

MIL-G-5514F
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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

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STANDARDSMilitary

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.

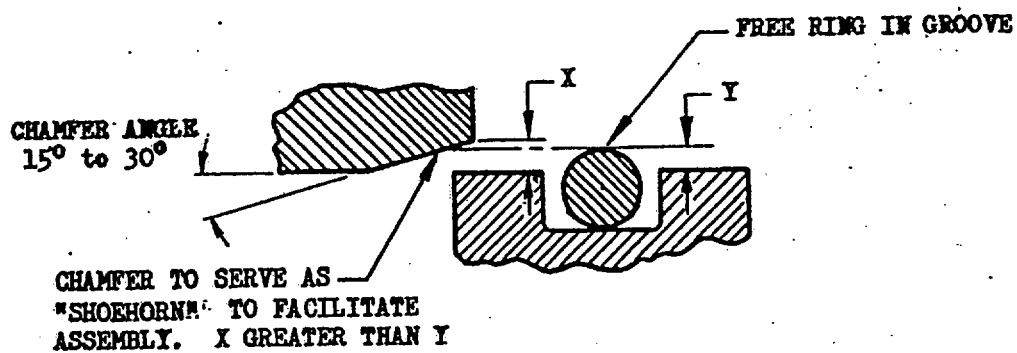
3.1.2 Operation over unrestrained areas.- Mechanisms which require that the packing pass over holes, ports, step diameters, etc., which would leave the ID, OD, or sides of the seal (see 4.2) unrestrained during its normal operation, shall be avoided. If, however, it is necessary to deviate from the above, 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).

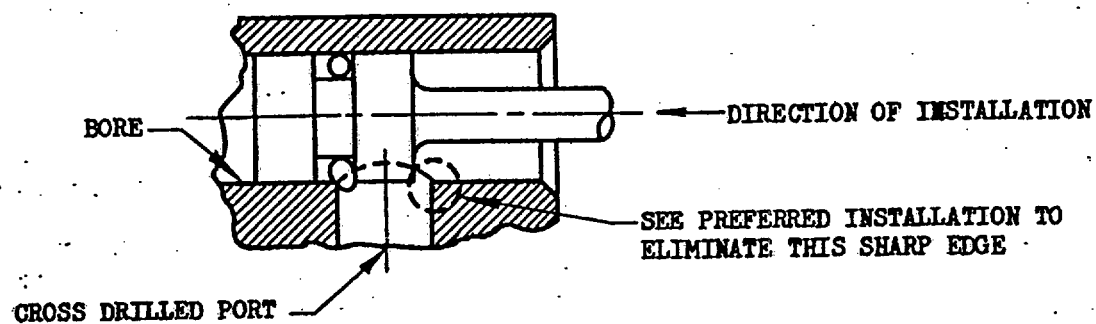
3.1.3 Gland materials.- Materials used in the manufacture of packing glands shall be in accordance with the requirements of the detail specification. All material used in packing glands shall satisfactorily resist corrosion during its normal service life.

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.

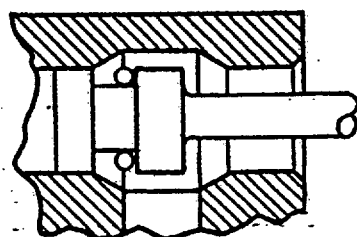
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BEVEL ON PACKING INSTALLATION



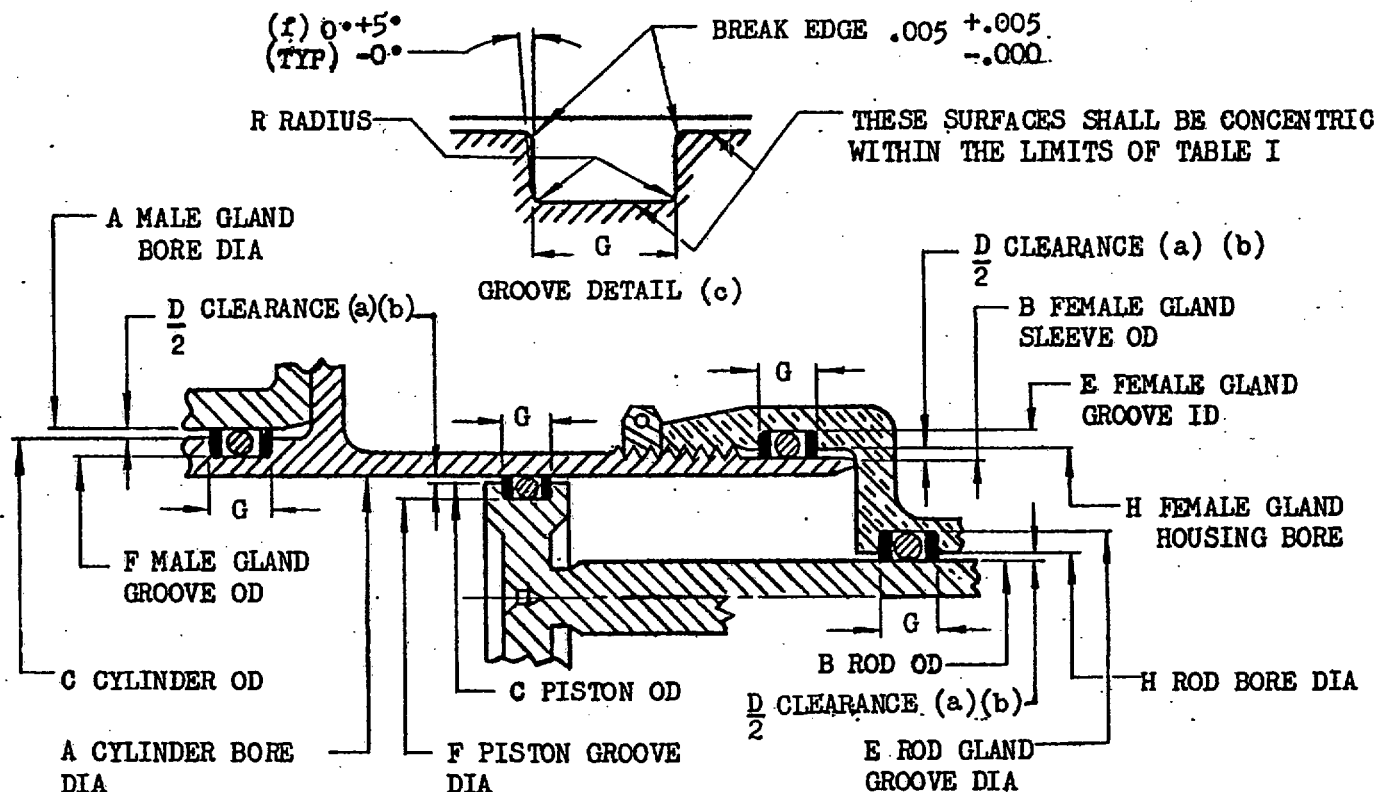
PREFERRED INSTALLATION



UNDERCUT BORE AS INDICATED

FIGURE 1. Methods to avoid sharp installation corners

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(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																					
INSTR. DASH NO.	INSTR. DASH NO.	INSTR. DASH NO.	SEAL INSTALLATION DIMENSIONS						DIAMETRAL CLEARANCE (A)		SQUEEZE		GROOVE WIDTH G			GROOVE CENTER RADIUS	ECCENTRICITY (e)	O-RING CROSS SECTION	O-RING INSIDE DIAMETER		
			EXTERNAL			INTERNAL					MINIMUM	MAXIMUM	GROOVE WIDTH G								
			PISTON OR CYLINDER OD	CYLINDER BORE OR MAX. GLAND CYLINDER BORE ID	PISTON GROOVE OD	ROD OR GLAND SLAVE OD	ROD BORE OR FEMALE GLAND HOUSING BORE ID	GROOVE ID	ACTUAL	PERCENT (REF)	ACTUAL	PERCENT (REF)	NO BACKUP RING	ONE BACKUP RING	TWO BACKUP RINGS						
		001	.093 .092	.095 .096	.033 .032	.033 .038	.035 .036	.075 .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	.006	13.4	.01723.3	.094 .104	.149 .159	.207 .217	.015 .005	.002	.070 ± .003	.364 ± .005	
		013	.548 .547	.550 .552	.438 .436	.438 .436	.437 .438	.547 .549	.005	.005	.009	13.4	.01723.3	.094 .104	.149 .159	.207 .217	.015 .005	.002	.070 ± .003	.426 ± .005	
		014	.611 .610	.613 .615	.501 .499	.501 .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	.624 .624	.623 .621	.625 .624	.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	.943 .939	.935 .933	.937 .938	1.047 1.049											.926		
		022	1.114 1.113	1.116 1.118	1.008 1.002	.998 .996	1.000 1.001	1.110 1.112											.989		
		023	1.136 1.175	1.178 1.180	1.068 1.064	1.060 1.063	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 1.361	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 1.483	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	2.364 ± .006
8		110	.548 .547	.550 .552	.372 .370	.371 .371	.375 .376	.551 .553	.005	.005	.009	9.0	.017	16.0	.141 .151	.183 .193	.245 .255	.015 .005	.002	.103 ± .003	.364 ± .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
		118	1.051 1.050	1.053 1.055	.875 .873	.873 .871	.875 .876	1.051 1.053													
		119	1.114 1.113	1.116 1.118	.938 .936	.935 .933	.937 .938	1.113 1.115												.862	
		120	1.176 1.175	1.178 1.180	1.000 .998	.998 .996	1.000 1.001	1.176 1.178												.924	
		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												.987	
		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																					
AM227 DASH NO.	AM230 DASH NO.	AM237 DASH NO.	SEAL INSTALLATION DIMENSIONS						EXTERNAL CLEARANCE (a)	SQUEEZE		GROOVE WIDTH G.			GROOVE CORNER RADIUS	ECCENTRICITY (e)	O-RING CROSS SECTION	O-RING INSIDE DIAMETER			
			EXTERNAL			INTERNAL				MINIMUM	MAXIMUM	NO BACKUP RING	ONE BACKUP RING	TWO BACKUP RINGS							
			PISTON OF CYLINDER OD	CYLINDER BORE OR MALE GLAND CYLINDER BORE ID	GROOVE OD	ROD OR BLANK SLEEVE OD	ROD BORE OR FEMALE GLAND HOUSING BORE ID	GROOVE ID		ACTUAL	PERCENT (REF)								ACTUAL	PERCENT (REF)	
																					EXT.
			1.364	1.366	1.188	1.185	1.187	1.363	.005	.005	.009	9.0	.017	16.0	.141	.183	.245	.015	.002	.103 ±.003	1.174 ±.006
	123		1.363	1.368	1.186	1.181	1.188	1.365							.151	.193	.255	.005			1.237
		124	1.426	1.428	1.250	1.248	1.250	1.426													1.299
			1.425	1.430	1.248	1.246	1.251	1.428													1.362
		125	1.489	1.491	1.313	1.310	1.312	1.488													1.424
			1.488	1.493	1.311	1.308	1.313	1.490													1.487 ±.006
		126	1.551	1.553	1.375	1.373	1.375	1.551		.005											1.549 ±.010
			1.550	1.555	1.373	1.371	1.376	1.553													1.612
		127	1.614	1.616	1.438	1.435	1.437	1.613		.006											1.674
			1.613	1.618	1.436	1.433	1.439	1.615													1.737
		128	1.676	1.678	1.500	1.498	1.500	1.676		.005											1.799
			1.675	1.680	1.498	1.496	1.502	1.678													1.862
		129	1.739	1.741	1.563	1.560	1.562	1.738		.006											1.925
			1.738	1.743	1.561	1.558	1.564	1.740													1.987
		130	1.802	1.805	1.627	1.623	1.625	1.801		.007											2.050
			1.801	1.807	1.625	1.621	1.627	1.803													2.112
		131	1.864	1.867	1.689	1.685	1.687	1.863		.006											2.175
			1.863	1.869	1.687	1.683	1.689	1.865													2.237
		132	1.927	1.930	1.752	1.748	1.750	1.926		.007											2.300
			1.926	1.932	1.750	1.746	1.752	1.928													2.362
		133	1.989	1.992	1.814	1.810	1.813	1.988		.006											2.425
			1.988	1.994	1.812	1.808	1.815	1.990													2.487
		134	2.052	2.055	1.877	1.873	1.876	2.051		.007											2.550
			2.051	2.057	1.875	1.871	1.878	2.053													2.612 ±.010
		135	2.115	2.118	1.940	1.936	1.939	2.114		.006											2.675 ±.015
			2.114	2.120	1.938	1.934	1.941	2.116													2.737
		136	2.177	2.180	2.002	1.998	2.001	2.176		.007											2.800 ±.015
			2.176	2.182	2.000	1.996	2.003	2.178													2.862
		137	2.240	2.243	2.065	2.061	2.064	2.239		.006											2.925
			2.239	2.245	2.063	2.059	2.066	2.241													2.987
		138	2.302	2.305	2.127	2.123	2.126	2.301		.007											3.050
			2.301	2.307	2.125	2.121	2.128	2.303													3.112
		139	2.365	2.368	2.190	2.186	2.189	2.364		.006											3.175
			2.364	2.370	2.188	2.184	2.191	2.366													3.237
		140	2.427	2.430	2.252	2.248	2.251	2.426		.007											3.300
			2.426	2.432	2.250	2.246	2.253	2.428													3.362
		141	2.490	2.493	2.315	2.311	2.314	2.489		.006											3.425
			2.488	2.495	2.313	2.309	2.316	2.491													3.487
		142	2.552	2.555	2.377	2.373	2.376	2.551		.007											3.550
			2.550	2.557	2.375	2.371	2.378	2.553													3.612 ±.010
		143	2.615	2.618	2.440	2.436	2.439	2.614		.006											3.675 ±.015
			2.613	2.620	2.438	2.434	2.441	2.616													3.737
		144	2.677	2.680	2.502	2.498	2.501	2.676		.007											3.800 ±.015
			2.675	2.682	2.500	2.496	2.503	2.678													3.862
		145	2.740	2.743	2.565	2.561	2.564	2.739		.006											3.925
			2.738	2.745	2.563	2.559	2.566	2.741													3.987
		146	2.802	2.805	2.627	2.623	2.626	2.801		.007											4.050
			2.800	2.807	2.625	2.621	2.628	2.803													4.112
		147	2.865	2.868	2.690	2.686	2.689	2.864		.006											4.175
			2.863	2.870	2.688	2.684	2.691	2.866													4.237
		148	2.927	2.930	2.752	2.748	2.751	2.926		.007											4.300 ±.015
			2.925	2.932	2.750	2.746	2.753	2.928													4.362
		149	2.990	2.993	2.815	2.811	2.814	2.989		.006											4.425
			2.988	2.995	2.813	2.809	2.816	2.991													4.487
15	210		.989	.991	.748	.748	.750	.991	.005	.005	.015	8.5	.025	15.0	.188	.235	.304	.025	.003	.139 ±.004	7734 ±.006
			.988	.993	.746	.746	.751	.993							.198	.245	.314	.010			.796
16	211		1.051	1.053	.810	.810	.812	1.053													.859
			1.050	1.055	.808	.808	.813	1.055													.921
17	212		1.114	1.116	.873	.873	.875	1.116													.984
			1.113	1.118	.871	.871	.876	1.118													1.046
18	213		1.176	1.178	.935	.935	.937	1.178													1.109
			1.175	1.180	.933	.933	.938	1.180													1.171
19	214		1.239	1.241	.998	.998	1.000	1.241													1.234
			1.238	1.243	.996	.996	1.001	1.243													1.296
20	215		1.301	1.303	1.060	1.060	1.062	1.303													1.359
			1.300	1.305	1.058	1.058	1.063	1.305													1.421
21	216		1.364	1.366	1.123	1.123	1.125	1.366													1.484 ±.006
			1.363	1.368	1.121	1.121	1.126	1.368													
22	217		1.426	1.428	1.185	1.185	1.187	1.428													
			1.425	1.430	1.183	1.183	1.188	1.430													
23	218		1.489	1.491	1.248	1.248	1.250	1.491													
			1.488	1.493	1.246	1.246	1.251	1.493													
24	219		1.551	1.553	1.310	1.310	1.312	1.553													
			1.550	1.555	1.308	1.308	1.313	1.555													
25	220		1.614	1.616	1.373	1.373	1.375	1.616													
			1.613	1.618	1.371	1.371	1.376	1.618													
26	221		1.676	1.678	1.435	1.435	1.437	1.678													
			1.675	1.682	1.433	1.433	1.438	1.682													
27	222		1.739	1.741	1.498	1.498	1.500	1.741	.005	.005	.005	8.5	.025	15.0	.188	.235	.304	.025	.003	.139 ±.004	1.484 ±.006
			1.738	1.743	1.496	1.496	1.501	1.743							.198	.245	.314	.012			

TABLE I (Continued)

O-RING GLAND DIMENSIONS																					
AM227 DASH NO.	AM230 DASH NO.	MS8775 DASH NO.	SEAL INSTALLATION DIMENSIONS						INTERNAL CLEARANCE (a)	SQUEEZE		GROOVE WIDTH (b)			GROOVE CORNER RADIUS	ECCENTRICITY (c)	O-RING CROSS SECTION	O-RING INSIDE DIAMETER			
			EXTERNAL			INTERNAL				MINIMUM	MAXIMUM	NO BACKUP RING	ONE BACKUP RING	TWO BACKUP RINGS							
			PISTON OR CYLINDER OD	CYLINDER BORE OR MALE O-RING CYLINDER BORE ID	GROOVE OD	ROD OR O-RING SLEEVE OD	ROD BORE OR FEMALE O-RING ROD BORE ID	GROOVE ID													
																			ACTUAL	PERCENT (REF)	ACTUAL
									EXT.	INT.	ACTUAL	PERCENT (REF)	ACTUAL	PERCENT (REF)	NO BACKUP RING	ONE BACKUP RING	TWO BACKUP RINGS				
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	.021	15.0	.188 1.198	.235 1.245	.304 1.314	.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 .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 .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	.006 .006										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 .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 .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	.007 .007										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	.007 .007										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	.006 .006										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	.006 .006										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	.007 .007										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	.007 .007										2.984		
13	235		3.365 3.363	3.368 3.370	3.125 3.123	3.123 3.121	3.126 3.128	3.366 3.368	.007 .007										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	.007 .007										3.234		
15	237		3.615 3.613	3.618 3.620	3.375 3.373	3.373 3.371	3.376 3.378	3.616 3.618	.007 .007										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	.007 .007										3.484		
17	239		3.865 3.863	3.868 3.870	3.625 3.623	3.623 3.621	3.626 3.628	3.866 3.868	.007 .007										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	.007 .007										3.734		
19	241		4.115 4.113	4.118 4.120	3.875 3.873	3.873 3.871	3.876 3.878	4.116 4.118	.007 .007										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	.007 .007										3.984		
21	243		4.365 4.363	4.368 4.370	4.125 4.123	4.123 4.121	4.126 4.128	4.366 4.368	.007 .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 .008										4.234		
23	245		4.614 4.612	4.618 4.620	4.375 4.373	4.373 4.371	4.376 4.378	4.615 4.617	.007 .007										4.359		
24	246		4.739 4.737	4.743 4.745	4.500 4.498	4.497 4.495	4.500 4.502	4.740 4.742	.008 .008										4.484		
25	247		4.864 4.862	4.868 4.870	4.625 4.623	4.623 4.621	4.626 4.628	4.865 4.867	.008 .008	.0115	8.5	.021	15.0	.188 1.198	.235 1.245	.304 1.314	.025 .010	.003	.139 ± .004	4.609 ± .015	
28	325		1.864 1.863	1.867 1.869	1.495 1.493	1.493 1.491	1.496 1.502	1.870 1.872	.006 .006	.017	8.3	.029	13.5	.283 1.293	.334 1.344	.424 1.434	.035 .020	.004	.210 ± .005	1.475 ± .010	
29	326		1.989 1.988	1.992 1.994	1.620 1.618	1.620 1.618	1.623 1.627	1.995 1.997	.006 .006										1.600		
30	327		2.115 2.114	2.118 2.120	1.746 1.744	1.746 1.744	1.750 1.752	2.120 2.122	.006 .006										1.725		
31	328		2.240 2.239	2.243 2.245	1.871 1.869	1.871 1.869	1.876 1.878	2.245 2.247	.007 .007										1.850		
32	329		2.365 2.364	2.368 2.370	1.996 1.994	1.996 1.994	2.001 2.003	2.370 2.372	.006 .006										1.975		
33	330		2.490 2.488	2.493 2.495	2.121 2.119	2.121 2.119	2.126 2.128	2.495 2.497	.007 .007										2.100		
34	331		2.615 2.613	2.618 2.620	2.246 2.244	2.246 2.244	2.251 2.253	2.620 2.622	.007 .007										2.225		
35	332		2.740 2.738	2.743 2.745	2.371 2.369	2.371 2.369	2.376 2.378	2.745 2.747	.007 .007										2.350		
36	333		2.865 2.863	2.868 2.870	2.496 2.494	2.496 2.494	2.501 2.503	2.870 2.872	.007 .007										2.475		
37	334		2.990 2.988	2.993 2.995	2.621 2.619	2.621 2.619	2.626 2.628	2.995 2.997	.007 .007										2.600 ± .010		
38	335		3.115 3.113	3.118 3.120	2.746 2.744	2.746 2.744	2.751 2.753	3.120 3.122	.007 .007										2.725 ± .015		
39	336		3.240 3.238	3.243 3.245	2.871 2.869	2.871 2.869	2.876 2.878	3.245 3.247	.007 .007	.017	8.3	.029	13.5	.283 1.293	.334 1.344	.424 1.434	.035 .020	.004	.210 ± .005	2.850	
40	337		3.365 3.363	3.368 3.370	2.996 2.994	2.996 2.994	3.000 3.002	3.369 3.371	.007 .007	.017	8.1	.029	13.5	.283 1.293	.334 1.344	.424 1.434	.035 .020	.004	.210 ± .005	2.975	
41	338		3.490 3.488	3.493 3.495	3.121 3.119	3.121 3.119	3.126 3.128	3.494 3.496	.007 .007										3.100		
42	339		3.615 3.613	3.618 3.620	3.246 3.244	3.246 3.244	3.251 3.253	3.619 3.621	.007 .007										3.225		
43	340		3.740 3.738	3.743 3.745	3.371 3.369	3.371 3.369	3.376 3.378	3.744 3.746	.007 .007										3.350		
44	341		3.865 3.863	3.868 3.870	3.496 3.494	3.496 3.494	3.500 3.502	3.869 3.871	.007 .007	.017	8.1	.029	13.5	.283 1.293	.334 1.344	.424 1.434	.035 .020	.004	.210 ± .005	3.475 ± .015	

SEAL APPLICATIONS ONLY

TABLE I (Continued)

TABLE I (Continued)																				
O-RING LAND DIMENSIONS																				
INCHES DASH NO.	MILLIMETERS DASH NO.	PISTON OR CYLINDER OD	SEAL INSTALLATION DIMENSIONS					DIAMETRAL CLEARANCE (a)	SQUEEZE -				GROOVE WIDTH G			GROOVE CORNER RADIUS	ECCENTRICITY (e)	O-RING CROSS SECTION	O-RING INSIDE DIAMETER	
			EXTERNAL		INTERNAL				MINIMUM	MAXIMUM	MINIMUM	MAXIMUM	NO BACKUP RING	ONE BACKUP RING	TWO BACKUP RINGS					
			Cyl. Bore or Male O.D.	Cyl. Bore ID	Groove OD	Rod or O.D. Sleeve OD	Hole or Female O.D.													Groove ID
45	342	3.990	3.993	3.621	3.622	3.625	3.996	.007	.007	.017	8.1	.029	13.5	.281	.374	.426	.015	.004	.210 ± .005	3.600 ± .015
46	343	4.115	4.118	3.744	3.747	3.750	4.119												3.725	
47	344	4.240	4.243	3.871	3.872	3.875	4.244												3.850	
48	345	4.365	4.368	3.996	3.997	4.000	4.369	.007											3.975	
49	346	4.489	4.493	4.121	4.122	4.125	4.494	.008											4.100	
50	347	4.614	4.618	4.246	4.247	4.250	4.619												4.225	
51	348	4.739	4.743	4.371	4.372	4.375	4.744												4.350	
52	349	4.864	4.868	4.496	4.498	4.500	4.869	.008	.007	.017	8.1	.029	13.5	.281	.374	.426	.015	.004	.210 ± .005	4.475
53	426	5.095	5.099	4.622	4.622	4.626	5.099	.009	.009	.029	10.2	.042	15.2	.375	.475	.579	.035	(e)	.275 ± .006	4.475
54	427	5.220	5.224	4.747	4.747	4.751	5.224												4.600	
55	428	5.345	5.349	4.872	4.872	4.876	5.349												4.725	
56	429	5.470	5.474	4.997	4.997	5.001	5.474												4.850	
57	430	5.595	5.599	5.122	5.122	5.126	5.599												4.975 ± .015	
58	431	5.720	5.724	5.247	5.247	5.251	5.724												5.100 ± .023	
59	432	5.845	5.849	5.372	5.372	5.376	5.849												5.225	
60	433	5.970	5.974	5.497	5.497	5.501	5.974												5.350	
61	434	6.095	6.099	5.622	5.622	5.626	6.099												5.475	
62	435	6.220	6.224	5.747	5.747	5.751	6.224												5.600	
63	436	6.345	6.349	5.872	5.872	5.876	6.349												5.725	
64	437	6.470	6.474	5.997	5.997	6.001	6.474												5.850	
65	438	6.595	6.599	6.122	6.122	6.126	6.599	.009	.009	.029	10.2	.042	15.2	.375	.475	.579	.035	(e)	5.975	
66	439	6.720	6.724	6.247	6.247	6.251	6.724												6.225	
67	440	6.845	6.849	6.372	6.372	6.376	6.849												6.475	
68	441	6.970	6.974	6.497	6.497	6.501	6.974												6.725	
69	442	7.095	7.099	6.622	6.622	6.626	7.099												6.975 ± .023	
70	443	7.220	7.224	6.747	6.747	6.751	7.224												7.225 ± .030	
71	444	7.345	7.349	6.872	6.872	6.876	7.349												7.475	
72	445	7.470	7.474	6.997	6.997	7.001	7.474												7.725	
73	446	7.595	7.599	7.122	7.122	7.126	7.599	.009	.009	.029	10.2	.042	15.2	.375	.475	.579	.035	(e)	7.975	
74	447	7.720	7.724	7.247	7.247	7.251	7.724												8.475	
75	448	7.845	7.849	7.372	7.372	7.376	7.849												8.975	
76	449	7.970	7.974	7.497	7.497	7.501	7.974												9.475	
77	450	8.095	8.099	7.622	7.622	7.626	8.099												9.975	
78	451	8.220	8.224	7.747	7.747	7.751	8.224												10.475	
79	452	8.345	8.349	7.872	7.872	7.876	8.349												10.975	
80	453	8.470	8.474	7.997	7.997	8.001	8.474												11.475	
81	454	8.595	8.599	8.122	8.122	8.126	8.599												11.975	
82	455	8.720	8.724	8.247	8.247	8.251	8.724												12.475	
83	456	8.845	8.849	8.372	8.372	8.376	8.849												12.975	
84	457	8.970	8.974	8.497	8.497	8.501	8.974												13.475	
85	458	9.095	9.099	8.622	8.622	8.626	9.099												13.975	
86	459	9.220	9.224	8.747	8.747	8.751	9.224												14.475	
87	460	9.345	9.349	8.872	8.872	8.876	9.349	.011	.010	.027	9.9	.045	15.1	.375	.475	.579	.035	(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.

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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.

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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 lieu of 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.

<u>Part of Unit</u>	<u>Surface roughness height rating</u>
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.)

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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" <u>1/</u>		
	No back-up ring	One back-up ring	Two back-up rings
-335 to -349	0.424	0.507	0.597
	.434	.517	.607
-425 to -460	.579	.729	.854
	.589	.739	.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 performance 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.

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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.

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3.4.2 Glands for packings and gaskets with nonextrusion 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.

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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.

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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 under 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 type II 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 established 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.

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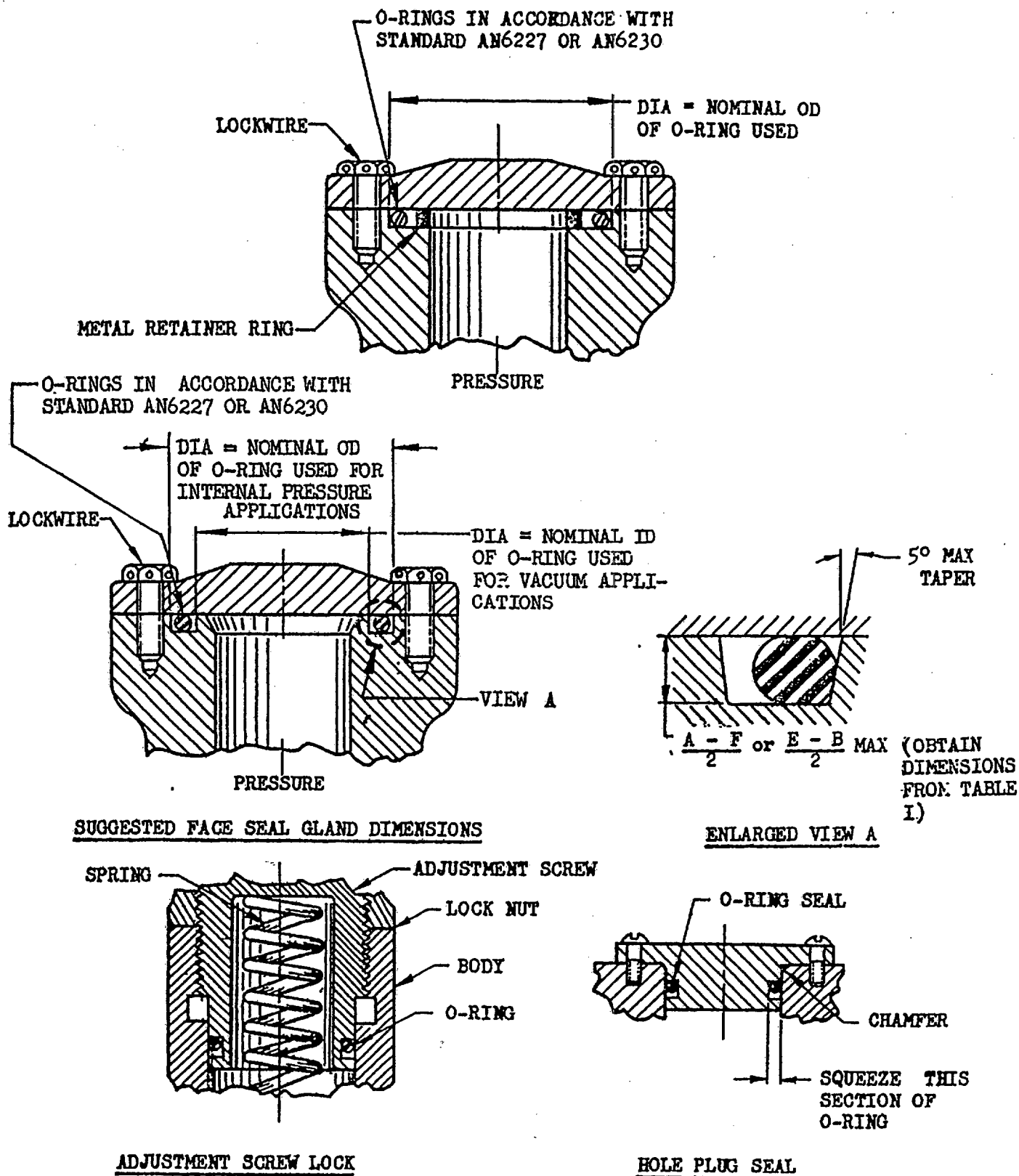


FIGURE 3. Typical installation of static seals

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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.

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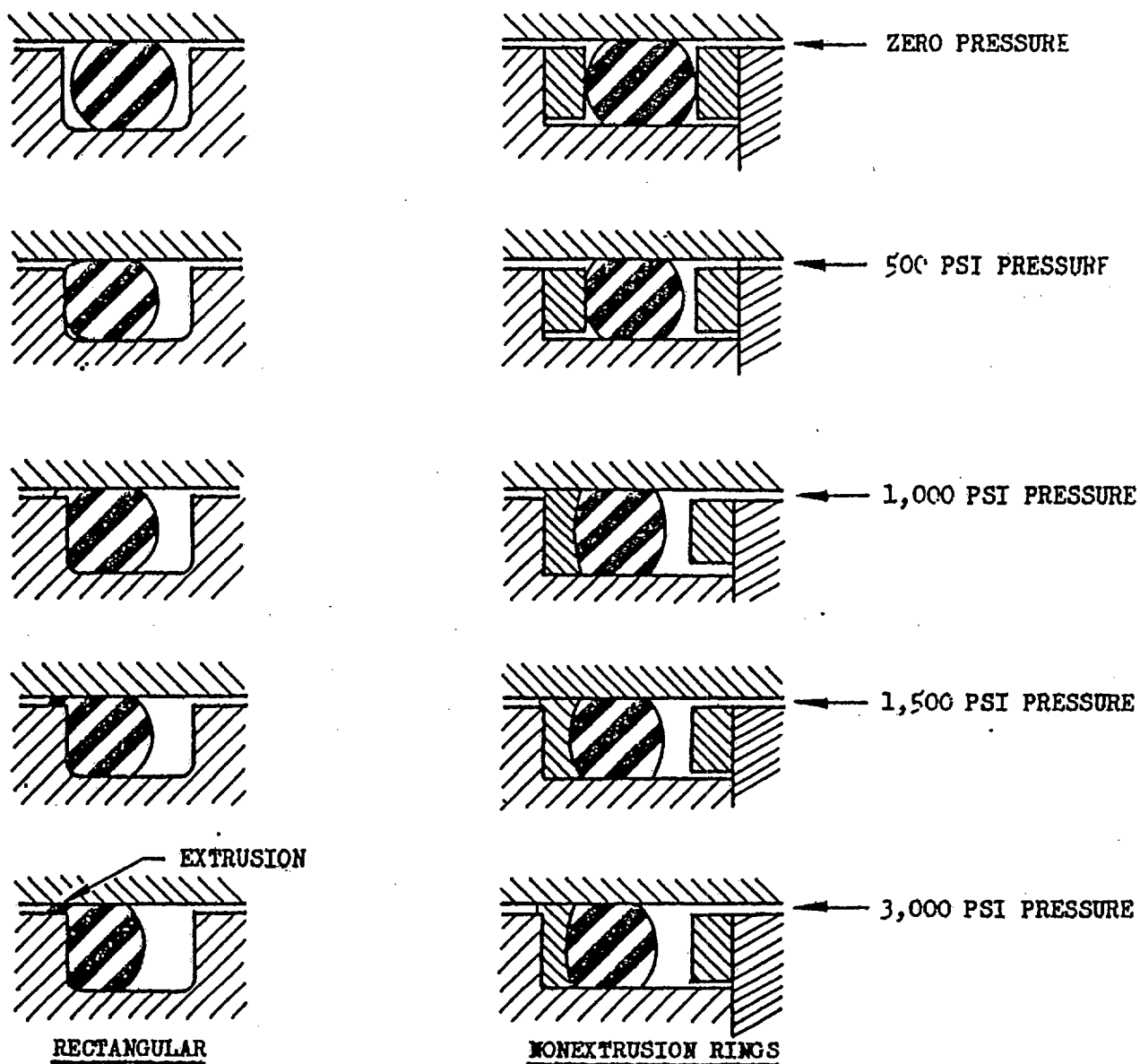


FIGURE 4. Relative positions of O-ring packings in different grooves at increasing pressures

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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.

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- (e) Gasket: A type of seal which is 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 convenience 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.

Custodians:

Army - AV
 Navy - AS
 Air Force - 11

Preparing activity:

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