AEROSPACE STANDARD

AS6235™	REV. B
Issued 2014-09 Revised 2021-11 Superseding AS6235A	

(R) Face Seal Gland Design, Static, O-Ring and Other Seals for Aerospace Hydraulic and Pneumatic Applications

RATIONALE

AS6235 has been revised from Revision A to Revision B to:

- Reduce the groove edge breaks for pressures over 3000 psi (20690 kPa) to be similar to those in AS4716.
- Make some editorial improvements.
- Update references.
- Delete Appendices A, B, C, and E and include them in AIR7358; rename previous Appendix D to Appendix A herein.

FOREWORD

The methodology for calculating gland dimensions in this document differs from other face seal specifications by using a more scientific approach. The glands in this document are for static face seals and have been specifically designed for aerospace fluid power applications using actual data obtained from testing for the specific elastomer materials and fluids included.

The groove depths have been sized using standard O-rings to AS568 with associated Class 2 tolerances, to provide sufficient squeeze for effective sealing in line with AS5857, i.e., 10% minimum, but not exceed maximum squeeze of 25% before any swell and at ambient temperature. Further differences from other face seal gland specifications concern the groove diameters as follows:

a. For internal pressure applications, the groove major diameters have been determined by limiting cramping (diametric compression) to 1% of the O-ring OD based on O-ring nominal dimensions while under nominal squeeze.

b. For external pressure applications, the groove minor diameters have been determined by limiting diametric stretch to 5% of the O-ring ID based on O-ring nominal dimensions while under nominal squeeze.

Both these limitations are in line with common industry practice.

The gland volume occupancy has been calculated using volume swell and thermal expansion and is generally limited to 95% maximum. The O-ring volume swell while under compression (squeeze) uses calculations determined from a study presented to AMS-CE Committee.

The calculations use the combined characteristics of fluid volume swell and thermal expansion to result in the greatest increase in O-ring volume by each dash size.

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https://www.sae.org/standards/content/AS6235B/

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1. SCOPE

This SAE Aerospace Standard (AS) specifies standardized gland design criteria and dimensions for static face seals for internal pressure and external pressure applications for aerospace hydraulic and pneumatic applications using the same dash size range as AS4716 and AS5857 where applicable.

NOTE: Some small diameter sizes are excluded because they are not practical.

1.1 Field of Application

AS6235 glands have been specifically designed for applications using AS568 size elastomeric O-rings with related Class 2 tolerances at the nominal system operating pressures up to 3000 psi (20690 kPa) utilizing no anti-extrusion (backup rings) and in circular shapes.

NOTES:

1. This AS does not make any recommendations for non-circular shaped glands.
2. While the gland dimensions herein have been designed for pressures up to 3000 psi (20690 kPa) these glands may be used for higher pressures, but extra precautions need to be taken and testing should be performed to ensure the integrity of the performance of the glands.
3. This specification covers the basic design criteria and recommendations for use with standard size elastomeric O-rings; however, these glands are also suitable for use with other elastomeric and polytetrafluoroethylene (PTFE) based seal geometries.
4. The groove dimensions specified in this standard do not support the mounting interface patterns described in ARP490. The requirements of this standard shall not be applied to the seal grooves designed to ARP490 pattern recommendations.

2. REFERENCES

2.1 Applicable Documents

The following publications form a part of this document to the extent specified herein. The latest issue of SAE publications shall apply. The applicable issue of other publications shall be the issue in effect on the date of the purchase order. In the event of a conflict between the text of this document and references cited herein, the text of this document takes precedence. Nothing in this document, however, supersedes applicable laws and regulations unless a specific exemption has been obtained.

2.1.1 SAE Publications

Available from SAE International, 400 Commonwealth Drive, Warrendale, PA 15096-0001, Tel: 877-606-7323 (inside USA and Canada) or +1 724-776-4970 (outside USA), www.sae.org.

AMS-P-83461 Packing, Preformed, Petroleum Hydraulic Fluid Resistant, Improved Performance at 275 °F (135 °C)

AMS-R-83485 Rubber, Fluorocarbon Elastomer, Improved Performance at Low Temperatures

AIR7358 Calculations and Background Information Used to Generate AS6235

ARP490 Electrohydraulic Servovalves

AS568 Aerospace Size Standard for O-Rings

AS1241 Fire Resistant Phosphate Ester Hydraulic Fluid for Aircraft

AS4716 Gland Design, O-Ring and Other Seals

AS5857 Gland Design, O-Ring and Other Elastomeric Seals, Static Applications

2.1.2 U.S. Government Publications

Copies of these documents are available online at https://quicksearch.dla.mil/.

MIL-P-25732 Packing, Preformed, Petroleum Hydraulic Fluid Resistant, Limited Service at 275 °F (135 °C) (Inactive)

MIL-PRF-5606 Performance Specification: Hydraulic Fluid, Petroleum Base; Aircraft, Missile, and Ordnance

MIL-PRF-83282 Hydraulic Fluid, Fire Resistant; Low Temperature, Synthetic Hydrocarbon Base NATO Code Number H537

MIL-PRF-87257 Hydraulic Fluid, Fire Resistant; Low Temperature, Synthetic Hydrocarbon Base, Aircraft and Missile

2.1.3 ASME Publications

Available from ASME, P.O. Box 2900, 22 Law Drive, Fairfield, NJ 07007-2900, Tel: 800-843-2763 (U.S./Canada), 001-800-843-2763 (Mexico), 973-882-1170 (outside North America), www.asme.org.

ASME B46.1 Surface Texture (Surface Roughness, Waviness, and Lay)

2.1.4 NAS Publications

Available from Aerospace Industries Association, 1000 Wilson Boulevard, Suite 1700, Arlington, VA 22209-3928, Tel: 703-358-1000, www.aia-aerospace.org.

NAS1613 Packing, Preformed, Ethylene Propylene Rubber

2.1.5 ISO Publications

Copies of these documents are available online at http://webstore.ansi.org/.

ISO 4287-1 Geometrical Product Specifications (GPS) - Surface Texture: Profile Method - Terms, Definitions and Surface Texture Parameters

2.2 Definitions

GLAND: This is the assembly of the component with a recess to contain the sealing element and the adjoining flat pressure-retaining plate in close contact with it.

GROOVE: This is the recess machined in one component that contains the sealing element.

NOTE: The terms gland and groove are not interchangeable in this document. Sections 4.1 and 5.1 explain their usage.

RACE-TRACK: The shape adopted by the O-ring cross-section when installed into the groove and squeezed axially (i.e., not the molded circular cross-section).

2.2.1 Internal and External Pressure Applications

The configuration of the seal and the placement of the seal within the gland depends on the direction of pressure. The axial seals may be pressurized from a source located within the seal's inner diameter (internal pressure application) or from a pressure source located outside the outer diameter of the seal (external pressure application). See Figures 1 and 2, respectively.

3. LIMITATIONS

The design criteria and standard glands outlined in this document are intended for use in static applications with AS568 O-ring dash sizes and the range of dash sizes was selected to be essentially the same as those listed in AS4716 except for some small sizes that are not practical and are therefore omitted.

4. GLAND CONFIGURATION

4.1 General

This document depicts groove depths similar to AS5857 in order to achieve a minimum squeeze level of 10% and radial widths similar to those for no backup rings to AS4716 to achieve acceptable gland occupancies. Some of the smaller dash sizes have a gland occupancy of more than 95%, but in no case is a gland occupancy of 100% exceeded. The glands are sized by diameter and referenced using AS568 O-ring dash sizes. The glands are intended to be closed to protect seals from any possible flow erosion; however, there are certain exceptions - see Note 1 in 4.2 (following Figure 3).

At operating pressures exceeding 3000 psi (20690 kPa), there is a greater risk of deflection of the flat mating surfaces and/or extension of the retaining bolts resulting in an extrusion gap.

Every precaution should be taken to ensure the integrity of the hardware under pressurized conditions including overpressure during impulse testing. The flatness of the mating faces comprising the gland(s) is of high importance and designs should ensure that the extrusion gap presented by any variation of the surfaces from the flat is maintained at a minimum to ensure the integrity of seal performance. Testing should be performed to ensure satisfactory performance.

The glands have been designed to also permit the use of alternate seal configurations where an extrusion gap may be realized, in which case, each application should be tested to ensure satisfactory performance.

4.2 Gland Details

Details for the standard gland design including break edge requirements are depicted in Figures 1 and 2.

NOTE: The dimensions used in Figure 1 through 3 are listed below:

ØA Groove OD for internal pressure applications

ØB Groove ID for external pressure applications

G Groove radial width

L Groove depth

R Groove radius

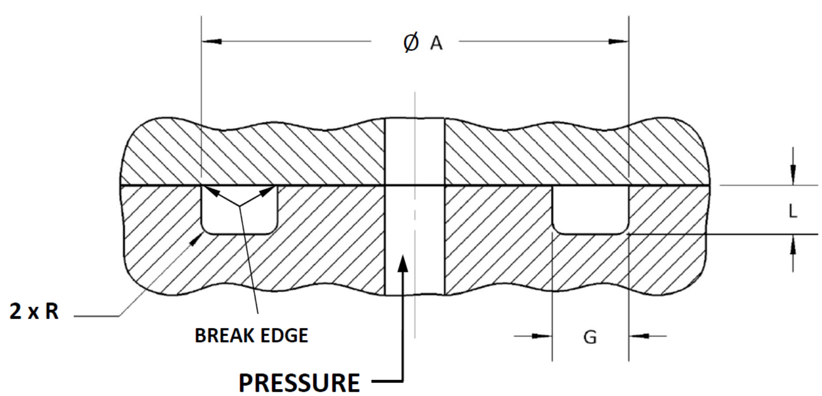


Figure 1 - Gland details - internal pressure applications

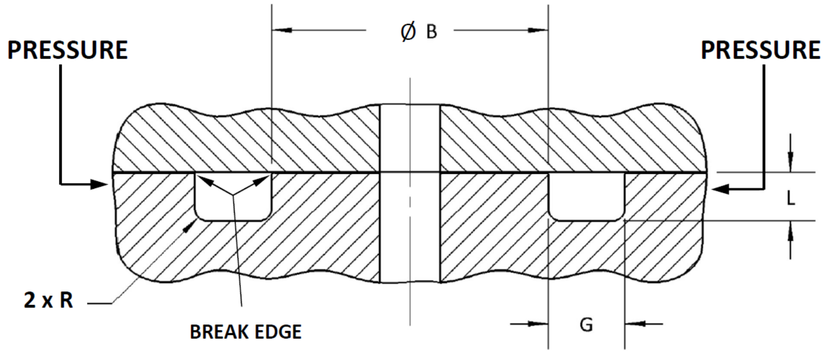


Figure 2 - Gland details - external pressure applications

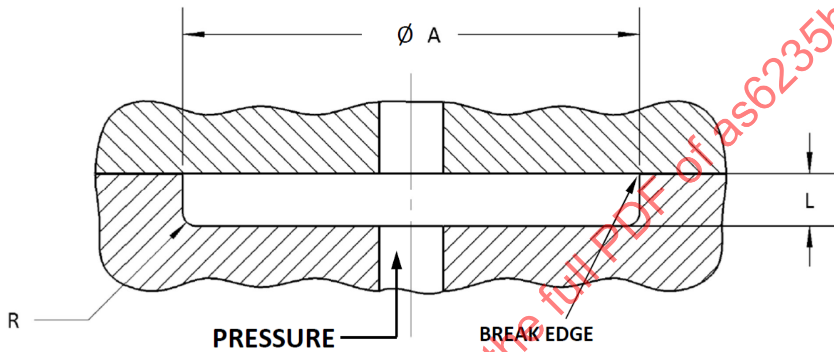


Figure 3 - Gland details - internal pressure applications

NOTES:

1. Glands for internal pressure applications to Figure 3 are generally not recommended; gland designs to Figure 1 protect the seal against any flow erosion and are required unless the seal is designed with a metal or suitable high modulus plastic internal protecting component.

2. Some internal pressure seal designs incorporate a metal or high modulus plastic component on the ID to prevent flow erosion, in which case grooves to Figure 3 may be used.

3. External pressure applications should also use closed glands to protect seals from the environment unless there is a separate component to protect the seal OD.

4. Seals using these gland configurations should be tested to prove suitability.

4.3 Dimensions

For the dash sizes listed, the dimensions and surface finish requirements in Table 1 and Tables 4 through 8 are similar to those in AS4716 and/or AS5857 for no backup width glands and are calculated to achieve a design goal of 95% maximum gland occupancy including volume swell plus thermal expansion to 275 °F (135 °C). Some of the smaller dash sizes have a gland occupancy in excess of 95% in order to maintain consistency of gland depths and gland widths throughout a series range; however, none of the glands has an occupancy of more than 100% under these conditions.

4.4 Volume Swell and Thermal Expansion Considerations

The volume swell while under compression has been the subject of testing, which provides the following equation:

$$\text{Volume Swell \%} = 1.958 + (0.648 \times V) - (0.0156 \times V \times S) \quad \text{(Eq. 1)}$$

where:

V = free-volume change in fluid (from material data sheets)

S = % squeeze in the gland

NOTE: The volume swell resulting from Equation 1 is a whole number.

The minimum O-ring axial squeeze at the ambient temperature of 75 °F (24 °C) to this standard is 10% per AS5857. Since the O-ring volume swell decreases as squeeze is increased, 10% squeeze will render the greatest volume swell. Where O-ring cross-section tolerances are at the maximum and groove depths are at the minimum, these circumstances will generate maximum squeeze and hence will generate the lowest volume swell. The set of circumstances found to generate the largest O-ring volume is with the O-ring dimensions on maximum and the groove depth on maximum (refer to AIR7358 Section A.2).

The swell and the coefficient of thermal expansion (CTE) combinations are based on using the following elastomers and fluids:

- NAS1613 elastomer in high and low-density phosphate ester fluids to AS1241.
- MIL-P-25732, AMS-P-83461, AMS-R-83485 elastomers all in MIL-PRF-5606, MIL-PRF-83282, and MIL-PRF-87257 fluids.

See details of elastomer swell and physical properties in AIR7358 Appendix D.

It should be noted that for calculation purposes it is essential to use the particular elastomer that has a combination of the greatest O-ring volume swell and volume thermal expansion. To use the greatest volume swell from all the fluid/elastomer tests and then use a different elastomer that has the greatest thermal expansion is a false set of circumstances.

The elastomer to produce the greatest increase in volume from the total of its discrete fluid volume swell and thermal expansion is AMS-P-83461 NBR elastomer tested in MIL-PRF-5606 for 70 hours at 275 °F (135 °C) resulting in a free swell of 16.3% and a CTE of 1.13 x 10^{-4} in/in/°F (2.03 x 10^{-4} mm/mm/°C).

A specific exclusion from this specification is all fluorosilicone elastomers. Due to a typical high CTE, this material type is not suitable for use in grooves to this specification if used at the maximum operating temperature of that material that is typically in the region of 350 °F (177 °C).

NOTES:

1. Where the squeeze is increased and/or the known swell and linear coefficient of thermal expansion for an alternate material exceed the limits stated above, the calculations shown in AIR7358 Appendix A should be followed to calculate the minimum radial gland width required to achieve the maximum volume occupancy of 95%. See the Digital Annex A of this document (Excel spreadsheet file) which may also be used to perform this calculation.

2. No accommodation has been made for thermal expansion or contraction of hardware.

The hardware dimensions that affect seal performance through temperature variation are principally the groove depths. At a low temperature, the seal material will shrink producing a loss in the squeeze. However, as the hardware will also shrink, the effect will not be quite so severe. Similarly, as the temperature increases the seal will expand, thereby increasing squeeze. However, as the hardware will also expand, the effect similarly will not be quite so severe. Since various materials are used for hardware, it is not possible to account for every material used for hardware; therefore, to take the worst possible case, no account is made for thermal effects of hardware dimensions in this standard.

5. GROOVE DETAILS

5.1 Groove Diameters

5.1.1 Internal Pressure Applications

The groove major diameter ØA is calculated as the O-ring nominal OD. However, when squeezed axially, the O-ring cross-section adopts a "race-track" shape. Assuming the mean diameter of a squeezed O-ring remains the same as that of the O-ring in a free condition, there will be an increase in the OD and, therefore, an interference fit of the O-ring OD within the groove major diameter (OD) ØA. In line with industry general practice, this specification limits the interference fit (cramping) to a maximum of 1% of the O-ring nominal OD.

To maintain gland occupancy below 100%, the groove major diameters for -008 and -009 have been increased as follows:

- -008 dash size ØA increased by 0.003 inch (0.08 mm).
- -009 dash size ØA increased by 0.001 inch (0.03 mm).

The following tolerances are then applied:

a. For diameters up to and including 3.010 inches (76.45 mm): +0.000/-0.006 inch (+0.00/-0.15 mm).

b. For diameters above 3.010 inches (76.45 mm): +0.000/-0.010 inch (+0.00/-0.25 mm).

5.1.2 External Pressure Applications

The groove minor diameter ØB is calculated as the O-ring nominal ID. However, when squeezed axially, the O-ring cross-section adopts a race-track shape. Assuming the mean diameter of a squeezed O-ring remains the same as that of the O-ring in a free condition, there will be a decrease in the ID and, therefore, an interference fit of the O-ring ID within the groove minor diameter ØB. In line with industry general practice, this specification limits the interference fit (stretch) to a maximum of 5% of the O-ring nominal ID.

The following tolerances are then applied:

a. For diameters up to and including 3.000 inches (76.20 mm): +0.006/-0.000 inch (+0.15/-0.00 mm)

b. For diameters above 3.000 inches (76.20 mm): +0.010/-0.000 inch (+0.25/-0.00 mm)

c. The groove diameters for internal pressure and external pressure applications are listed in Table 1.

5.2 Tabulation of Groove Dimensions and O-ring Volume Occupancies

The groove major diameters ØA and minor diameters ØB (see Figures 1 and 2 as applicable) and maximum volume occupancies are listed in Table 1.

Table 1 - Standard groove diameters and maximum gland occupancies for internal and external pressure applications

Gland and AS568 Dash No.	Inches		Millimeters		Maximum Gland Occupancy	
	Groove ØA Internal Pressure Max Min	Groove ØB External Pressure Min Max	Groove ØA Internal Pressure Max Min	Groove ØB External Pressure Min Max	Internal Pressure Gland	External Pressure Gland
006	-	0.107	-	2.72	-	84.05%
		0.112		2.85		
007	-	0.140	-	3.56	-	82.91%
		0.145		3.68		
008	0.328	0.173	8.33	4.39	98.58%	82.94%
	0.323	0.178	8.20	4.52		
009	0.357	0.206	9.07	5.23	99.25%	83.25%
	0.352	0.211	8.94	5.36		
010	0.387	0.239	9.83	6.07	98.77%	83.24%
	0.382	0.244	9.70	6.20		
011	0.448	0.301	11.38	7.65	97.21%	84.06%
	0.443	0.306	11.25	7.77		
012	0.511	0.364	12.98	9.25	95.87%	84.66%
	0.506	0.369	12.85	9.37		
013	0.572	0.426	14.53	10.82	95.10%	85.11%
	0.567	0.431	14.40	10.95		
014	0.634	0.489	16.10	12.42	94.49%	85.48%
	0.629	0.494	15.98	12.55		
015	0.696	0.551	17.68	14.00	94.16%	86.04%
	0.691	0.556	17.55	14.12		
016	0.758	0.614	19.25	15.60	94.03%	86.50%
	0.753	0.619	19.13	15.72		
017	0.820	0.676	20.83	17.17	93.55%	86.66%
	0.815	0.681	20.70	17.30		
018	0.882	0.739	22.40	18.77	93.26%	86.80%
	0.877	0.744	22.28	18.90		
019	0.943	0.801	23.95	20.35	93.02%	86.92%
	0.938	0.806	23.83	20.47		
020	1.006	0.864	25.55	21.95	92.71%	87.02%
	1.001	0.869	25.43	22.07		

Table 1 - Standard groove diameters and maximum gland occupancies for internal and external pressure applications (continued)

Gland and AS568 Dash No.	Inches		Millimeters		Maximum Gland Occupancy	
	Groove ØA Internal Pressure Max Min	Groove ØB External Pressure Min Max	Groove ØA Internal Pressure Max Min	Groove ØB External Pressure Min Max	Internal Pressure Gland	External Pressure Gland
021	1.067	.926	27.10	23.52	92.53%	87.11%
	1.062	.931	26.98	23.65		
022	1.129	.989	28.68	25.12	92.46%	87.27%
	1.124	.994	28.55	25.25		
023	1.191	1.051	30.25	26.70	92.23%	87.34%
	1.186	1.056	30.12	26.82		
024	1.254	1.114	31.85	28.30	92.03%	87.40%
	1.249	1.119	31.73	28.42		
025	1.316	1.176	33.43	29.87	91.92%	87.52%
	1.311	1.181	33.30	30.00		
026	1.379	1.239	35.03	31.47	91.75%	87.56%
	1.374	1.244	34.90	31.60		
027	1.441	1.301	36.60	33.05	91.60%	87.61%
	1.436	1.306	36.47	33.17		
028	1.504	1.364	38.20	34.65	91.59%	87.77%
	1.499	1.369	38.08	34.77		

Table 1 - Standard groove diameters and maximum gland occupancies for internal and external pressure applications (continued)

Gland and AS568 Dash No.	Inches		Millimeters		Maximum Gland Occupancy	
	Groove ØA Internal Pressure Max Min	Groove ØB External Pressure Min Max	Groove ØA Internal Pressure Max Min	Groove ØB External Pressure Min Max	Internal Pressure Gland	External Pressure Gland
106	-	0.169 0.174	-	4.29 4.42	-	77.69%
107	-	0.202 0.207	-	5.13 5.26	-	78.10%
108	0.452 0.447	0.235 0.240	11.48 11.35	5.97 6.10	96.10%	78.21%
109	0.513 0.508	0.299 0.304	13.03 12.90	7.60 7.72	94.41%	78.74%
110	0.576 0.571	0.362 0.367	14.63 14.50	9.20 9.32	92.96%	79.46%
111	0.637 0.632	0.424 0.429	16.18 16.05	10.77 10.90	92.08%	80.02%
112	0.700 0.695	0.487 0.492	17.78 17.65	12.37 12.50	91.22%	80.47%
113	0.761 0.756	0.549 0.554	19.33 19.20	13.95 14.07	90.96%	81.08%
114	0.823 0.818	0.612 0.617	20.90 20.78	15.55 15.67	90.75%	81.59%
115	0.885 0.880	0.674 0.679	22.48 22.35	17.12 17.25	90.22%	81.81%
116	0.947 0.942	0.737 0.742	24.05 23.93	18.72 18.85	89.89%	82.00%
117	1.008 1.003	0.799 0.804	25.60 25.48	20.30 20.42	89.70%	82.26%
118	1.071 1.066	0.862 0.867	27.20 27.08	21.90 22.02	89.35%	82.40%
119	1.132 1.127	0.924 0.929	28.75 28.63	23.47 23.60	89.13%	82.52%
120	1.195 1.190	0.987 0.992	30.35 30.23	25.07 25.20	88.85%	82.63%

Table 1 - Standard groove diameters and maximum gland occupancies for internal and external pressure applications (continued)

Gland and AS568 Dash No.	Inches		Millimeters		Maximum Gland Occupancy	
	Groove ØA Internal Pressure Max Min	Groove ØB External Pressure Min Max	Groove ØA Internal Pressure Max Min	Groove ØB External Pressure Min Max	Internal Pressure Gland	External Pressure Gland
121	1.256	1.049	31.90	26.65	88.69%	82.73%
	1.251	1.054	31.78	26.77		
122	1.318	1.112	33.48	28.25	88.54%	82.82%
	1.313	1.117	33.35	28.37		
123	1.380	1.174	35.05	29.82	88.48%	83.03%
	1.375	1.179	34.93	29.95		
124	1.443	1.237	36.65	31.42	88.28%	83.09%
	1.438	1.242	36.53	31.55		
125	1.505	1.299	38.23	33.00	88.11%	83.16%
	1.500	1.304	38.10	33.12		
126	1.568	1.362	39.83	34.60	87.95%	83.21%
	1.563	1.367	39.70	34.72		
127	1.630	1.424	41.40	36.17	87.81%	83.26%
	1.625	1.429	41.28	36.30		
128	1.693	1.487	43.00	37.77	87.67%	83.31%
	1.688	1.492	42.88	37.90		
129	1.755	1.549	44.58	39.35	87.71%	83.50%
	1.750	1.554	44.45	39.47		
130	1.818	1.612	46.18	40.95	87.59%	83.54%
	1.813	1.617	46.05	41.07		
131	1.880	1.674	47.75	42.52	87.48%	83.57%
	1.875	1.679	47.63	42.65		
132	1.943	1.737	49.35	44.12	87.37%	83.60%
	1.938	1.742	49.23	44.25		
133	2.005	1.799	50.93	45.70	87.28%	83.63%
	2.000	1.804	50.80	45.82		
134	2.068	1.862	52.53	47.30	87.19%	83.66%
	2.063	1.867	52.40	47.42		
135	2.131	1.925	54.13	48.90	87.19%	83.77%
	2.126	1.930	54.00	49.02		

Table 1 - Standard groove diameters and maximum gland occupancies for internal and external pressure applications (continued)

Gland and AS568 Dash No.	Inches		Millimeters		Maximum Gland Occupancy	
	Groove ØA Internal Pressure Max Min	Groove ØB External Pressure Min Max	Groove ØA Internal Pressure Max Min	Groove ØB External Pressure Min Max	Internal Pressure Gland	External Pressure Gland
136	2.193 2.188	1.987 1.992	55.70 55.58	50.47 50.60	87.11%	83.79%
137	2.256 2.251	2.050 2.055	57.30 57.18	52.07 52.20	87.03%	83.81%
138	2.318 2.313	2.112 2.117	58.88 58.75	53.65 53.77	86.96%	83.83%
139	2.381 2.376	2.175 2.180	60.48 60.35	55.25 55.37	86.89%	83.85%
140	2.443 2.438	2.237 2.242	62.05 61.93	56.82 56.95	86.82%	83.87%
141	2.506 2.501	2.300 2.305	63.65 63.53	58.42 58.55	86.87%	83.99%
142	2.568 2.563	2.362 2.367	65.23 65.10	60.00 60.12	86.81%	84.00%
143	2.631 2.626	2.425 2.430	66.83 66.70	61.60 61.72	86.75%	84.01%
144	2.693 2.688	2.487 2.492	68.40 68.28	63.17 63.30	86.69%	84.02%
145	2.756 2.751	2.550 2.555	70.00 69.88	64.77 64.90	86.64%	84.03%
146	2.818 2.813	2.612 2.617	71.58 71.45	66.35 66.47	86.59%	84.04%
147	2.881 2.876	2.675 2.68	73.18 73.05	67.95 68.07	86.61%	84.11%
148	2.943 2.938	2.737 2.742	74.75 74.63	69.52 69.65	86.56%	84.12%
149	3.006 3.001	2.800 2.805	76.35 76.23	71.12 71.25	86.51%	84.13%

Table 1 - Standard groove diameters and maximum gland occupancies for internal and external pressure applications (continued)

Gland and AS568 Dash No.	Inches		Millimeters		Maximum Gland Occupancy	
	Groove ØA Internal Pressure Max Min	Groove ØB External Pressure Min Max	Groove ØA Internal Pressure Max Min	Groove ØB External Pressure Min Max	Internal Pressure Gland	External Pressure Gland
210	1.019	0.734	25.88	18.64	91.58%	82.05%
	1.014	0.739	25.76	18.77		
211	1.080	0.796	27.43	20.22	91.25%	82.25%
	1.075	0.801	27.31	20.35		
212	1.143	0.859	29.03	21.82	90.85%	82.43%
	1.138	0.864	28.91	21.95		
213	1.204	0.921	30.58	23.39	90.60%	82.59%
	1.199	0.926	30.46	23.52		
214	1.266	0.984	32.16	24.99	90.37%	82.74%
	1.261	0.989	32.03	25.12		
215	1.328	1.046	33.73	26.57	90.09%	82.87%
	1.323	1.051	33.60	26.70		
216	1.390	1.109	35.31	28.17	90.06%	83.12%
	1.385	1.114	35.18	28.30		
217	1.451	1.171	36.86	29.74	89.90%	83.21%
	1.446	1.176	36.73	29.87		
218	1.514	1.234	38.46	31.34	89.68%	83.31%
	1.509	1.239	38.33	31.47		
219	1.575	1.296	40.01	32.92	89.54%	83.39%
	1.570	1.301	39.88	33.05		
220	1.638	1.359	41.61	34.52	89.36%	83.47%
	1.633	1.364	41.48	34.65		
221	1.699	1.421	43.16	36.09	89.25%	83.54%
	1.694	1.426	43.03	36.22		
222	1.762	1.484	44.76	37.69	89.25%	83.76%
	1.757	1.489	44.63	37.82		
223	1.887	1.609	47.93	40.87	88.96%	83.86%
	1.882	1.614	47.80	41.00		

Table 1 - Standard groove diameters and maximum gland occupancies for internal and external pressure applications (continued)

Gland and AS568 Dash No.	Inches		Millimeters		Maximum Gland Occupancy	
	Groove ØA Internal Pressure Max Min	Groove ØB External Pressure Min Max	Groove ØA Internal Pressure Max Min	Groove ØB External Pressure Min Max	Internal Pressure Gland	External Pressure Gland
224	2.012 2.007	1.734 1.739	51.11 50.98	44.04 44.17	88.71%	83.95%
225	2.137 2.132	1.859 1.864	54.28 54.15	47.22 47.35	88.62%	84.16%
226	2.262 2.257	1.984 1.989	57.46 57.33	50.39 50.52	88.42%	84.23%
227	2.387 2.382	2.109 2.114	60.63 60.50	53.57 53.70	88.24%	84.28%
228	2.512 2.507	2.234 2.239	63.81 63.68	56.74 56.87	88.15%	84.41%
229	2.637 2.632	2.359 2.364	66.98 66.85	59.92 60.05	88.01%	84.45%
230	2.762 2.757	2.484 2.489	70.16 70.03	63.09 63.22	87.87%	84.49%
231	2.887 2.882	2.609 2.614	73.33 73.20	66.27 66.40	87.75%	84.52%
232	3.012 3.002	2.734 2.739	76.51 76.25	69.44 69.57	87.92%	84.67%
233	3.137 3.127	2.859 2.864	79.68 79.43	72.62 72.75	87.81%	84.70%
234	3.262 3.252	2.984 2.989	82.86 82.60	75.79 75.92	87.71%	84.72%
235	3.387 3.377	3.109 3.119	86.03 85.78	78.97 79.22	87.61%	84.74%
236	3.512 3.502	3.234 3.244	89.21 88.95	82.14 82.40	87.52%	84.76%
237	3.637 3.627	3.359 3.369	92.38 92.13	85.32 85.57	87.44%	84.78%
238	3.762 3.752	3.484 3.494	95.56 95.30	88.49 88.75	87.37%	84.80%

Table 1 - Standard groove diameters and maximum gland occupancies for internal and external pressure applications (continued)

Gland and AS568 Dash No.	Inches		Millimeters		Maximum Gland Occupancy	
	Groove ØA Internal Pressure Max Min	Groove ØB External Pressure Min Max	Groove ØA Internal Pressure Max Min	Groove ØB External Pressure Min Max	Internal Pressure Gland	External Pressure Gland
239	3.887 3.877	3.609 3.619	98.73 98.48	91.70 91.92	87.39%	84.90%
240	4.012 4.002	3.734 3.744	101.90 101.65	94.84 95.10	87.32%	84.92%
241	4.137 4.127	3.859 3.869	105.08 104.83	98.02 98.27	87.26%	84.93%
242	4.262 4.252	3.984 3.994	108.26 108.00	101.19 101.45	87.20%	84.94%
243	4.387 4.377	4.109 4.119	111.43 111.18	104.37 104.62	87.14%	84.95%
244	4.512 4.502	4.234 4.244	114.61 114.35	107.54 107.80	87.12%	85.00%
245	4.637 4.627	4.359 4.369	117.78 117.53	110.72 110.97	87.07%	85.00%
246	4.762 4.752	4.484 4.494	120.96 120.70	113.89 114.15	87.02%	85.01%
247	4.887 4.877	4.609 4.619	124.13 123.88	117.07 117.32	86.98%	85.02%

Table 1 - Standard groove diameters and maximum gland occupancies for internal and external pressure applications (continued)

Gland and AS568 Dash No.	Inches		Millimeters		Maximum Gland Occupancy	
	Groove ØA Internal Pressure Max Min	Groove ØB External Pressure Min Max	Groove ØA Internal Pressure Max Min	Groove ØB External Pressure Min Max	Internal Pressure Gland	External Pressure Gland
325	1.899 1.894	1.475 1.480	48.24 48.11	37.47 37.59	89.67%	82.37%
326	2.023 2.018	1.600 1.605	51.38 51.26	40.64 40.77	89.37%	82.53%
327	2.147 2.142	1.725 1.730	54.53 54.41	43.82 43.94	89.12%	82.67%
328	2.270 2.265	1.850 1.855	57.66 57.53	46.99 47.12	88.94%	82.80%
329	2.395 2.390	1.975 1.980	60.83 60.71	50.17 50.29	88.81%	83.03%
330	2.520 2.515	2.100 2.105	64.01 63.88	53.34 53.47	88.59%	83.12%
331	2.645 2.640	2.225 2.230	67.18 67.06	56.52 56.64	88.39%	83.21%
332	2.770 2.765	2.350 2.355	70.36 70.23	59.69 59.82	88.21%	83.28%
333	2.895 2.890	2.475 2.480	73.53 73.41	62.87 62.99	88.11%	83.41%
334	3.020 3.010	2.600 2.605	76.71 76.45	66.04 66.17	88.13%	83.48%
335	3.145 3.135	2.725 2.730	79.88 79.63	69.22 69.34	87.98%	83.53%
336	3.270 3.260	2.850 2.855	83.06 82.8	72.39 72.52	87.85%	83.58%
337	3.395 3.385	2.975 2.980	86.23 85.98	75.57 75.69	87.84%	83.74%
338	3.520 3.510	3.100 3.110	89.40 89.15	78.74 78.99	87.72%	83.78%
339	3.645 3.635	3.225 3.235	92.58 92.33	81.92 82.17	87.61%	83.81%

Table 1 - Standard groove diameters and maximum gland occupancies for internal and external pressure applications (continued)

Gland and AS568 Dash No.	Inches		Millimeters		Maximum Gland Occupancy	
	Groove ØA Internal Pressure Max Min	Groove ØB External Pressure Min Max	Groove ØA Internal Pressure Max Min	Groove ØB External Pressure Min Max	Internal Pressure Gland	External Pressure Gland
340	3.770 3.760	3.350 3.360	95.76 95.50	85.09 85.34	87.51%	83.85%
341	3.895 3.885	3.475 3.485	98.93 98.68	88.27 88.52	87.42%	83.88%
342	4.020 4.010	3.600 3.610	102.11 101.85	91.44 91.69	87.42%	84.00%
343	4.145 4.135	3.725 3.735	105.28 105.03	94.62 94.87	87.34%	84.03%
344	4.270 4.260	3.850 3.860	108.46 108.20	97.79 98.04	87.26%	84.05%
345	4.395 4.385	3.975 3.985	111.63 111.38	100.97 101.22	87.19%	84.07%
346	4.520 4.510	4.100 4.110	114.81 114.55	104.14 104.39	87.12%	84.09%
347	4.645 4.635	4.225 4.235	117.98 117.73	107.32 107.57	87.09%	84.15%
348	4.770 4.760	4.350 4.360	121.16 120.90	110.49 110.74	87.03%	84.17%
349	4.895 4.885	4.475 4.485	124.33 124.08	113.67 113.92	86.97%	84.19%

Table 1 - Standard groove diameters and maximum gland occupancies for internal and external pressure applications (continued)

Gland and AS568 Dash No.	Inches		Millimeters		Maximum Gland Occupancy	
	Groove ØA Internal Pressure Max Min	Groove ØB External Pressure Min Max	Groove ØA Internal Pressure Max Min	Groove ØB External Pressure Min Max	Internal Pressure Gland	External Pressure Gland
425	5.025 5.015	4.475 4.485	127.64 127.38	113.67 113.92	84.96%	81.28%
426	5.150 5.140	4.600 4.610	130.81 130.56	116.84 117.09	84.89%	81.31%
427	5.275 5.265	4.725 4.735	133.99 133.73	120.02 120.27	84.82%	81.33%
428	5.400 5.390	4.850 4.860	137.16 136.91	123.19 123.44	84.76%	81.35%
429	5.525 5.515	4.975 4.985	140.34 140.08	126.37 126.62	84.77%	81.44%
430	5.650 5.640	5.100 5.110	143.51 143.26	129.54 129.79	84.71%	81.46%
431	5.775 5.765	5.225 5.235	146.69 146.43	132.71 132.97	84.65%	81.48%
432	5.900 5.890	5.350 5.360	149.86 149.61	135.89 136.14	84.60%	81.50%
433	6.025 6.015	5.475 5.485	153.04 152.78	139.07 139.32	84.55%	81.51%
434	6.150 6.140	5.600 5.610	156.21 155.96	142.24 142.49	84.50%	81.53%
435	6.275 6.265	5.725 5.735	159.39 159.13	145.42 145.67	84.45%	81.55%
436	6.400 6.390	5.850 5.860	162.56 162.31	148.59 148.84	84.41%	81.56%
437	6.525 6.515	5.975 5.985	165.74 165.48	151.77 152.02	84.37%	81.58%
438	6.775 6.765	6.225 6.235	172.09 171.83	158.12 158.37	84.32%	81.64%
439	7.025 7.015	6.475 6.485	178.44 178.18	164.47 164.72	84.25%	81.67%

Table 1 - Standard groove diameters and maximum gland occupancies for internal and external pressure applications (continued)

Gland and AS568 Dash No.	Inches		Millimeters		Maximum Gland Occupancy	
	Groove ØA Internal Pressure Max Min	Groove ØB External Pressure Min Max	Groove ØA Internal Pressure Max Min	Groove ØB External Pressure Min Max	Internal Pressure Gland	External Pressure Gland
440	7.275 7.265	6.725 6.735	184.79 184.53	170.82 171.07	84.18%	81.69%
441	7.525 7.515	6.975 6.985	191.14 190.88	177.17 177.42	84.11%	81.71%
442	7.775 7.765	7.225 7.235	197.49 197.23	183.52 183.77	84.11%	81.78%
443	8.025 8.015	7.475 7.485	203.84 203.58	189.87 190.12	84.05%	81.80%
444	8.275 8.265	7.725 7.735	210.19 209.93	196.22 196.47	83.99%	81.82%
445	8.525 8.515	7.975 7.985	216.54 216.28	202.57 202.82	83.94%	81.83%
454	13.025 13.015	12.475 12.485	330.84 330.58	316.87 317.12	83.46%	82.10%
455	13.525 13.515	12.975 12.985	343.54 343.28	329.57 329.82	83.42%	82.11%
456	14.025 14.015	13.475 13.485	356.24 355.98	342.27 342.52	83.44%	82.17%
457	14.525 14.515	13.975 13.985	368.94 368.68	354.97 355.22	83.40%	82.18%
458	15.025 15.015	14.475 14.485	381.64 381.38	367.67 367.92	83.36%	82.18%
459	15.525 15.515	14.975 14.985	394.34 394.08	380.37 380.62	83.33%	82.19%
460	16.025 16.015	15.475 15.485	407.04 406.78	393.07 393.32	83.29%	82.19%

NOTE: It can be seen from Table 1 that several of the small sizes exceed 95% maximum gland occupancy. However, the likelihood of actually achieving this limit in practice is extremely remote.

5.3 Groove Depths

It is desirable to maintain ambient squeeze no higher than 25% to avoid excessive compression set. A squeeze level of 25% at room temperature becomes over 30% squeeze at temperatures of 300 °F (150 °C) or higher. When this is coupled with the fall-off in critical strain-to-break of most rubber materials, this 30+% squeeze becomes dangerously close to the failure strain of the rubber at high temperatures. Therefore, this specification has an upper limit on O-ring squeeze of 25% at ambient temperature as shown in Table 2, yet maintains a minimum squeeze at ambient temperature of 10%, per AS5857. Table 2 also shows that the minimum squeeze at -65 °F (-54 °C) is maintained above the minimum recommendation of 5% (per AS4716) and for the 000 series only, minimally exceeds 25% squeeze with swell at 275 °F.

For reference, Table 2 also shows the maximum squeeze (%) for each O-ring cross-section when subjected to volume swell and thermal expansion.

Table 2 - Maximum and minimum squeeze levels at various temperature limits

O-Ring Series	Minimum Squeeze % -65 °F (-54 °C) (No Swell)	Minimum Squeeze % Ambient (No Swell)	Maximum Squeeze % Ambient (No Swell)	Maximum Squeeze % with Swell at 275 °F (135 °C)
000	9.01	10.45	23.29	27.97
100	8.55	10.00	18.87	23.83
200	8.93	10.37	18.18	23.18
300	8.80	10.24	17.21	22.27
400	8.59	10.04	16.73	21.82

The groove depth L for each O-ring cross-section has been calculated to ensure a minimum O-ring squeeze of 10% at ambient temperature using equation 2 below:

O-ring squeezed axial dimension = O-ring minimum cross-section x 0.9 (Eq. 2A)

O-ring squeezed axial dimension = Calculated Maximum Groove Depth L (Eq. 2B)

The groove depths L are then rounded down to the nearest 0.001 inch (0.03 mm) to ensure a minimum of 10% squeeze.

The following tolerances are then applied:

- Series 000, 100, 200: +0.000/-0.004 inch (+0.00/-0.10 mm)
- Series 300: +0.000/-0.006 inch (+0.00/-0.15 mm)
- Series 400: +0.000/-0.008 inch (+0.00/-0.20 mm)

It should be noted that as swell occurs while in a gland, the squeeze levels listed in Table 2 are valid provided the swell does not result in the O-ring coming into contact with both outer and inner diameters of the gland. Once this contact occurs the O-ring OD and ID surfaces are both subject to compression; therefore, the effective squeeze and internal stresses on the O-ring increas dramatically. As a result, further swell is thereby significantly restricted (Equation 1) and for the O-rings listed in Table 2 as exceeding 95% gland occupancy, the likelihood of actually achieving such high levels is remote.

Also, the likelihood of tolerances on both hardware and O-ring coinciding to produce maximum occupancy, although possible, is remote. The spread of possible Gland Occupancy % for the most critical 000 series is very wide. As an example, Table 3 shows the range of minimum, nominal, and maximum gland occupancies for a sample of the 000 series, i.e., -008, -013, -020, and -028 sizes for internal pressure applications . Although the goal was to achieve a maximum of 95% occupancy, the slightly excessive maximum possible occupancy for sizes dash 008 through dash 013, by virtue of the above explanation, is not a concern.

Table 3 - 000 series range of gland occupancies by varying component tolerances

Internal Pressure Applications					
			Gland Occupancy % with Swell & Thermal Expansion		
O-Ring & Gland Dash Size	Gland Maximum OD Inches	Gland Maximum OD Millimeters	Maximum Gland Volume Minimum O-Ring Volume	Nominal Gland Volume Nominal O-Ring Volume	Minimum Gland Volume Maximum O-Ring Volume
008	0.331	8.41	76.59%	85.34%	98.90%
013	0.572	14.53	72.61%	82.93%	95.10%
020	1.006	25.55	70.64%	81.27%	92.71%
028	1.504	38.20	69.92%	80.49%	91.59%

5.4 Groove Radial Width

The groove radial widths G are based on calculations per AIR7358 and generally use a maximum gland volume occupancy of 95%. The groove edge break volume is not included in the calculations. In some cases the groove widths are rounded down for practical and consistency reasons, but in no case does volume occupancy exceed 100%. Tables 4 and 5 list groove widths that are either per calculations, per rounded calculations, or the same as AS4716. For the -108 size for internal pressure, the maximum groove width of 0.146 inch (3.71 mm) is used in order to maintain the minimum inner gland wall thickness.

Table 4 - Groove cross-section dimensions for internal pressure applications

<table>
<tr><th rowspan="3">Gland and AS568 O-Ring Dash No.</th><th colspan="4">Internal Pressure Applications</th></tr>
<tr><th colspan="2">Inches</th><th colspan="2">Millimeters</th></tr>
<tr><th>Groove Width G Min Max</th><th>Groove Depth L Min Max</th><th>Groove Width G Min Max</th><th>Groove Depth L Min Max</th></tr>
<tr><td>008 thru 028</td><td>0.098
0.103</td><td>0.056
0.060</td><td>2.49
2.62</td><td>1.42
1.52</td></tr>
<tr><td>108</td><td>0.141
0.146</td><td rowspan="2">0.086
0.090</td><td>3.58
3.71</td><td rowspan="2">2.18
2.29</td></tr>
<tr><td>109 thru 149</td><td>0.141
0.151</td><td>3.58
3.84</td></tr>
<tr><td>210 thru 247</td><td>0.188
0.198</td><td>0.117
0.121</td><td>4.78
5.03</td><td>2.97
3.07</td></tr>
<tr><td>325 thru 349</td><td>0.281
0.291</td><td>0.178
0.184</td><td>7.14
7.39</td><td>4.52
4.67</td></tr>
<tr><td>425 thru 460</td><td>0.375
0.385</td><td>0.234
0.242</td><td>9.53
9.78</td><td>5.94
6.15</td></tr>
</table>

Table 5 - Groove cross-section dimensions for external pressure applications

Gland and AS568 O-Ring Dash No.	External Pressure Applications			
	Inches		Millimeters	
	Groove Width G Min Max	Groove Depth L Min Max	Groove Width G Min Max	Groove Depth L Min Max
006 thru 028	0.098 0.103	0.056 0.060	2.49 2.62	1.42 1.52
106 thru 149	0.141 0.151	0.086 0.090	3.58 3.84	2.18 2.29
210 thru 247	0.188 0.198	0.117 0.121	4.78 5.03	2.97 3.07
325 thru 349	0.281 0.291	0.178 0.184	7.14 7.39	4.52 4.67
425 thru 460	0.375 0.385	0.234 0.242	9.53 9.78	5.94 6.15

For gland dash sizes up to and including -109, the widths for zero backup grooves per AS5857 are larger than those per AS4716. For gland dash sizes -110 and above, the reverse is the case. The narrower groove widths per AS4716 are adopted throughout since space is always at a premium, but is more critical for smaller sizes.

A further reason is that historically, groove dimensions for specialist designs of face seals have been based on AS4716, which is a derivative of previous military specifcations. AS5857 is a more recent specification and while it is specifically for static seals, custom seal designs based on AS4716 dimensions and tolerances were already established within the industry with no reason to introduce designs based on AS5857.

For both internal pressure and external pressure applications, the limiting minimum O-ring ID was taken into account and was applied as 0.102 inch (2.59 mm) for series 000 O-rings and 0.153 inch (3.87 mm) for all series 100 and larger O-rings.

These limits were determined by assuming a minimum flow passage diameter of 0.062 inch (1.58 mm) and a supporting maximum groove wall thickness of 0.020 inch (0.51 mm) for series 000 O-rings and 0.030 inch (0.76 mm) for series 100 cross-section O-rings.

It is not necessary to apply such limitations to series 200, 300, and 400 O-rings as their inside diameters are much larger. Groove widths and depths by dash number are listed in Tables 4 and 5. Size -108 for internal pressure has a different groove width to the remainder of the 100 series sizes to maintain a groove ID with a minimum of 0.153 inch (3.89 mm).

5.5 Groove Corner Break Edge

The corner break edge requirements (see Figures 1 through 3) are per AS4716 and AS5857 and are listed in Table 6.

Table 6 - Groove break edge details

System Pressure		Groove Break Edge Requirements	
Pressure (psig)	Pressure (kPa)	Inches	Millimeters
≤3000	≤20690	0.005 + 0.005/-0.000	0.13 + 0.13/-0.00
>3000	>20690	0.002 + 0.005/-0.000	0.051 + 0.13/-0.00

5.6 Groove Corner Radii

The groove corner radii (see Figures 1 through 3) dimension R are per AS4716 and AS5857 and are listed in Table 7.

Table 7 - Groove standard corner radius dimensions

Gland and AS568 Dash No.	Inches		Millimeters	
	Corner Radius Maximum	Corner Radius Minimum	Corner Radius Maximum	Corner Radius Minimum
006 to 028	0.015	0.005	0.38	0.13
106 to 149	0.015	0.005	0.38	0.13
210 to 247	0.025	0.010	0.64	0.25
325 to 349	0.035	0.020	0.89	0.51
425 thru 460	0.035	0.020	0.89	0.51

5.7 Surface Finishes of Glands

The following surface finishes in Table 8 (indicated as surface roughness as defined in ASME B46.1 (ISO 4287-1) shall be used in glands containing O-ring and other elastomeric seals.

Table 8 - Surface roughness requirements

Surface within Gland	Surface Roughness Ra (µin) per ASME B46.1	Surface Roughness Ra (µm) per ISO 4287-1
Sealing Faces	16 (max) See Note	0.4 (max) See Note
O-ring Contact Diameter (Outer Diameter for Internal Pressure Type) (Inner Diameter for External Pressure Type)	32 (max)	0.8 (max)
O-ring Non-contact Diameter (Inner Diameter for Internal Pressure Type) (Outer Diameter for External Pressure Type)	63 (max)	1.6 (max)

NOTE: The optimum recommended roughness for dynamic applications is 4 to 12 µin (0.1 to 0.3 µm) Ra. The use of HVOF (high-velocity oxygenated fuel) coatings will require a 4 µin (0.1 µm) Ra (max) roughness with consideration to post-process super-finishing/polishing.

The sealing faces are the surface of the closing plate and the bottom of the groove, which are essentially parallel to each other and perpendicular to the flow port.

The gland surfaces must be free from all machining irregularities exceeding the above values. Gland edges shall be smooth and true and free of nicks, scratches, and burrs, etc.

6. NOTES

6.1 Metric Equivalents

The dimensions and properties in inch/pound/Fahrenheit units in this AS are the primary units; the dimensions and properties in SI units are shown as the approximate equivalents of the primary units and are presented only for information. When using the Excel files in the Digital Annex, although the metric spreadsheets can be observed, due to slight discrepancies in conversions it is recommended that the imperial data be regarded as the primary units for use in applications.

6.2 Revision Indicator

A change bar (l) located in the left margin is for the convenience of the user in locating areas where technical revisions, not editorial changes, have been made to the previous issue of this document. An (R) symbol to the left of the document title indicates a complete revision of the document, including technical revisions. Change bars and (R) are not used in original publications, nor in documents that contain editorial changes only.

PREPARED BY SAE A-6C2 SEALS COMMITTEE

APPENDIX A - DESCRIPTION OF THE DIGITAL ANNEX A

A.1 INTRODUCTION

The attached Digital Annex is an Excel file consisting of five worksheets with labels as follows:

a. Calculator

b. Internal Pressure Imperial

c. Internal Pressure Metric

d. External Pressure Imperial

e. External Pressure Metric

All worksheets are protected; however, worksheets b, c, d, and e do not have the cells' contents hidden, i.e., the user can see the construction of each cell for further reference.

A.1.1 Calculator

This worksheet is interactive with the other four worksheets. The layout consists of three separate blocks to permit results to be obtained for gland dimensions and tolerances in either inches or millimeters, minimum and maximum squeeze and gland occupancy:

- Per the AS6235 standard.
- For alternate elastomer materials.
- For non-standard O-rings.

A more detailed explanation is presented in Section A.2.

Note. The Technical Style Manual protocol of expressing inch dimensions less than one inch without a zero before the decimal point has NOT been followed in Sheet 1 (the Design Calculator) and a zero before the decimal for inch dimensions less than one inch is used. This is because it is not possible in Excel to change the format when switching from metric to inch dimensions.

A.1.2 Worksheets for Internal and External Pressure Applications in Imperial and Metric Units

Worksheets b and d are the worksheets used to calculate the gland dimensions used in AS6235 and as such are included as a record. Worksheets c and e are metric conversions of worksheets b and c, respectively, for information purposes. Because worksheets c and e are conversions, the calculations for groove widths may not tally entirely when converted back to inches and gland occupancies may also not tally. However, the accuracy of results in worksheets c and e are sufficiently close to be workable.

An additional row has been made to each worksheet to permit calculations for gland dimensions for non-standard O-ring dimensions and tolerances.

All four worksheets are protected; however, each cell reveals the calculation although no changes can be made.

A.2 INSTRUCTIONS ON THE USE OF THE CALCULATOR WORKSHEET

NOTES:

1. This worksheet can be printed for record purposes.
2. When using the Excel files in the Digital Annex, although the metric spreadsheets can be observed, because of slight discrepancies due to conversions it is recommended that the imperial data be regarded as the primary source for use in applications.

A.2.1 Major Choices

See Figure A1A for the explanation below.

Note that only the white cells can be changed. All results are in the yellow cells.

All cells other than the white cells are protected and cannot be changed by the user.

There are two fields to enter personal information; the user's name and project information.

The magenta cells indicating Y/N choices in their adjacent white cells cause other magenta cells to change to the appropriate heading parameter, e.g., changing Y to N in cell F6 will cause cell L6 to change to "Y", i.e., metric units and the CTE in cell P13 to change from in/in/°F to mm/mm/°C, cell P16 to change from °F to °C, and cells JK17 and P21 to change from INCHES to MILLIMETERS.

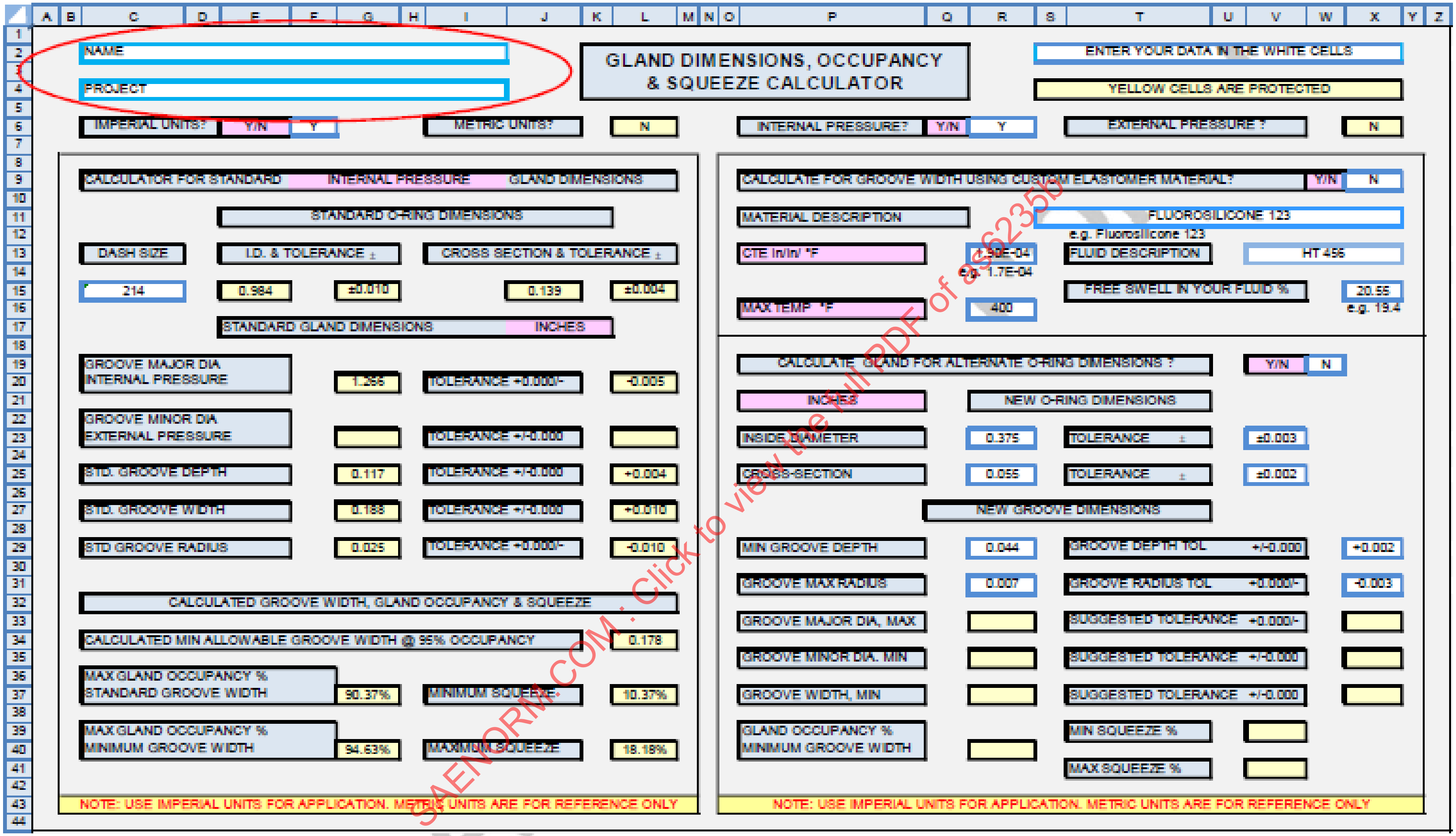
The current settings show the following choices:

We have chosen Imperial units (inches and °F), so cell F6 is set at "Y". To change this to metric units, click on the "Y" cell and a drop-down list arrow will appear. Click on the arrow and the list of Y and N will appear; to make your choice, click on "Y" or "N."

For example, we have chosen an internal pressure application, cell R6 indicating "Y". It will be noticed that yellow cells G23 and L23 are blank since these are results for external pressure applications and not pertinent to the current choice. If a choice of "N" in cell R6 is made, this will enable the external pressure application to replace the internal pressure application, consequently cell X6 will change to "Y" and cells F9 – I9 will change to "EXTERNAL PRESSURE". Also cells G20 and L20 would be blank and cells G23 and L23 would be populated.

The current choice for elastomer material is the AS6235 standard, indicated by "N" in cell X9 to NOT choose special elastomer characteristics.

We are not considering non-standard O-ring sizes and/or tolerances as indicated by "N" in cell W19.


GLAND DIMENSIONS, OCCUPANCY & SQUEEZE CALCULATOR
NAME
PROJECT
ENTER YOUR DATA IN THE WHITE CELLS
YELLOW CELLS ARE PROTECTED
IMPERIAL UNITS? Y/N Y
METRIC UNITS? N
INTERNAL PRESSURE? Y/N Y
EXTERNAL PRESSURE ? N
CALCULATOR FOR STANDARD INTERNAL PRESSURE GLAND DIMENSIONS
STANDARD O-RING DIMENSIONS
DASH SIZE
I.D. & TOLERANCE ±
CROSS SECTION & TOLERANCE ±
214
0.984
±0.010
0.139
±0.004
STANDARD GLAND DIMENSIONS INCHES
GROOVE MAJOR DIA INTERNAL PRESSURE 1.266 TOLERANCE +0.000/- -0.005
GROOVE MINOR DIA EXTERNAL PRESSURE TOLERANCE +/-0.000
STD. GROOVE DEPTH 0.117 TOLERANCE +/-0.000 +0.004
STD. GROOVE WIDTH 0.188 TOLERANCE +/-0.000 +0.010
STD GROOVE RADIUS 0.025 TOLERANCE +0.000/- -0.010
CALCULATED GROOVE WIDTH, GLAND OCCUPANCY & SQUEEZE
CALCULATED MIN ALLOWABLE GROOVE WIDTH @ 95% OCCUPANCY 0.178
MAX GLAND OCCUPANCY % STANDARD GROOVE WIDTH 90.37% MINIMUM SQUEEZE 10.37%
MAX GLAND OCCUPANCY % MINIMUM GROOVE WIDTH 94.63% MAXIMUM SQUEEZE 18.18%
NOTE: USE IMPERIAL UNITS FOR APPLICATION. METRIC UNITS ARE FOR REFERENCE ONLY
CALCULATE FOR GROOVE WIDTH USING CUSTOM ELASTOMER MATERIAL? Y/N N
MATERIAL DESCRIPTION FLUOROSILICONE 123
e.g. Fluorosilicone 123
CTE in/in/ °F 1.90E-04
e.g. 1.7E-04
FLUID DESCRIPTION HT 456
FREE SWELL IN YOUR FLUID % 20.55
e.g. 19.4
MAX TEMP °F 400
CALCULATE GLAND FOR ALTERNATE O-RING DIMENSIONS ? Y/N N
INCHES
NEW O-RING DIMENSIONS
INSIDE DIAMETER 0.375 TOLERANCE ± ±0.003
CROSS-SECTION 0.055 TOLERANCE ± ±0.002
NEW GROOVE DIMENSIONS
MIN GROOVE DEPTH 0.044 GROOVE DEPTH TOL +/-0.000 +0.002
GROOVE MAX RADIUS 0.007 GROOVE RADIUS TOL +0.000/- -0.003
GROOVE MAJOR DIA, MAX SUGGESTED TOLERANCE +0.000/-
GROOVE MINOR DIA, MIN SUGGESTED TOLERANCE +/-0.000
GROOVE WIDTH, MIN SUGGESTED TOLERANCE +/-0.000
GLAND OCCUPANCY % MINIMUM GROOVE WIDTH
MIN SQUEEZE %
MAX SQUEEZE %
NOTE: USE IMPERIAL UNITS FOR APPLICATION. METRIC UNITS ARE FOR REFERENCE ONLY