SAE Aerospace
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AEROSPACE RECOMMENDED PRACTICE

SAE ARP1234 | REV. B

Issued 1979-06
Revised 2001-11
Reaffirmed 2012-11

Superseding ARP1234A

Gland Design, Elastomeric O-Ring Seals, Static Axial, Without Back-Up Rings

RATIONALE

ARP1234B has been reaffirmed to comply with the SAE five-year review policy.

FOREWORD

Changes in this Revision are format/editorial only.

1. SCOPE:

1.1 This document establishes standard gland design criteria and dimensions for static axial O-ring seal applications without anti-extrusion devices.

1.2 SI unit conversions for U.S. Customary Units have been provided for reference purposes.

1.3 The criteria herein are similar, but not identical, to those in MIL-G-5514.

2. PURPOSE:

The purpose of this document is to provide the aerospace industry with standardized dimensional criteria for static axial elastomeric O-ring seal glands, without back-up rings. It supplements ARP1231, "Gland Design, Elastomeric O-Ring Seals, General Considerations."

3. GENERAL REQUIREMENTS:

3.1 Applicable Documents:

3.1.1 ANSI B46.1-1978 - Surface Texture

3.1.2 ANSI Y14.36-1978 - Surface Texture Symbols

3.1.3 AS568 - Uniform Dash Numbering System for O-Rings

3.1.4 ARP1231 - Gland Design, Elastomeric O-Ring Seals, General Considerations

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http://www.sae.org/technical/standards/ARP1234B

3.2 Gland Configurations:

3.2.1 General: A static axial O-ring seal is one which compresses the surfaces normal to the ID and OD of the O-ring. The most common axial gland configurations are depicted in Figures 1A, 1B and 1C. The preferred configuration is one that provides a complete groove in one part, as in Figure 1A. This configuration minimizes the number of gaps through which the seal can extrude and reduces the potential damage to the seal during assembly. The use of configurations with one gland wall missing, as in Figure 1C, is not recommended because it may result in damage of the seal through pressure reversals.

3.2.2 Non-Circular Glands: Although axial seals are usually circular, alternate configurations like that in Figure 1D are sometimes used.

3.2.3 Placement of the seal within the groove depends on the direction of the pressure. Axial seals may be pressurized from a pressure source located within the seal's inner diameter (internal pressure application) or from a source located outside the outer diameter of the seal (external pressure application). The gland should be designed such that, prior to applying pressure, the seal will be in contact with the gland wall away from the pressure side of the seal.

3.2.4 Standard Glands: Standard dimensions for axial seal glands are tabulated in Tables 4 & 5. These dimensions are for use with seals conforming to AS568 tolerances. They are computed in accordance with the criteria defined in para. 4 and in ARP1231.

3.2.5 Exceptions: Standard glands are not provided for all O-ring seals listed in AS568. This ARP is limited to the AS568 sizes listed in Table 5. O-ring seal sizes not listed are not recommended for axial seals because the seal ID after installation becomes too small for practical use.

3.3 Surface Texture:

Figure 1A defines the preferred surface texture to be used with the various glands described in this document. For critical applications, no flaws should be permitted in the sealing areas.

4. DESIGN CRITERIA:

4.1 Groove Circumference or Length:

4.1.1 Internal Pressure Application: The groove circumference or length should be such that the outer diameter of the O-ring seal will be line-on-line with the outer wall of the groove when the seal is at nominal size and the groove outer wall is at maximum size (i.e., for circular glands, Amax = Knom + 2 Wnom).

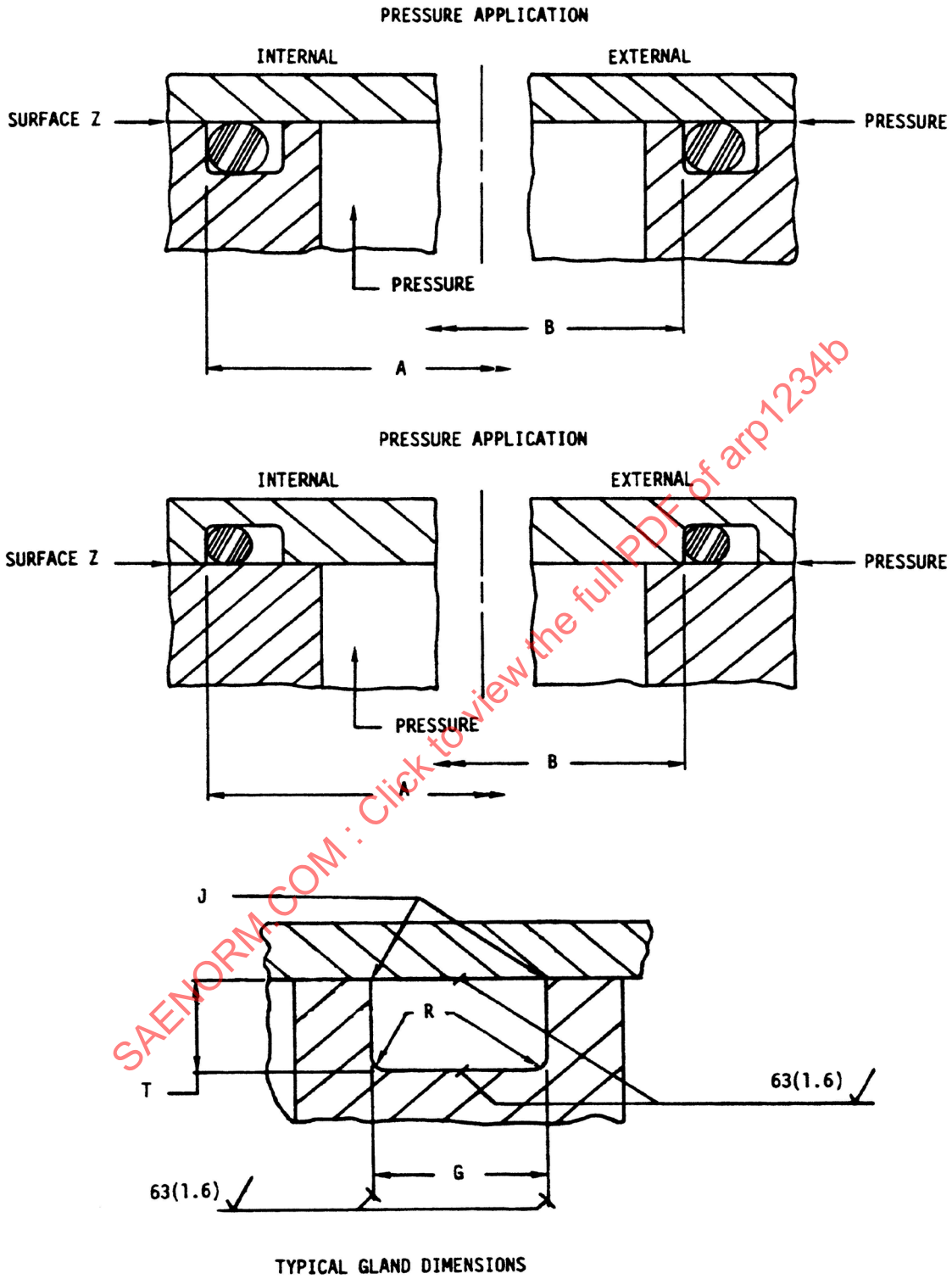

FIGURE 1A - O-Ring Seal Axial Gland Preferred Designs

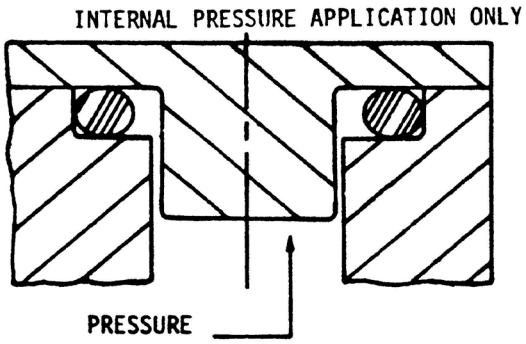

FIGURE 1B - O-Ring Seal Axial Glands Alternate Design

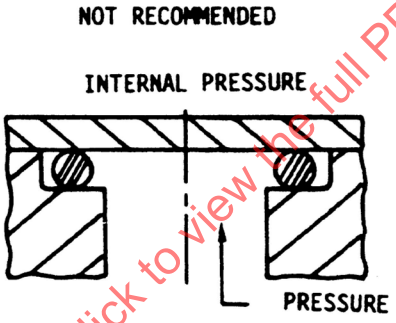

FIGURE 1C - O-Ring Seal Axial Glands

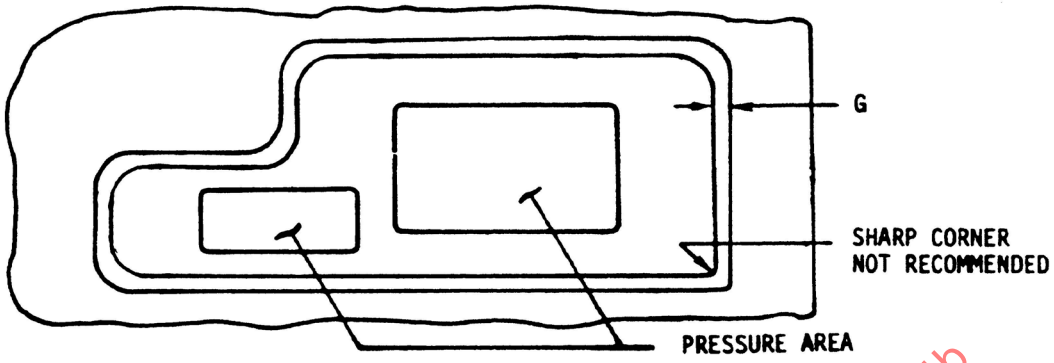

FIGURE 1D - Example of Non-Circular Groove Configuration

NOTES: (FIG. 1A, 1B, 1C & 1D)

. SURFACE TEXTURE: SYMBOLS PER ANSI Y14.36; REQUIREMENTS PER ANSI B46.1-1978.

. DIMENSIONS IN ( ) ARE MICROMETRES.

. SEE TABLES 4 & 5 FOR RECOMMENDED VALUES FOR T, G, A & B.

. SEE TABLE 1 FOR RECOMMENDED VALUES FOR J AND R.

TABLE 1 - Gland Edge Breaks & Radii

AS 568 Dash No.	Nom. O-Ring Cross-Section Dia.		Edge Break J		Radius R	
	Inches	mm	Inches	mm	Inches	mm
-004 thru -050	.070	1.78	.005-.015	0.13-0.38	.010-.020	0.25-0.51
-102 thru -178	.103	2.62	.010-.020	0.25-0.51	.020-.030	0.51-0.76
-201 thru -284	.139	3.53	.010-.020	0.25-0.51	.020-.030	0.51-0.76
-309 thru -395	.210	5.33	.010-.020	0.25-0.51	.020-.030	0.51-0.76
-425 thru -475	.275	6.98	.010-.020	0.25-0.51	.020-.030	0.51-0.76

4.1.2 External Pressure Application: The groove circumference or length should be such that the inner diameter of the O-ring seal will be line-on-line with the inner wall of the groove when the seal inner diameter is at nominal size and the groove inner wall is at minimum size (i.e., for circular glands, Bmin = Knom).

4.2 O-Ring Seal Squeeze:

4.2.1 To avoid leakage and to compensate for any sealing surface distortion during operation, the axial O-ring seal gland should be designed to achieve nominal squeezes as shown in Table 2. The gland depths given in Table 4 are based on this level of nominal squeeze.

TABLE 2 - O-Ring Seal Squeeze

AS 568 Dash No.	Nom. O-Ring Cross-Section Dia.		Nominal Squeeze % of W Nominal
	Inches	mm	
-004 thru -050	.070	1.78	26%
-102 thru -178	.103	2.62	24%
-201 thru -284	.139	3.53	21%
-309 thru -395	.210	5.33	18%
-425 thru -475	.275	6.98	15%

4.3 O-Ring Seal Swell:

4.3.1 To accommodate O-ring seal swell, gland widths should be dimensioned to achieve a volume which is greater than the maximum swollen seal volume. In selecting gland widths, consideration must also be given to standardization of widths to cover a broad range of seal sizes. Such standardization is desirable to achieve reduction in inventory of tools and gages. Standard widths have been provided in Table 4.

4.3.2 The formulae for calculating gland widths are presented in Figure 2. It will be noted that for a selected excess volume (m) and a selected cross sectional dia. (W), the gland widths computed from Figure 2 will vary with seal ID (K). In order to achieve the gland width standardization presented in Table 4, compromises in excess gland volume were necessary. These compromises result in minimum excess volumes which vary between 15 & 55%, with most sizes between 30 & 40%. When it is desired to design a gland having a specific excess volume, the formulae in Figure 2 shall be used.

4.4 Clearances:

4.4.1 Surfaces labeled Z in Figure 1 should be maintained as flat as possible, consistent with manufacturing requirements. In addition, the strength of the mating parts shall be sufficient to minimize distortion of the parts during operation. Distortion and lack of flatness can cause O-ring seal extrusion into the resulting gap between surfaces.

1. For Internal Pressure Applications:

$$Gmin = 1/2\left(\overline{AA} - \sqrt{\overline{AA}^2 - \overline{BB}}\right)$$

$$\overline{AA} = Amin + \frac{Fmin}{Tmin}$$

$$\overline{BB} = \frac{\pi\, Amin\, Fmin + mVs}{.7854\, Tmin}$$

$$Gmax = Gmin + .010(0.25\ mm)$$

2. For External Pressure Applications:

$$Gmin = 1/2\left(\sqrt{\overline{CC}^2 + \overline{DD}} - \overline{CC}\right)$$

$$\overline{CC} = Bmin + \frac{Fmin}{Tmin}$$

$$\overline{DD} = \left(\frac{\pi\, Bmin\, Fmin + mVs}{.7854\, Tmin}\right)$$

$$Gmax = Gmin + .010(0.25\ mm)$$

$$Fmin = .4292\ (Rmax)^2$$

A, B, G & T are gland dimensions per Figure 1A.

m = the factor used to increase the seal volume to the expected value after installation and soaking. Example: 30% excess volume desired; m = 1.3

V_s = maximum unsoaked seal diameter

$$= 2.4674\ (Kmax + Wmax)\ (Wmax)^2$$

K = Seal inside diameter
W = Seal cross section diameter
R = Gland corner radii per Table 1

FIGURE 2 - Formulae for Computing Gland Widths

4.4.2 The plug-to-bore diametral clearances shown in Figure 1B must be held to a minimum to prevent seal damage during operation. The maximum clearance values in Table 3 are recommended.

TABLE 3 - Recommended Maximum Diametral Clearance

AS 568 Dash No.	Nominal Seal Cross Section		Max. Dia. Clearance	
	Inch	mm	Inch	mm
-004 thru -014	.070 (ID ≤ .500)	1.78 (ID ≤ 12.7)	.008	.204
-015 thru -050	.070 (ID > .500)	1.78 (ID > 12.7)	.010	.254
-102 thru -179	.103	2.62	.012	.304
-201 thru -284	.139	3.53	.016	.406
-309 thru -395	.210	5.33	.018	.458
-425 thru -475	.275	6.98	.024	.610

TABLE 4 - Standard Gland Widths and Depths

Inch

AS 568 Dash No.	Nom. Seal Cross Section	Width (G)	Depth (T)
-004 thru -050	.070	.125-.135	.049-.055
-102 thru -179	.103	.170-.180	.075-.081
-201 thru -284	.139	.210-.220	.107-.113
-309 thru -395	.210	.300-.310	.169-.175
-425 thru -475	.275	.355-.365	.231-.237

mm

AS 568 Dash No.	Nom. Seal Cross Section	Width (G)	Depth (T)
-004 thru -050	1.78	3.18-3.43	1.24-1.40
-102 thru -179	2.62	4.32-4.57	1.90-2.06
-201 thru -284	3.53	5.33-5.59	2.72-2.87
-309 thru -395	5.33	7.62-7.87	4.29-4.44
-425 thru -475	6.98	9.02-9.27	5.87-6.02

TABLE 5 - Standard Gland Dia's.

Gland and AS 568 Dash No.	Internal Pressure Application - Dia. A Inch	mm	External Pressure Application - Dia. B Inch	mm
-004	--	--	.070- .075	1.78 - 1.90
-005	--	--	.101- .106	2.57 - 2.69
-006	--	--	.114- .119	2.90 - 3.02
-007	--	--	.145- .150	3.68 - 3.81
-008	--	--	.176- .181	4.47 - 4.60
-009	--	--	.208- .213	5.28 - 5.41
-010	--	--	.239- .244	6.07 - 6.20
-011	.436- .441	11.07 - 11.20	.301- .306	7.65 - 7.77
-012	.499- .504	12.57 - 12.80	.364- .369	9.25 - 9.37
-013	.561- .566	14.25 - 14.38	.426- .431	10.82 - 10.95
-014	.624- .629	15.85 - 15.98	.489- .494	12.42 - 12.55
-015	.686- .691	17.42 - 17.55	.551- .556	14.00 - 14.12
-016	.749- .754	19.02 - 19.15	.614- .619	15.60 - 15.72
-017	.811- .816	20.50 - 20.73	.676- .681	17.17 - 17.30
-018	.874- .879	22.20 - 22.33	.739- .744	18.77 - 18.90
-019	.936- .941	23.77 - 23.90	.801- .806	20.35 - 20.47
-020	.999- 1.004	25.37 - 25.50	.864- .869	21.95 - 22.07
-021	1.061- 1.066	26.95 - 27.08	.926- .931	23.52 - 23.65
-022	1.124- 1.129	28.55 - 28.68	.989- .994	25.12 - 25.25
-023	1.186- 1.191	30.12 - 30.25	1.051- 1.056	26.70 - 26.82
-024	1.249- 1.254	31.72 - 31.85	1.114- 1.119	28.30 - 28.42
-025	1.311- 1.316	33.30 - 33.43	1.176- 1.181	29.87 - 30.00
-026	1.374- 1.379	34.90 - 35.03	1.239- 1.244	31.47 - 31.60
-027	1.436- 1.441	35.47 - 35.60	1.301- 1.306	33.05 - 33.17
-028	1.499- 1.504	38.07 - 38.20	1.364- 1.369	34.65 - 34.77
-029	1.624- 1.629	41.25 - 41.38	1.489- 1.494	37.82 - 37.95
-030	1.749- 1.754	44.42 - 44.55	1.614- 1.619	41.00 - 41.12
-031	1.874- 1.879	47.60 - 47.73	1.739- 1.744	44.17 - 44.30
-032	1.999- 2.004	50.77 - 50.90	1.864- 1.869	47.35 - 47.47
-033	2.124- 2.129	53.95 - 54.08	1.989- 1.994	50.52 - 50.65
-034	2.249- 2.254	57.12 - 57.25	2.114- 2.119	53.70 - 53.82
-035	2.374- 2.379	60.30 - 60.43	2.239- 2.244	56.87 - 57.00
-036	2.499- 2.504	63.47 - 63.60	2.364- 2.369	60.05 - 60.17
-037	2.624- 2.629	66.65 - 66.78	2.489- 2.494	63.22 - 63.35
-038	2.749- 2.754	69.82 - 69.95	2.614- 2.619	66.40 - 66.52
-039	2.874- 2.879	73.00 - 73.13	2.739- 2.744	69.57 - 69.70
-040	2.999- 3.004	76.17 - 76.30	2.864- 2.869	72.75 - 72.87
-041	3.124- 3.129	79.35 - 79.48	2.989- 2.994	75.92 - 76.05
-042	3.374- 3.379	85.70 - 85.83	3.239- 3.244	82.27 - 82.40
-043	3.624- 3.629	92.05 - 92.18	3.489- 3.494	88.62 - 88.75
-044	3.874- 3.879	98.40 - 98.53	3.739- 3.744	94.97 - 95.10
-045	4.124- 4.129	104.75 -104.88	3.989- 3.994	101.32 -101.45
-046	4.374- 4.379	111.10 -111.23	4.239- 4.244	107.67 -107.80
-047	4.624- 4.629	117.45 -117.58	4.489- 4.494	114.02 -114.15
-048	4.874- 4.879	123.80 -123.93	4.739- 4.744	120.37 -120.50
-049	5.124- 5.129	130.15 -130.28	4.989- 4.994	126.72 -126.85
-050	5.374- 5.379	136.50 -136.63	5.239- 5.244	133.07 -133.20
-102	--	--	.049- .054	1.24 - 1.37
-103	--	--	.081- .086	2.06 - 2.18
-104	--	--	.112- .117	2.84 - 2.97
-105	--	--	.143- .148	3.63 - 3.76

TABLE 5 - Standard Gland Dia's. (Cont.)

Gland and AS 568 Dash No.	Internal Pressure Application - Dia. A Inch	mm	External Pressure Application - Dia. B Inch	mm
-106	--	--	.174- .179	4.42 - 4.55
-107	--	--	.206- .211	5.23 - 5.36
-108	--	--	.237- .242	6.02 - 6.15
-109	--	--	.299- .304	7.59 - 7.72
-110	.563- .568	14.30 - 14.43	.362- .367	9.19 - 9.32
-111	.625- .630	15.88 - 16.00	.424- .429	10.77 - 10.90
-112	.688- .693	17.48 - 17.60	.487- .492	12.37 - 12.50
-113	.750- .755	19.05 - 19.18	.549- .554	13.94 - 14.07
-114	.813- .818	20.65 - 20.78	.612- .617	15.54 - 15.67
-115	.875- .880	22.22 - 22.35	.674- .679	17.12 - 17.25
-116	.938- .943	23.83 - 23.95	.737- .742	18.72 - 18.85
-117	1.000- 1.005	25.40 - 25.53	.799- .804	20.29 - 20.42
-118	1.063- 1.068	27.00 - 27.13	.862- .867	21.89 - 22.02
-119	1.125- 1.130	28.58 - 28.70	.924- .929	23.47 - 23.60
-120	1.188- 1.193	30.18 - 30.30	.987- .992	25.07 - 25.20
-121	1.250- 1.255	31.75 - 31.88	1.049- 1.054	26.64 - 26.77
-122	1.313- 1.318	33.35 - 33.48	1.112- 1.117	28.24 - 28.37
-123	1.375- 1.380	34.92 - 35.05	1.174- 1.179	29.82 - 29.95
-124	1.438- 1.443	36.53 - 36.65	1.237- 1.242	31.42 - 31.55
-125	1.500- 1.505	38.10 - 38.23	1.299- 1.304	32.99 - 33.12
-126	1.563- 1.568	39.70 - 39.83	1.362- 1.367	34.59 - 34.72
-127	1.625- 1.630	41.28 - 41.40	1.424- 1.429	36.17 - 36.30
-128	1.688- 1.693	42.88 - 43.00	1.487- 1.492	37.77 - 37.90
-129	1.750- 1.755	44.45 - 44.58	1.549- 1.554	39.34 - 39.47
-130	1.813- 1.818	46.05 - 46.18	1.612- 1.617	40.94 - 41.07
-131	1.875- 1.880	47.62 - 47.75	1.674- 1.679	42.52 - 42.65
-132	1.938- 1.943	49.23 - 49.35	1.737- 1.742	44.12 - 44.25
-133	2.000- 2.005	50.80 - 50.93	1.799- 1.804	45.69 - 45.82
-134	2.063- 2.068	52.40 - 52.53	1.862- 1.867	47.29 - 47.42
-135	2.126- 2.131	54.00 - 54.13	1.925- 1.930	48.90 - 49.02
-136	2.188- 2.193	55.58 - 55.70	1.987- 1.992	50.47 - 50.60
-137	2.251- 2.256	57.18 - 57.30	2.050- 2.055	52.07 - 52.20
-138	2.313- 2.318	58.75 - 58.88	2.112- 2.117	53.64 - 53.77
-139	2.376- 2.381	60.35 - 60.48	2.175- 2.180	55.24 - 55.37
-140	2.438- 2.443	61.93 - 62.05	2.237- 2.242	56.82 - 56.95
-141	2.501- 2.506	63.53 - 63.65	2.300- 2.305	58.42 - 58.55
-142	2.563- 2.568	65.10 - 65.23	2.362- 2.367	59.99 - 60.12
-143	2.626- 2.631	66.70 - 66.83	2.425- 2.430	61.60 - 61.72
-144	2.688- 2.693	68.28 - 68.40	2.487- 2.492	63.17 - 63.30
-145	2.751- 2.756	69.88 - 70.00	2.550- 2.555	64.77 - 64.90
-146	2.813- 2.818	71.45 - 71.58	2.612- 2.617	66.34 - 66.47
-147	2.876- 2.881	73.05 - 73.18	2.675- 2.680	67.94 - 68.07
-148	2.938- 2.943	74.63 - 74.75	2.737- 2.742	69.52 - 69.65
-149	3.001- 3.006	76.23 - 76.35	2.800- 2.805	71.12 - 71.25
-150	3.063- 3.068	77.80 - 77.93	2.862- 2.867	72.69 - 72.82
-151	3.188- 3.193	80.98 - 81.10	2.987- 2.992	75.87 - 76.00
-152	3.438- 3.443	87.33 - 87.45	3.237- 3.242	82.22 - 82.35
-153	3.688- 3.693	93.68 - 93.80	3.487- 3.492	88.57 - 88.70
-154	3.938- 3.943	100.03 -100.15	3.737- 3.742	94.92 - 95.05
-155	4.188- 4.193	106.38 -106.50	3.987- 3.992	101.27 -101.40
-156	4.438- 4.443	112.73 -112.85	4.237- 4.242	107.62 -107.75
-157	4.688- 4.693	119.08 -119.20	4.487- 4.492	113.97 -114.10

TABLE 5 - Standard Gland Dia's. (Cont.)

Gland and AS 568 Dash No.	Internal Pressure Application - Dia. A Inch	mm	External Pressure Application - Dia. B Inch	mm
-158	4.938- 4.943	125.43 -125.55	4.737- 4.742	120.32 -120.45
-159	5.188- 5.193	131.78 -131.90	4.987- 4.992	126.67 -126.80
-160	5.438- 5.443	138.13 -138.25	5.237- 5.242	133.02 -133.15
-161	5.688- 5.693	144.48 -144.60	5.487- 5.492	139.37 -139.50
-162	5.938- 5.943	150.83 -150.95	5.737- 5.742	145.72 -145.85
-163	6.188- 6.193	157.18 -157.30	5.987- 5.992	152.07 -152.20
-164	6.438- 6.443	163.53 -163.65	6.237- 6.242	158.42 -158.55
-165	6.688- 6.693	169.88 -170.00	6.487- 6.492	164.77 -164.90
-166	6.938- 6.943	176.23 -176.35	6.737- 6.742	171.12 -171.25
-167	7.188- 7.193	182.58 -182.70	6.987- 6.992	177.47 -177.60
-168	7.438- 7.443	188.93 -189.05	7.237- 7.242	183.82 -183.95
-169	7.688- 7.693	195.28 -195.40	7.487- 7.492	190.17 -190.30
-170	7.938- 7.943	201.63 -201.75	7.737- 7.742	196.52 -196.65
-171	8.188- 8.193	207.98 -208.10	7.987- 7.992	202.87 -203.00
-172	8.438- 8.443	214.33 -214.45	8.237- 8.242	209.22 -209.35
-173	8.688- 8.693	220.68 -220.80	8.487- 8.492	215.57 -215.70
-174	8.938- 8.943	227.03 -227.15	8.737- 8.742	221.92 -222.05
-175	9.188- 9.193	233.38 -233.50	8.987- 8.992	228.27 -228.40
-176	9.438- 9.443	239.73 -239.85	9.237- 9.242	234.62 -234.75
-177	9.688- 9.693	246.08 -246.20	9.487- 9.492	240.97 -241.10
-178	9.938- 9.943	252.43 -252.55	9.737- 9.742	247.32 -247.45
-201	--	--	.171- .176	4.34 - 4.47
-202	--	--	.234- .239	5.94 - 6.07
-203	--	--	.296- .301	7.52 - 7.65
-204	--	--	.359- .364	9.12 - 9.25
-205	.694- .699	17.63 - 17.75	.421- .426	10.69 - 10.82
-206	.757- .762	19.23 - 19.35	.484- .489	12.29 - 12.42
-207	.819- .824	20.80 - 20.93	.546- .551	13.87 - 14.00
-208	.882- .887	22.40 - 22.53	.609- .614	15.47 - 15.60
-209	.944- .949	23.98 - 24.10	.671- .676	17.04 - 17.17
-210	1.007- 1.012	25.58 - 25.70	.734- .739	18.64 - 18.77
-211	1.069- 1.074	27.15 - 27.28	.796- .801	20.22 - 20.35
-212	1.132- 1.137	28.75 - 28.88	.859- .864	21.82 - 21.95
-213	1.194- 1.199	30.33 - 30.45	.921- .926	23.39 - 23.52
-214	1.257- 1.262	31.93 - 32.05	.984- .989	24.99 - 25.12
-215	1.319- 1.324	33.50 - 33.63	1.046- 1.051	26.57 - 26.70
-216	1.382- 1.387	35.10 - 35.23	1.109- 1.114	28.17 - 28.30
-217	1.444- 1.449	36.68 - 36.80	1.171- 1.176	29.74 - 29.87
-218	1.507- 1.512	38.28 - 38.40	1.234- 1.239	31.34 - 31.47
-219	1.569- 1.574	39.85 - 39.98	1.296- 1.301	32.92 - 33.05
-220	1.632- 1.637	41.45 - 41.58	1.359- 1.364	34.52 - 34.65
-221	1.694- 1.699	43.03 - 43.15	1.421- 1.426	36.09 - 36.22
-222	1.757- 1.762	44.63 - 44.75	1.484- 1.489	37.69 - 37.82
-223	1.882- 1.887	47.80 - 47.93	1.609- 1.614	40.87 - 41.00
-224	2.007- 2.012	50.98 - 51.10	1.734- 1.739	44.04 - 44.17
-225	2.132- 2.137	54.15 - 54.28	1.859- 1.864	47.22 - 47.35
-226	2.257- 2.262	57.33 - 57.45	1.984- 1.989	50.39 - 50.52
-227	2.382- 2.387	60.50 - 60.63	2.109- 2.114	53.57 - 53.70
-228	2.507- 2.512	63.68 - 63.80	2.234- 2.239	56.74 - 56.87
-229	2.632- 2.637	66.85 - 66.98	2.359- 2.364	59.92 - 60.05
-230	2.757- 2.762	70.03 - 70.15	2.484- 2.489	63.09 - 63.22

TABLE 5 - Standard Gland Dia's. (Cont.)

Gland and AS 568 Dash No.	Internal Pressure Application - Dia. A Inch	mm	External Pressure Application - Dia. B Inch	mm
-231	2.882- 2.887	73.20 - 73.33	2.609- 2.614	66.27 - 66.40
-232	3.007- 3.012	76.38 - 76.50	2.734- 2.739	69.44 - 69.57
-233	3.132- 3.137	79.55 - 79.68	2.859- 2.864	72.62 - 72.75
-234	3.257- 3.262	82.73 - 82.85	2.984- 2.989	75.79 - 75.92
-235	3.382- 3.387	85.90 - 86.03	3.109- 3.114	78.97 - 79.10
-236	3.507- 3.512	89.08 - 89.20	3.234- 3.239	82.14 - 82.27
-237	3.632- 3.637	92.25 - 92.38	3.359- 3.364	85.32 - 85.45
-238	3.757- 3.762	95.43 - 95.55	3.484- 3.489	88.49 - 88.62
-239	3.882- 3.887	98.60 - 98.73	3.609- 3.614	91.67 - 91.80
-240	4.007- 4.012	101.78 -101.90	3.734- 3.739	94.84 - 94.97
-241	4.132- 4.137	104.95 -105.08	3.859- 3.864	98.02 - 98.15
-242	4.257- 4.262	108.13 -108.25	3.984- 3.989	101.19 -101.32
-243	4.382- 4.387	111.30 -111.43	4.109- 4.114	104.37 -104.50
-244	4.507- 4.512	114.48 -114.60	4.234- 4.239	107.54 -107.67
-245	4.632- 4.637	117.65 -117.78	4.359- 4.364	110.72 -110.85
-246	4.757- 4.762	120.83 -120.95	4.484- 4.489	113.89 -114.02
-247	4.882- 4.887	124.00 -124.13	4.609- 4.614	117.07 -117.20
-248	5.007- 5.012	127.18 -127.30	4.734- 4.739	120.24 -120.37
-249	5.132- 5.137	130.35 -130.48	4.859- 4.864	123.42 -123.55
-250	5.257- 5.262	133.53 -133.65	4.984- 4.989	126.59 -126.72
-251	5.382- 5.387	136.70 -136.83	5.109- 5.114	129.77 -129.90
-252	5.507- 5.512	139.88 -140.00	5.234- 5.239	132.94 -133.07
-253	5.632- 5.637	143.05 -143.18	5.359- 5.364	136.12 -136.25
-254	5.757- 5.762	146.23 -146.35	5.484- 5.489	139.29 -139.42
-255	5.882- 5.887	149.40 -149.53	5.609- 5.614	142.47 -142.60
-256	6.007- 6.012	152.58 -152.70	5.734- 5.739	145.64 -145.77
-257	6.132- 6.137	155.75 -155.88	5.859- 5.864	148.82 -148.95
-258	6.257- 6.262	158.93 -159.05	5.984- 5.989	151.99 -152.12
-259	6.507- 6.512	165.28 -165.40	6.234- 6.239	158.34 -158.47
-260	6.757- 6.762	171.63 -171.75	6.484- 6.489	164.69 -164.82
-261	7.007- 7.012	177.98 -178.10	6.734- 6.739	171.04 -171.17
-262	7.257- 7.262	184.33 -184.45	6.984- 6.989	177.39 -177.52
-263	7.507- 7.512	190.68 -190.80	7.234- 7.239	183.74 -183.87
-264	7.757- 7.762	197.03 -197.15	7.484- 7.489	190.09 -190.22
-265	8.007- 8.012	203.38 -203.50	7.734- 7.739	196.44 -196.57
-266	8.257- 8.262	209.73 -209.85	7.984- 7.989	202.79 -202.92
-267	8.507- 8.512	216.08 -216.20	8.234- 8.239	209.14 -209.27
-268	8.757- 8.762	222.43 -222.55	8.484- 8.489	215.49 -215.62
-269	9.007- 9.012	228.78 -228.90	8.734- 8.739	221.84 -221.97
-270	9.257- 9.262	235.13 -235.25	8.984- 8.989	228.19 -228.32
-271	9.507- 9.512	241.48 -241.60	9.234- 9.239	234.54 -234.67
-272	9.757- 9.762	247.83 -247.95	9.484- 9.489	240.89 -241.02
-273	10.007-10.012	254.18 -254.30	9.734- 9.739	247.24 -247.37
-274	10.257-10.262	260.53 -260.65	9.984- 9.989	253.59 -253.72
-275	10.757-10.762	273.23 -273.35	10.484-10.489	266.29 -266.42
-276	11.257-11.262	285.93 -286.05	10.984-10.989	278.99 -279.12
-277	11.757-11.762	298.63 -298.75	11.484-11.489	291.69 -291.82
-278	12.257-12.262	311.33 -311.45	11.984-11.989	304.39 -304.52
-279	13.257-13.262	336.73 -336.85	12.984-12.989	329.79 -329.92
-280	14.257-14.262	362.13 -362.25	13.984-13.989	355.19 -355.32
-281	15.257-15.262	387.53 -387.65	14.984-14.989	380.59 -380.72