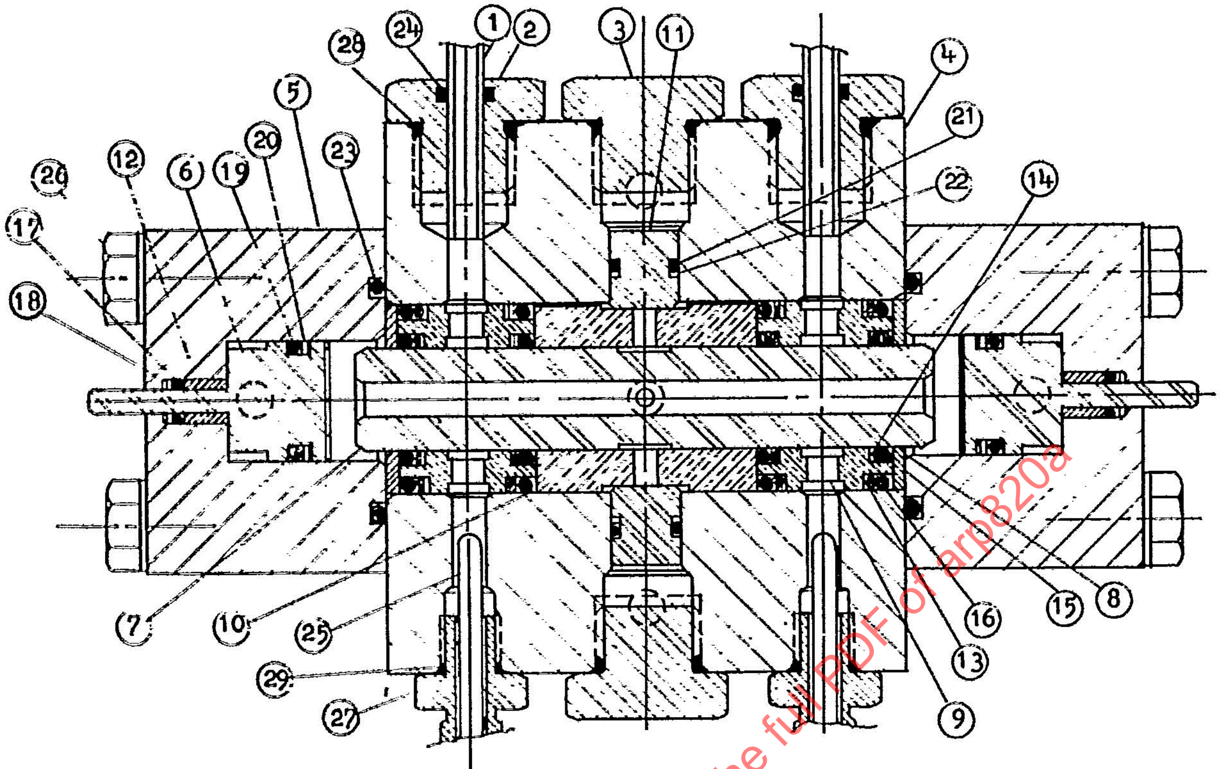


Figure 1. Static Test Fixture



PARTS LIST

820-1 - GLASS COLLECTING TUBE
820-2 - AN-814-8 PLUG (MODIFIED)
820-3 - AN 814-8-PLUG
820-4 - BLOCK (DAC 3777908)
820-5 - COVER PLATE (DAC 4777909)
820-6 - PISTON (DAC 2777910)
820-7 - ROD (DAC 2777911)
820-8 - WASHER (DAC 2777912)
820-9 - GLAND (DAC 2777913)
820-10 - SLEEVE (DAC 2777914)
820-11 - PISTON (DAC 2777915)
820-12 - SLEEVE (DAC 2777917)
820-13 - WASHER (DAC 2777918)
820-14 - WASHER (DAC 2777919)
820-15 - NAS XXXX-116 SIZE O-RING
820-16 - NAS XXXX-216 SIZE O-RING
820-17 - O-RING (DAC-S-4363922-3; NAS XXXX-008 SIZE)
820-18 - MS 28774-8 BACKUP RING
820-19 - O-RING (DAC-S-4363922-13; NAS XXXX-115 SIZE)
820-20 - MS 28774-115 BACKUP RING
820-21 - O-RING (DAC-S-4363922-7; NAS XXXX-012 SIZE)
820-22 - MS 28774-12 BACKUP RING
820-23 - O-RING (DAC-S-4363922-27; NAS XXXX-222 SIZE)
820-24 - O-RING (DAC-S-4363922-5; NAS XXXX-010 SIZE)
820-25 - THERMOCOUPLE ASSY.
820-26 - AN 6-21 BOLT
820-27 - MS 21924-4 BULKHEAD FTG.
820-28 - GASKET (DAC-S-2372288-8; NAS XXXX-8 SIZE)
820-29 - GASKET (DAC-S-2372288-4; NAS XXXX-4 SIZE)

Figure 2. Test Fixture Cross Section

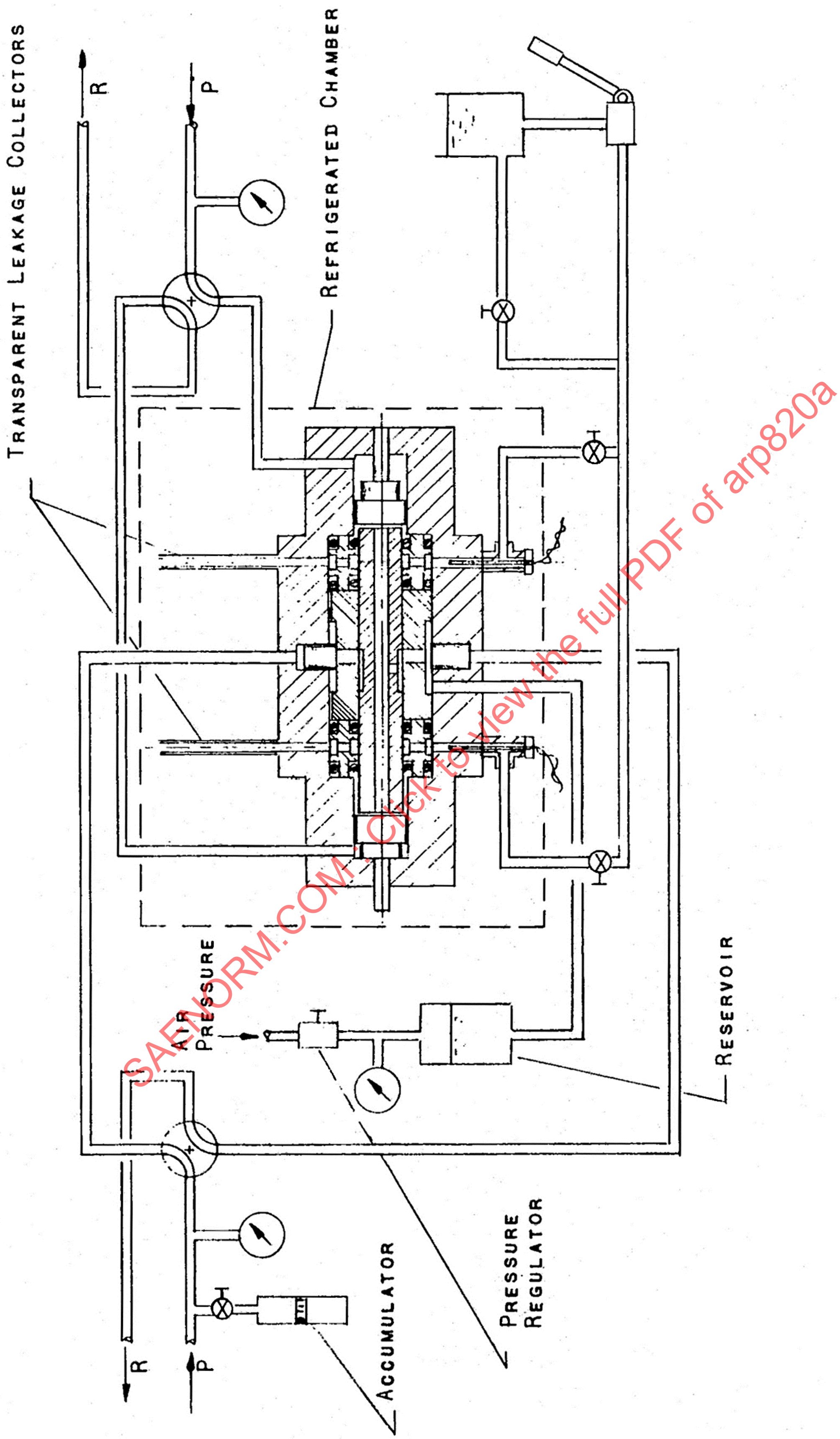


Figure 3. Test Schematic

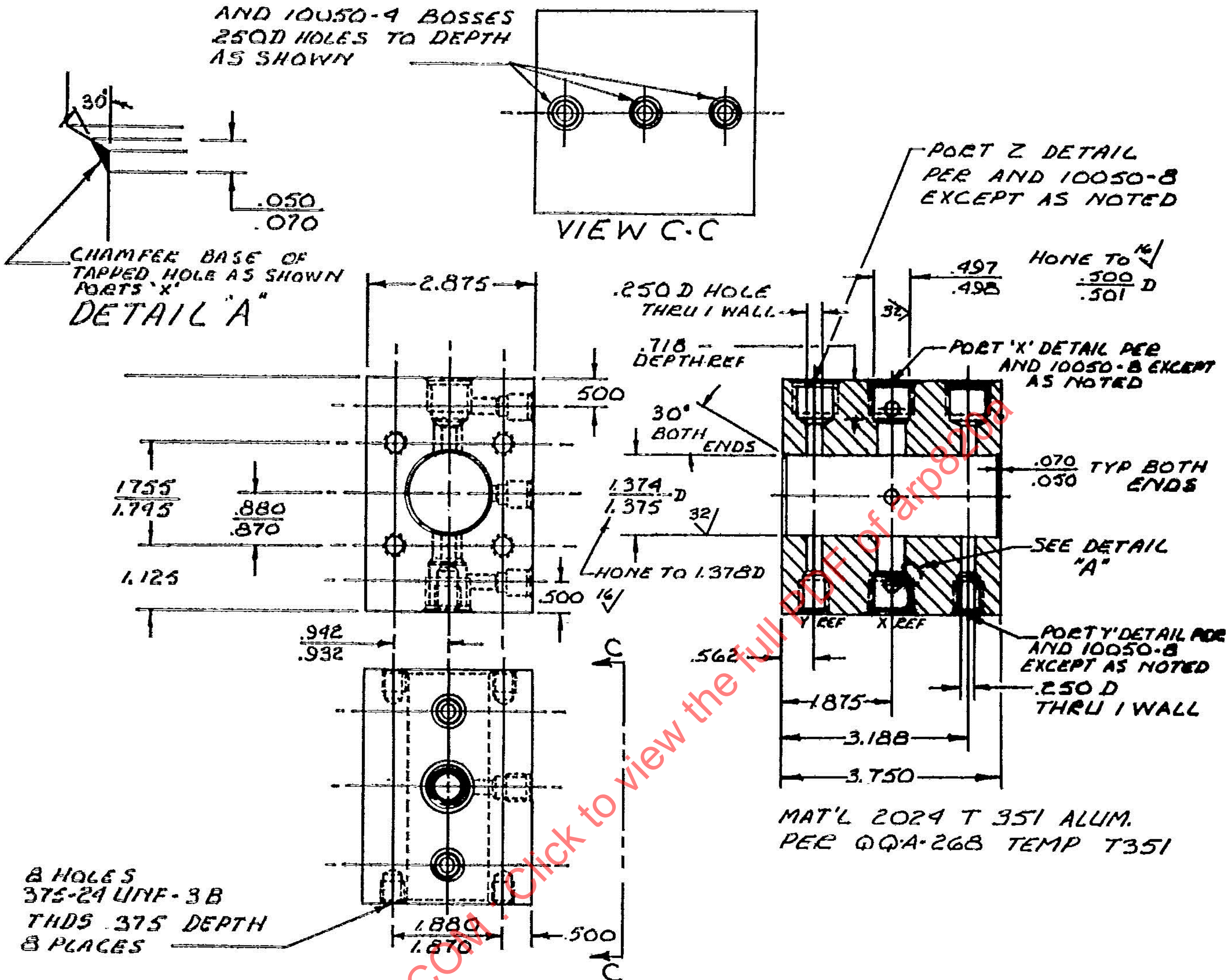


Figure 4. Block

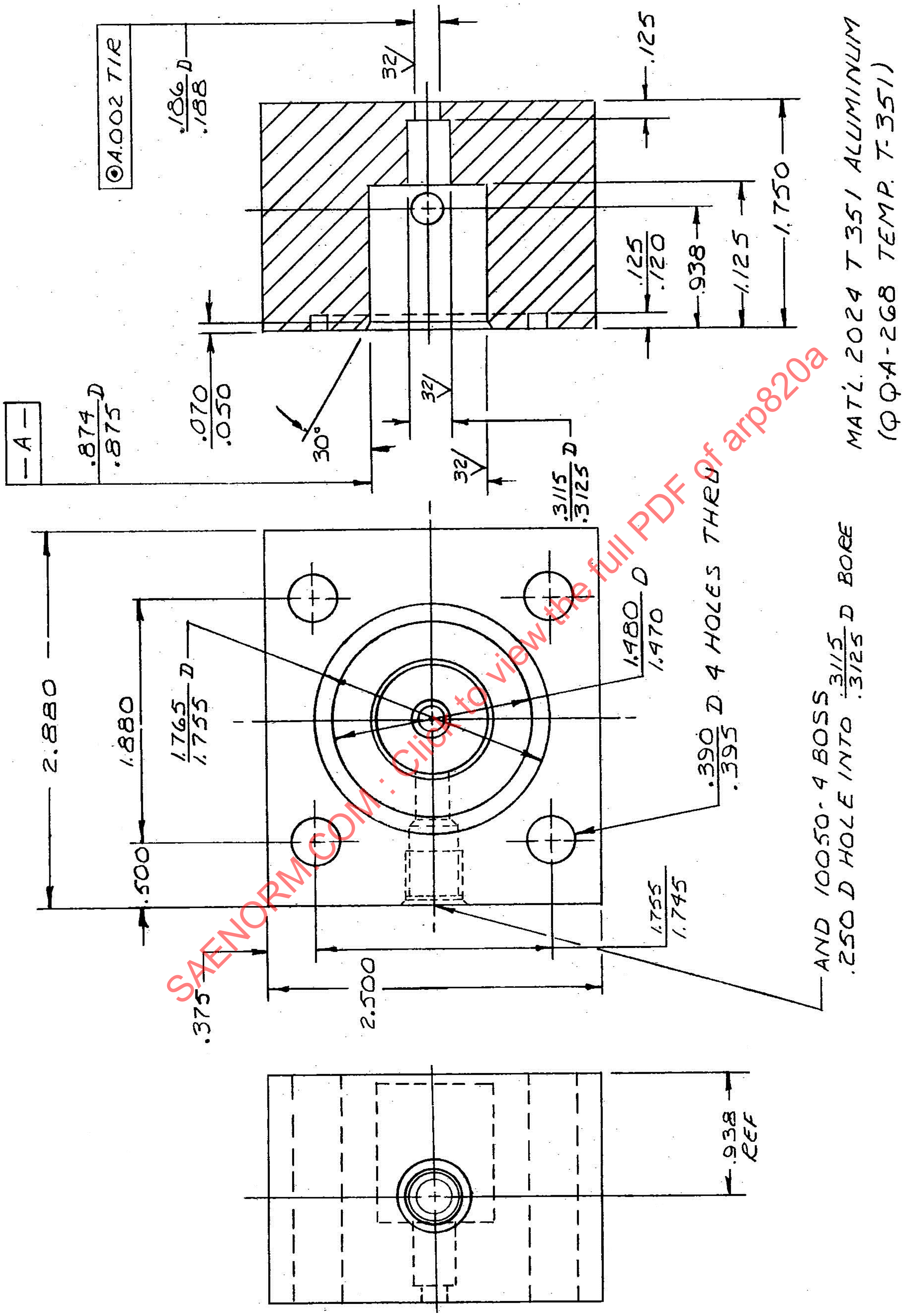


Figure 5. Cover Plate

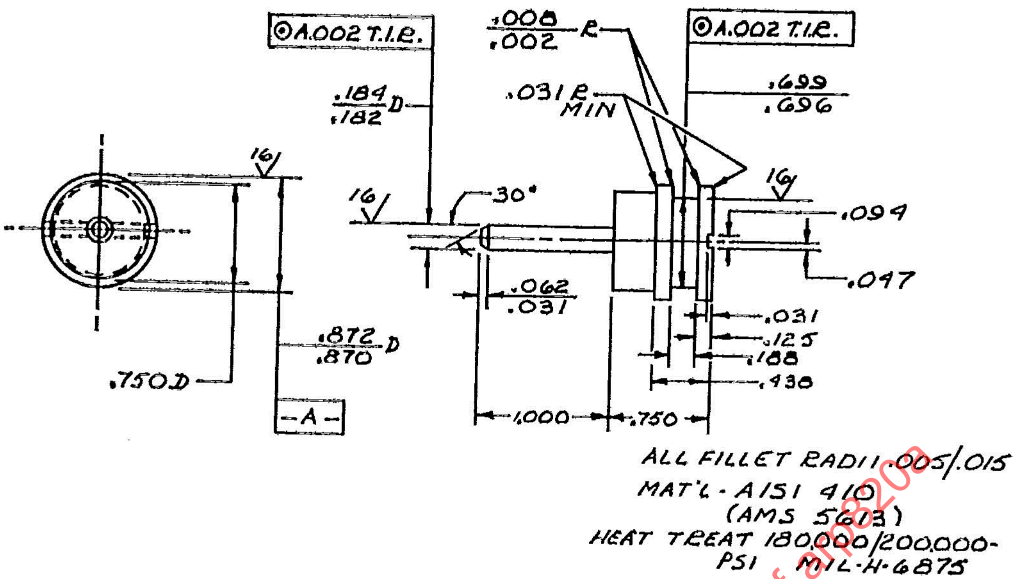


Figure 6. Piston

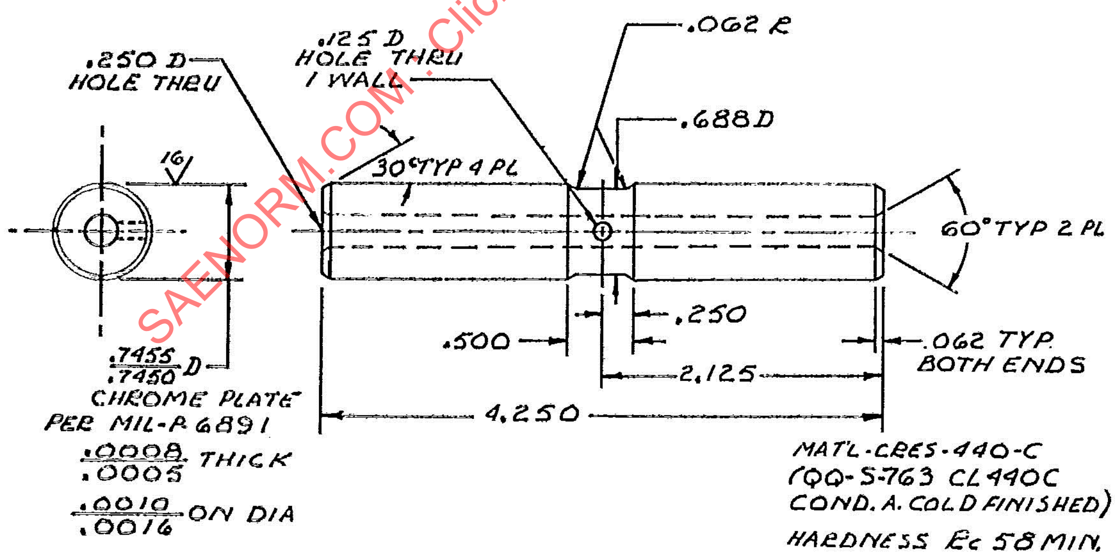


Figure 7. Rod