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MILITARY SPECIFICATION

GLAND DESIGN; PACKINGS, HYDRAULIC, GENERAL REQUIREMENTS FOR

This specification is mandatory for use by all Departments and Agencies of the Department of Defense.

1. SCOPE

1.1 Scope.- This specification covers basic design criteria recommendations for use and application in packings, gaskets, packing and gasket glands (see 4.2), and related features for use in hydraulic equipment utilized in systems designed in accordance with MIL-H-5440.

1.2 Classification.- Hydraulic system packings and gaskets shall be of the following types and classes:

Types	Temperature range
Type I	-65° to +160° F
Type II	-65° to +275° F
Type III	-65° to +450° F

Classes
- Class 1, 1,500 psi - Where the unit operating pressure at the packing is a normal 1,500 pounds per square inch (psi).
- Class 2, 3,000 psi - Where the unit operating pressure at the packing is a normal 3,000 psi.

2. APPLICABLE DOCUMENTS

2.1 The following documents, of the issue in effect on date of invitation for bids or request for proposal, form a part of this specification to the extent specified herein:

* SPECIFICATIONS

Military

MIL-P-5510	Packing, Preformed Straight Thread Tube Fitting Boss
MIL-P-5516	Packing Preformed, Petroleum Hydraulic Fluid Resistant, 160° F
MIL-H-5606	Hydraulic Fluid, Petroleum Base, Aircraft, Missile and Ordnance
MIL-P-25732	Packing, Preformed, Petroleum Hydraulic Fluid Resistant, 275° F

FSC 1650

* STANDARDS

Military

MS27595	Retainer, Packing Backup, Continuous Ring, Tetrafluoroethylene
MS28772	Packing, D-Ring, Shock Strut
MS28773	Retainer, Packing Backup, Tetrafluoroethylene, Straight Thread Tube Fitting Boss
MS28774	Retainer, Packing Backup, Single Turn, Tetrafluoroethylene
MS28775	Packing, Preformed, Hydraulic, +275° F (O-Ring)
MS28778	Packing, Preformed, Straight Thread Tube Fitting Boss
MS28782	Retainer, Packing, Back-Up, Teflon
MS28783	Ring, Gasket, Back-up, Teflon
MS33514	Fitting End, Standard Dimensions for Flareless Tube Connection and Gasket Seal
MS33515	Fitting End, Standard Dimensions for Bulkhead Flareless Tube Connections
MS33566	Fittings, Installation of Flareless Tube, Straight-Threaded Connectors
MS33656	Fitting End, Standard Dimensions for Flared Tube Connection and Gasket Seal
MS33649	Bosses, Fluid Connection - Internal Straight Thread
MS33657	Fitting End, Standard Dimensions for Bulkhead Flared Tube Connections
AN6227	Packing, O-Ring Hydraulic
AN6230	Gasket, O-Ring Hydraulic
AND10064	Fittings, Installation of Flared Tube, Straight Threaded Connectors

(Copies of specifications, standards, drawings, and publications required by suppliers in connection with specific procurement functions should be obtained from the procuring activity or as directed by the contracting officer.)

2.2 Other publications.- The following document forms a part of this specification to the extent specified herein. Unless otherwise indicated, the issue in effect on date of invitation for bids or request for proposal, shall apply.

United States of America Standards Institute

USASI B46.1 - 1962	Surface Texture (Surface Roughness, Waviness, and Lay)

(Application for copies should be addressed to the United States of America Standards Institute, 10 East 40th Street, New York, New York 10017.)

3. REQUIREMENTS

3.1 General design requirements for hydraulic units.-

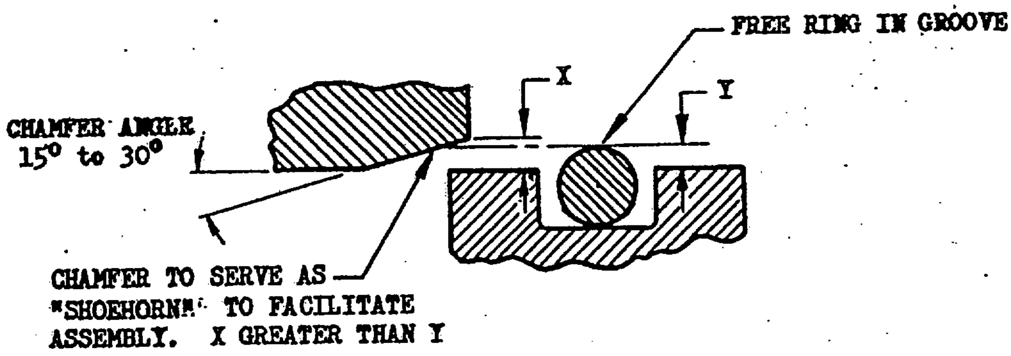
3.1.1 Installation of packings.- Mechanisms shall be so designed that no damage to the packings would be incurred on installation by passing the packings over threads or other sharp corners. The diameters or threads over which, or through which, packings confined in glands must be inserted at installation, shall be of such size that there will be a diametrical clearance between the packings and the thread at the most unfavorable extreme tolerances. Chamfered edge annular undercuts shall be used at all cross-holes; in addition, chamfers shall be used at the ends of bores with sloped areas clear of intersecting holes. This is required because where a packing under squeeze (see 4.2) crosses even a round edge cross-hole, it may be partially severed as a result of localized protrusion. Typical methods of undercutting and chamfering, as well as illustration of pinched packings, which are to be avoided, are shown in figure 1.

3.1.2 Operation over unrestrained areas.- Mechanisms which require that the packing pass over holes, ports, step diameters, etc., which would leave the ID, OD, or sides of the seal (see 4.2) unrestrained during its normal operation, shall be avoided. If, however, it is necessary to deviate from the above, qualification tests satisfactory to the Services must be performed to substantiate the design. In such tests, consideration shall be given to: (a) Use of the appropriate highest swell-approved packings, (b) aging in the appropriate highest swell-approved fluid, (c) adverse maximum packing squeeze if such test conditions are warranted by analysis of the particular design. The Services will designate the applicable high-swell packing and fluid upon request.

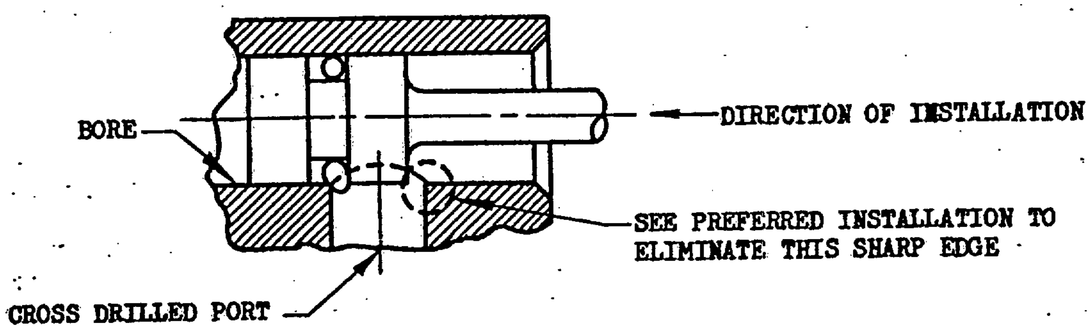
3.1.2.1 Dynamic seal (see 4.2) travel.- A running seal gland shall be so located in a component that the leading edge of the groove or gland, at its position of extreme travel or adjustment, including adverse tolerances, shall remain sufficiently distant from the nearest edge of any chamfer, undercut, or other departure from the bore, or equivalent diameter, that there can be no extrusion, cutting, or other damage to the seal throughout the operating pressure and temperature ranges. In general, the same practice applies to static seals (see 4.2).

3.1.3 Gland materials.- Materials used in the manufacture of packing glands shall be in accordance with the requirements of the detail specification. All material used in packing glands shall satisfactorily resist corrosion during its normal service life.

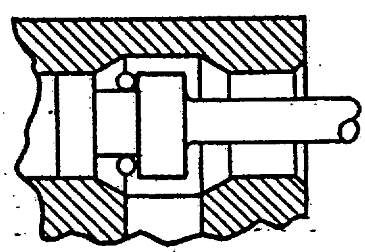
3.1.4 O-ring packing gland dimensions.- O-ring packing glands, both nominal and otherwise, should be made to the recommended requirements indicated herein. A nominal O-ring installation shall be considered one that uses a cylinder bore or piston rod having the equivalent dimensions (see figure 2) and corresponding to the O-rings as listed in table I herein. Nominal glands shall be used wherever possible.



BEVEL ON PACKING INSTALLATION

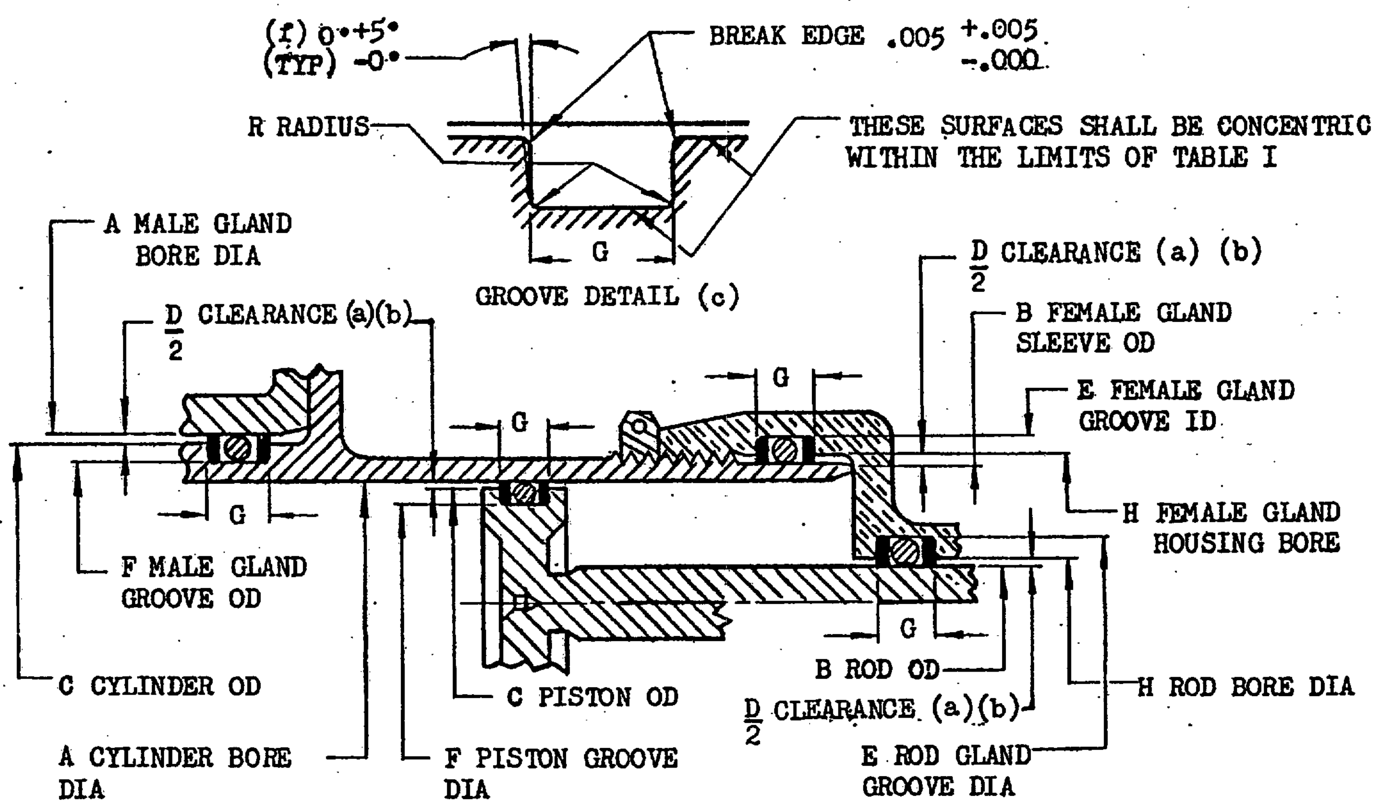


PREFERRED INSTALLATION



UNDERCUT BORE AS INDICATED

FIGURE 1. Methods to avoid sharp installation corners



(SEE TABLE I FOR DIMENSIONS.)

(a) DIAMETRICAL CLEARANCE IS THE TOTAL DIFFERENCE BETWEEN THE BORE ID AND THE MEMBER CONTAINED THEREIN.
(b) SEE 3.5.4 IF USING STATIC O-RING SEALS.
(c) TOTAL INDICATOR READING, BETWEEN GROOVE AND ADJACENT BEARING SURFACE. SEE GROOVE DETAIL.
(d) ONE OR TWO NONEXTRUSION RINGS SHALL BE USED IN ACCORDANCE WITH 3.4.3.
(e) CAUTION SHOULD BE OBSERVED TO INSURE THAT THE RADIUS USED AT THE BOTTOM OF THE GLAND DOES NOT RESULT IN NOTCH SENSITIVITY OF THE GLAND DESIGN OR CREATE AN INSTALLATION PROBLEM.
(f) FOR THE GROOVE ANGLE, BETTER PERFORMANCE IS OBTAINED AT THE 0 DEGREE ANGLE.
(g) EITHER THE GROOVE DIAMETER DIMENSION OR THE OPPOSING SEALING SURFACE DIMENSION MAY BE HELD WITHIN CLOSER LIMITS THAN THOSE SPECIFIED TO GAIN ADDITIONAL MACHINING TOLERANCE ON ITS OPPOSING DIMENSION, PROVIDED THE ACCUMULATED TOLERANCE OF THE TWO DIMENSIONS DOES NOT EXCEED THAT SPECIFIED.

EXAMPLE: FOR AN MS28775-221 O-RING
"A" DIAMETER MAY BE HELD TO 1.678/1.679
IN LIEU OF 1.678/1.680 TO GAIN AN "F" DIAMETER
DIMENSION OF 1.435/1.432 IN LIEU OF 1.435/1.433.

FIGURE 2. Gland design

TABLE I

O-RING GLAND DIMENSIONS

AN6227 DASH NO.	AN6230 DASH NO.	MS28775 DASH NO.	SEAL INSTALLATION DIMENSIONS: EXTERNAL: "C" PISTON OR CYLINDER OD	EXTERNAL: "A" CYLINDER BORE OR MALE GLAND CYLINDER BORE ID	EXTERNAL: "F" GROOVE OD	INTERNAL: "B" ROD OR GLAND SLEEVE OD	INTERNAL: "H" ROD BORE OR FEMALE GLAND HOUSING BORE ID	INTERNAL: "E" GROOVE ID	DIAMETRAL CLEARANCE (a) "D" MAX. EXT.	DIAMETRAL CLEARANCE (a) "D" MAX. INT.	SQUEEZE MINIMUM ACTUAL	SQUEEZE MINIMUM PERCENT (REF)	SQUEEZE MAXIMUM ACTUAL	SQUEEZE MAXIMUM PERCENT (REF)	GROOVE WIDTH G: NO BACKUP RING	GROOVE WIDTH G: ONE BACKUP RING	GROOVE WIDTH G: TWO BACKUP RINGS	GROOVE CORNER RADIUS	ECCENTRICITY (c)	O-RING CROSS SECTION	O-RING INSIDE DIAMETER	
		001	.093 .092	.095 .096	.033 .032	.033 .038	.035 .036	.095 .096	.004	.004	.005	13.5	.012	27.9	.063 .073			.015 .005	.002	.040 ±.003	.029 ±.004	
		002	.126 .125	.128 .129	.048 .047	.048 .047	.050 .051	.128 .129			.006	12.8	.013	24.5	.073 .083					.050 ±.003	.042	
		003	.157 .156	.159 .160	.063 .062	.063 .062	.065 .066	.159 .160			.008	14.0	.015	23.8	.083 .093					.060 ±.003	.056	
		004	.188 .187	.190 .191	.076 .075	.076 .075	.078 .079	.190 .191			.009	13.4	.016	21.9	.094 .104	.149 .159	.207 .217			.070 ±.003	.070	
		005	.219 .218	.221 .222	.108 .107	.108 .107	.010 .011	.221 .222			.0095	14.2	.0165	22.6							.101 ±.004	
1		006	.233 .232	.235 .236	.123 .122	.123 .122	.125 .126	.235 .236			.010	13.4	.017	23.3							.114 ±.005	
2		007	.264 .263	.266 .267	.154 .153	.154 .153	.156 .157	.266 .267													.145	
3		008	.295 .294	.297 .298	.185 .184	.185 .184	.187 .188	.297 .298													.176	
4		009	.327 .326	.329 .330	.217 .216	.217 .216	.219 .220	.329 .330													.208	
5		010	.358 .357	.360 .361	.248 .247	.248 .247	.250 .251	.360 .361													.239	
6		011	.420 .419	.422 .423	.310 .309	.310 .309	.312 .313	.422 .423													.301	
7		012	.483 .482	.485 .486	.373 .372	.373 .372	.375 .376	.485 .486	.004	.004	.010	13.4	.017	23.3	.094 .104	.149 .159	.207 .217	.015 .005	.002	.070 ±.003	.364 ±.005	
		013	.548 .547	.550 .552	.438 .436	.435 .433	.437 .438	.547 .549	.005	.005	.009	13.4	.017	23.3	.094 .104	.149 .159	.207 .217	.015 .005	.002	.070 ±.003	.426 ±.005	STATIC APPLICATIONS ONLY
		014	.611 .610	.613 .615	.501 .499	.498 .496	.500 .501	.610 .612													.489	
		015	.673 .672	.675 .677	.563 .561	.560 .558	.562 .563	.672 .674													.551	
		016	.736 .735	.738 .740	.626 .624	.623 .621	.625 .626	.735 .737													.614	
		017	.798 .797	.800 .802	.688 .686	.685 .683	.687 .688	.797 .799													.676	
		018	.861 .860	.863 .865	.751 .749	.748 .746	.750 .751	.860 .862													.739 ±.005	
		019	.923 .922	.925 .927	.813 .811	.810 .808	.812 .813	.922 .924													.801 ±.006	
		020	.989 .988	.991 .993	.879 .877	.873 .871	.875 .876	.985 .987													.864	
		021	1.051 1.050	1.053 1.055	.941 .939	.935 .933	.937 .938	1.047 1.049													.926	
		022	1.114 1.113	1.116 1.118	1.004 1.002	.998 .996	1.000 1.001	1.110 1.112													.989	
		023	1.176 1.175	1.178 1.180	1.066 1.064	1.060 1.058	1.062 1.063	1.172 1.174													1.051	
		024	1.239 1.238	1.241 1.243	1.129 1.127	1.123 1.121	1.125 1.126	1.235 1.237													1.114	
		025	1.301 1.300	1.303 1.305	1.191 1.189	1.185 1.183	1.187 1.188	1.297 1.299													1.176	
		026	1.364 1.363	1.366 1.368	1.254 1.252	1.248 1.246	1.250 1.251	1.360 1.362													1.239	
		027	1.426 1.425	1.428 1.430	1.316 1.314	1.310 1.308	1.312 1.313	1.422 1.424													1.301	
		028	1.489 1.488	1.491 1.493	1.379 1.377	1.373 1.371	1.375 1.376	1.485 1.487	.005	.005	.009	13.4	.017	23.3	.094 .104	.149 .159	.207 .217	.015 .005	.002	.070 ±.003	1.364 ±.006	
8		110	.548 .547	.550 .552	.372 .370	.373 .371	.375 .376	.551 .553	.005	.005	.009	9.0	.017	16.0	.141 .151	.183 .193	.245 .255	.015 .005	.002	.103 ±.003	.362 ±.005	
9		111	.611 .610	.613 .615	.435 .433	.435 .433	.437 .438	.613 .615													.424	
10		112	.673 .672	.675 .677	.497 .495	.498 .496	.500 .501	.676 .678													.487	
11		113	.736 .735	.738 .740	.560 .558	.560 .558	.562 .563	.738 .740													.549	
12		114	.798 .797	.800 .802	.622 .620	.623 .621	.625 .626	.801 .803													.612	
13		115	.861 .860	.863 .865	.685 .683	.685 .683	.687 .688	.863 .865													.674	
14		116	.923 .922	.925 .927	.747 .745	.748 .746	.750 .751	.926 .928	.005	.005	.009	9.0	.017	16.0	.141 .151	.183 .193	.245 .255	.015 .005	.002	.103 ±.003	.737 ±.005	
		117	.989 .988	.991 .993	.813 .811	.810 .808	.812 .813	.988 .990	.005	.005	.009	9.0	.017	16.0	.141 .151	.183 .193	.245 .255	.015 .005	.002	.103 ±.003	.799 ±.006	STATIC APPLICATIONS ONLY
		118	1.051 1.050	1.053 1.055	.875 .873	.873 .871	.875 .876	1.051 1.053													.862	
		119	1.114 1.113	1.116 1.118	.938 .936	.935 .933	.937 .938	1.113 1.115													.924	
		120	1.176 1.175	1.178 1.180	1.000 .998	.998 .996	1.000 1.001	1.176 1.178													.987	
		121	1.239 1.238	1.241 1.243	1.063 1.061	1.060 1.058	1.062 1.063	1.238 1.240													1.049	
		122	1.301 1.300	1.303 1.305	1.125 1.123	1.123 1.121	1.125 1.126	1.301 1.303	.005	.005	.009	9.0	.017	16.0	.141 .151	.183 .193	.245 .255	.015 .005	.002	.103 ±.003	1.112 ±.006	

TABLE I. (Continued)

O-RING GLAND DIMENSIONS

STATIC APPLICATIONS ONLY (MS28775 dash nos. 123 through 149)

			SEAL INSTALLATION DIMENSIONS – EXTERNAL			SEAL INSTALLATION DIMENSIONS – INTERNAL			DIAMETRAL CLEARANCE (a) "D" MAX.		SQUEEZE – MINIMUM		SQUEEZE – MAXIMUM		GROOVE WIDTH G						
AN6227 DASH NO.	AN6230 DASH NO.	MS28775 DASH NO.	"C" PISTON OR CYLINDER OD	"A" CYLINDER BORE OR MALE GLAND CYLINDER BORE ID	"F" GROOVE OD	"B" ROD OR GLAND SLEEVE OD	"H" ROD BORE OR FEMALE GLAND HOUSING BORE ID	"E" GROOVE ID	EXT.	INT.	ACTUAL	PERCENT (REF)	ACTUAL	PERCENT (REF)	NO BACKUP RING	ONE BACKUP RING	TWO BACKUP RINGS	GROOVE CORNER RADIUS	ECCENTRICITY (c)	"W" O-RING CROSS SECTION	O-RING INSIDE DIAMETER
		123	1.364 1.363	1.366 1.368	1.188 1.186	1.185 1.183	1.187 1.188	1.363 1.365	.005	.005	.009	9.0	.017	16.0	.141 .151	.183 .193	.245 .255	.015 .005	.002	.103 ±.003	1.174 ±.006
		124	1.426 1.425	1.428 1.430	1.250 1.248	1.248 1.246	1.250 1.251	1.426 1.428													1.237
		125	1.489 1.488	1.491 1.493	1.313 1.311	1.310 1.308	1.312 1.313	1.488 1.490													1.299
		126	1.551 1.550	1.553 1.555	1.375 1.373	1.373 1.371	1.375 1.376	1.551 1.553		.005											1.362
		127	1.614 1.613	1.616 1.618	1.438 1.436	1.435 1.433	1.437 1.439	1.613 1.615		.006											1.424
		128	1.676 1.675	1.678 1.680	1.500 1.498	1.498 1.496	1.500 1.502	1.676 1.678													1.487 ±.006
		129	1.739 1.738	1.741 1.743	1.563 1.561	1.560 1.558	1.562 1.564	1.738 1.740	.005												1.549 ±.010
		130	1.802 1.801	1.805 1.807	1.627 1.625	1.623 1.621	1.625 1.627	1.801 1.803	.006												1.612
		131	1.864 1.863	1.867 1.869	1.689 1.687	1.685 1.683	1.687 1.689	1.863 1.865													1.674
		132	1.927 1.926	1.930 1.932	1.752 1.750	1.748 1.746	1.750 1.752	1.926 1.928		.006											1.737
		133	1.989 1.988	1.992 1.994	1.814 1.812	1.810 1.808	1.813 1.815	1,988 1.990		.007											1.799
		134	2.052 2.051	2.055 2.057	1.877 1.875	1.873 1.871	1.876 1.878	2.051 2.053													1.862
		135	2.115 2.114	2.118 2.120	1.940 1.938	1.936 1.934	1.939 1.941	2.114 2.116													1.925
		136	2.177 2.176	2.180 2.182	2.002 2.000	1.998 1.996	2.001 2.003	2.176 2.178													1.987
		137	2.240 2.239	2.243 2.245	2.065 2.063	2.061 2.059	2.064 2.066	2.239 2.241													2.050
		138	2.302 2.301	2.305 2.307	2.127 2.125	2.123 2.121	2.126 2.128	2.301 2.303													2.112
		139	2.365 2.364	2.368 2.370	2.190 2.188	2.186 2.184	2.189 2.191	2.364 2.366													2.175
		140	2.427 2.426	2.430 2.432	2.252 2.250	2.248 2.246	2.251 2.253	2.426 2.428	.006												2.237
		141	2.490 2.488	2.493 2.495	2.315 2.313	2.311 2.309	2.314 2.316	2.489 2.491	.007												2.300
		142	2.552 2.550	2.555 2.557	2.377 2.375	2.373 2.371	2.376 2.378	2.551 2.553													2.362
		143	2.615 2.613	2.618 2.620	2.440 2.438	2.436 2.434	2.439 2.441	2.614 2.616													2.425
		144	2.677 2.675	2.680 2.682	2.502 2.500	2.498 2.496	2.501 2.503	2.676 2.678													2.487
		145	2.740 2.738	2.743 2.745	2.565 2.563	2.561 2.559	2.564 2.566	2.739 2.741													2.550
		146	2.802 2.800	2.805 2.807	2.627 2.625	2.623 2.621	2.626 2.628	2.801 2.803													2.612 ±.010
		147	2.865 2.863	2.868 2.870	2.690 2.688	2.686 2.684	2.689 2.691	2.864 2.866													2.675 ±.015
		148	2.927 2.925	2.930 2.932	2.752 2.750	2.748 2.746	2.751 2.753	2.926 2.928													2.737
		149	2.990 2.888	2.993 2.995	2.815 2.813	2.811 2.809	2.814 2.816	2.989 2.991	.007	.007	.009	9.0	.017	16.0	.141 .151	.183 .193	.245 .255	.015 .005	.002	.103 ±.003	2.800 ±.015
15		210	.989 .988	.991 .993	.748 .746	.748 .746	.750 .751	.991 .993	.005	.005	.0115	8.5	.0215	15.0	.188 .198	.235 .245	.304 .314	.025 .010	.003	.139 ±.004	.734 ±.006
16		211	1.051 1.050	1.053 1.055	.810 .808	.810 .808	.812 .813	1.053 1.055													.796
17		212	1.114 1.113	1.116 1.118	.873 .871	.873 .871	.875 .876	1.116 1.118													.859
18		213	1.176 1.175	1.178 1.180	.935 .933	.935 .933	.937 .938	1.178 1.180													.921
19		214	1.239 1.238	1.241 1.243	.998 .996	.998 .996	1.000 1.001	1.241 1.243													.984
20		215	1.301 1.300	1.303 1.305	1.060 1.058	1.060 1.058	1.062 1.063	1.303 1.305													1.046
21		216	1.364 1.363	1.366 1.368	1.123 1.121	1.123 1.121	1.125 1.126	1.366 1.368													1.109
22		217	1.426 1.425	1.428 1.430	1.185 1.183	1.185 1.183	1.187 1.188	1.428 1.430													1.171
23		218	1.489 1.488	1.491 1.493	1.248 1.246	1.248 1.246	1.250 1.251	1.491 1.493													1.234
24		219	1.551 1.550	1.553 1.555	1.310 1.308	1.310 1.308	1.312 1.313	1.553 1.555													1.296
25		220	1.614 1.613	1.616 1.618	1.373 1.371	1.373 1.371	1.375 1.376	1.616 1.618													1.359
26		221	1.676 1.675	1.678 1.680	1.435 1.433	1.435 1.433	1.437 1.438	1.678 1.680													1.421
27		222	1.739 1.738	1.741 1.743	1.498 1.496	1.498 1.496	1.500 1.501	1.741 1.743	.005	.005	.0115	8.5	.0215	15.0	.188 .198	.235 .245	.304 .314	.025 .010	.003	.139 ±.004	1.484 ±.006

TABLE I (Continued)

O-RING GLAND DIMENSIONS

AN6227 DASH NO.	AN6230 DASH NO.	MS28775 DASH NO.	SEAL INSTALLATION DIMENSIONS: EXTERNAL: "C" PISTON OR CYLINDER OD	"A" CYLINDER BORE OR MALE GLAND CYLINDER BORE ID	"F" GROOVE OD	INTERNAL: "B" ROD OR GLAND SLEEVE OD	"H" ROD BORE OR FEMALE GLAND HOUSING BORE ID	"E" GROOVE ID	DIAMETRAL CLEARANCE (a) "D" MAX. EXT.	INT.	SQUEEZE: MINIMUM ACTUAL	PERCENT (REF)	MAXIMUM ACTUAL	PERCENT (REF)	GROOVE WIDTH G: NO BACKUP RING	ONE BACKUP RING	TWO BACKUP RINGS	GROOVE CORNER RADIUS	ECCENTRICITY (c)	O-RING CROSS SECTION	O-RING INSIDE DIAMETER
	1	223	1.864 1.863	1.867 1.869	1.624 1.622	1.623 1.621	1.625 1.627	1.866 1.868	.006	.006	.0115	8.5	.0215	15.0	.188 .198	.235 .245	.304 .314	.025 .010	.003	.139 ±.004	1.609 ±.010
	2	224	1.989 1.988	1.992 1.994	1.749 1.747	1.748 1.746	1.750 1.752	1.991 1.993		.006											1.734
	3	225	2.115 2.114	2.118 2.120	1.875 1.873	1.873 1.871	1.876 1.878	2.116 2.118		.007											1.859
	4	226	2.240 2.239	2.243 2.245	2.000 1.998	1.998 1.996	2.001 2.003	2.241 2.243													1.984
	5	227	2.365 2.364	2.368 2.370	2.125 2.123	2.123 2.121	2.126 2.128	2.366 2.368	.006												2.109
	6	228	2.490 2.488	2.493 2.495	2.250 2.248	2.248 2.246	2.251 2.253	2.491 2.493	.007												2.234
	7	229	2.615 2.613	2.618 2.620	2.375 2.373	2.373 2.371	2.376 2.378	2.616 2.618													2.359
	8	230	2.740 2.738	2.743 2.745	2.500 2.498	2.498 2.496	2.501 2.503	2.741 2.743													2.484
	9	231	2.865 2.863	2.868 2.870	2.625 2.623	2.623 2.621	2.626 2.628	2.866 2.868													2.609 ±.010
	10	232	2.990 2.988	2.993 2.995	2.750 2.748	2.748 2.746	2.751 2.753	2.991 2.993													2.734 ±.015
	11	233	3.115 3.113	3.118 3.120	2.875 2.873	2.873 2.871	2.876 2.878	3.116 3.118													2.859
	12	234	3.240 3.238	3.243 3.245	3.000 2.998	2.997 2.995	3.000 3.002	3.240 3.242													2.984
	13	235	3.365 3.363	3.368 3.370	3.125 3.123	3.122 3.120	3.125 3.127	3.365 3.367													3.109
	14	236	3.490 3.488	3.493 3.495	3.250 3.248	3.247 3.245	3.250 3.252	3.490 3.492													3.234
	15	237	3.615 3.613	3.618 3.620	3.375 3.373	3.372 3.370	3.375 3.377	3.615 3.617													3.359
	16	238	3.740 3.738	3.743 3.745	3.500 3.498	3.497 3.495	3.500 3.502	3.740 3.742													3.484
	17	239	3.865 3.863	3.868 3.870	3.625 3.623	3.622 3.620	3.625 3.627	3.865 3.867													3.609
	18	240	3.990 3.988	3.993 3.995	3.750 3.748	3.747 3.745	3.750 3.752	3.990 3.992													3.734
	19	241	4.115 4.113	4.118 4.120	3.875 3.873	3.872 3.870	3.875 3.877	4.115 4.117													3.859
	20	242	4.240 4.238	4.243 4.245	4.000 3.998	3.997 3.995	4.000 4.002	4.240 4.242													3.984
	21	243	4.365 4.363	4.368 4.370	4.125 4.123	4.122 4.120	4.125 4.127	4.365 4.367	.007												4.109
	22	244	4.489 4.487	4.493 4.495	4.250 4.248	4.247 4.245	4.250 4.252	4.490 4.492	.008												4.234
	23	245	4.614 4.612	4.618 4.620	4.375 4.373	4.372 4.370	4.375 4.377	4.615 4.617		.007											4.359
	24	246	4.739 4.737	4.743 4.745	4.500 4.498	4.497 4.495	4.501 4.503	4.740 4.742		.008											4.484
	25	247	4.864 4.862	4.868 4.870	4.625 4.623	4.622 4.620	4.626 4.628	4.865 4.867	.008	.008	.0115	8.5	.0215	15.0	.188 .198	.235 .245	.304 .314	.025 .010	.003	.139 ±.004	4.609 ±.015
28		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	.006	.006	.017	8.3	.029	13.5	.281 .291	.334 .344	.424 .434	.035 .020	.004	.210 ±.005	1.475 ±.010
29		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													1.600
30		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		.006											1.725
31		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		.007											1.850
32		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	.006												1.975
33		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	.007												2.100
34		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													2.225
35		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													2.350
36		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													2.475
37		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													2.600 ±.010
38		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													2.725 ±.015
39		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			.017	8.3									2.850
40		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			.017	8.1									2.975
41		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													3.100
42		339	3.615 3.613	3.618 3.620	3.246 3.244	3.247 3.245	3.250 3.252	3.619 3.621													3.225
43		340	3.740 3.738	3.743 3.745	3.371 3.369	3.372 3.370	3.375 3.377	3.744 3.746													3.350
44		341	3.865 3.863	3.868 3.870	3.496 3.494	3.497 3.495	3.500 3.502	3.869 3.871	.007	.007	.017	8.1	.029	13.5	.281 .291	.334 .344	.424 .434	.035 .020	.004	.210 ±.005	3.475 ±.015

STATIC APPLICATIONS ONLY (dash nos. 1 through 25)

TABLE I (Continued)

O-RING GLAND DIMENSIONS

AN6227 DASH NO.	AN6230 DASH NO.	MS28775 DASH NO.	SEAL INSTALLATION DIMENSIONS – EXTERNAL – "C" PISTON OR CYLINDER OD	EXTERNAL – "A" CYLINDER BORE OR MALE GLAND CYLINDER BORE ID	EXTERNAL – "F" GROOVE OD	INTERNAL – "B" ROD OR GLAND SLEEVE OD	INTERNAL – "H" ROD BORE OR FEMALE GLAND HOUSING BORE ID	INTERNAL – "K" GROOVE ID	DIAMETRAL CLEARANCE (a) "D" MAX. EXT.	DIAMETRAL CLEARANCE (a) "D" MAX. INT.	SQUEEZE – MINIMUM – ACTUAL	SQUEEZE – MINIMUM – PERCENT (REF)	SQUEEZE – MAXIMUM – ACTUAL	SQUEEZE – MAXIMUM – PERCENT (REF)	GROOVE WIDTH G – NO BACKUP RING	GROOVE WIDTH G – ONE BACKUP RING	GROOVE WIDTH G – TWO BACKUP RINGS	GROOVE CORNER RADIUS	ECCENTRICITY (c)	O-RING CROSS SECTION	O-RING INSIDE DIAMETER
45		342	3.990 3.988	3.993 3.995	3.621 3.619	3.622 3.620	3.625 3.627	3.994 3.996	.007	.007	.017	8.1	.029	13.5	.281 .291	.334 .344	.424 .434	.035 .020	.004	.210 ±.005	3.600 ±.015
46		343	4.115 4.113	4.118 4.120	3.746 3.744	3.747 3.745	3.750 3.752	4.119 4.121													3.725
47		344	4.240 4.238	4.243 4.245	3.871 3.869	3.872 3.870	3.875 3.877	4.244 4.246													3.850
48		345	4.365 4.363	4.368 4.370	3.996 3.994	3.997 3.995	4.000 4.002	4.369 4.371	.007												3.975
49		346	4.489 4.487	4.493 4.495	4.121 4.119	4.122 4.120	4.125 4.127	4.494 4.496	.008												4.100
50		347	4.614 4.612	4.618 4.620	4.246 4.244	4.247 4.245	4.250 4.252	4.619 4.621													4.225
51		348	4.739 4.737	4.743 4.745	4.371 4.369	4.372 4.370	4.375 4.377	4.744 4.746													4.350
52		349	4.864 4.862	4.868 4.870	4.496 4.494	4.498 4.495	4.500 4.502	4.869 4.871	.008	.007	.017	8.1	.029	13.5	.281 .291	.334 .344	.424 .434		.004	.210 ±.005	4.475
38		425	4.970 4.968	4.974 4.977	4.497 4.494	4.497 4.494	4.501 4.503	4.974 4.977	.009	.009	.027	10.2	.0425	15.1	.375 .385	.475 .485	.579 .589		(e)	.275 ±.006	4.475
53		426	5.095 5.093	5.099 5.102	4.622 4.619	4.622 4.619	4.626 4.628	5.099 5.102													4.600
54		427	5.220 5.218	5.224 5.227	4.747 4.744	4.747 4.744	4.751 4.753	5.224 5.227													4.725
55		428	5.345 5.343	5.349 5.352	4.872 4.869	4.872 4.869	4.876 4.878	5.349 5.352													4.850
56		429	5.470 5.468	5.474 5.477	4.997 4.994	4.997 4.994	5.001 5.003	5.474 5.477													4.975 ±.015
57		430	5.595 5.593	5.599 5.602	5.122 5.119	5.122 5.119	5.126 5.128	5.599 5.602													5.100 ±.023
58		431	5.720 5.718	5.724 5.727	5.247 5.244	5.247 5.244	5.251 5.253	5.724 5.727													5.225
59		432	5.845 5.843	5.849 5.852	5.372 5.369	5.372 5.369	5.376 5.378	5.849 5.852													5.350
60		433	5.970 5.968	5.974 5.977	5.497 5.494	5.497 5.494	4.501 5.503	5.974 5.977													5.475
61		434	6.095 6.093	6.099 6.102	5.622 5.619	5.622 5.619	5.626 5.628	6.099 6.102													5.600
62		435	6.220 6.218	6.224 6.227	5.747 5.744	5.747 5.744	5.751 5.753	6.224 6.227													5.725
63		436	6.345 6.343	6.349 6.352	5.872 5.869	5.872 5.869	5.876 5.878	6.349 6.352													5.850
64		437	6.470 6.468	6.474 6.477	5.997 5.994	5.997 5.994	5.501 5.503	6.474 6.477													5.975
65		438	6.720 6.718	6.724 6.727	6.247 6.244	6.247 6.244	6.251 6.253	6.724 6.727		.009											6.225
66		439	6.970 6.968	6.974 6.977	6.497 6.494	6.497 6.494	6.501 6.504	6.974 6.977		.010											6.475
67		440	7.220 7.218	7.224 7.227	6.747 6.744	6.747 6.744	6.751 6.754	7.224 7.227													6.725
68		441	7.470 7.468	7.474 7.477	6.997 6.994	6.997 6.994	7.001 7.004	7.474 6.477													6.975 ±.023
69		442	7.720 7.718	7.724 7.727	7.247 7.244	7.247 7.244	7.251 7.254	7.724 7.727													7.225 ±.030
70		443	7.970 7.968	7.974 7.977	7.497 7.494	7.497 7.494	7.501 7.504	7.974 7.977													7.475
71		444	8.220 8.218	8.224 8.227	7.747 7.744	7.747 7.744	7.751 7.754	8.224 8.227													7.725
72		445	8.470 8.468	8.474 8.477	7.997 7.994	7.997 7.994	8.001 8.004	8.474 8.477	.009												7.975
73		446	8.970 8.967	8.974 8.977	8.497 8.494	8.497 8.494	8.501 8.504	8.974 8.977	.010		.026	10.2									8.475
74		447	9.470 9.467	9.474 9.478	8.997 8.994	8.997 8.994	9.001 9.004	9.474 9.478	.011		.027	9.9									8.975
75		448	9.970 9.967	9.974 9.978	9.497 9.494	9.497 9.494	9.501 9.504	9.974 9.978													9.475
76		449	10.470 10.467	10.474 10.478	9.997 9.994	9.997 9.994	10.001 10.004	10.474 10.478													9.975
77		450	10.970 10.967	10.974 10.978	10.497 10.494	10.497 10.494	10.501 10.504	10.974 10.978													10.475
78		451	11.470 11.467	11.474 11.478	10.997 10.994	10.997 10.994	11.001 11.004	11.474 11.478													10.975
79		452	11.970 11.967	11.974 11.978	11.497 11.494	11.497 11.494	11.501 11.504	11.974 11.978													11.475
80		453	12.470 12.467	12.474 12.478	11.997 11.994	11.997 11.994	12.001 12.004	12.474 12.478													11.975
81		454	12.970 12.967	12.974 12.978	12.497 12.494	12.497 12.494	12.501 12.504	12.974 12.978													12.475
82		455	13.470 13.467	13.474 13.478	12.997 12.994	12.997 12.994	13.001 13.004	13.474 13.478													12.975
83		456	13.970 13.967	13.974 13.978	13.497 13.494	13.497 13.494	13.501 13.504	13.974 13.978													13.475
84		457	14.470 14.467	14.474 14.478	13.997 13.994	13.997 13.994	14.001 14.004	14.474 14.478													13.975
85		458	14.970 14.967	14.974 14.978	14.497 14.494	14.497 14.494	14.501 14.504	14.974 14.978													14.475
86		459	15.470 15.467	15.474 15.478	14.997 14.994	14.997 14.994	15.001 15.004	15.474 15.478													14.975
87		460	15.970 15.967	15.974 15.978	15.497 15.494	15.497 15.494	15.501 15.504	15.974 15.978	.011	.010	.027	9.9	.0425	15.1	.375 .385	.475 .485	.579 .589	.035 .020	(e)	.275 ±.006	15.475 ±.030

TABLE I (Continued)

NOTE: Caution should be used in applying the -001 through -005 sizes. While being installed in an external groove, they might be stretched beyond the elastic limit, with probable failures or incipient failures resulting. Moreover, there is no standard backup ring for -001 through -003; therefore, for pressures in excess of 1500 PSI the diametral clearance (extrusion gap) must be reduced.

It is recommended that wherever possible, O-rings with a larger cross sectional diameter ("W" dimension) be used in preference to -020 through -028 and -131 through -149, so as to provide a more adequate seal. Therefore, these sizes are not preferred.

3.1.4.1 Nominal sized installations.- Dimensions, tolerances, and allowable eccentricities for piston rods, cylinder bores, and rod and head gland groove diameters, lengths and shapes, and allowable diametrical clearances for nominal O-ring installations shall be carefully selected and closely controlled in order to provide for required service life, prevention of extrusion, minimum leakage, and freedom from binding throughout the required range of operating temperatures and pressures. For glands to seal up to and including 2,500 psi pressure, the data given in table I of this specification, under the column titled "No backup rings," are suitable for type I systems. For glands to seal up to and including 3,000 psi pressure, the data given in table I of this specification under the columns titled "One backup ring" and "Two backup rings" are suitable for type I and type II systems.

3.1.4.2 Other than nominal sized installations.- Glands of sizes other than nominal will be referred to as nonstandard herein. The use of nonstandard gland cylinder bores, piston rods, etc., shall be held to a minimum consistent with the design performance and weight considerations of the component. When a nonstandard bore or rod is used, the closest standard packing dash number shall be selected as determined from the nominal packing size as listed in table I. The selection of packing size in a nonstandard gland shall be based primarily on the consideration of performance. The nonstandard groove diameter and dimensions pertaining thereto should be calculated in the same manner as for standard nominal glands by the formulas of table I. However, where O-rings are stretched, consideration should be given to low-temperature leakage, since the stretch and shrinkage combine in reducing the O-ring's cross-sectional area. In addition, when using nonstandard gland dimensions, great care in the selection of a nonextrusion device must be taken. For example, MS28782 rings cannot be used indiscriminately on nonstandard gland dimensions.

3.1.5 Qualification of special packing glands.- When packing gland designs differ from the recommended design practices as given in this section, or design conditions in the component dictate, the particular gland shall be qualified by tests suitable to the procuring activity. The Services will base their requirements for such tests on past Service experience and laboratory tests, and may require the use of particular makes of approved packings, gaskets, and fluids in the qualification tests.

3.1.5.1 Service experience has shown that low squeeze O-ring installations designed to provide reduced O-ring friction are unsatisfactory, although the low squeeze installation may have passed qualification tests. For this reason, a design O-ring squeeze that is less than the minimum value specified in table I shall be tested to adverse tolerances. This shall be accomplished by the use of MIL-H-5606 low swell fluid specified by the Services and machining the O-ring gland to provide the low limit of design O-ring squeeze.

3.2 Standard packings.-

3.2.1 Type I systems.- All packings used in hydraulic equipment for type I systems, designed in accordance with this specification, shall be standard-approved packings conforming to MIL-P-5516, AN6227, AN6230, and MS28772.

3.2.2 Type II systems.- All O-ring packings used in hydraulic equipment for type II systems, designed in accordance with this specification, shall be standard-approved packings conforming to MIL-P-25732 and MS28775.

3.2.3 Type III systems.- Since there are no standard packings presently available for use in type III hydraulic system equipment, any packing installation selected for this temperature range shall be qualified in the component and subsequently approved by the procuring activity based on the component qualification test.

3.2.4 Use of O-ring packings.- O-ring packings are intended for use as static or running seals in hydraulic system components. If used as running seals without nonextrusion devices, the O-ring seals shall be used only at operating pressures not greater than 1,500 psi in types I, II, and III systems, unless the extrusion gap is maintained small enough to prevent extrusion of the O-ring for the life of the component at the highest pressure. Usage with nonextrusion devices is specified in 3.4. O-ring packings may be used for static seals. Design and installation details for such use are specified in 3.5.

3.2.4.2 Use of D-ring packings.- D-ring packings are intended for use as rod seals only in landing gear shock struts. The D-ring packing is designed primarily for use in lieuof the O-ring packings in landing gear installations where spiral failure of the O-ring packing is a problem. It may be used without backup or with one or two backup rings (see 4.2), depending on the pressure, deflection, and other requirements of the specific utilization. For the diametrical dimensions of the installation of D-rings, the dimensions established in table I for O-rings are recommended. For groove width (dimensions "G"), the dimensions of table II are recommended. The MS28772 D-rings in their full range of sizes are equivalent in ID and OD dimensions to the MS28775 O-rings in sizes -335 through -460.

* 3.2.5 Surface finishes of glands.- The following surface finishes shall be used in units containing O-ring packings, unless performance or qualification tests indicate that other surface finishes are satisfactory. These finishes are indicated as surface roughness as defined in USASI B46.1 - 1962.

Part of Unit	Surface roughness height rating
Cylinder bor or piston rod (diameter over which packing must slide)	16 (max.)
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.)

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

TABLE II. D-ring gland width dimensions

Dash No.	Groove width "G" 1/		
	No back-up ring	One back-up ring	Two back-up rings
-335 to -349	0.424 .434	0.507 .517	0.597 .607
-425 to -460	.579 .589	.729 .739	.854 .864

1/ See (d) of figure 2.

3.2.6 O-ring groove shape.- Rectangular type groove shapes, following the general design criteria of table I, are preferred. The grooves may have up to 5 degrees slope on the sides to facilitate machining; the radius in the bottom corners of the groove must be a compromise between strength requirements, type of nonextrusion device, and adequate groove volume. When TFE (see 4.2) rings are used, the radius must be a minimum consistent with installation and performmance requirements. The width of the groove shall be consistent with the performance requirements of the gland and the type of nonextrusion device used. Consideration should be given to cross-sectional squeeze and volumetric swell of the O-ring owing to oil immersion and temperature. The recommended groove width dimensions are shown in table I. Narrower grooves make it more difficult to remove the O-ring for inspection and replacement and increase the possibility of nicking and scratching the edge of the groove during removal of the O-ring. The outer corner of the groove must be smooth with the corner broken slightly to prevent sharpness. Too large a corner radius will contribute toward local failure. This effect will be greater with increased operating pressures and temperatures.

3.2.7 Number of O-rings per gland.- The use of two or more O-rings in the same groove or in adjacent grooves can produce pressure traps between the adjacent O-rings and a subsequent rise in temperature takes place causing thermal expansion of the fluid or lubricant. Such conditions have caused jamming of units in service. If the use of two or more O-rings are required for some design reason, adequate provision, such as venting of the space between the O-rings, must be made to prevent pressure trap.

3.2.8 Breathing.- The piston head gland of actuating cylinders and similar components in which the gland is confined by a lightweight cylindrical member, which breathes diametrically as pressure is applied, may have a total diametrical working clearance greater than that shown by the clearance columns of table I in type I systems. Experience with actuators up to 5-1/2 inch bore diameter has indicated that the diametrical breathing, owing to pressure application only, should not exceed approximately 0.0020 inch per inch of bore diameter at the midpoint of the cylinder barrel with the piston bottomed at one end of the cylinder. The breathing should actually be less than 0.0020 inch per inch of bore diameter in the transverse plane immediately adjacent to the normal actuating cylinder piston head seal, owing to decreasing cylinder material flexure at this point. Breathing will usually be less in small-diameter low-pressure cylinders owing to manufacturing considerations. In large diameter cylinders, or units which have large values of diametrical breathing, tests will have to be made the satisfaction of the procuring activity to insure adequate life of the seal and gland.

3.3 Nonstandard hydraulic packings.-

3.3.1 Use of nonstandard hydraulic packings.-

3.3.1.1 Type I and type II systems.- When a satisfactory installation using standard packings is not possible owing to performance requirements, nonstandard packings such as TFE cap rings may be used, subject to approval by the procuring activity, and provided the unit satisfactorily completes qualification tests.

3.3.2 Design considerations.- On nonstandard packing and packing gland designs, consideration shall be given to the design application and the following point shall be noted: Surface finish, extreme temperature, sealing, low-pressure and high-pressure leakage, air inclusion as a result of servo operation without fluid pressure, etc.

3.4 Nonextrusion devices.-

3.4.1 Application of nonextrusion devices (backup rings).-

3.4.1.1 Type I and type II systems.- Where required, to permit a component to conform to performance or qualification tests, nonextrusion devices within the packing gland may be used. At lower pressures, nonextrusion devices will prolong the normal wearing life of the O-ring and, at higher pressures, nonextrusion devices permit greater diametrical clearances between mating parts. Unless otherwise approved by the procuring activity, the applicable standard packings and backup devices shall be used.

3.4.1.2 Type III systems.- Packings and backup rings for use in type III systems shall be designed in such manner as to fulfill the performance and qualification test requirements of the individual hydraulic component.

3.4.2 Glands for packings and gaskets with nonextruion devices.- Glands for combination of packings with backup rings and for gaskets with backup rings shall be designed to the same considerations as for nominal rectangular grooves, but with the following additional considerations. The width of the groove is of great importance, since a groove which is too wide may permit the backup rings to roll and thus become ineffective as a nonextrusion device. Angles in excess of 5 degrees on the side of the groove may produce the same result. A groove which is too narrow may cause high friction and extreme difficulty on installation. The data shown in table I have been found to be acceptable and desirable. Glands for TFE nonextrusion devices must have corner radii consistent with the performance and cross-sectional requirements of the TFE backup rings; otherwise difficult installation and operation problems may result.

3.4.3 Installation of nonextrusion rings.- The use of two backup rings in each gland, one on either side of the O-ring seal, even though the pressure application is from one side only, is desired in all cases to facilitate standardization of groove dimensions and service procedures. Where it is self-evident, however, that pressure can be applied from one direction only, and space limitations to provide for two rings create a hardship, a single backup ring may be used; this ring to be placed on the side of the O-ring away from the pressure. When the pressure differential across a packing is unidirectional, only one backup ring need be installed. This backup ring shall be on the low-pressure side. The groove width dimensions shown in table I for one backup ring may be used, as applicable.

* 3.4.3.1 Continuous turn TFE backup rings.- A continuous TFE ring may be used for new designs. Installation of the small sizes of this ring into the gland will probably require use of split- or multiple-piece adapters. Continuous turn backup rings shall be in accordance with the uncut sizes of MS28774. For Air Force use, continuous turn backup rings shall be in accordance with MS27595, or the uncut sizes of MS28774.

3.4.3.2 Spiral TFE backup rings.- Great care must be exercised in the installation of spiral TFE backup rings. If the groove radii are large for structural reasons, the spirals may be sheared upon installation. Therefore, it is important that when installing spiral TFE backup rings that the mating part be rotated in the proper direction, so that the spiral will tend to wrap itself deeper into the groove and will not be sheared off when the parts are assembled. Spiral TFE backup rings shall be in accordance with MS28782 and MS28783.

3.4.3.3 Single-turn TFE backup rings.- This ring may be used for new designs. It is the simplest to install and does not require any special installation procedures. Single turn backup rings shall be in accordance with MS28774.

3.5 Static seals.-

3.5.1 Type I and type II systems.- All nonmoving packings (static seals) used for sealing of fluid pressures shall be standard-approved static seals. These static seals shall not be compressed into threads or against other irregular or rough surfaces which would cut or otherwise damage them. Recommended static seal glands are shown in table I. The groove fillet radius and the fatigue requirements should receive very careful consideration.

3.5.2 Type III systems.- Static seals and backup rings for use in type III systems shall be designed in such manner as to fulfill the performance and qualification test requirements of the individual hydraulic component.

3.5.3 O-ring gasket seals.- O-ring gaskets conforming to part nos. AN6230-1 through -25 and MS28775 -013 through -028, -117 through -149, and -223 through -247 are intended only for use as static (nonmoving) seals and shall not be used as dynamic (moving) seals. All the detail requirements specified for O-ring packings will apply to the use of O-ring static seals conforming to part nos. AN6230-1 through -25, and MS28775-223 through -247, except as noted in the following paragraphs.

3.5.4 Pressure limitations and use of O-ring static seals.-

3.5.4.1 Type I systems.- Static seals conforming to AN6230 may be used at pressures up to and including 1,500 psi, provided the clearances, eccentricities, and other requirements of table I are not exceeded. Above 1,500 psi pressure, the AN6230 O-ring static seals and the sizes of AN6227 O-ring packings used as static seals, shall be used with the applicable backup rings in accordance with table I. If the diametrical clearance can be held to a maximum of 0.0025 inch under the worst condition of tolerances, eccentricities, breathing, etc., the backup rings need not be used. The use of AN6227 packings as static seals in lieu of AN6230 static seals is preferred in all sizes.

3.5.4.2 Type II systems.- Static seals conforming to MS28775 should be used at pressures up to 3,000 psi with backup rings in accordance with table I and requirements herein on nonextrusion devices, unless it can be proven by qualification tests that glands will perform satisfactorily without nonextrusion backup rings. Leather backup rings shall not be used in type II systems.

3.5.5 Use of straight thread tube fitting boss gasket.-

* 3.5.5.1 Type I systems.- The gasket for type I systems is a 90 Shore Durometer O-ring gasket, defined by MS28778 and MIL-P-5510. This gasket is not suitable for interchangeable usage with MIL-P-5516 and MIL-P-25732 seals owing primarily to lack of flexibility at cold temperatures and lack of resilience. For this reason, the MS28778 gasket shall be used only in connection with straight thread tube fitting glands, such as in the boss conforming to MS33649, with end fittings in accordance with MS33656 and MS33657 assembled in accordance with AND10064; and MS33514 and MS33515 assembled in accordance with MS33566. This usage includes such other parts as end caps on check valves wherein the dimensions of the gland duplicate the tube fitting and boss drawings enumerated above. In certain fitting installations, as shown on AND20064, the MS28773 nonextrusion rings must be used with the MS28778 gasket.

* 3.5.5.2 Type II systems.- The requirements of type II systems are identical to type I systems.

3.5.5.3 Type III systems.- Gaskets suitable for the temperature ranges of this system which satisfactorily pass the qualification test requirements of the fitting installation shall be used.

3.5.6 Static face seals.-

3.5.6.1 Type I systems.- The use of static face seals should be avoided wherever a breathing problem exists and a submerged radial squeeze seal design is feasible. Where static face seals are desired, gaskets conforming to AN6227 or AN6230, may be used. In such installations the depth of the groove shall be in accordance with table I.

3.5.6.1.1 Design details.- Metallic surfaces contacting the O-ring face seals shall have a surface finish no rougher than 32 microinches, in accordance with USASI B46.1 - 1962. The cap or coverplate must be as rigid as necessary to prevent excessive breathing which would introduce an extrusion gap at the joint. The important feature in face seal design is to provide squeeze on the groove section and prevent any possible radial movement of the O-ring uder pressure application. Provisions shall be made to insure that the O-ring cannot be displaced from its groove under any flow or pressure condition.

3.5.6.2 Type II and type III systems.- Static face seals, suitable for the temperature ranges of these systems, shall satisfactorily pass the qualification test requirements of the installation to be used. Usage of MS28775 seals is recommended for typeII systems.

3.6 Design data on use of dynamic and static seals.-

3.6.1 Design data.- The design data contained in this section are intended to supply the designer with the basic fundamental reasons behind the requirements of this specification and the results which may be expected when there is deviation from those requirements. Typical installation of static seals is shown in figure 3.

3.6.2 O-ring squeeze.- Referring to table I, the O-ring squeeze is represented by the difference between the free O-ring cross-section diameter and dimensions $\frac{A-F}{2}$ or $\frac{E-B}{2}$ (as applicable).

3.6.2.1 Type I systems.- In order to produce an acceptable product that will perform satisfactorily throughout its normal life, it is recommended that O-ring packing squeeze and dimensions listed in table I be used. The minimum squeeze and dimensions shown in table I are so establsihed that with all tolerances, clearances, eccentricities, side loads, and linear contraction of the packing compound taken into consideration, there will still be a positive interference remaining on the O-ring section throughout the temperature range of this type system.

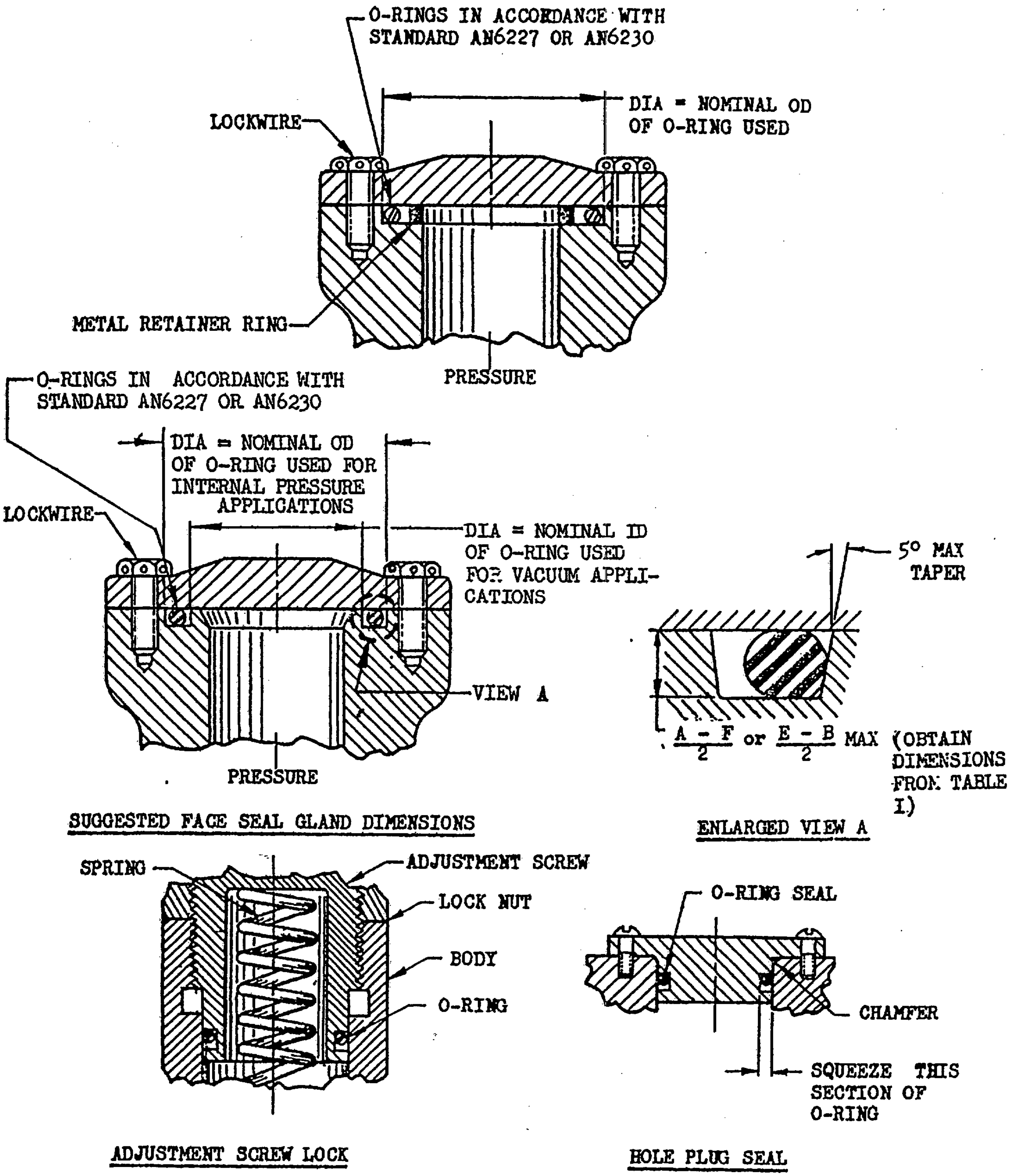


FIGURE 3. Typical installation of static seals

3.6.2.2 Type II systems.- For these systems, it is recommended that the O-ring packing squeeze dimensions listed in table I be used. However, since insufficient test information is available as of the date of this revision, other squeeze dimensions may be desirable for particular applications.

3.6.2.3 Change of squeeze considerations.- The following items were considered in setting up the dimensions shown in table I for type I systems and must be given due consideration when deviations from these dimensions are made. For type II systems, these considerations may not be directly applicable.

3.6.2.3.1 Decrease squeeze.- Decreasing the squeeze will slightly reduce friction and breakout under low hydraulic pressure (under 500 psi) operating conditions. When reduced squeeze is used, a better surface finish is usually required for low-pressure sealing. The saving in friction will be neutralized at high pressures owing to compression of the O-ring into the end of the groove. Figure 4 illustrates this condition as well as positions of packing in their grooves under various degrees of pressure. Breakout friction of O-ring type packing will be higher than running friction, being dependent on factors of surface finish, time, pressure, squeeze, etc. Particular care must be taken to insure that low-pressure and low-temperature leakage is not encountered.

3.6.2.3.2 Increase squeeze.- Greater O-ring squeeze than specified in table I may result in greater assembly problems, requiring larger or flatter angle levels, or both, at shoulders, etc., (see figure 1). Increasing the squeeze will also tend to increase the scrubbing and rolling of the O-ring during operation which may in turn result in shorter packing life. The friction at low-operating pressure will be increased. The greater squeeze may, however, result in lowering the critical cold temperature of the unit from the standpoint of low-temperature leakage. When squeeze is increased beyond that shown in table I and backup rings are required, those listed in table I cannot be used owing to interference.

3.6.3 Diametrical clearance.- The greatest factor in reducing the life of O-ring packings is the extrusion of the O-ring into the clearance gap. The clearance consequently should be held as small as practicable with special attention given to factors such as thermal expansions, pressure expansions, side load, eccentricities, type of motion, and other basic considerations of surface finish, lubrication, and accuracy which affect O-ring life. Backup rings or nonextrusion devices permit the use of slightly larger gaps. Diametrical clearance is the total difference between the diameter of the bore and the diameter of the member contained therein.

3.6.4 General limitations of O-rings.- O-ring packings and gaskets have some general limitations which should be kept in mind when designing hydraulic units. Some of these limitations are as follows.

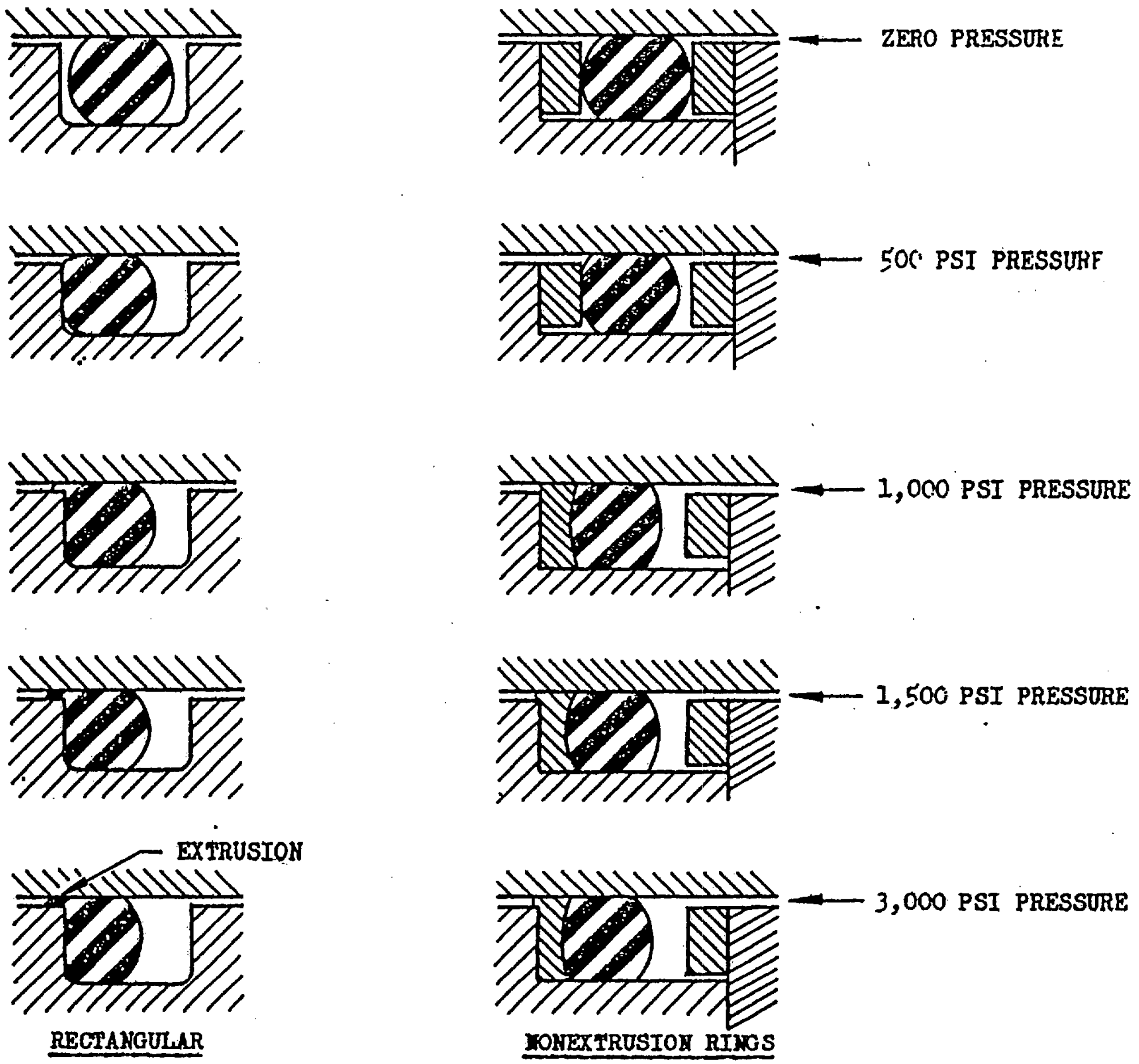


FIGURE 4. Relative positions of O-ring packings in different grooves at increasing pressures

3.6.4.1 Friction.- In some units, such as surface control boost cylinders, the breakout friction of O-rings can cause undesirable drag, which if not taken into consideration in the original design, may produce designs which are not suitable for the purpose intended. Breakout friction is caused by the extrusion of the packing material into the surface irregularities of the mating surfaces or adhesion, or both, of these materials (see 3.6.2). Breakout friction of O-rings is higher than running friction. All standard packings have some minimum friction value which cannot be materially reduced by practical methods of design. When friction problems are encountered, a special gland installation should be considered preferable to special packings (see 3.6).

3.6.4.2 Oscillation.- O-ring packings, when used to seal rapidly oscillating mechanisms, have not always proven successful in past installations. Special studies must be made in designs of this type to provide for proper life and performance.

3.6.4.3 Rotary seals.- Standard packings are not specifically designed as rotary seals. However, where infrequent rotary motion or low peripheral velocity is required, they may be used, provided consistent surface finishes over the entire gland are used and eccentricities are accurately controlled. In addition, the use of low-friction nonextrusion devices have been found to be helpful in prolonging life and improving performance.

3.6.4.4 Precaution.- Glands in which the O-ring is seriously deformed or distorted by crushing or other loads (stretching and twisting) can induce permanent set and disintegration in the O-ring. Increased temperatures or strains, or both, induced in a seal will cause rapid deterioration of the seal owing to the strain aging and permanent set properties of seal compounds.

4. NOTES

4.1 Intended use.- The procedures covered by this specification are intended to establish gland design and installation methods of packings and gaskets for use in hydraulic equipment design in accordance with MIL-H-5440.

4.2 Definitions.- General terms used herein are defined as follows:

(a) Squeeze: The dimension by which a packing is distorted from its molded shape when installed in a packing gland.
(b) Seal: A device to retain fluid within a hydraulic component. The seal may consist of two or more components, such as a packing in a gland, and a packing and backup ring in a gland, etc.
(c) Packing: The component of a seal which serves as a sealing medium by nature of its plastic or elastic properties, or its ability to deform into the shape of the gland.
(d) Gland: The component of the seal which forms the cavity or inclusion which surrounds and supports the packing and controls the squeeze.

(e) Gasket: A type of seal which if formed by crushing the packing material into the gland such that the cavity formed by the gland is normally filled with the packing material.
(f) Dynamic seal: A type of seal where there is relative motion between some part of the gland and the packing, such as a piston or shaft seal.
(g) Static seal: A type of seal where there is no relative motion between the packing and any part of the gland, although limited freedom may be provided to permit the packing to change its shape within the gland when under pressure.
(h) Backup ring: A device used to prevent pressure and friction from extruding the O-ring packing through the clearance gap of a seal,
(i) TFE: A tetrafluoroethylene resin.

* 4.3 Marginal indicia.- The margins of this specification are marked to indicate where changes, deletions, or additions to the previous issue have been made. This is done as a convience only and the Government assumes no liability whatsoever for inaccuracies in these notations. Figures are not so marked. Bidders and contractors are cautioned to evaluate the requirements of this document based on the entire content as written, irrespective of the marginal notations and relationship to the last previous issue.

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