SAE Aerospace
An SAE International Group

AEROSPACE STANDARD

SAE AS4716

REV. A

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Superseding AS4716

(R) Gland Design, O-ring and Other Elastomeric Seals

1. SCOPE:

1.1 Scope:

This SAE Aerospace Standard (AS) provides standardized gland (groove) design criteria and dimensions for elastomeric seal glands for static and dynamic applications. The glands have been specifically designed for applications using SAE AS568 size O-rings, with related class 2 tolerances, at pressures exceeding 1500 psi (10,342 kPa) utilizing one or two anti-extrusion (backup) rings and applications at pressures under 1500 psi (10,342 kPa) without backup rings. The glands have been sized to provide sufficient squeeze for effective sealing while at the same time limiting squeeze to allow satisfactory operation in dynamic applications. While this specification covers the basic design criteria and recommendations for use with standard size O-rings, these glands are also suitable for use with other elastomeric, and polytetrafluoroethylene (PTFE) based seals and packings.

2. REFERENCES:

2.1 Applicable Documents:

The following publications form a part of this specification to the extent specified herein. The latest issue of all SAE Technical Reports shall apply.

TO PLACE A DOCUMENT ORDER:
Tel: 877-606-7323 (inside USA and Canada)
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2.1.1 SAE Publications: Available from SAE, 400 Commonwealth Drive, Warrendale, PA 15096-0001. Web site: http://www.sae.org or 724-776-4841

AS568	Aerospace Size Standard for O-rings
AS5781	Aerospace Standard, Retainers (Back-up Rings), Hydraulic and Pneumatic, Polytetrafluoroethylene Resin, Single Turn
AS5782	Aerospace Standard, Retainers (Back-up Rings), Hydraulic and Pneumatic, Polytetrafluoroethylene Resin, Solid Un-cut
AS8791	Aerospace Standard, Hydraulic and Pneumatic Retainer (Back-up Rings), Polytetrafluoroethylene Resin
ARP4727	Gland Design, Computation of Seal Squeeze and Gland Volume

2.1.2 ASME Publications: Available from the American Society of Mechanical Engineers, 22 Law Drive, Box 2300, Fairfield, NJ, web site: http://www.asme.org or 800-843-2763

ASME B46.1	Surface Texture (Surface roughness, waviness & lay)

2.1.3 National Aerospace Standard Publications: Available from Aerospace Industries Association, Inc., 1000 Wilson Boulevard, Suite 1700, Arlington, VA 22209-3901, web site: http://www.aia-aerospace.org or 703-358-1000

NAS 1611	Packing, Preformed O-Ring, Phosphate Ester Resistant
NAS 1612	Packing, Preformed, Straight Thread Tube Fitting Boss, Phosphate Ester Resistant

2.1.4 Military Publications: Available from Department of Defense Single Stock Point (DODSSP), Building 4 / Section D, 700 Robbins Avenue, Philadelphia, PA 19111-5094, web site: http://assist.daps.dla.mil/quicksearch/

MIL-G-5514	Gland Design; Packing, Hydraulic, General Requirements For (Inactive for new Design)

2.2 Order of Precedence:

In the event of a conflict between the text of this document and the references cited herein, the text of this documents takes precedence. Nothing in this document, however, supersedes applicable laws and regulations unless a specific exemption has been obtained.

3. TECHNICAL REQUIREMENTS:

3.1 Gland Configuration:

3.1.1 General: As a general rule, O-rings and other elastomeric seals operating above 1500 psi (10,342 kPa) should utilize backup rings or other devices of this nature to prevent seal extrusion. O-ring seal glands designed for backup ring use must be increased in width. Therefore, this document depicts gland widths for applications using none, one and two backup rings. While these glands are sized based on standard O-rings, they are to be used with other elastomeric and PTFE seals. These seals should be designed to perform in these standard size glands.

3.1.2 Dimensions: The dimensions listed in Tables 1 through 5 are similar to the dimensions in MIL-G- 5514 Revision G. Changes have been made to the Gland OD (F) and the Gland ID (E) to obtain the desired O-ring squeeze as stated in Table 1 (also see Figures 1 and 2). Changes have been made to the gland width dimensions to achieve a design goal of 85% maximum gland occupancy. (This was achieved except for sizes -004, -008, -010, -013 and -110 in which the gland occupancy slightly exceeds 85%.) Also, gland wall angle and break edge dimensions have been included to permit these glands to be used at pressures up to 8000 psi (55,158 kPa).

3.1.3 Limitations: The design criteria and standard glands set forth in this document are intended for use in static and dynamic applications with SAE AS568 O-rings. Dash numbers 013 through 028, 117 through 149 and 223 through 247 are intended for static applications only due to the possibility of spiral failure occurring in these smaller cross-section - larger diameter O-ring sizes. Also, glands conforming to the dimensions listed herein for dash numbers 001 through 004 do not meet the squeeze goal of an installed deflection of at least 0.005 in on the O-ring cross-section using the most adverse accumulation of tolerances and O-ring stretch (see Appendix A). Therefore, the -001 through -004 sizes may not be suitable for many applications. Glands are designed so that they will not have more than 85% gland occupancy (15% free space) at 75 °F (24 °C). (See Appendix B.) The standard glands described herein are designed for up to 8000 psig (55,158 kPa) applications and for use in seal applications where the free swell is limited to 20%.

NOTE: The general use of 0.070 in O-ring sizes and smaller is not recommended for external applications due to the increased possibility of leakage.

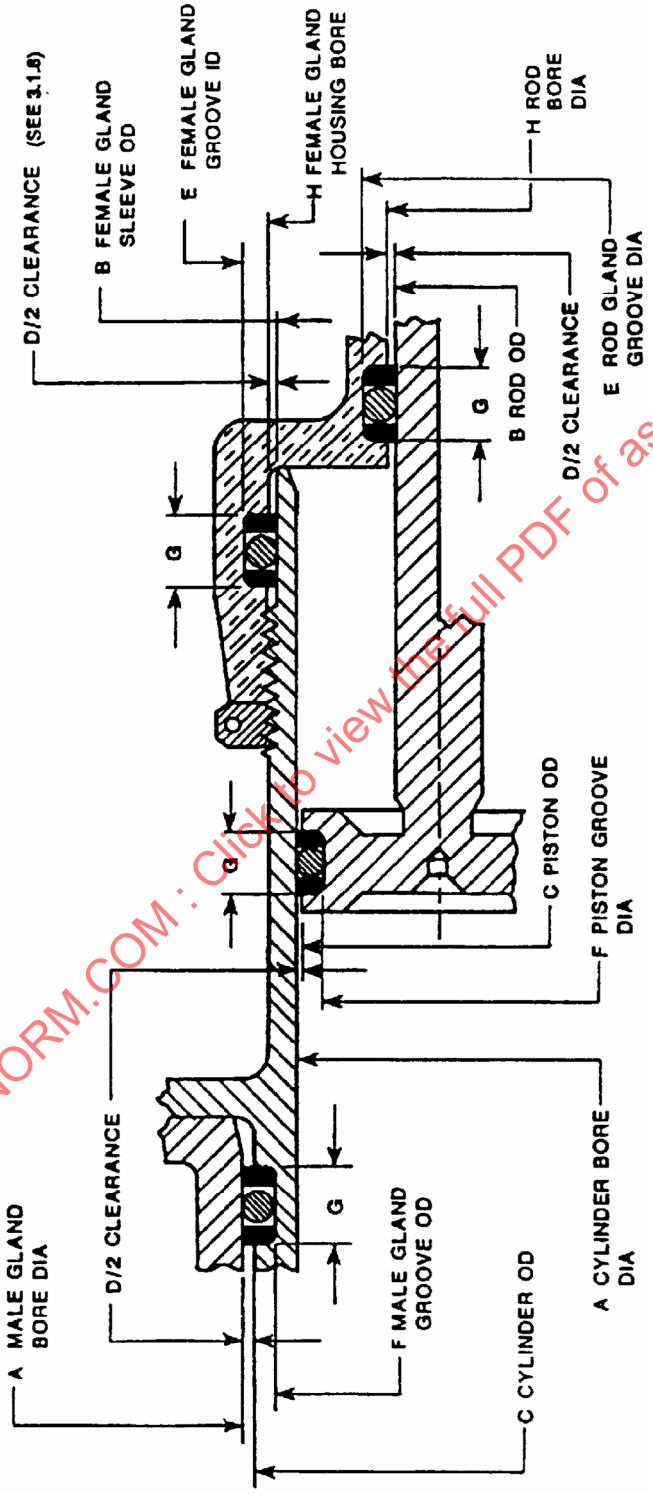
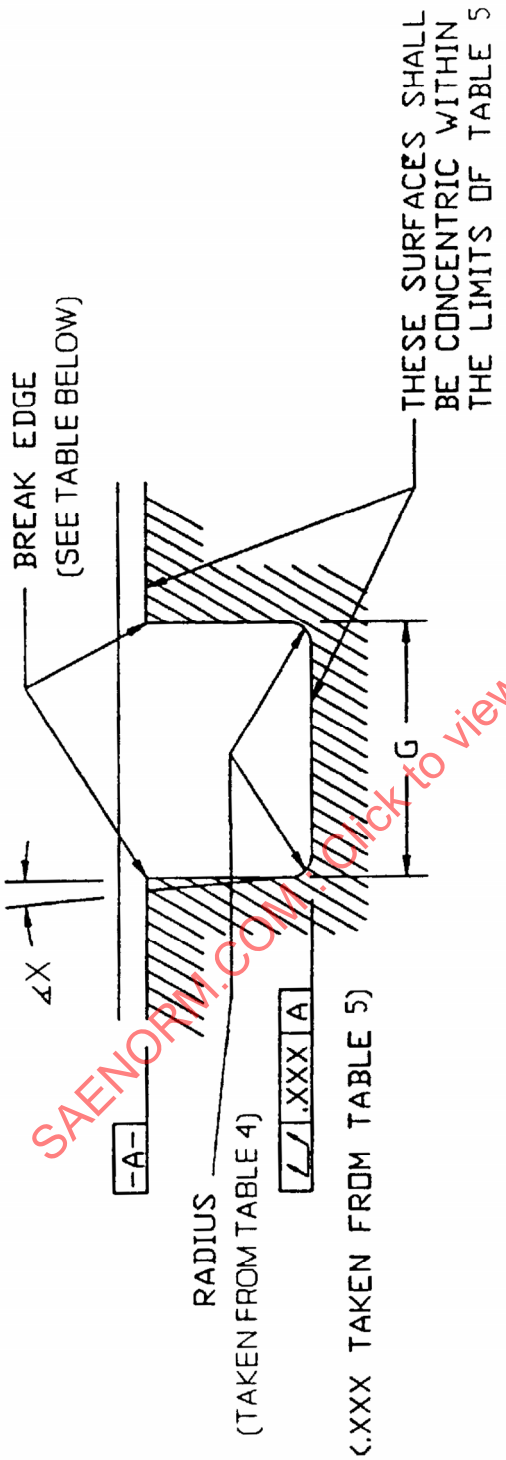


FIGURE 1 - Gland Design



GROOVE WALL ANGLE (∠X)	
PRESSURE (PSIG)	∠X (DEGREES)
≤ 3000	0.0 +5.0/-0.0
4000 TO 6000	0.0 +2.0/-0.0
> 6000 TO 8000	0.0 ±0.5

BREAK EDGE	
PRESSURE (PSIG)	GROOVE EDGE BREAK
≤ 4000	.005 +.005/-.000
> 4000	.002 +.008/-.000

FIGURE 2 - Groove Detail

TABLE 1 - Standard Gland Dimensions and O-ring Squeeze in Inches

Gland and AS568 Dash No.	Piston Or Cylinder OD C	Cylinder Bore ID A	Gland OD F	Rod or Gland Sleeve OD B	Rod Bore ID H	Gland ID E	Actual Minimum Squeeze ------- Piston/ Rod	Actual Maximum Squeeze ------- Piston/ Rod
001	.093	.095	.033	.033	.035	.095	.0000	.0145
	.092	.096	.032	.032	.036	.096	.0000	.0145
002	.126	.128	.048	.048	.050	.128	.0000	.0147
	.125	.129	.047	.047	.051	.129	.0000	.0147
003	.157	.159	.063	.063	.065	.159	.0015	.0164
	.156	.160	.062	.062	.066	.160	.0015	.0164
004	.188	.190	.076	.076	.078	.190	.0026	.0182
	.187	.191	.075	.075	.079	.191	.0026	.0182
005	.219	.221	.115	.108	.110	.217	.0051	.0200
	.218	.222	.114	.107	.111	.218	.0054	.0204
006	.233	.235	.129	.123	.125	.232	.0052	.0199
	.232	.236	.128	.122	.126	.233	.0052	.0199
007	.264	.266	.158	.154	.156	.264	.0052	.0197
	.263	.267	.157	.153	.157	.265	.0051	.0196
008	.295	.297	.189	.185	.187	.294	.0057	.0199
	.294	.298	.188	.184	.188	.295	.0059	.0202
009	.327	.329	.220	.217	.219	.327	.0052	.0192
	.326	.330	.219	.216	.220	.328	.0052	.0193
010	.358	.360	.250	.248	.250	.359	.0052	.0190
	.357	.361	.249	.247	.251	.360	.0050	.0189
011	.420	.422	.312	.310	.312	.421	.0057	.0193
	.419	.423	.311	.309	.313	.422	.0054	.0191
012	.483	.485	.375	.373	.375	.484	.0060	.0194
	.482	.486	.374	.372	.376	.485	.0057	.0192
013	.548	.550	.441	.435	.437	.545	.0050	.0196
	.547	.552	.439	.433	.438	.547	.0050	.0198
014	.611	.613	.504	.498	.500	.608	.0052	.0197
	.610	.615	.502	.496	.501	.610	.0051	.0199
015	.673	.675	.566	.560	.562	.670	.0052	.0200
	.672	.677	.564	.558	.563	.672	.0051	.0202
016	.736	.738	.629	.623	.625	.733	.0052	.0203
	.735	.740	.627	.621	.626	.735	.0051	.0205
017	.798	.800	.691	.685	.687	.795	.0054	.0204
	.797	.802	.689	.683	.688	.797	.0052	.0205
018	.861	.863	.753	.748	.750	.858	.0050	.0200
	.860	.865	.751	.746	.751	.860	.0053	.0205
019	.923	.925	.815	.810	.812	.920	.0051	.0200
	.922	.927	.813	.808	.813	.922	.0053	.0205
020	.989	.991	.881	.873	.875	.983	.0050	.0198
	.988	.993	.879	.871	.876	.985	.0054	.0205
021	1.051	1.053	.943	.935	.937	1.045	.0051	.0199
	1.050	1.055	.941	.933	.938	1.047	.0055	.0205

NOTE: Highlighted dash sizes (-013 to -028) , (-117 to -149) and (-223 to -247) are for static use only.

TABLE 1 - Standard Gland Dimensions and O-ring Squeeze in Inches (Continued)

Gland and AS568 Dash No.	Piston Or Cylinder OD C	Cylinder Bore ID A	Gland OD F	Rod or Gland Sleeve OD B	Rod Bore ID H	Gland ID E	Actual Minimum Squeeze ------- Piston/ Rod	Actual Maximum Squeeze ------- Piston/ Rod
022	1.114 1.113	1.116 1.118	1.006 1.004	.998 .996	1.000 1.001	1.108 1.110	.0051 .0055	.0200 .0205
023	1.176 1.175	1.178 1.180	1.068 1.066	1.060 1.058	1.062 1.063	1.170 1.172	.0052 .0055	.0200 .0205
024	1.239 1.238	1.241 1.243	1.131 1.129	1.123 1.121	1.125 1.126	1.233 1.235	.0052 .0056	.0200 .0205
025	1.301 1.300	1.303 1.305	1.193 1.191	1.185 1.183	1.187 1.188	1.295 1.297	.0052 .0056	.0201 .0205
026	1.364 1.363	1.366 1.368	1.256 1.254	1.248 1.246	1.250 1.251	1.358 1.360	.0053 .0056	.0201 .0205
027	1.426 1.425	1.428 1.430	1.318 1.316	1.310 1.308	1.312 1.313	1.420 1.422	.0053 .0056	.0202 .0205
028	1.489 1.488	1.491 1.493	1.381 1.379	1.373 1.371	1.375 1.376	1.483 1.485	.0053 .0056	.0203 .0205
104	.295 .294	.297 .298	.128 .127	.123 .122	.125 .126	.295 .296	.0051 .0051	.0204 .0205
105	.327 .326	.329 .330	.158 .157	.154 .153	.156 .157	.327 .328	.0052 .0052	.0201 .0203
106	.358 .357	.360 .361	.187 .186	.185 .184	.187 .188	.359 .360	.0052 .0052	.0199 .0199
107	.389 .388	.391 .392	.215 .214	.217 .216	.219 .220	.392 .393	.0050 .0050	.0195 .0196
108	.420 .419	.422 .423	.246 .245	.248 .247	.250 .251	.423 .424	.0052 .0053	.0196 .0197
109	.483 .482	.485 .486	.308 .307	.310 .309	.312 .313	.486 .487	.0051 .0053	.0192 .0194
110	.548 .547	.550 .552	.379 .377	.373 .371	.375 .376	.546 .548	.0053 .0052	.0204 .0204
111	.611 .610	.613 .615	.441 .439	.435 .433	.437 .438	.609 .611	.0052 .0050	.0202 .0201
112	.673 .672	.675 .677	.502 .500	.498 .496	.500 .501	.672 .674	.0053 .0053	.0201 .0203
113	.736 .735	.738 .740	.565 .563	.560 .558	.562 .563	.734 .736	.0052 .0052	.0204 .0207
114	.798 .797	.800 .802	.627 .625	.623 .621	.625 .626	.797 .799	.0053 .0052	.0210 .0211
115	.861 .860	.863 .865	.689 .687	.685 .683	.687 .688	.859 .861	.0050 .0054	.0206 .0212
116	.923 .922	.925 .927	.751 .749	.748 .746	.750 .751	.923 .925	.0053 .0050	.0208 .0207
117	.989 .988	.991 .993	.817 .815	.810 .808	.812 .813	.985 .987	.0050 .0050	.0205 .0209

NOTE: Highlighted dash sizes (-013 to -028) , (-117 to -149) and (-223 to -247) are for static use only.

TABLE 1 - Standard Gland Dimensions and O-ring Squeeze in Inches (Continued)

Gland and AS568 Dash No.	Piston Or Cylinder OD C	Cylinder Bore ID A	Gland OD F	Rod or Gland Sleeve OD B	Rod Bore ID H	Gland ID E	Actual Minimum Squeeze ------- Piston/ Rod	Actual Maximum Squeeze ------- Piston/ Rod
118	1.051	1.053	.879	.873	.875	1.048	.0052	.0207
	1.050	1.055	.877	.871	.876	1.050	.0051	.0209
119	1.114	1.116	.942	.935	.937	1.110	.0053	.0206
	1.113	1.118	.940	.933	.938	1.112	.0052	.0209
120	1.176	1.178	1.003	.998	1.000	1.173	.0050	.0204
	1.175	1.180	1.001	.996	1.001	1.175	.0053	.0209
121	1.239	1.241	1.066	1.060	1.062	1.235	.0050	.0203
	1.238	1.243	1.064	1.058	1.063	1.237	.0054	.0209
122	1.301	1.303	1.128	1.123	1.125	1.298	.0052	.0204
	1.300	1.305	1.126	1.121	1.126	1.300	.0055	.0209
123	1.364	1.366	1.191	1.185	1.187	1.360	.0051	.0205
	1.363	1.368	1.189	1.183	1.188	1.362	.0054	.0210
124	1.426	1.428	1.253	1.248	1.250	1.423	.0052	.0206
	1.425	1.430	1.251	1.246	1.251	1.425	.0055	.0210
125	1.489	1.491	1.316	1.310	1.312	1.485	.0052	.0206
	1.488	1.493	1.314	1.308	1.313	1.487	.0055	.0210
126	1.551	1.553	1.378	1.373	1.375	1.548	.0053	.0207
	1.550	1.555	1.376	1.371	1.376	1.550	.0056	.0210
127	1.614	1.616	1.441	1.435	1.437	1.610	.0053	.0206
	1.613	1.618	1.439	1.433	1.439	1.612	.0051	.0215
128	1.676	1.678	1.503	1.498	1.500	1.673	.0054	.0207
	1.675	1.680	1.501	1.496	1.502	1.675	.0052	.0215
129	1.739	1.741	1.566	1.560	1.562	1.735	.0053	.0208
	1.738	1.743	1.564	1.558	1.564	1.737	.0051	.0215
130	1.802	1.805	1.631	1.623	1.625	1.798	.0053	.0217
	1.801	1.807	1.629	1.621	1.627	1.800	.0051	.0215
131	1.864	1.867	1.693	1.685	1.687	1.860	.0053	.0217
	1.863	1.869	1.691	1.683	1.689	1.862	.0052	.0215
132	1.927	1.930	1.756	1.748	1.750	1.923	.0054	.0217
	1.926	1.932	1.754	1.746	1.752	1.925	.0052	.0215
133	1.989	1.992	1.818	1.810	1.813	1.984	.0054	.0218
	1.988	1.994	1.816	1.808	1.815	1.986	.0052	.0225
134	2.052	2.055	1.881	1.873	1.876	2.047	.0055	.0218
	2.051	2.057	1.879	1.871	1.878	2.049	.0053	.0225
135	2.115	2.118	1.944	1.936	1.939	2.110	.0054	.0219
	2.114	2.120	1.942	1.934	1.941	2.112	.0052	.0225
136	2.177	2.180	2.006	1.998	2.001	2.172	.0055	.0219
	2.176	2.182	2.004	1.996	2.003	2.174	.0053	.0225
137	2.240	2.243	2.069	2.061	2.064	2.235	.0055	.0219
	2.239	2.245	2.067	2.059	2.066	2.237	.0053	.0225
138	2.302	2.305	2.131	2.123	2.126	2.297	.0055	.0219
	2.301	2.307	2.129	2.121	2.128	2.299	.0053	.0225

NOTE: Highlighted dash sizes (-013 to -028) , (-117 to -149) and (-223 to -247) are for static use only.

TABLE 1 - Standard Gland Dimensions and O-ring Squeeze in Inches (Continued)

Gland and AS568 Dash No.	Piston or Cylinder OD C	Cylinder Bore ID A	Gland OD F	Rod or Gland Sleeve OD B	Rod Bore ID H	Gland ID E	Actual Minimum Squeeze ------- Piston/ Rod	Actual Maximum Squeeze ------- Piston/ Rod
139	2.365 2.364	2.368 2.370	2.194 2.192	2.186 2.184	2.189 2.191	2.360 2.362	.0056 .0054	.0219 .0225
140	2.427 2.426	2.430 2.432	2.256 2.254	2.248 2.246	2.251 2.253	2.422 2.424	.0056 .0054	.0219 .0225
141	2.490 2.488	2.493 2.495	2.319 2.317	2.311 2.309	2.314 2.316	2.485 2.487	.0050 .0053	.0225 .0225
142	2.552 2.550	2.555 2.557	2.381 2.379	2.373 2.371	2.376 2.378	2.547 2.549	.0051 .0053	.0225 .0225
143	2.615 2.613	2.618 2.620	2.444 2.442	2.436 2.434	2.439 2.441	2.610 2.612	.0051 .0054	.0225 .0225
144	2.677 2.675	2.680 2.682	2.506 2.504	2.498 2.496	2.501 2.503	2.672 2.674	.0051 .0054	.0225 .0225
145	2.740 2.738	2.743 2.745	2.569 2.567	2.561 2.559	2.564 2.566	2.735 2.737	.0052 .0054	.0225 .0225
146	2.802 2.800	2.805 2.807	2.631 2.629	2.623 2.621	2.626 2.628	2.797 2.799	.0052 .0054	.0225 .0225
147	2.865 2.863	2.868 2.870	2.694 2.692	2.686 2.684	2.689 2.691	2.860 2.862	.0051 .0054	.0225 .0225
148	2.927 2.925	2.930 2.932	2.756 2.754	2.748 2.746	2.751 2.753	2.922 2.924	.0052 .0054	.0225 .0225
149	2.990 2.988	2.993 2.995	2.819 2.817	2.811 2.809	2.814 2.816	2.985 2.987	.0052 .0054	.0225 .0225
210	.989 .988	.991 .993	.750 .748	.748 .746	.750 .751	.989 .991	.0052 .0054	.0244 .0247
211	1.051 1.050	1.053 1.055	.812 .810	.810 .808	.812 .813	1.051 1.053	.0054 .0055	.0244 .0248
212	1.114 1.113	1.116 1.118	.874 .872	.873 .871	.875 .876	1.115 1.117	.0051 .0052	.0242 .0243
213	1.176 1.175	1.178 1.180	.936 .934	.935 .933	.937 .938	1.177 1.179	.0052 .0053	.0242 .0244
214	1.239 1.238	1.241 1.243	.999 .997	.998 .996	1.000 1.001	1.240 1.242	.0054 .0054	.0243 .0244
215	1.301 1.300	1.303 1.305	1.061 1.059	1.060 1.058	1.062 1.063	1.302 1.304	.0055 .0056	.0243 .0244
216	1.364 1.363	1.366 1.368	1.124 1.122	1.123 1.121	1.125 1.126	1.365 1.367	.0054 .0055	.0246 .0247
217	1.426 1.425	1.428 1.430	1.186 1.184	1.185 1.183	1.187 1.188	1.427 1.429	.0055 .0056	.0246 .0247
218	1.489 1.488	1.491 1.493	1.249 1.247	1.248 1.246	1.250 1.251	1.490 1.492	.0056 .0057	.0246 .0247
219	1.551 1.550	1.553 1.555	1.311 1.309	1.310 1.308	1.312 1.313	1.552 1.554	.0057 .0058	.0246 .0248

NOTE: Highlighted dash sizes (-013 to -028) , (-117 to -149) and (-223 to -247) are for static use only.

TABLE 1 - Standard Gland Dimensions and O-ring Squeeze in Inches (Continued)

Gland and AS568 Dash No.	Piston or Cylinder OD C	Cylinder Bore ID A	Gland OD F	Rod or Gland Sleeve OD B	Rod Bore ID H	Gland ID E	Actual Minimum Squeeze ------- Piston/ Rod	Actual Maximum Squeeze ------- Piston/ Rod
220	1.614 1.613	1.616 1.618	1.374 1.372	1.373 1.371	1.375 1.376	1.615 1.617	.0058 .0059	.0247 .0248
221	1.676 1.675	1.678 1.680	1.436 1.434	1.435 1.433	1.437 1.438	1.677 1.679	.0059 .0059	.0247 .0248
222	1.739 1.738	1.741 1.743	1.499 1.497	1.498 1.496	1.500 1.501	1.740 1.742	.0057 .0058	.0250 .0250
223	1.864 1.863	1.867 1.869	1.625 1.623	1.623 1.621	1.625 1.627	1.865 1.867	.0053 .0054	.0254 .0255
224	1.989 1.988	1.992 1.994	1.750 1.748	1.748 1.746	1.750 1.752	1.990 1.992	.0055 .0056	.0254 .0255
225	2.115 2.114	2.118 2.120	1.876 1.874	1.873 1.871	1.876 1.878	2.115 2.117	.0054 .0050	.0255 .0260
226	2.240 2.239	2.243 2.245	2.001 1.999	1.998 1.996	2.001 2.003	2.240 2.242	.0055 .0051	.0255 .0260
227	2.365 2.364	2.368 2.370	2.126 2.124	2.123 2.121	2.126 2.128	2.365 2.367	.0056 .0052	.0255 .0260
228	2.490 2.488	2.493 2.495	2.251 2.249	2.248 2.246	2.251 2.253	2.490 2.492	.0051 .0052	.0260 .0260
229	2.615 2.613	2.618 2.620	2.376 2.374	2.373 2.371	2.376 2.378	2.615 2.617	.0051 .0053	.0260 .0260
230	2.740 2.738	2.743 2.745	2.501 2.499	2.498 2.496	2.501 2.503	2.740 2.742	.0052 .0054	.0260 .0260
231	2.865 2.863	2.868 2.870	2.626 2.624	2.623 2.621	2.626 2.628	2.865 2.867	.0053 .0054	.0260 .0260
232	2.990 2.988	2.993 2.995	2.751 2.749	2.748 2.746	2.751 2.753	2.990 2.992	.0052 .0053	.0260 .0260
233	3.115 3.113	3.118 3.120	2.876 2.874	2.873 2.871	2.876 2.878	3.115 3.117	.0053 .0054	.0260 .0260
234	3.240 3.238	3.243 3.245	3.001 2.999	2.997 2.995	3.000 3.002	3.239 3.241	.0053 .0055	.0260 .0260
235	3.365 3.363	3.368 3.370	3.126 3.124	3.122 3.120	3.125 3.127	3.364 3.366	.0054 .0055	.0260 .0260
236	3.490 3.488	3.493 3.495	3.251 3.249	3.247 3.245	3.250 2.252	3.489 3.491	.0054 .0056	.0260 .0260
237	3.615 3.613	3.618 3.620	3.376 3.374	3.372 3.370	3.375 3.377	3.614 3.616	.0055 .0056	.0260 .0260
238	3.740 3.738	3.743 3.745	3.501 3.499	3.497 3.495	3.500 3.502	3.739 3.741	.0055 .0057	.0260 .0260
239	3.865 3.863	3.868 3.870	3.626 3.624	3.622 3.620	3.625 3.627	3.864 3.866	.0055 .0056	.0260 .0260
240	3.990 3.988	3.993 3.995	3.751 3.749	3.747 3.745	3.750 3.752	3.989 3.991	.0055 .0056	.0260 .0260

NOTE: Highlighted dash sizes (-013 to -028) , (-117 to -149) and (-223 to -247) are for static use only.

TABLE 1 - Standard Gland Dimensions and O-ring Squeeze in Inches (Continued)

Gland and AS568 Dash No.	Piston or Cylinder OD C	Cylinder Bore ID A	Gland OD F	Rod or Gland Sleeve OD B	Rod Bore ID H	Gland ID E	Actual Minimum Squeeze ------- Piston/ Rod	Actual Maximum Squeeze ------- Piston/ Rod
241	4.115 4.113	4.118 4.120	3.876 3.874	3.872 3.870	3.875 3.877	4.114 4.116	.0056 .0057	.0260 .0260
242	4.240 4.238	4.243 4.245	4.001 3.999	3.997 3.995	4.000 4.002	4.239 4.241	.0056 .0057	.0260 .0260
243	4.365 4.363	4.368 4.370	4.126 4.124	4.122 1.120	4.125 4.127	4.364 4.366	.0056 .0057	.0260 .0260
244	4.489 4.487	4.493 4.495	4.251 4.249	4.247 4.245	4.250 4.252	4.489 4.491	.0051 .0057	.0265 .0260
245	4.614 4.612	4.618 4.620	4.376 4.374	4.372 4.370	4.375 4.377	4.614 4.616	.0051 .0058	.0265 .0260
246	4.739 4.737	4.743 4.745	4.501 4.499	4.497 4.495	4.501 4.503	4.739 4.741	.0052 .0053	.0265 .0265
247	4.864 4.862	4.868 4.870	4.626 4.624	4.622 4.620	4.626 4.628	4.864 4.866	.0052 .0053	.0265 .0265
325	1.864 1.863	1.867 1.869	1.495 1.493	1.498 1.496	1.500 1.502	1.870 1.872	.0081 .0079	.0322 .0318
326	1.989 1.988	1.992 1.994	1.620 1.618	1.623 1.621	1.625 1.627	1.995 1.997	.0083 .0081	.0323 .0319
327	2.115 2.114	2.118 2.120	1.746 1.744	1.748 1.746	1.750 1.752	2.120 2.122	.0085 .0083	.0322 .0320
328	2.240 2.239	2.243 2.245	1.871 1.869	1.873 1.871	1.876 1.878	2.245 2.247	.0087 .0080	.0323 .0325
329	2.365 2.364	2.368 2.370	1.996 1.994	1.998 1.996	2.001 2.003	2.370 2.372	.0086 .0080	.0326 .0329
330	2.490 2.488	2.493 2.495	2.121 2.119	2.123 2.121	2.126 2.128	2.495 2.497	.0083 .0081	.0332 .0330
331	2.615 2.613	2.618 2.620	2.246 2.244	2.248 2.246	2.251 2.253	2.620 2.622	.0084 .0083	.0332 .0330
332	2.740 2.738	2.743 2.745	2.371 2.369	2.373 2.371	2.376 2.378	2.745 2.747	.0085 .0084	.0332 .0330
333	2.865 2.863	2.868 2.870	2.496 2.494	2.498 2.496	2.501 2.503	2.870 2.872	.0085 .0084	.0334 .0332
334	2.990 2.988	2.993 2.995	2.621 2.619	2.623 2.621	2.626 2.628	2.995 2.997	.0087 .0085	.0334 .0332
335	3.115 3.113	3.118 3.120	2.746 2.744	2.748 2.746	2.751 2.753	3.120 3.122	.0088 .0087	.0334 .0332
336	3.240 3.238	3.243 3.245	2.871 2.869	2.873 2.871	2.876 2.878	3.245 3.247	.0089 .0088	.0334 .0332
337	3.365 3.363	3.368 3.370	2.996 2.994	2.997 2.995	3.000 3.002	3.369 3.371	.0087 .0087	.0335 .0335
338	3.490 3.488	3.493 3.495	3.121 3.119	3.122 3.120	3.125 3.127	3.494 3.496	.0088 .0088	.0335 .0335

NOTE: Highlighted dash sizes (-013 to -028) , (-117 to -149) and (-223 to -247) are for static use only.

TABLE 1 - Standard Gland Dimensions and O-ring Squeeze in Inches (Continued)

Gland and AS568 Dash No.	Piston or Cylinder OD C	Cylinder Bore ID A	Gland OD F	Rod or Gland Sleeve OD B	Rod Bore ID H	Gland ID E	Actual Minimum Squeeze ------- Piston/ Rod	Actual Maximum Squeeze -------Piston/ Rod
339	3.615	3.618	3.246	3.247	3.250	3.619	.0089	.0335
	3.613	3.620	3.244	3.245	3.252	3.621	.0089	.0335
340	3.740	3.743	3.371	3.372	3.375	3.744	.0090	.0335
	3.738	3.745	3.369	3.370	3.377	3.746	.0090	.0335
341	3.865	3.868	3.496	3.497	3.500	3.869	.0091	.0335
	3.863	3.870	3.494	3.495	3.502	3.871	.0090	.0335
342	3.990	3.993	3.621	3.622	3.625	3.994	.0090	.0335
	3.988	3.995	3.619	3.620	3.627	3.996	.0089	.0335
343	4.115	4.118	3.746	3.747	3.750	4.119	.0090	.0335
	4.113	4.120	3.744	3.745	3.752	4.121	.0090	.0335
344	4.240	4.243	3.871	3.872	3.875	4.244	.0091	.0335
	4.238	4.245	3.869	3.870	3.877	4.246	.0091	.0335
345	4.365	4.368	3.996	3.997	4.000	4.369	.0092	.0335
	4.363	4.370	3.994	3.995	4.002	4.371	.0091	.0335
346	4.489	4.493	4.121	4.122	4.125	4.494	.0087	.0340
	4.487	4.495	4.119	4.120	4.127	4.496	.0092	.0335
347	4.614	4.618	4.246	4.247	4.250	4.619	.0087	.0340
	4.612	4.620	4.244	4.245	4.252	4.621	.0092	.0335
348	4.739	4.743	4.371	4.372	4.375	4.744	.0088	.0340
	4.737	4.745	4.369	4.370	4.377	4.746	.0092	.0335
349	4.864	4.868	4.496	4.497	4.500	4.869	.0088	.0340
	4.862	4.870	4.494	4.495	4.502	4.871	.0093	.0335
425	4.970	4.974	4.497	4.497	4.501	4.974	.0175	.0480
	4.968	4.977	4.494	4.494	4.503	4.977	.0175	.0480
426	5.095	5.099	4.622	4.622	4.626	5.099	.0176	.0480
	5.093	5.102	4.619	4.619	4.628	5.102	.0176	.0480
427	5.220	5.224	4.747	4.747	4.751	5.224	.0176	.0480
	5.218	5.227	4.744	4.744	4.753	5.227	.0176	.0480
428	5.345	5.349	4.872	4.872	4.876	5.349	.0177	.0480
	5.343	5.352	4.869	4.869	4.878	5.352	.0177	.0480
429	5.470	5.474	4.997	4.997	5.001	5.474	.0176	.0480
	5.468	5.477	4.994	4.994	5.003	5.477	.0176	.0480
430	5.595	5.599	5.122	5.122	5.126	5.599	.0176	.0480
	5.593	5.602	5.119	5.119	5.128	5.602	.0176	.0480
431	5.720	5.724	5.247	5.247	5.251	5.724	.0177	.0480
	5.718	5.727	5.244	5.244	5.253	5.727	.0177	.0480
432	5.845	5.849	5.372	5.372	5.376	5.849	.0178	.0480
	5.843	5.852	5.369	5.369	5.378	5.852	.0178	.0480
433	5.970	5.974	5.497	5.497	5.501	5.974	.0178	.0480
	5.968	5.977	5.494	5.494	5.503	5.977	.0178	.0480
434	6.095	6.099	5.622	5.622	5.626	6.099	.0179	.0480
	6.093	6.102	5.619	5.619	5.628	6.102	.0179	.0480

TABLE 1 - Standard Gland Dimensions and O-ring Squeeze in Inches (Continued)

Gland and AS568 Dash No.	Piston or Cylinder OD C	Cylinder Bore ID A	Gland OD F	Rod or Gland Sleeve OD B	Rod Bore ID H	Gland ID E	Actual Minimum Squeeze ------- Piston/ Rod	Actual Maximum Squeeze ------- Piston/ Rod
435	6.220	6.224	5.747	5.747	5.751	6.224	.0179	.0480
	6.218	6.227	5.744	5.744	5.753	6.227	.0179	.0480
436	6.345	6.349	5.872	5.872	5.876	6.349	.0180	.0480
	6.343	6.352	5.869	5.869	5.878	6.352	.0180	.0480
437	6.470	6.474	5.997	5.997	6.001	6.474	.0180	.0480
	6.468	6.477	5.994	5.994	6.003	6.477	.0180	.0480
438	6.720	6.724	6.247	6.247	6.251	6.724	.0180	.0480
	6.718	6.727	6.244	6.244	6.253	6.727	.0180	.0480
439	6.970	6.974	6.497	6.497	6.501	6.974	.0181	.0480
	6.968	6.977	6.494	6.494	6.504	6.977	.0176	.0485
440	7.220	7.224	6.747	6.747	6.751	7.224	.0182	.0480
	7.218	7.227	6.744	6.744	6.754	7.227	.0177	.0485
441	7.470	7.474	6.997	6.997	7.001	7.474	.0182	.0480
	7.468	7.477	6.994	6.994	7.004	7.477	.0177	.0485
442	7.720	7.724	7.247	7.247	7.251	7.724	.0181	.0480
	7.718	7.727	7.244	7.244	7.254	7.727	.0176	.0485
443	7.970	7.974	7.497	7.497	7.501	7.974	.0182	.0480
	7.968	7.977	7.494	7.494	7.504	7.977	.0177	.0485
444	8.220	8.224	7.747	7.747	7.751	8.224	.0183	.0480
	8.218	8.227	7.744	7.744	7.754	8.227	.0178	.0485
445	8.470	8.474	7.997	7.997	8.001	8.474	.0183	.0480
	8.468	8.477	7.994	7.994	8.004	8.477	.0178	.0485
446	8.970	8.974	8.497	8.497	8.501	8.974	.0177	.0485
	8.967	8.977	8.494	8.494	8.504	8.977	.0177	.0485
447	9.470	9.474	8.997	8.997	9.001	9.474	.0168	.0485
	9.467	9.478	8.994	8.994	9.004	9.478	.0173	.0485
448	9.970	9.974	9.497	9.497	9.501	9.974	.0169	.0485
	9.967	9.978	9.494	9.494	9.504	9.978	.0174	.0485
449	10.470	10.474	9.997	9.997	10.001	10.474	.0170	.0485
	10.467	10.478	9.994	9.994	10.004	10.478	.0175	.0485
450	10.970	10.974	10.497	10.497	10.501	10.974	.0170	.0485
	10.967	10.978	10.494	10.494	10.504	10.978	.0175	.0485
451	11.470	11.474	10.997	10.997	11.001	11.474	.0170	.0485
	11.467	11.478	10.994	10.994	11.004	11.478	.0176	.0485
452	11.970	11.974	11.497	11.497	11.501	11.974	.0171	.0485
	11.967	11.978	11.494	11.494	11.504	11.978	.0176	.0485
453	12.470	12.474	11.997	11.997	12.001	12.474	.0172	.0485
	12.467	12.478	11.994	11.994	12.004	12.478	.0177	.0485
454	12.970	12.974	12.497	12.497	12.501	12.974	.0173	.0485
	12.967	12.978	12.494	12.494	12.504	12.978	.0178	.0485
455	13.470	13.474	12.997	12.997	13.001	13.474	.0173	.0485
	13.467	13.478	12.994	12.994	13.004	13.478	.0178	.0485

TABLE 1 - Standard Gland Dimensions and O-ring Squeeze in Inches (Continued)

Gland and AS568 Dash No.	Piston or Cylinder OD C	Cylinder Bore ID A	Gland OD F	Rod or Gland Sleeve OD B	Rod Bore ID H	Gland ID E	Actual Minimum Squeeze ------- Piston/ Rod	Actual Maximum Squeeze ------- Piston/ Rod
456	13.970	13.974	13.497	13.497	13.501	13.974	.0172	.0485
	13.967	13.978	13.494	13.494	13.504	13.978	.0177	.0485
457	14.470	14.474	13.997	13.997	14.001	14.474	.0173	.0485
	14.467	14.478	13.994	13.994	14.004	14.478	.0178	.0485
458	14.970	14.974	14.497	14.497	14.501	14.974	.0173	.0485
	14.967	14.978	14.494	14.494	14.504	14.978	.0178	.0485
459	15.470	15.474	14.997	14.997	15.001	15.474	.0174	.0485
	15.467	15.478	14.994	14.994	15.004	15.478	.0179	.0485
460	15.970	15.974	15.497	15.497	15.501	15.974	.0174	.0485
	15.967	15.978	15.494	15.494	15.504	15.978	.0179	.0485

TABLE 2 - Standard Gland Width for Zero, One, and Two Backup

Gland and AS568 Dash No.	O-ring Cross Section W Min	O-ring Cross Section W Max	Gland Width G No Backup Ring Min	Gland Width G No Backup Ring Max	Gland Width G One Backup Ring Min	Gland Width G One Backup Ring Max	Gland Width G Two Backup Rings Min	Gland Width G Two Backup Rings Max
001	.037	.043	.070	.075	--	--	--	--
002	.047	.053	.077	.082	--	--	--	--
003	.057	.063	.088	.093	--	--	--	--
004 to 009	.067	.073	.098	.103	.154	.164	.210	.220
010 to 028	.067	.073	.094	.099	.150	.160	.207	.217
104 to 149	.100	.106	.141	.151	.183	.193	.245	.255
210 to 247	.135	.143	.188	.198	.235	.245	.304	.314
325 to 349	.205	.215	.281	.291	.334	.344	.424	.434
424 to 460	.269	.281	.375	.385	.475	.485	.579	.589

TABLE 3 - Standard Gland Diametral Clearance Dimensions

Gland and AS568 Dash No.	O-ring Cross Section W Min	O-ring Cross Section W Max	Diametral Clearance D Max Exterior	Diametral Clearance D Max Interior
001	.037	.043	.004	.004
002	.047	.053	.004	.004
003	.057	.063	.004	.004
004 to 012	.067	.073	.004	.004
013 to 028	.067	.073	.005	.005
104 to 109	.100	.106	.004	.004
110 to 126	.100	.106	.005	.005
127 to 129	.100	.106	.005	.006
130 to 132	.100	.106	.006	.006
133 to 140	.100	.106	.006	.007
141 to 149	.100	.106	.007	.007
210 to 222	.135	.143	.005	.005
223 and 224	.135	.143	.006	.006
225 to 227	.135	.143	.006	.007
228 to 243	.135	.143	.007	.007
244 and 245	.135	.143	.008	.007
246 and 247	.135	.143	.008	.008
325 to 327	.205	.215	.006	.006
328 and 329	.205	.215	.006	.007
330 to 345	.205	.215	.007	.007
346 to 349	.205	.215	.008	.007
425 to 438	.269	.281	.009	.009
439 to 445	.269	.281	.009	.010
446	.269	.281	.010	.010
447 to 460	.269	.281	.011	.010

TABLE 4 - Standard Corner Radius Dimensions

Gland and AS568 Dash No.	Corner Radius Maximum	Corner Radius Minimum
001 to 028	.015	.005
104 to 149	.015	.005
210 to 247	.025	.010
325 to 349	.035	.020
425 to 460	.035	.020

TABLE 5 - Eccentricity for Standard Glands

Gland and AS568 Dash No.	Maximum Eccentricity
001 to 028	.002
104 to 149	.002
210 to 247	.003
325 to 349	.004
425 to 460	.005

3.1.4 Surface Finishes of Glands: The following surface finishes in Table 6 (indicated as surface roughness as defined in ASME B46.1 shall be used in units containing O-ring and other elastomeric seals:

TABLE 6

Part on Unit	Surface Roughness Ra (µin)
Cylinder bore or piston rod (diameter over which packaging must slide)	16 (max) See Note
O-ring groove diameter:	
Dynamic Seals	32 (max)
Static Seals	63 (max)
O-ring groove sides when no backup ring is used:	
Dynamic Seals	32 (max)
Static Seals	63 (max)
O-ring groove sides when backup rings are used	63 (max)

Note: Optimum recommended roughness for dynamic application is 4 to 12 Ra. The use of HVOF (High Velocity Oxygenated Fuel) coatings will require a 4 Ra (max) roughness with consideration to post process super-finishing / polishing.

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

3.1.5 O-ring Seal Squeeze: (Reference ARP4727, Gland Design, Computation of Seal Squeeze and Gland Volume) The minimum squeeze (see Table 1) is represented by the difference (interference) between the minimum cross-section of the installed O-ring and the maximum permitted gland depth. The O-ring used to calculate minimum squeeze is one with the minimum free cross-section diameter and minimum ID. The minimum cross-section diameter of the installed O-ring is obtained by subtracting the change in the minimum free cross-section diameter, caused by the stretching of the O-ring during installation, from the minimum free cross-section diameter. The maximum gland depth is that obtained using gland parts that provide the maximum possible diametral clearance, maximum eccentricity of gland parts and maximum possible radial displacement of the gland parts in the direction to cause maximum gland depth and minimum seal squeeze at the seal location that is 180° away from the direction of radial displacement.

The maximum O-ring squeeze in Table 1 is represented by the difference between the maximum cross-section diameter of an installed O-ring and the minimum gland depth. The O-ring used to calculate maximum squeeze is an O-ring of maximum free cross-section diameter and maximum ID. The maximum cross-section diameter of the installed O-ring is obtained by subtracting the change in the maximum free cross-section diameter, caused by the stretching of the O-ring during installation, from the maximum free cross-section diameter. The minimum gland depth for a piston type gland is that obtained using MIN bore diameter, MIN piston diameter, maximum eccentricity of gland parts and maximum possible radial displacement of the MIN piston diameter with respect to the MIN bore diameter. The minimum gland depth for a rod type gland is that obtained using MAX rod diameter, MAX rod clearance diameter, maximum eccentricity of gland parts and maximum possible radial displacement of the MAX rod diameter with respect to the MAX rod clearance diameter.

The formulas used for calculating the reduced seal cross- section for piston and rod type glands under minimum and maximum squeeze conditions are listed in Appendix A. The formulas used to calculate the minimum and maximum seal squeeze (listed in Table 1) for piston and rod type glands are also listed in Appendix A.

3.1.6 Temperature Considerations in Gland Design: The calculations used in this standard have been based on a temperature of 75 °F (24 °C). The suitability of the glands should be verified for the temperature extremes expected in service. Differences in the coefficient of expansion of different metals can result in differences in diametral clearance which may be a factor at temperature extremes. Even more important is the difference in the coefficient of thermal expansion of the seal material and the gland materials. Elastomers may have a coefficient of expansion as much as 10 times that of steel. Gland overfill at high temperatures must be avoided. Elastomer contraction at low temperatures may require some modification of the gland dimensions herein to assure adequate squeeze at low temperatures, particularly those lower than -40 °F (-40 °C). A particularly severe application occurs when an unpressurized cylinder at low temperature is pressurized. Leakage is likely to occur until such time as warmer fluid causes expansion of the elastomer. Leakage can be prevented in such cases by ensuring that adequate squeeze is provided by taking into account changes in gland and elastomer dimensions that occur at low temperature plus the radial expansion (i.e., gland "breathing") that will occur with the application of pressure. Usually, satisfactory designs can be achieved within the dimensions of this standard by simply reducing the permitted tolerances on mating parts to achieve increased squeeze.

3.1.7 Installation of Non-extrusion Rings: For pressures above 1500 psi, the use of two backup rings in each gland, one on either side of the O-ring seal, is recommended to insure proper extrusion protection. Dimensions for gland widths to accommodate the use of two backup rings are shown in Table 2. Where it is self evident that pressure can be applied from one direction only and space requirements for two rings create a hardship, a single backup ring may be used. This ring is to be placed on the side of the O-ring away from the pressure. The groove width dimensions shown in Table 2 for one backup ring may be used, as applicable. For applications where the pressure does not exceed 1500 psi, backup rings are not required but may be used to provide greater extrusion protection.

NOTE: The AS4716 gland dimensions are different from the previous MIL-G-5514 for the -0XX, -1XX and the -2XX series dash sizes and the application of AS8791 and "MS" backup rings may result in a compressive radial fit and are not recommended for use.

Optimum fit and limit conditions can be achived with the use of backup rings per AS5781 and AS5782.

3.1.8 Diametral Clearances: The diametral clearance, "D" in Figure 1, is the total difference between the bore ID (A) and the piston OD (C) or the total difference between the rod OD (B) and the rod bore ID (H). The diametral clearance shall be as listed in Table 3.

3.1.9 Groove Detail: Details for the standard groove design, including edge break and groove wall angle requirements, are depicted in Figure 2. Groove corner radius shall be in accordance with Table 4.

3.1.10 Eccentricity: The eccentricity, referred to in Table 5, is the total indicator reading, between the groove and the adjacent bearing surface (see Figure 2). As indicated in Figure 1, the designated surfaces shall be concentric within the limits of Table 5.

3.1.11 Cylinder Breathing: For operating pressures of 3000 psig (20,684 kPa) and lower, radial expansion of the cylinder bore (i.e., cylinder wall "breathing") shall be limited to 0.002 in/in of cylinder bore at operating pressure. For operating pressures greater than 3000 psig (20,684 kPa), radial expansion of the cylinder bore shall be limited to 0.0015 in/in of cylinder bore at operating pressure.

3.1.12 O-ring Assembly: To facilitate O-ring assembly, the edge where the piston and O-ring assembly enters a cylinder bore should be chamfered to prevent pinching or other damage to the O-ring seal (see Figure 3).

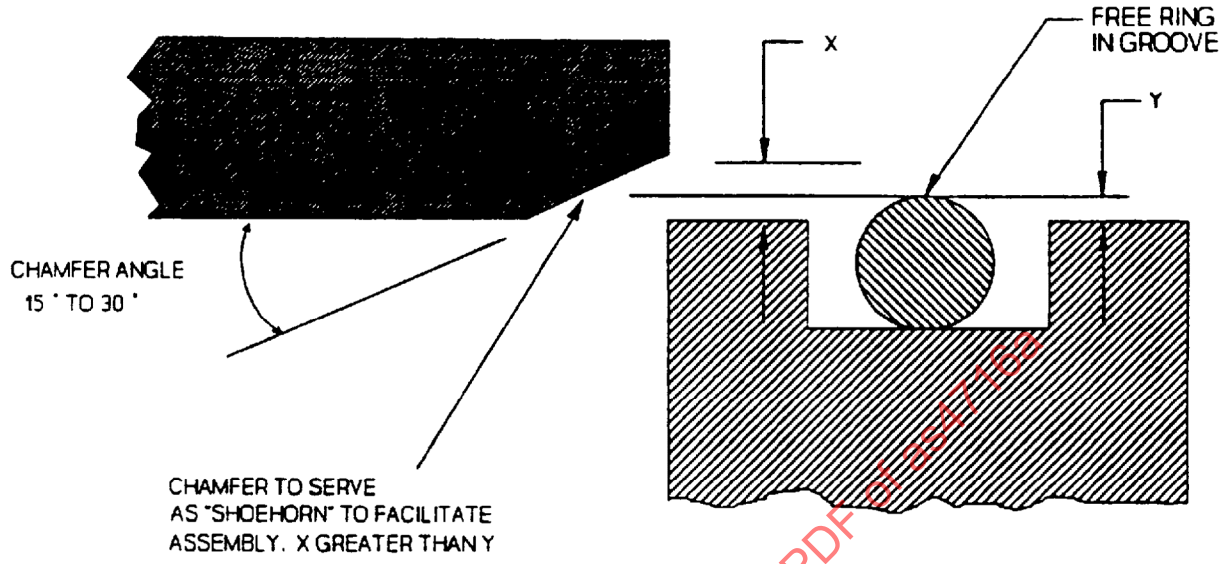


FIGURE 3 - O-ring Assembly

4. NOTES:

4.1 Key Words:

The following are “key words” to facilitate document word search:

Gland, Groove, O-ring, Packing, Seal, Squeeze, Dynamic

4.2 The 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.

4.3 Change Summary:

The following is a general listing of the Revision A changes:

1. Added expanded dash sizes for the -104 through -109 piston and rod sizes. Glands were developed using centerline O-ring stretch calculations and fixed AS568 sizes. The minimum squeeze was set at 0.005 inches.

2. Added new hyperbolic equation in Appendix A for calculating the effect of stretch. The equation is applicable for all (ID/CX) < or = 2.95. This equation was applied to dash sizes -109 and smaller and -008 and smaller.

3. Revised the gland diameters for the -005, -006 and -007 sizes using the new equation.

4. Added the -104 to -109 sizes to Table 2, Table 3, Table 4 and Table 5.

5. Corrected error with the -026 piston OD, -215 gland OD and the -240 gland OD.

6. Added references to the new AS5781 (Single turn) and AS5782 (Solid) backup ring specifications. Added disclaimers for the use of AS8791 and "MS" backup rings.

7. Updated the Applicable Document sections with current specification references and document availability. Eliminated all references to cancelled or inactive specifications.

8. Added reference to the use of HVOF coated surfaces and recommended roughness profiles to Table 6.

9. Added text reference siting the suitable dynamic as well as static dash sizes under LIMITATION.

10. Eliminated the reference Class and Type hydraulic systems, as this document is valid up to 8000 psi.

11. Added the equivalent kPa units for psi.

12. In the Applicable Documents section, added telephone number and web site contact data.

13. Added a KEY WORD section 4.1.

14. Added a Change Summary section 4.3.

4.3 (Continued):

15. Corrected (added) the missing equation symbols (-, + etc.) in the Appendix A and B.

16. Dropped the page breaks in the Appendix A and B.

17. Added reference to the ARP4727 in 2.1.1 and 3.1.5.

18. Further amended the contact data for ASME and deleted the (ANSI) references under surface texture and surface finish.

19. Changed the use of "mean" in B.2.1 to "centerline".

PREPARED UNDER THE JURISDICTION OF
THE SEALS PANEL OF SUBCOMMITTEE A-6C, FLUID POWER DISTRIBUTION ELEMENTS OF
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APPENDIX A
O-RING SQUEEZE CALCULATIONS AND DESIGN CONSIDERATIONS

A.1 SCOPE:

This appendix provides the calculations and design considerations that were used to develop the minimum and maximum squeeze numbers listed in the last two columns of Table 1. This appendix is not a mandatory part of the specification.

A.2 CALCULATIONS:

A.2.1 Reduced Seal Cross-Section for Piston Type Glands:

A.2.1.1 For Minimum Squeeze Condition:

A.2.1.1.1 Minimum Squeeze where (seal inside diameter/seal radial cross section of the nominal O-ring size) > 2.95
(-009 and larger diameter .070 in CX seals, -110 and larger diameter .103 in CX seals, and all other CX seals for use in glands listed in Table 1)

$$RECXMINP = (MIN\ W) - [(MIN\ W) * (FACREDINCX)] \qquad \text{(Eq. A1)}$$

where:

RECXMINP = Reduced Seal Cross Section (CX) for Calculating MIN Squeeze for Piston Type Glands

W = Seal CX

FACREDINCX (Factor for Reduction in Seal CX) is defined below:

$FACREDINCX = 0$ if $X \leq 0$

or

$FACREDINCX = .0001 + 1.06X - 10X^2$ if $X \leq 0.03$ and > 0

or

$FACREDINCX = .0056 + .59X - .46X^2$ if $X > 0.03$

$$X = \frac{(MIN\ PGS - MIN\ S)}{(MIN\ S)}$$

PGD = Piston Groove Diameter
S = Seal Inside Diameter

A.2.1.1.2 Minimum Squeeze where (seal inside diameter/seal radial cross section of the nominal O-ring size) < or = 2.95
(-008 and smaller diameter .070 in CX seals, -109 and smaller diameter .103 in CX seals)

$$RECXMINP = (MIN\ W) - [(MIN\ W) * (FACREDINCX)] \quad \text{(Eq. A2)}$$

where:

RECXMINP = Reduced Seal Cross Section (CX) for Calculating MIN Squeeze for Piston Type Glands

W = Seal CX

FACREDINCX (Factor for Reduction in Seal CX) is defined below:

FACREDINCX = 0 if $X \leq 0$

or

$$FACREDINCX = 100 * X / (315 * e^{(-MIN\ S/MIN\ W)} + 165 + 100*X) \text{ if } X > 0$$

$$X = \frac{(MIN\ PGD - MIN\ S)}{(MIN\ S)}$$

A.2.1.2 For Maximum Squeeze Condition:

A.2.1.2.1 Maximum Squeeze where (seal inside diameter/seal radial cross section of the nominal O-ring size) > 2.95
(-009 and larger diameter .070 in CX seals, -110 and larger diameter .103 in CX seals, and all other CX seals for use in glands listed in Table 1)

$$RECXMAXP = (MAX\ W) - [(MAX\ W) * (FACREDINCX)] \quad \text{(Eq. A3)}$$

where:

RECXMAXP = Reduced Seal Cross Section (CX) for Calculating MAX Squeeze for Piston Type Glands

FACREDINCX is as defined above in A.2.1.1.1 except that

$$X = \frac{(MAX\ PGD - MAX\ S)}{(MAX\ S)}$$

A.2.1.2.2 Maximum Squeeze where (seal inside diameter/seal radial cross section of the nominal O-ring size) < or = 2.95
(-008 and smaller diameter .070 in CX seals, -109 and smaller diameter .103 in CX seals)

$$RECXMAXP = (MAX\ W) - [(MAX\ W) * (FACREDINCX)] \quad \text{(Eq. A4)}$$

where:

RECXMAXP = Reduced Seal Cross Section (CX) for Calculating MAX Squeeze for Piston Type Glands

W = Seal CX

FACREDINCX (Factor for Reduction in Seal CX) is defined below:

FACREDINCX = 0 if $X \leq 0$

or

$$FACREDINCX = 100 * X / (315 * e^{(-MAX\ S/MAX\ W)} + 165 + 100*X) \text{ if } X > 0$$

$$X = \frac{(MAX\ PGD - MAX\ S)}{(MAX\ S)}$$

A.2.2 Reduced Seal Cross-Section for Rod Type Glands:

A.2.2.1 For Minimum Squeeze Condition:

A.2.2.1.1 Minimum Squeeze where (seal inside diameter/seal radial cross section of the nominal O-ring size) > 2.95
(-009 and larger diameter .070 in CX seals, -110 and larger diameter .103 in CX seals, and all other CX seals for use in glands listed in Table 1)

$$RECXMINR = (MIN\ W) - [(MIN\ W) * (FACREDINCX)] \quad \text{(Eq. A5)}$$

where:

RECXMINR = Reduced Seal Cross Section (CX) for Calculating MIN Squeeze for Rod Type Glands

W = Seal CX