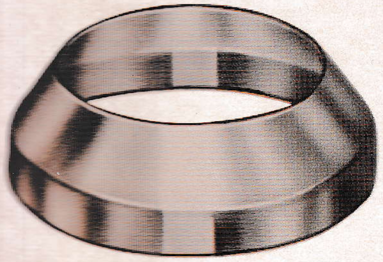
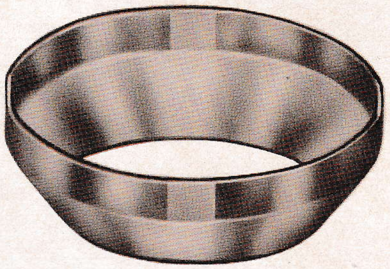
# conical seals





## VOI-SHAN

MANUFACTURING COMPANY
A DIVISION OF VOI-SHAN INDUSTRIES, INC.
8463 HIGUERA ST., CULVER CITY, CALIFORNIA

# The Conical Seal* by Voi-Shan

**What it is:** A soft, malleable crush washer designed for the conical sealing surface of the AN type flared fittings.

**Why it is needed:** Leakage problems often exist in low viscous gas systems where the conical surfaces of flared fittings and mating tubes are damaged due to manufacturing and handling procedures. The seal takes up for these imperfections and closes off the joint. Slight variations in concentricity are also corrected by the use of the CONICAL SEAL.

**Features of the seal:**

- Can be readily applied to AN standard fittings.
- Torque on the seals in accordance with AND 10064.
- When installed between the mating surfaces of the fittings and tubes it "flows" into any minute imperfections and forms a very effective SEAL.
- Four equally spaced friction flats hold the seal in place until the connection is torqued-up.
- No assembly part number change required.
- The seals are Lox cleaned and packaged in accordance with VS-VSF-5-1 specification to insure contamination free service.
- This seal can be used in AND 10050 Boss type connections. Contact Voi-Shan for details.

**Materials:**

COPPER. For use on all systems where the tubing and fittings are corrosion resistant steel and the fluids are compatible.

COPPER-TIN PLATED. For use on all systems where corrosion resistant tubing joins aluminum alloy fittings, or vice-versa, to eliminate galvanic action.

ALUMINUM. For use on all aluminum alloy systems, at the discretion of the design engineer.

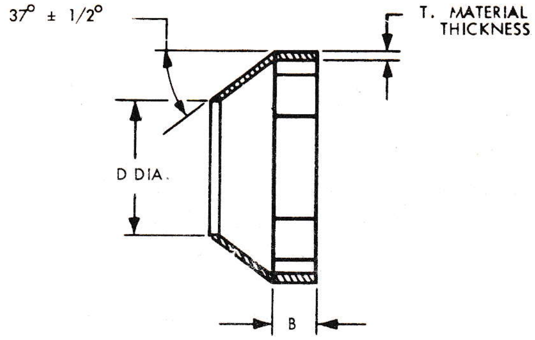
NICKEL. For use on all corrosion resistant steel systems handling fluids not compatible with copper, at the discretion of the design engineer.

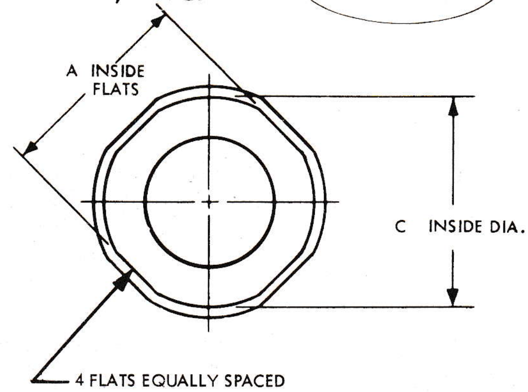
**Sizes:** Dash (—) 2 through dash (—) 48 line sizes in all materials.

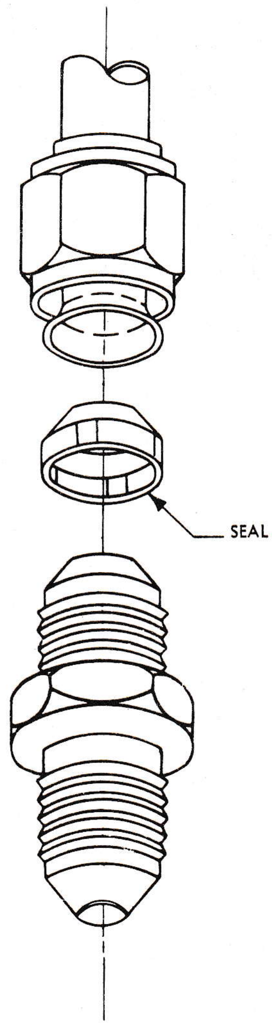
**Availability:** All parts are stock items.

*Manufactured under license from General Dynamics Corporation

# VOI-SHAN MANUFACTURING COMPANY
## A DIVISION OF VOI-SHAN INDUSTRIES, INC.




| DASH NO. | TUBE SIZE O.D. | A + .005 - .000 | B + .000 - .015 | C + .005 - .000 | D +.015 -.000 | T MAT'L. SIZE |
|---|---|---|---|---|---|---|
| 2 | 1/8 | .240 | .060 | .245 | .103 | .005 |
| 3 | 3/16 | .302 | | .307 | .166 | |
| 4 | 1/4 | .354 | .075 | .359 | .213 | |
| 5 | 5/16 | .416 | | .421 | .275 | |
| 6 | 3/8 | .471 | | .476 | .338 | |
| 8 | 1/2 | .649 | .095 | .654 | .446 | .010 |
| 9 | 9/16 | .717 | | .722 | .529 | |
| 10 | 5/8 | .762 | .105 | .767 | .562 | |
| 11 | 11/16 | .877 | | .882 | .625 | |
| 12 | 3/4 | .933 | | .938 | .687 | |
| 14 | 7/8 | 1.065 | | 1.070 | .826 | |
| 16 | 1 | 1.183 | .125 | 1.188 | .936 | |
| 20 | 1-1/4 | 1.496 | | 1.501 | 1.175 | |
| 24 | 1-1/2 | 1.745 | | 1.750 | 1.410 | |
| 28 | 1-3/4 | 2.120 | | 2.125 | 1.680 | |
| 32 | 2 | 2.370 | | 2.375 | 1.913 | |
| 40 | 2-1/2 | 2.877 | .055 | 2.882 | 2.500 | .015 |
| 44 | 2-3/4 | 3.127 | | 3.132 | 2.742 | |
| 47 | 2-15/16 | 3.235 | .090 | 3.245 | 3.015 | |
| 48 | 3 | 3.377 | .055 | 3.382 | 2.990 | |

PATENT APPLIED FOR

CODE IDENT. NO.
92215

| APPROVED DATE | TITLE | STANDARD |
|---|---|---|
| 5 NOVEMBER 1959 | SEAL - CONICAL FLARED FITTING | VSF 1015 |
| LATEST REVISION DATE 10 MAY 1962 | | SHEET 1 OF 2 |

**NOTES:**

1. REMOVE ALL SHARP EDGES AND BURRS.
2. THESE PARTS ARE ANNEALED. DIMENSIONS "A" AND "C" SHALL BE VERIFIED BY INSTALLING THE GAGKET ON A STANDARD FITTING PER MS 24385 OR MS 24386 OF APPROPRIATE SIZE. AN OUT-OF-ROUND CONDITION WHICH DOES NOT PREVENT SUCH INSTALLATION SHALL NOT BE CAUSE FOR REJECTION UNLESS THE GASKET MATERIAL IS CREASED OR NICKED.

**MATERIAL:**

"A" BEFORE DASH NUMBER INDICATES ALUMINUM ALLOY 1100 (2S) SHEET, CONDITION "O" PER QQ-A-561 SPECIFICATION.

"C" BEFORE DASH NUMBER INDICATES OXYGEN FREE COPPER STRIP, SOFT-ANNEALED PER QQ-C-576 SPECIFICATION.

"CT" BEFORE DASH NUMBER INDICATES OXYGEN FREE COPPER STRIP, SOFT-ANNEALED PER QQ-C-576 SPECIFICATION, TIN-PLATED PER AMS 2408-2.

"N" BEFORE DASH NUMBER INDICATES LOW-CARBON NICKEL STRIP, ANNEALED PER ASTM-B162-58T SPECIFICATION.

"NT" BEFORE DASH NUMBER INDICATES LOW-CARBON NICKEL STRIP, ANNEALED PER ASTM-B162-58T SPECIFICATION, TIN-PLATED PER AMS 2408-2.

"NS" BEFORE DASH NUMBER INDICATES LOW-CARBON NICKEL STRIP, ANNEALED PER ASTM-B162-58T SPECIFICATION. SILVER PLATED PER AMS 2410.

"T" BEFORE DASH NUMBER INDICATES TIN PER MIL-T-12076.

**FINISH & PACKAGING:**

1. PARTS TO BE CLEANED AND PACKAGED IN ACCORDANCE WITH VOI-SHAN SPECIFICATION VS-VSF-5-1. NO CODING WILL APPEAR IN THE PART NUMBER.
2. PARTS MARKETED IN BULK, WILL BE CODED WITH LETTER "B" AFTER DASH NUMBER.

**EXAMPLE OF CODE:**

VSF 1015 N 12
- 12 — DASH NUMBER (3/4 O.D. TUBE)
- N — MATERIAL (NICKEL)
- VSF 1015 — BASIC PART NUMBER

VSF 1015 CT 8
- 8 — DASH NUMBER (1/2 O.D. TUBE)
- CT — MATERIAL (TIN PLATED COPPER)
- VSF 1015 — BASIC PART NUMBER

VSF 1015 T 4 B
- B — CODE FOR NON-LOX CLEAN BULK PACKAGING
- 4 — DASH NUMBER (1/4 O.D. TUBE)
- T — MATERIAL (TIN)
- VSF 1015 — BASIC PART NUMBER

PATENT APPLIED FOR

| APPROVED DATE | TITLE | CODE IDENT. NO. 92215 |
|---|---|---|
| 5 NOVEMBER 1959 | SEAL - CONICAL FLARED FITTING | STANDARD |
| LATEST REVISION DATE | | VSF 1015 |
| 16 JANUARY 1962 | | SHEET 2 OF 2 |

MANUFACTURING DEVELOPMENT

DEPARTMENT 290

INTERIM REPORT NO. AN59MD3008-1

# FLARED TUBING - SURVEY OF CONCENTRICITY PROBLEM AND LEAKAGE ON HIGH PRESSURE LINES.

CONVAIR-ASTRONAUTICS

AUGUST 1959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Department 290.

## ABSTRACT

The report describes an evaluation by Manufacturing Research and Development, Dept. 290-2, assisted by Engineering, Pneumatics Design Group, to improve production tube flaring methods and equipment, for high pressure helium service.
It was found, due to orange peel effects on the surface of the flared portion of the tube, and the material hardness of mating surfaces, leakage of helium was inevitable. The most effective and practical method of sealing the mating surface was accomplished by fitting a soft copper flared fitting seal, which has since become a standard production fitting.

Another cause for leakage was due to discrepancies existing in Military Standard Drawings involved. Until drawings have been revised in accordance with the recommendations of this report, fittings are not adequate for high pressure helium line assemblies.

Interim Report No. AN59MD3008-1, Development of Flared Fittings for Helium Lines; - Operating Pressure 3000 psi. Further copies of this report are obtainable from Manufacturing Research and Development, Dept. 290-2, Ext. 1275.

TABLE OF CONTENTS

**TITLE: FLARED TUBING - SURVEY OF CONCENTRICITY PROBLEM AND LEAKAGE ON HIGH PRESSURE LINES.**

## OBJECT:

An investigation to determine the cause of leaks in production tube flaring methods and equipment, subjected to helium gas under pressure up to approximately 3000 psi.

## INTRODUCTION:

Present methods while satisfactory for hydraulic and pneumatic systems are not adequate for high pressure helium service. This investigation originated due to an Engineering request for Manufacturing Research and Development, Department 290-2, to assist in determining the cause of leaks in production flared tubes and fittings, subjected to helium gas under pressure.
Three phases were followed:

a. Dimensional check of all component parts used in the various assemblies.

b. Check of all part drawing tolerances and surface finishes for incompatibility.

c. Check of assembly methods, including torque accuracies, alignment, etc.

It was considered the cause of leakage could be attributed to one or more of these factors.

## CONCLUSIONS:

a. Due to the uneven surface of flared portions of the tube and the material hardness of mating surfaces and parts, an improved method of sealing was essential.

b. Grease or compound material forced between the mating surfaces had been used to seal against leakage with only minor success. Introducing contaminative particles into the system by this or any similar method used for sealing is undesirable.

c. The most practical method of sealing the mating surface of assemblies is by the copper crush washer developed under subject tests, (see Fig. 1).

d. Discrepancies prevail in Military Standard Drawings listed in this report. Until drawings have been revised as recommended, these fittings are not suitable for high pressure helium service.

## RECOMMENDATIONS:

a. The Copper seal in accordance with Engineering Drawing No. D27-80572 (see Fig. 9) should be fitted to all assemblies involving helium high pressure service.

b. Further studies should be made with regard to torque valves and dry lube film applied to threads, to replace KEL. F now applied by hand.

c. Modifications to Military Standard Drawings as listed in Fig. 2, are recommended to avoid failure when fittings are used for helium high pressure service.

d. Demand individual packaging for shipping, handling and storage. Have all parts source examined by Convair Inspection, to allow cleaning and packaging by the Vendor. This eliminates need for opening packages prior to use.

## DEVELOPMENT:

The investigation began in October 1958 with a dimensional check of component parts and tolerances. Surface finishes of mating parts were investigated, and assembly methods for torque accuracies and alignment were closely examined. Every precaution was observed to provide perfection of production tube flaring methods and equipment to secure leakproof assemblies. Over one hundred assemblies were tested, of which few were capable of withstanding 200 psi or over, even when over-torque was applied to nuts securing assembly fittings.

The check revealed, seals could not be effected applying normal torque values in keeping with Military Standard maximum tolerances.

The investigation continued by removing parts from the final assembly line, which were cleaned and degreased by approved method and reassembled in the normal manner.

Increased torque applied to the nut of re-assemblies helped in preventing leakage. A pressure of 3000 psi however, could not be maintained.

It became apparent that grease, or a similar compound, had been used in assemblies for sealing. Due to the existing limitation of contaminative particles entering into the system, this practice was undesirable, and moreover was not effective as a sealing method.

A metallographic examination of the mating surfaces at the seal, proved them to be sufficiently uneven to cause leakage of helium gas under pressure. It was also found, grease or a similar compound, entering the porous structure of the mating surfaces, was only partly effective as a seal.

Obviously, a suitable material was essential to seal off the porous mating surfaces.

Copper, the most inexpensive of the soft materials was chosen. This material would not contaminate the system.

Five fittings were copper plated with varying thicknesses between .0005 to .005 and tested for leakage with negative results. Five copper washers formed by hand from .010 thickness, soft copper sheet, were fitted with normal torque applied. Assemblies satisfactorily withstood 3000 psi pressure.

Temporary tools were made to produce a limited quantity of copper seals, with which to make further tests under simulated vibration, also an ultimate burst test. Form dies were ordered to fabricate a conical shape washer with a retaining flange conforming to Fig. 9.

Resulting from this investigation, it was found discrepancies exist on Military Standard Drawings of parts involved in the subject assemblies.

From Figures 3, 6, and 8, it will be observed, eccentricity accumulation could cause a gap of .014 between the flared tube and fitting. The allowable radius tolerance on two parts involved, (MS33584 Tube, and MS20819 Sleeve), introduces an interference preventing the sleeve from coming in contact with the tube flare by .004", (see Fig. 7).

The amount of gap due to angular tolerance is shown in Fig. 5.

From Fig. 4 it will be seen, dimension "S" on AN818 Nut, is not controlled to prevent threads coming in contact with "J" diameter of MS20819 Sleeve.
Corrective action is recommended in Fig. 2.

## RESULTS:

a. Assemblies fitted with a hand formed copper washer acting as a seal, satisfactorily withstood and maintained a pressure of 3000 psi helium pressure.

b. The evaluation proved the necessity for providing a flared fitting soft copper seal conforming to Engineering Drawing No. D27-80572 (Fig. 9), on all helium service assemblies, as a standard production item.

## SUMMARY:

Two significant failings resulted from this evaluation by Manufacturing Research and Development, Dept. 290-2 to determine the cause of leaks in production tube flaring methods and equipment subjected to helium gas under high pressure.

a. Metallographic examination of the mating surfaces of assemblies, proved them to be sufficiently uneven to allow leakage of helium gas under pressure.

b. Discrepancies in dimensions and tolerances, existing on Military Standard Drawings of parts involving accumulated eccentricity and inefficient joints, proved a serious source of leakage.

Necessary revisions to Military Standard Drawings, to correct this failing are recommended, (See Table, Fig. 2).

Sealing of the uneven mating surfaces was satisfactorily accomplished by fitting a soft copper flared fitting seal, which has recently become a standard production fitting for high pressure helium service, (See Fig. 1 and Fig. 9).

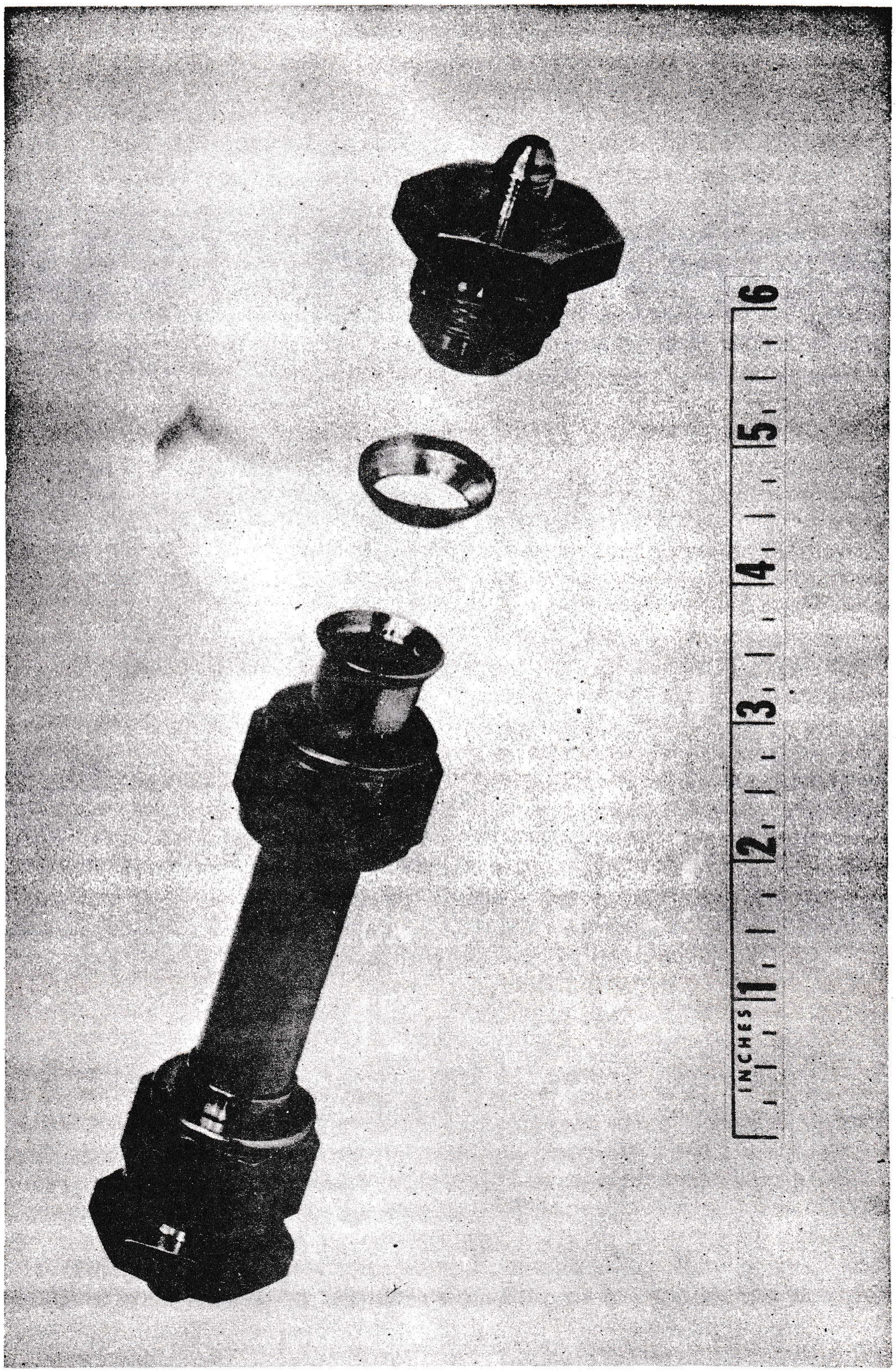


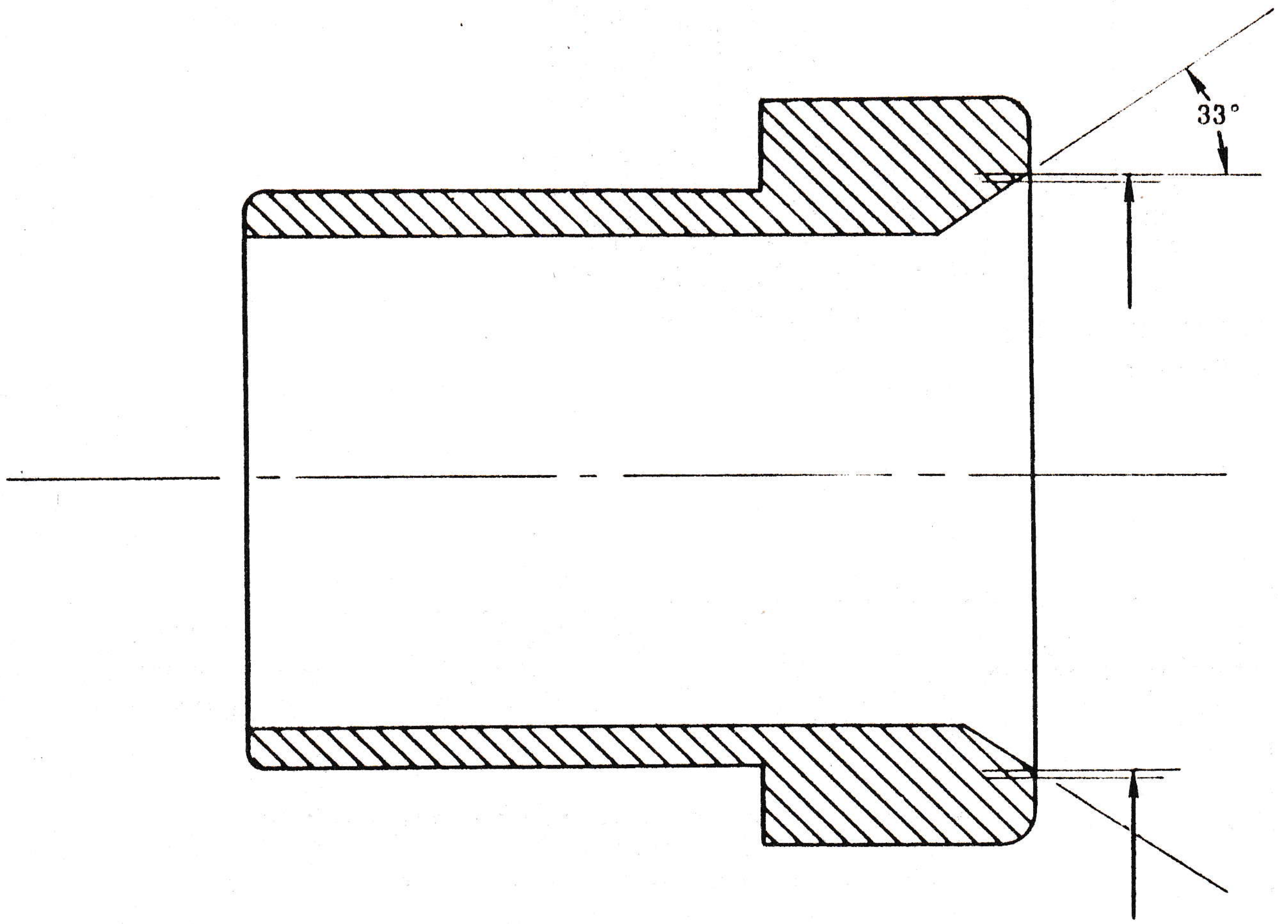

Fig. 1

RECOMMENDED REVISIONS TO MILITARY STANDARD
DRAWINGS FOR USE WITH HIGH PRESSURE HELIUM SYSTEMS.

| DRAWING NO. | TITLE | REVISION |
|---|---|---|
| MS24381<br><br>MS24386<br><br>MS33656<br><br>MS33657 | Fitting End, Flared<br>Tube Connection<br>Fitting End, Flared<br>Tube Connection<br>Fitting End, Flared<br>Tube Connection<br>Fitting End, Flared<br>Tube Connection | Reduce concentricity tolerance from .008 to .002 T.I.R.<br>Maintain 32 micro inch finish on all fittings as shown in precision fitting drawings MS24385 and MS24386.<br>Keep pitch diameter of threads to low limit of tolerance to insure mating nut freedom to shift when necessary, (Smooth finish of threads must be maintained). |
| MS20819 | Sleeve Coupling | Reduce concentricity tolerance from .005 and .010 T.I.R. to .002 T.I.R. on all sizes (see also Fig. 3). Change the angle from 33° to 31° to insure contact at the end of sleeve, in case all four surfaces would be on the low limit of tolerance. (Refer to Fig. 4). Radius on inside of sleeve is now the same as radius of the tube flare "B" in MS33584. Increase radius "B" + 10%, revise tolerance to read $^{+.010}_{-.000}$<br>Control "G" dia. to match "A" dia. of AN818 nut. Remove 1° angle. (Refer to Fig. 5). |
| AN818 | Nut | Hold thread pitch diameter to high limit of tolerance to insure freedom to shift and turn in the M.S. fitting. Control "F" diameter on nut to match "G" diameter of Drawing MS20819, sleeve for the distance of "J" on said drawing.<br>* This will insure uniformity in amount of radial thrust the nut applies to the sleeve. Control the length "S" on AN818 nut to prevent sleeve contacting threads. (Refer to Fig. 5). |
| MS33583<br><br>MS33584 | Tubing End, Double<br>Flare Standard<br>Tubing End, Standard<br>Dimensions for Flared | Rigid inspection must be maintained on tools and machines used for flaring.<br>Use carbide mandrels exclusively.<br>Provide check gauges that will check concentricity of tubes flares in addition to diameter and angle.<br>(Refer to Fig. 6 and Fig. 7). |
| MS33583<br><br>MS33584 | Tubing End, Double<br>Flare, Standard<br>Tubing End, Standard<br>Dimensions for Flared. | Tolerance on dimension "B" should be changed from + .010 to $^{+.000}_{-.010}$ |

* Tests prove the nut does carry radial load although not designed to do so.

Fig. 2




ARROW INDICATES ECCENTRICITY ALLOWABLE -.005 TIR

COSINE 33° = .83867
.83867 X.005=.00419335

Fig. 3

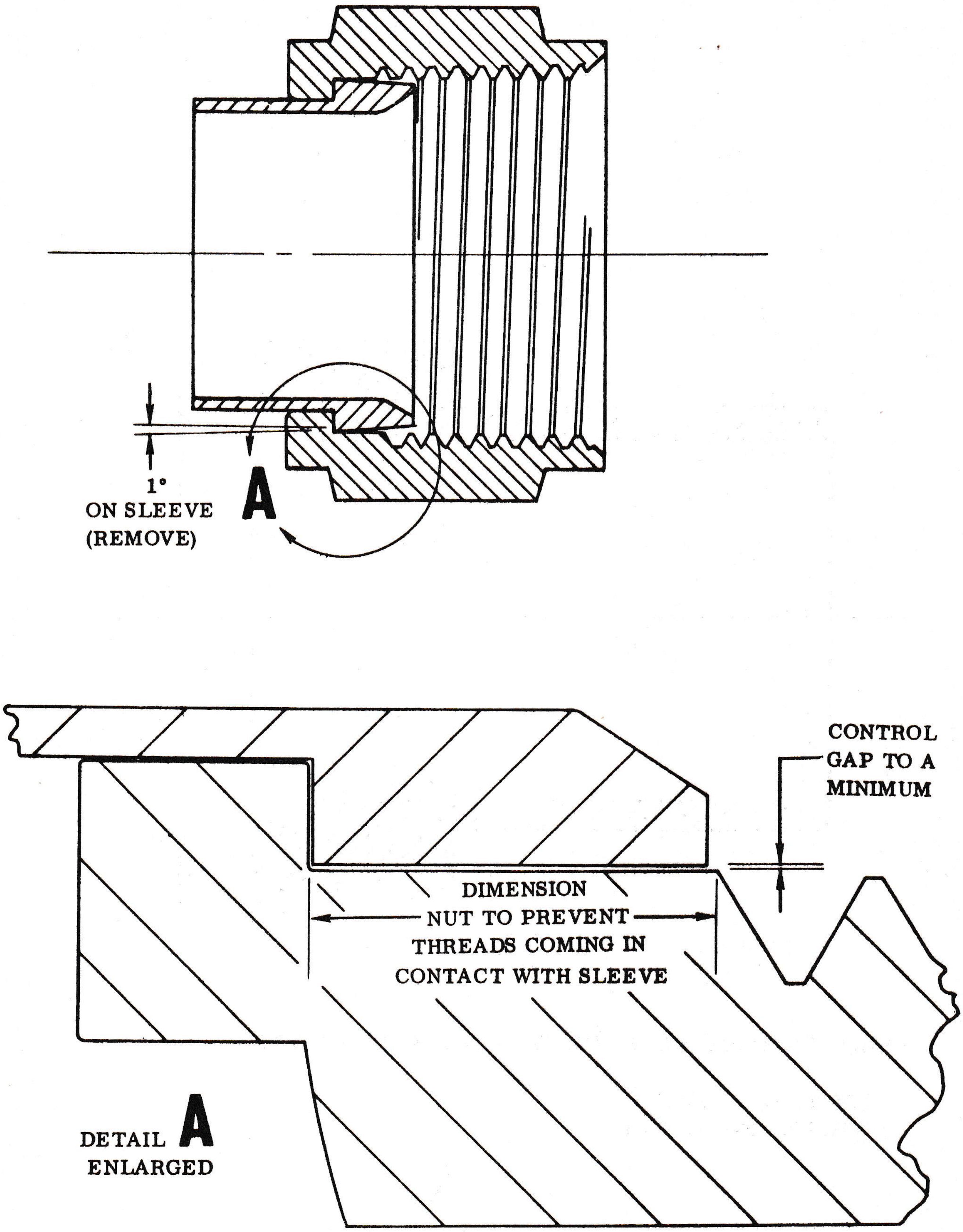
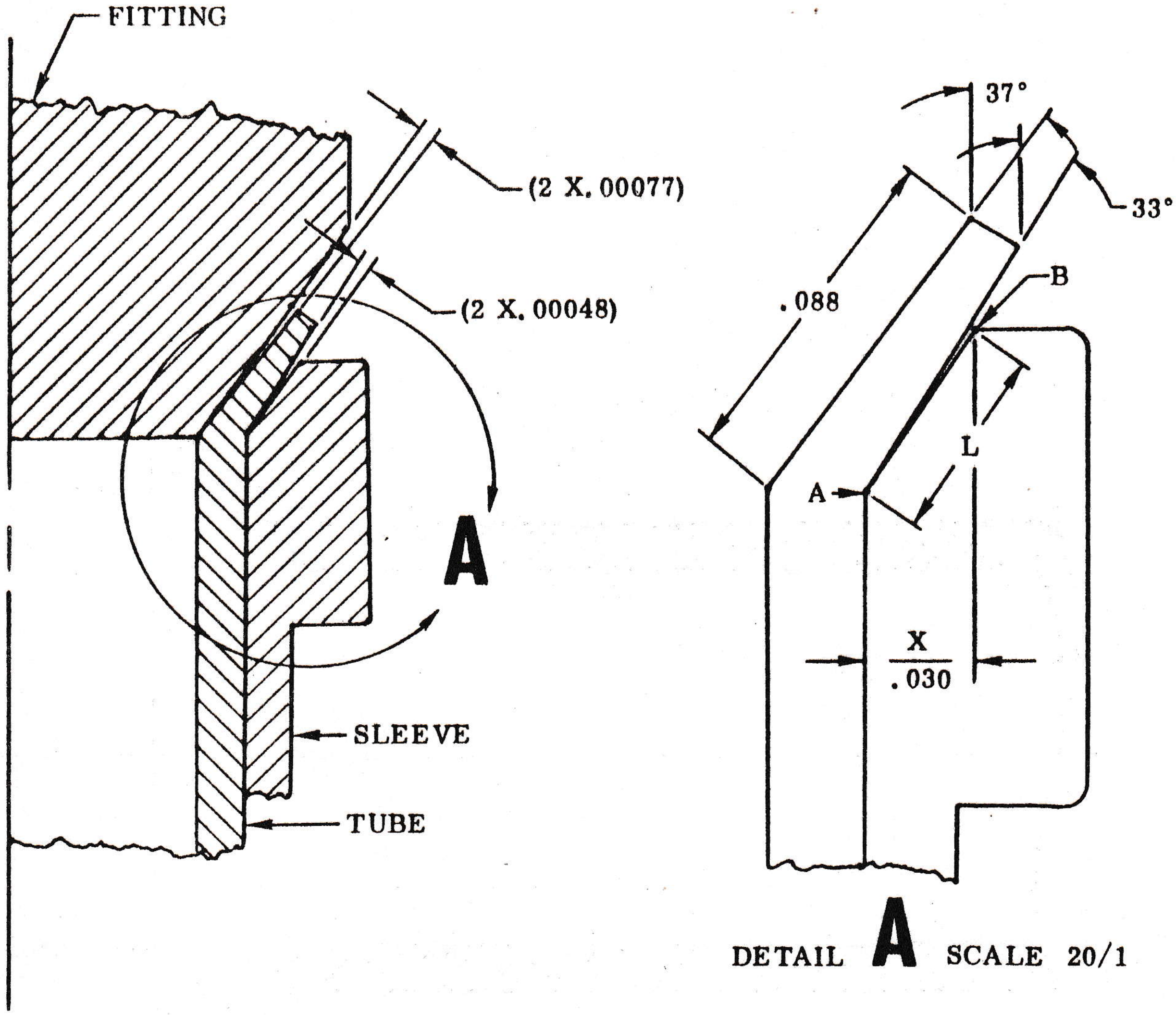

1°
ON SLEEVE
(REMOVE)
A
CONTROL
GAP TO A
MINIMUM
DIMENSION
NUT TO PREVENT
THREADS COMING IN
CONTACT WITH SLEEVE
DETAIL A
ENLARGED

Fig. 4




PT. A = B DIA. OF MS20819 =.255
PT. B = F DIA. OF MS20819 =.315

$$X = \frac{.315 - .255}{2} = .030$$

TAN 1/2° = 00873
COSEC 33° = 1.8361

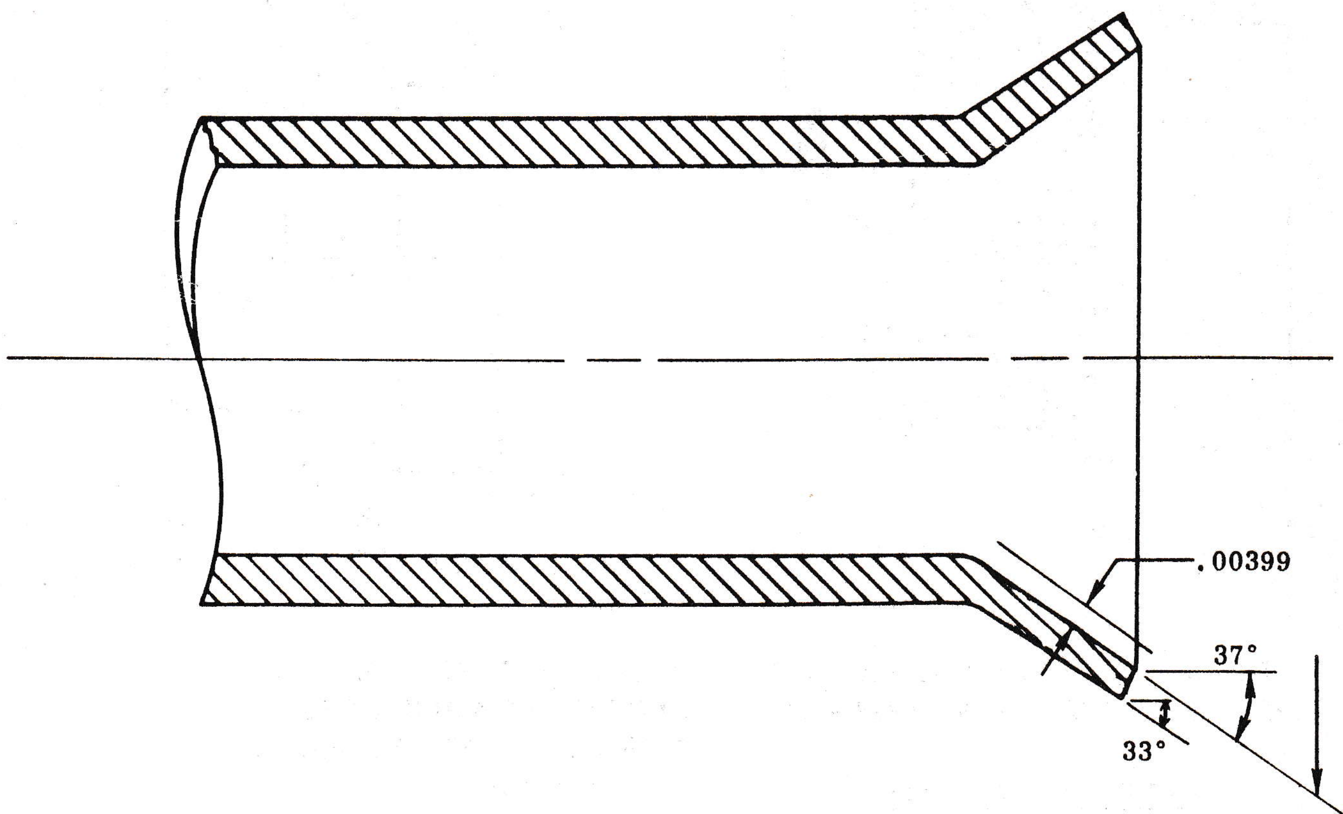
L = .030 X 1.8361 = .055083

INSIDE TUBE = .00873 X .088 = .00077

OUTSIDE TUBE = .00873 X .055 = .00048

TOTAL OPENING POSSIBLE DUE TO ALL 4 SURFACES BEING 1/2° FROM NOMINAL.
= .00250

Fig. 5




ARROW INDICATES ECCENTRICITY ALLOWABLE -.005 TIR

COSINE 37° = .79864

.79864 X .005 = .00399320

Fig. 6

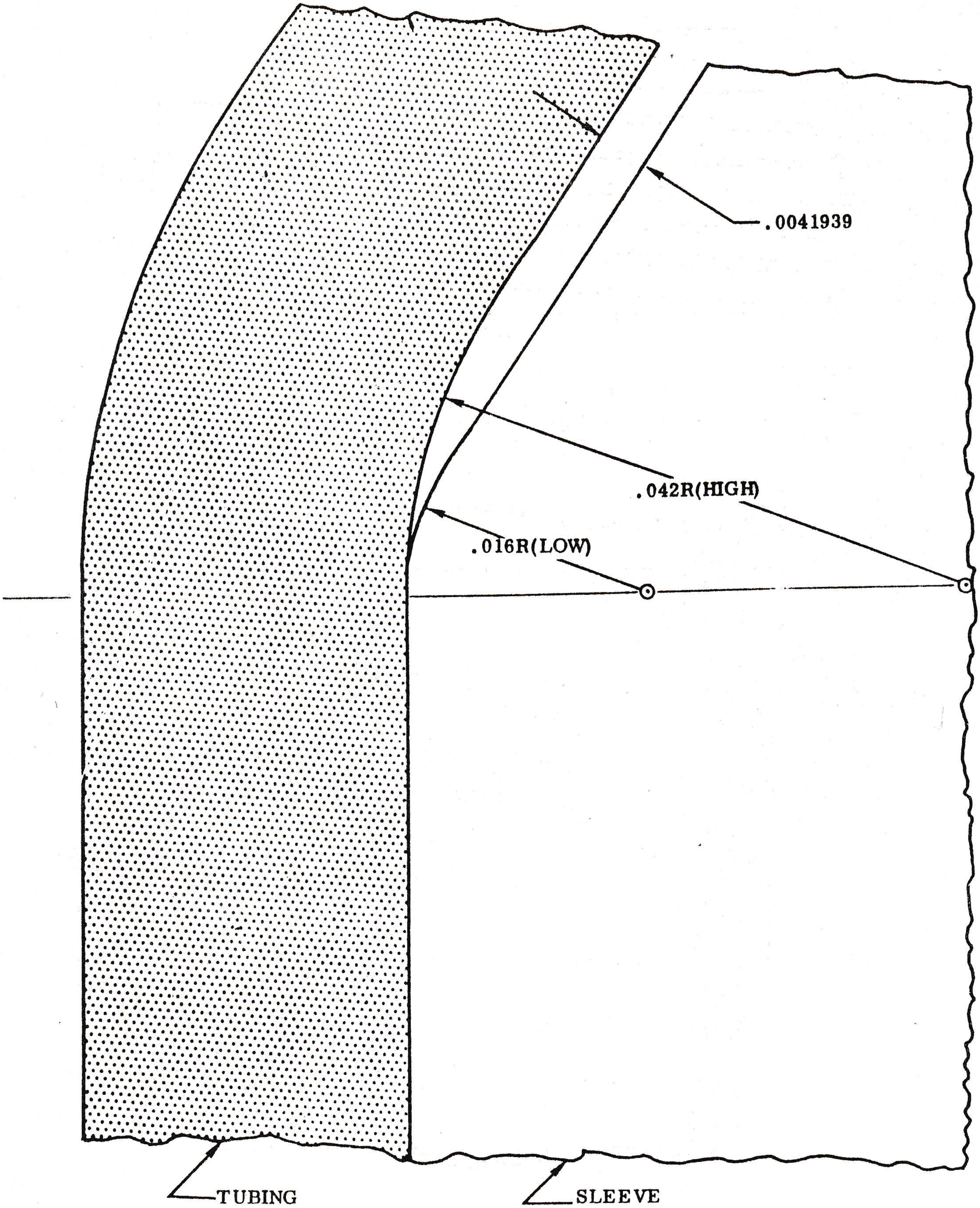



Fig. 7

1/4" TUBING, (100 X SCALE)

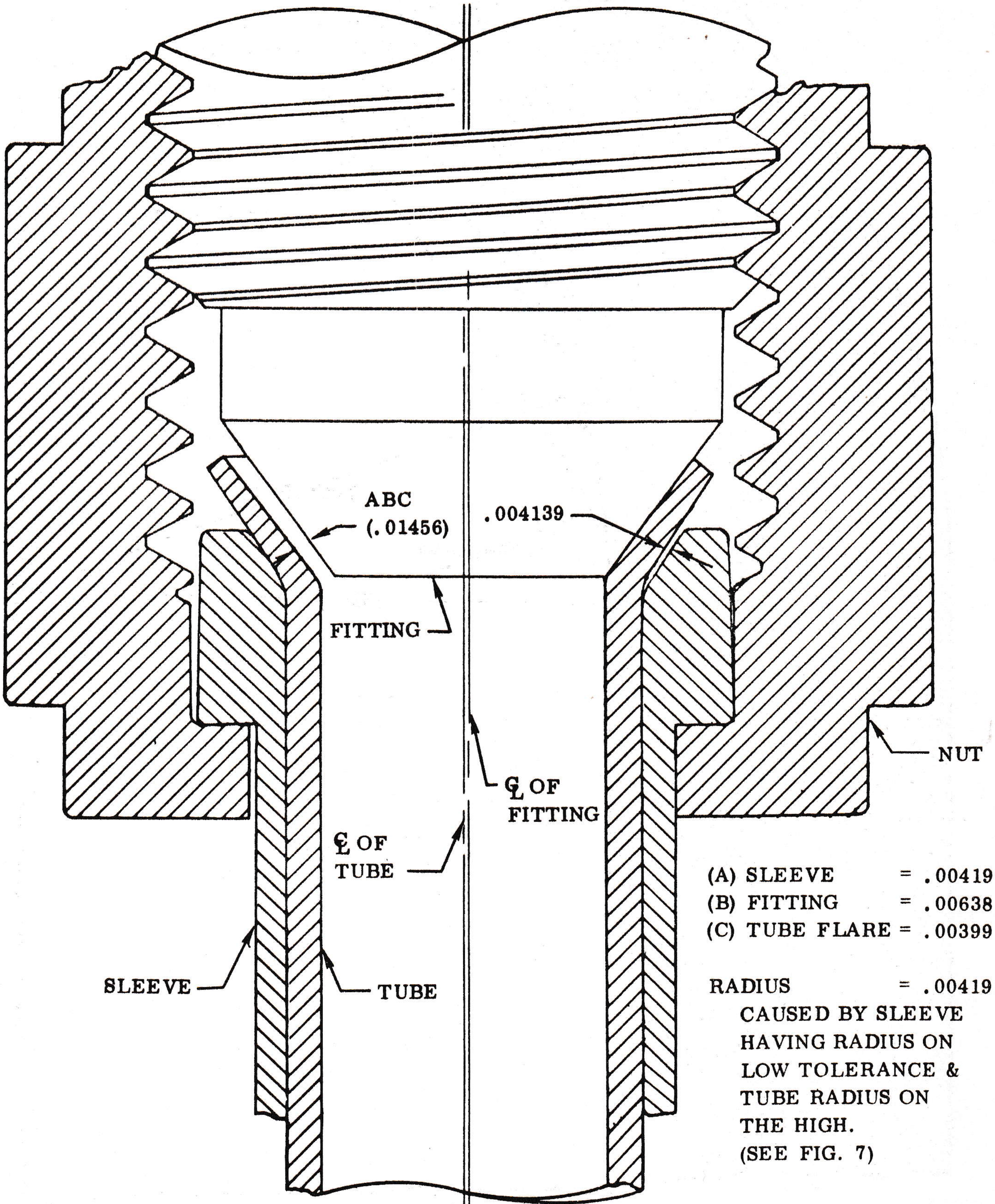
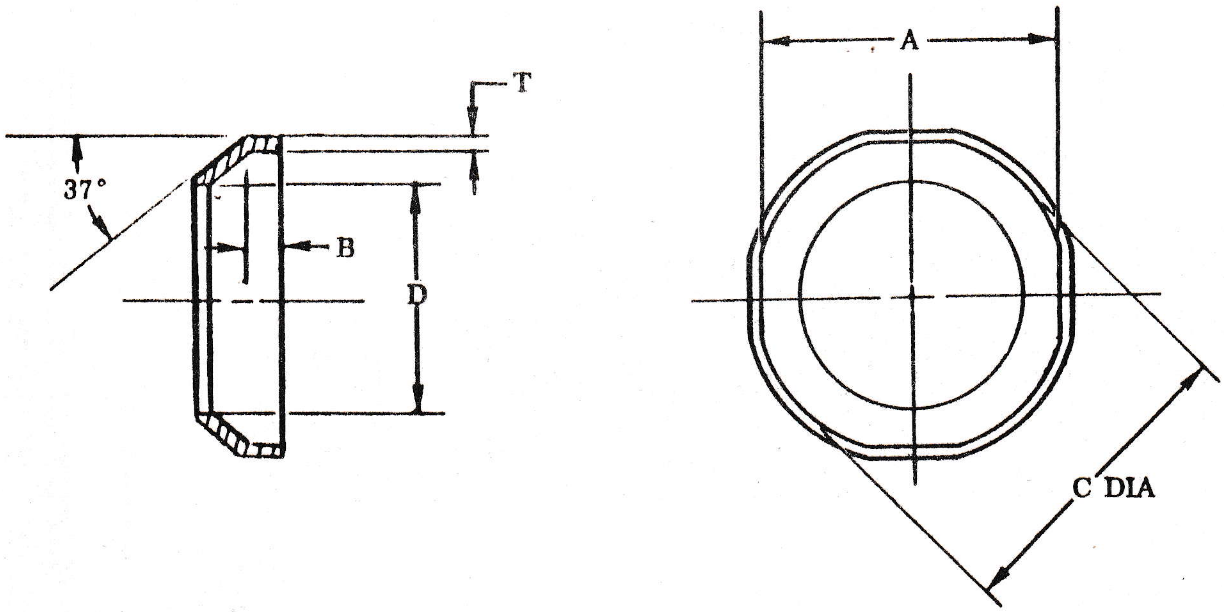

ABC
(.01456)
.004139
FITTING
NUT
℄ OF
FITTING
℄ OF
TUBE
SLEEVE
TUBE
(A) SLEEVE = .00419
(B) FITTING = .00638
(C) TUBE FLARE = .00399
RADIUS = .00419
CAUSED BY SLEEVE
HAVING RADIUS ON
LOW TOLERANCE &
TUBE RADIUS ON
THE HIGH.
(SEE FIG. 7)

Fig. 8

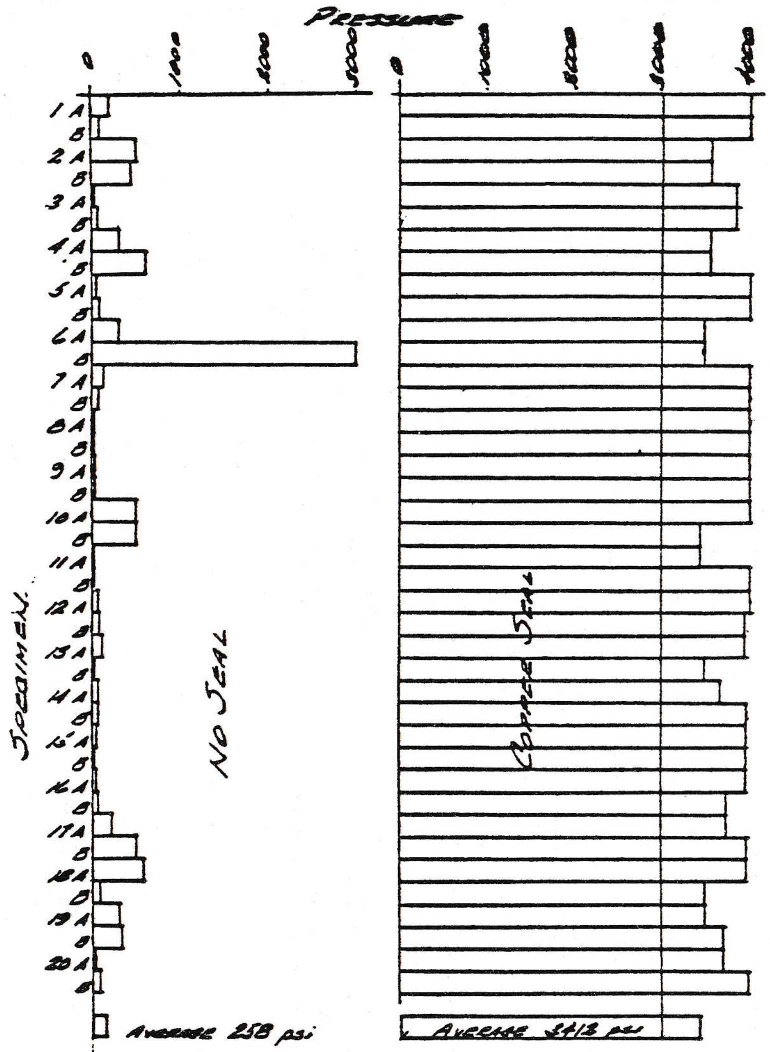



Reference Dng No. 27-80572

| DASH NO. | TUBE SIZE | +.005 -.000 A | +.020 -.000 B | +.005 -.000 C | +.015 -.000 D | T |
|---|---|---|---|---|---|---|
| -7 | -4 | .354 | | .359 | .213 | |
| -9 | -5 | .416 | .060 | .421 | .275 | .005 |
| -11 | -6 | .471 | | .476 | .338 | |
| -13 | -8 | .649 | .080 | .654 | .446 | |
| -15 | -10 | .762 | .090 | .767 | .562 | .010 |
| -17 | -12 | .933 | | .938 | .687 | |
| -19 | -16 | 1.183 | | 1.188 | .936 | |
| -21 | -20 | 1.496 | | 1.501 | 1.175 | |
| -23 | -24 | 1.745 | .110 | 1.750 | 1.410 | .0136 |
| -25 | -28 | 2.120 | | 2.125 | 1.680 | |
| -27 | -32 | 2.370 | | 2.375 | 1.913 | |

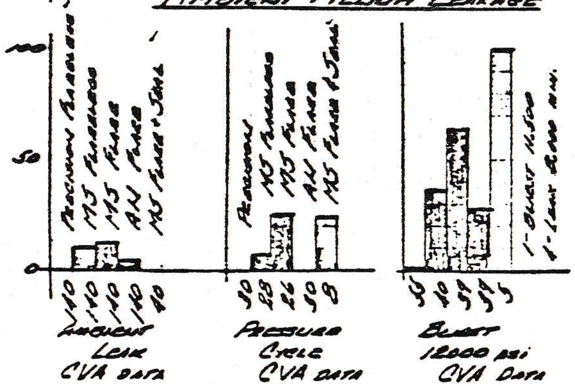
Seal - Soft Copper Flared Fitting

Fig. 9




% Failure 98 % Failure 0

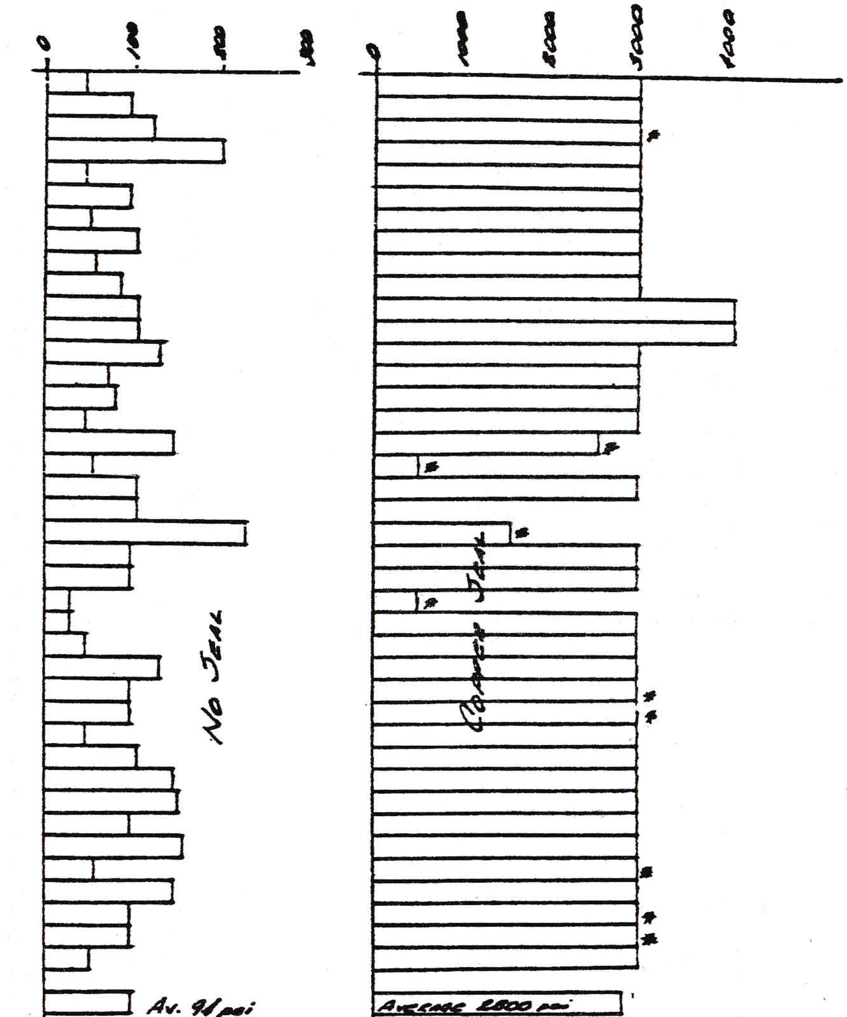
## Ambient Helium Leakage




Vibration to Failure-Stress reversal @ 75% of min yield @ 900 cpm.

MIN. 5000 cy
MAX 134,000 cy
Av. 54,250 cy

1 in. Dia x.049




% Failure 100 % Failure 27

## Ambient Helium Leakage

Pressure cycle % Failure 25

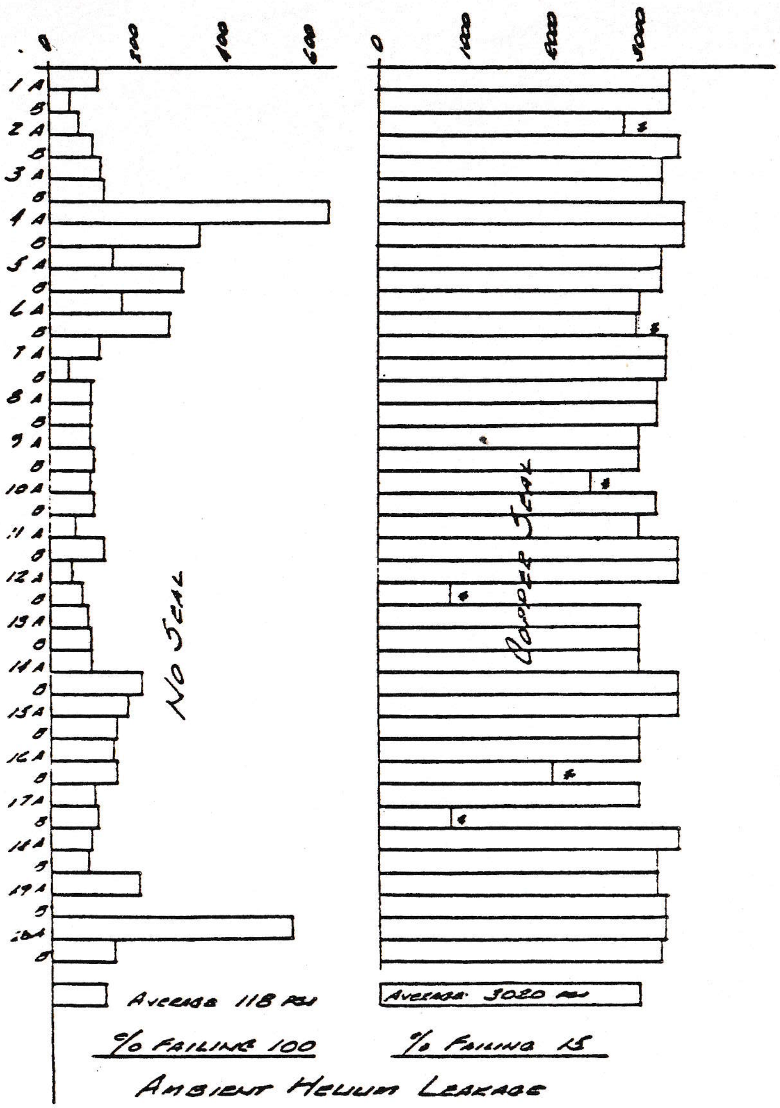
Vibration 900 cpm
MIN. 15,706 cy
MAX. 25,275 cy
Av. 21,000 cy

Burst 12000 psi % Failure 0

## Convair Astronautics - Comparison Tests

## Flared vs Flared with Seal

3/4" Dia x.049




% Failing 100 — % Failing 15

Ambient Helium Leakage

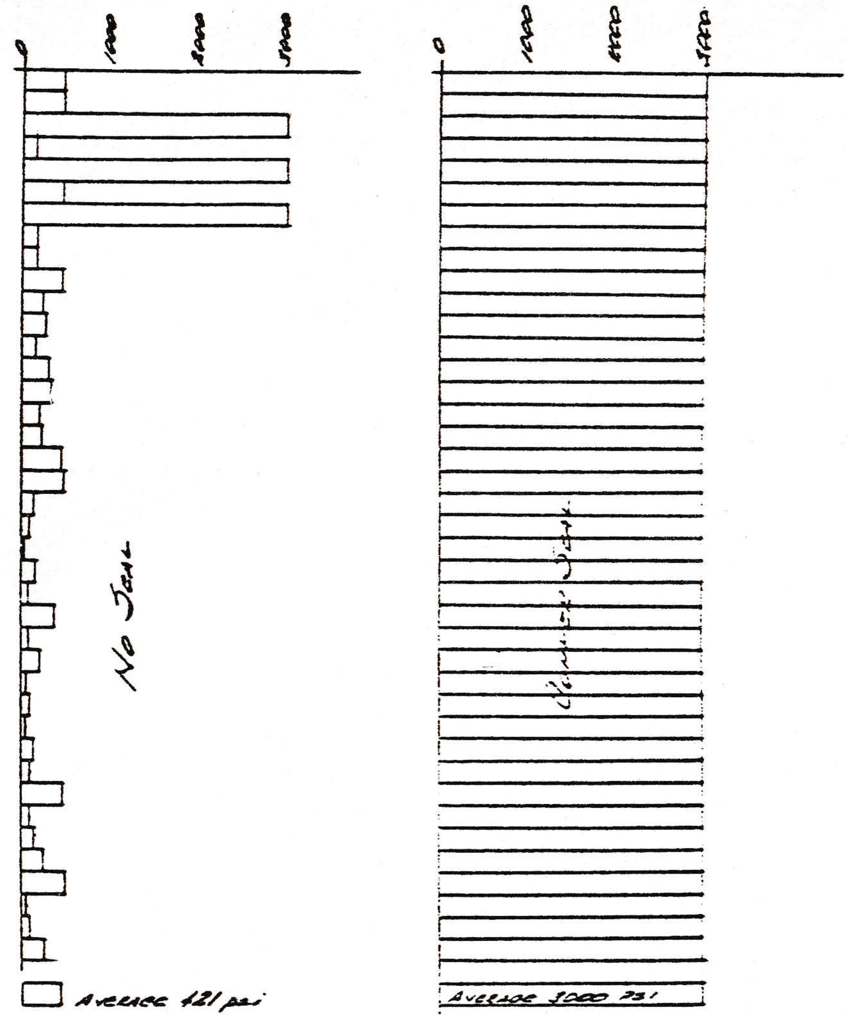
Pressure Cycle % Failing 0
Vibration 900 cpm
Min. 11,025 cy
Max. 25,347 cy
Av. 17,700 cy

Burst 12000 psi % Failing 16

5/8" DIA x .035

Convair Astronautics Comparison Tests

Flared vs Flared with Seal




% Failing 93 — % Failing 0

Ambient Helium Leakage

Pressure Cycle % Failing 0
Vibration 900 cpm
Min 11,900 cy
Max 37,600 cy
Av. 39,500 cy

Burst 12000 psi % Failing 0

Convair Astronautics Comparison Tests

Flared vs Flared with Seal

1/2 Dia x .028