INCH-POUND

MIL-G-5514G
1 NOVEMBER 1993
SUPERSEDING
MIL-G-5514F
15 JANUARY 1969

MILITARY SPECIFICATION

GLAND DESIGN; PACKINGS, HYDRAULIC, GENERAL REQUIREMENTS FOR

This specification is approved 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 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 Government documents.

2.1.1 Specifications, standards, and handbooks. The following specifications, standards, and handbooks form a part of this document to the extent specified herein. Unless otherwise specified, the issues of these documents are those listed in the issue of the Department of Defense Index of Specifications and Standards (DODISS) and supplement thereto, cited in the solicitation (see 6.2).

Beneficial comments (recommendations, additions, deletions) and any pertinent data which may be of use in improving this document should be addressed to: Oklahoma City Air Logistics Center/TICLA, Tinker AFB, OK 74145-5990 by using the Standardization Document Improvement proposal (DD Form 1426) appearing at the end of this document or by letter.

AMSC N/A FSC 1650

SPECIFICATIONS

Federal

PPP-B-636	Boxes, Shipping, Fiberboard
PPP-B-640	Boxes, Fiberboard, corrugated, Triple-Wall PPP-C-795 Cushioning Material, Flexible, cellular, Plastic Film, For Packaging Applications
PPP-C-795	Cushioning Material, Flexible, cellular, Plastic Film, For Packaging Applications
PPP-C-1752	Cushioning Material, Packaging, Unicellular Polyethylene Foam, Flexible

Military

MIL-P-116	Preservation, Methods Of
MIL-B-131	Barrier Material, Watervaporproof, Greaseproof, Flexible
MIL-D-1OOO	Drawings, Engineering and Associated List
MIL-P-4861	Packing, Preformed, Rubber, packing of
MIL-P-5510	Packing, Preformed Straight Thread Tube Fitting Boss, Type I Hydraulic (-65° F to 160° F)
MIL-P-5516	Packing Preformed, Petroleum Hydraulic Fluid Resistant, 160° F
MIL-H-5606	Hydraulic Fluid, Petroleum Base, Aircraft, Missle and Ordnance
MIL-R-8791	Retainer, Packing, Hydraulic And Pneumatic, Polytetrafluoriethylene Resin, (single turn)
MIL-R-8791/l	Retainer, Packing, Hydraulic And Pneumatic, Polytetrafluoroethylene Resi N
MIL-P-25732	Packing, preformed, Petroleum Hydraulic Fluid Resistant, Limited Services At 275° F (135° C)
MIL-P-83461	Packings, Preformed, Petroleum Hydraulic Fluid Resistant, Improved Performance at 275° F (135° C)
MIL-P-83461/l	Packing, Preformed, Petroleum Hydraulic Fluid Resistant, Improved Performance at 275° F (135° C), Sizes and Tolerances
MIL-P-83462	Packing, Preformed, Petroleum Hydraulic Fluid Resistant, Improved Performance at 275° F (135° C), For Use In Boss Fittings, Sizes and Tolerances
MIL-P-87175	Packing, Preformed Petroleum Hydraulic Fluid Resistant, Fluoroelastomer
MIL-P-87175/1	Packing, Preformed, Petroleum Hydraulic Fluid Resistant, Fluoroelastomer, Grade 70, Sizes and Tolerances
MIL-P-87175/2	Packing, Preformed, Petroleum Hydraulic Fluid Resistant, Phosphonitrilic, Grade 80, Sizes and Tolerances

STANDARDS

Federal

FED-STD-101	Test Procedures For Packing Materials

Military

MIL-STD-129	Marking For Shipment And Storage
MIL-STD-2073/l	DOD Materiel Procedures For Development And Application of Packaging Requirements

MS21344	Fitting-Installation of Flared Tube, Straight Thread Connectors, Design Standard For
MS27595	Retainer, Packing Backup, Continuous Ring, Tetra-fluoroethylene
MS28772	Packing, Preformed (D-Ring, Shock Strut)
MS28773	Retainer, Packing Backup, Tetrafluoroethylene, Straight Thread Tube Fitting Boss
MS28774	Retainer, Packing Backup, Single Turn, Tetrafluor-ethylene
MS28774	Retainer, 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 Bulkhead Flare-less Tube Connections
MS33515	Fitting End, Standard Dimensions For Bulkhead Flare-less Tube Connections
MS33566	Fittings, Installation of Flareless W, 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

(Unless otherwise indicated, copies of federal and military specifications. standards, and handbooks are available from the Standardization Document Order Desk, Bldg 4D, 700 Robbins Ave, Philadelphia, PA 19111-5094.)

2.1.2 Other Government documents, drawings, and Publications. The following other Government documents, drawings, and publications form a part of this document to the extent specified herein. Unless otherwise specified, the issues are those cited in the solicitation.

ANSI/ASME B46.1-85 Surface Texture (Surface Roughness, Waviness and Lay)

(Application for copies should be addressed to the American National Standards Institute, 1430 Broadway, New York NY 10018) .

(Nongovernment standards and other publications are normally available from the organization which prepare or which distribute the documents. These documents also may be available in or through libraries or other informational services.}

2.2 Order of Precedence. In the event of a conflict between the text of this document and the references cited herein (except for related associated detail specifications, specification sheets, or MS standards), the text of this document takes precedence. Nothing in this document, however, supersedes applicable laws and regulations unless a specific exemption has been obtained.

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 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 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 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.

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.

3.2.4 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.

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 1,500 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 Service 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 O-ring installation. Service experience has shown that low squeeze 0-ring installations designed to provide reduced 0-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 tin Table I shall be tested to adverse tolerances. This shall be accomplished by the use of MIL-M-5606 low swell fluid specified by the Services and machining the ()-ring gland to provide the low limit of design O-ring squeeze.

3.2 Standard packings.

3.2.1 Type I Systems. All packing used in hydraulic equipment for Type I systems, designed in accordance with this specification, shall be standard approved packing conforming to MS28772 and MIL-P-5516, MS28778 and MIL-P-5510, and MS28775 and MIL-P-25732.

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. Itd in the component and subsequently approved by the procuring activity based on the component qualification test.

3.2.4 Use of 0-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 Figure 1. only at operating pressures not greater than 1,500 psi in Types II II, and III systems, unless the extrusion gap is maintained small enough to prevent extrusion of the Cl-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.

3.2.4.1 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 U-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, 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 ANSI/ASME B46.1-85.

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 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 s 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 tin 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 Redundant seals. Two seals in separate seal grooves may be used in tandem with or without venting the space between the seals. The two seal unvented combination is restricted to applications where one side of the tandem seal combination is vented to the atmosphere. This application must allow for increase in breakout and running friction of dynamic seals. The first stage of an unvented tandem seal combination must be resistant to extension in the upstream direction. The use of two or more seals in the same cavity is not permitted.

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 applies, 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 0.20020 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 to the satisfaction of the procuring activity to ensure 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 and non-circular cross section elastomeric shapes 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 gland designs, consideration shall be given to the design application and the following points 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, non-extrusion devices permit greater diametrical clearances between mating parts. Unless otherwise approved by the procurihg activity, the applicable standard packings and backup devices shall be used.

3.4.1.2 Type III systems. Packings and backup rins for use in Type III system shall be designed in such manner as to fulfill the performance and qualification test requirements of the individual hydraulic component. purchase order, the contractor may use his own or any other facilities

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 considerationsas for nominal rectangular grooves, 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 ring; otherwise difficult installation and operation problems may result.

3.4.3 Installation of nonextrusion rims. 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 MS2828774. 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 radius 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 and MIL-P-8791/l.

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. Recommenended 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 static seals. O-ring packing conforming to the sizes shown in MS28775, MIL-P-83461/1, and MIL-P-87175/l for -013 through -028, -117 through -149, and -223 through - 247 are intended for use as static seals. All of the detail requirements specified for O-ring packing will apply to the use of o-ring static seals, 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 MS28775, MIL-P-83461/1, and MIL-P-87175/l 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 o-ring 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.

3.5.4.2 Type II systems. Static seals conforming to MS28775, MIL-P-83461/1, and MIL-P-87175/l 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.

3.5.5 Use of straight thread tube fitting boss packing.

3.5.5.1 Type I and Type II systems. The packing for type I and Type II systems is defined by MS28778, MIL-P-5510, and MIL-P-83461/2 packing 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 MS21344, 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 MS23344 the MS28773 nonextrusion rings must be used with the MS28778 gasket.

3.5.5.2 Type III systems. Packing 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, packing conforming to MS28775, MIL-P-83461, or MIL-P-87175/l 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 ANSI/ASME B46.1-85. 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 ensure 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 system. 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.

3.6.1 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 staic seals is shown in Figure 3.

3.6.2 O-ring squeeze. Referring to Table I, the o-ring squeeze it represented by the difference between the free O-ring cross-section diameter and dimensions A-F or E-B (as applicable).
2 2

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 0-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.

3.6.2.2 Type II systems. For these systems, it is recommeded that the O-ring packing squeeze dimensions listed in Table I be used.

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 maynot 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 ensure 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 bevels, 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 shown in Figure 4.

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 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 or a special packing should be considered.

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.

3.7 Reclaimed materials. The use of reclaimed materials shall be encouraged to the maximum extent possible.

4. QUALITY ASSURANCE PROVISIONS.

4.3 Responsibility for inspection. Unless otherwise specified in the contract or purchase order, the contractor is responsible for the performance of all inspection requirements (examinations and tests) as specified herein. Except as otherwise specified in the contract or purchase order, the contractor may use his own or any other facilities suitable for the performance of the inspection requirements specified herein, unless disapproved by the Government. The Government reserves the right to perform any of the inspections set forth in this specification where such inspections are deemed necessary to ensure supplies and services conform to prescribed requirements.

4.1.1 Responsibility for compliance. All items shall meet all requirements of Sections 3 and 5. The inspection set forth in this specification shall become a part of the contractor's overall inspection system or quality program. The absence of any inspection requirements in the specification shall not relieve the contractor of the responsibility of ensuring that all products or supplies submitted to the Government for acceptance comply with all requirements of the contract. Sampling inspection, as part of manufacturing operations is an acceptable proctice to ascertain confromance to requirements, however, this does not authorize submission of know defective material, either indicated or actual, nor does it commit the Government to accept defective material.

5. PACKAGING

5.1 Preservation. Preservation shall be Level "A" as specified.

5.1.1 Preservation-packaging. Unless otherwise specified by the contracting activity, shall be packed in Quantity Unit Pack (QUP) of one each. Each item will be provided a preservation method IC-1 in accordance with (IAW) MIL-P-116.

5.1.2 Cleaning. Item shall be cleaned IAW MIL-P-116.

5.1.3 Drying. Immediately aftr cleaning, the item shall be dried following any one or combination of the drying procedures listed in MIL-P-116. The drying procedures employed shall not be injurious to the item.

5.1.4 Level A. Item shall be preserved IAW MIL-P-116 as specified.

5.2 Packing. Packing shall be Level "A", "B", or "C", IAW MIL-P-116.

5.2.1 Ccmtainer-Cushioning. Unit container requirements shall conform to MIL-B-131, barrier material, unless otherwise large enough to allow for application of sufficient cushioning/wrap material, between the item and unit container. Item cushioning/Trap material shall conform to PPP-C-1752 or PPP-C-795 and provide sufficient density and thickness to protect the unit container from punctures. Intermediate/shipping containers shall be large enough to allow for application of sufficient cushioning material, between the unit container and intermediate/shipping container. Cushioning material shall be of sufficient density and thickness to ensure shock transmission does not exceed peak values in G's established for the item.

5.2.2 Level A. Fiberboard containers do not meet Level "A" container criteria.

5.2.3 Level B. Item will be preserved as specified in 5.1.1 shall be packed in exterior containers conforming to PPP-B-636, weather-resistant, unless otherwise specified by the contracting activity. Exterior container shall be uniform shape, size and minimum tare and cube, consistent with the protection required. Closure shall be IAW appropriate PPP-B-636 procedures as specified, by contracting activity.

5.2.4 Level C. Item will be packed in such a manner that will affords adequate protection against physical/mechanical damage during direct domestic shipment from the supply source to the first receiving activity. These packs shall conform to MIL-STD-2073-1.

5.3 Marking. Unit, intermediate, and exterior containers shall be marked IAW special markings required by the contracting activity, SPI and MIL_-STD-129.

5.4 Inspection and test. Test of methods of preservation shall be accomplished IAW Section 4 of MIL-P-116 to ensure compliance with Section 5 of this specification. Packaging tests shall be conducted IAW rough handling as specified in FED-STD-101.

6. NOTES

(This section contains information of a general or explanatory nature that may be helpful, but is not mandatory.)

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

6.2 Acquisition requirements. Acquisition documents must specify the following:

a. Title, number, and date of the specification.
b. Issue of DODISS to be cited in the solicitation and if required, the specific issue of individual documents referenced (see 2.1).

6.3 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. 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 sea.
f. 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.
g. Backup ring: A device used to prevent pressure and friction from extruding the O-ring packing through the clearance gap of a seal.
h. TFE : A tetrafluoroethylene resin.

6.5 Subject term [key word) listing.

Dynamic
Face seals
Grooves
O-Rings
Seals
Squeeze
Static

TABLE I. O-Ring gland dimensions

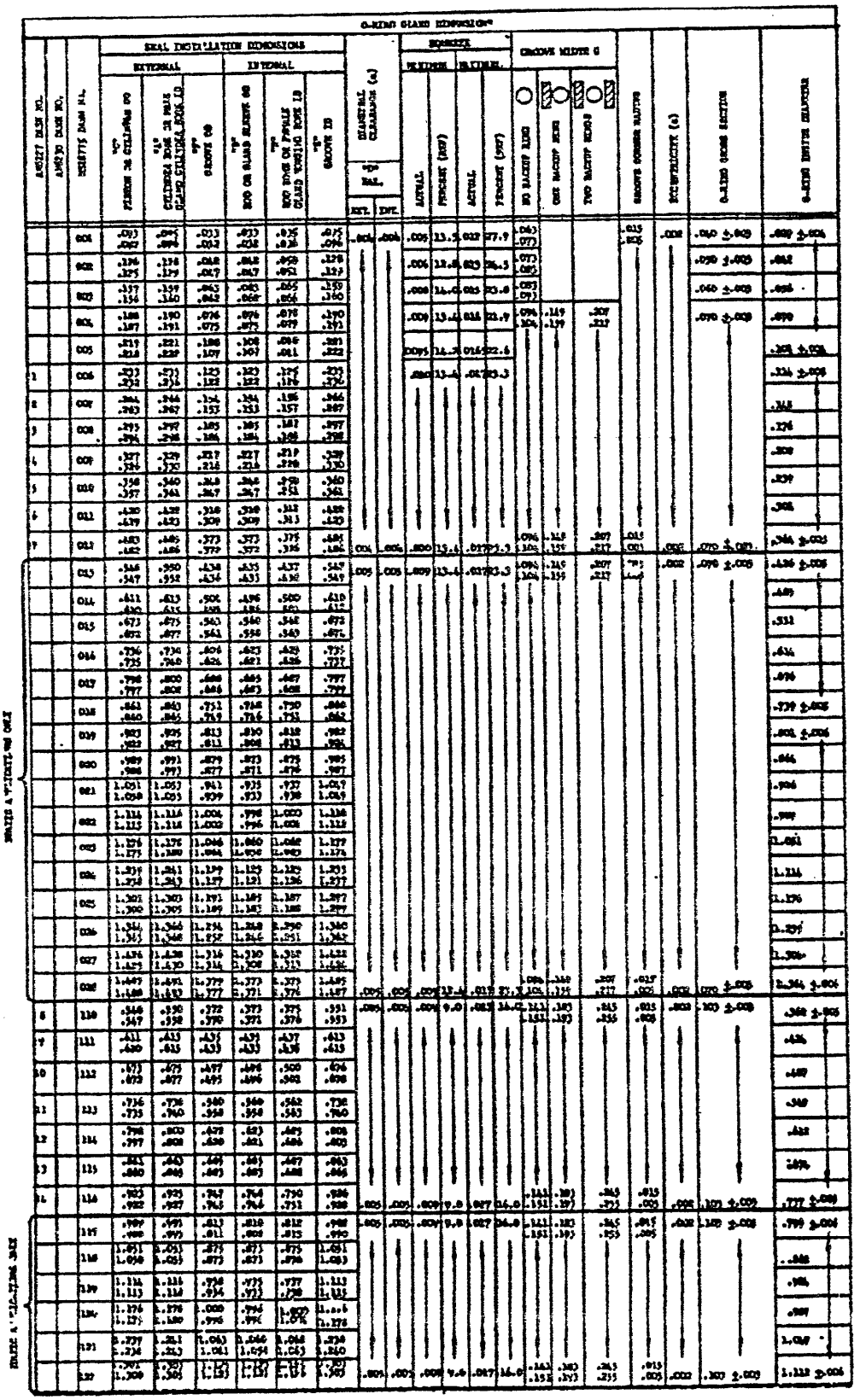


TABLE I. O-Ring gland dimensions -Continued.

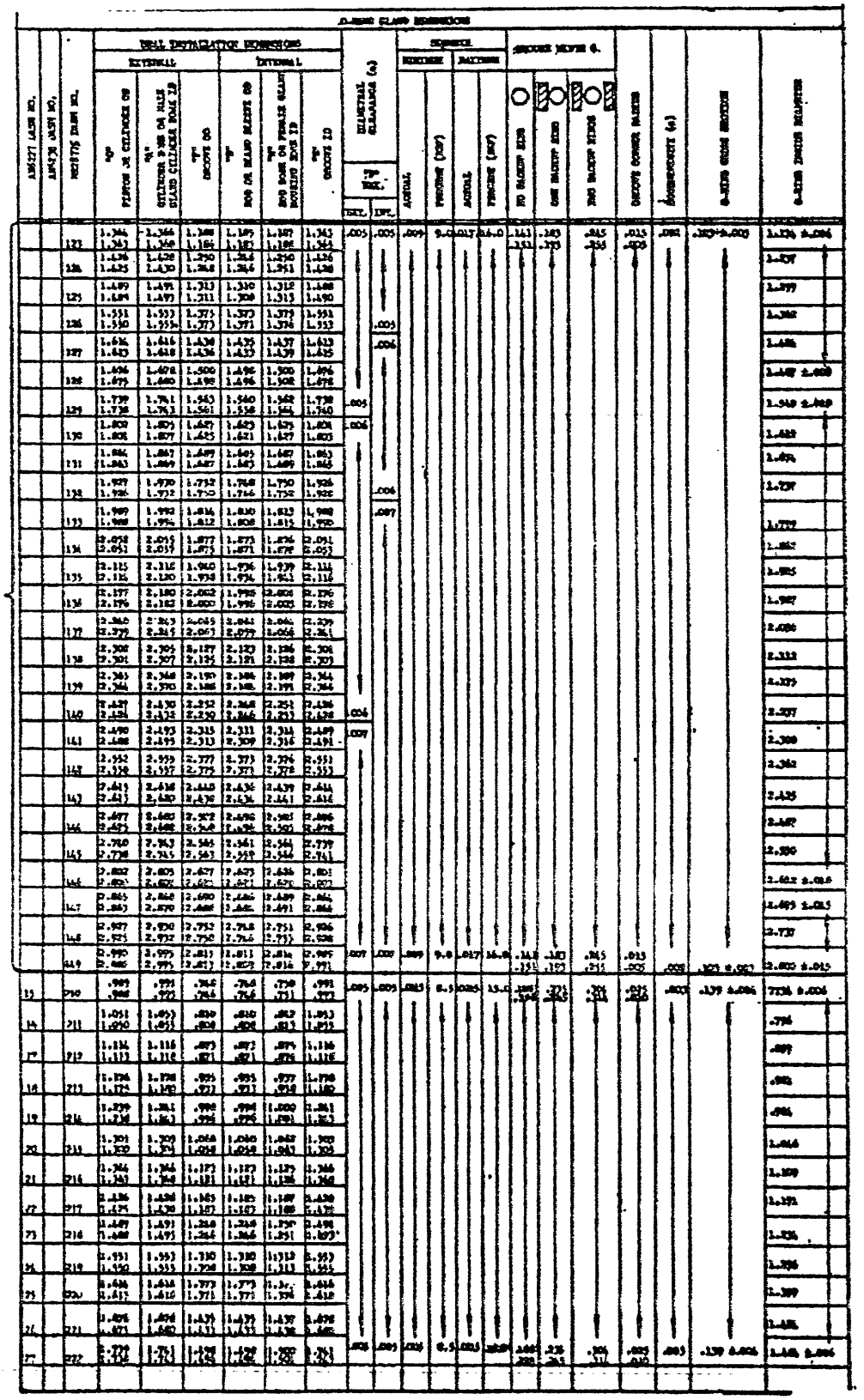


TABLE I. O-Ring gland dimensions -Continued.

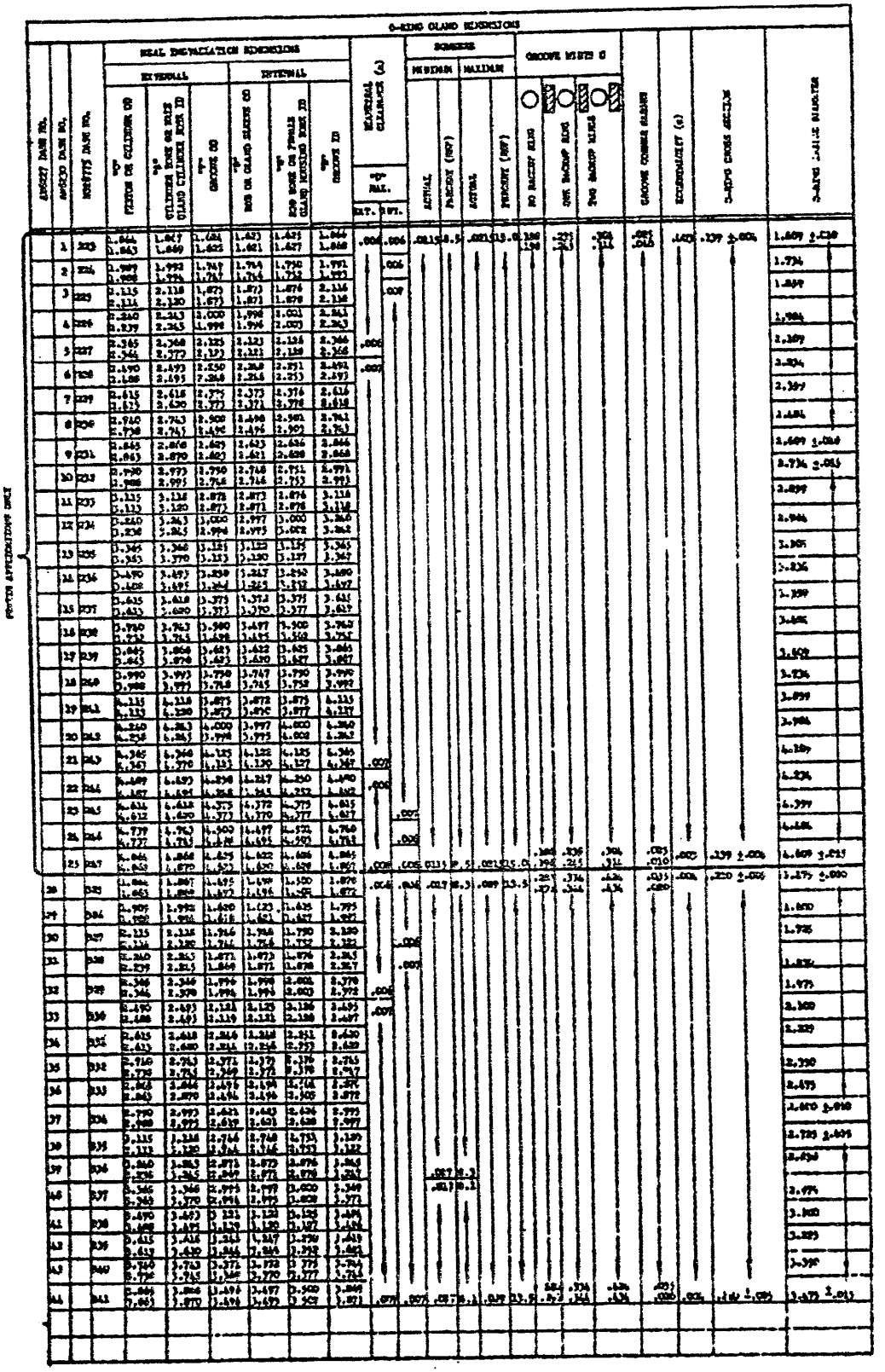


TABLE I. O-Ring gland dimensions -Continued.

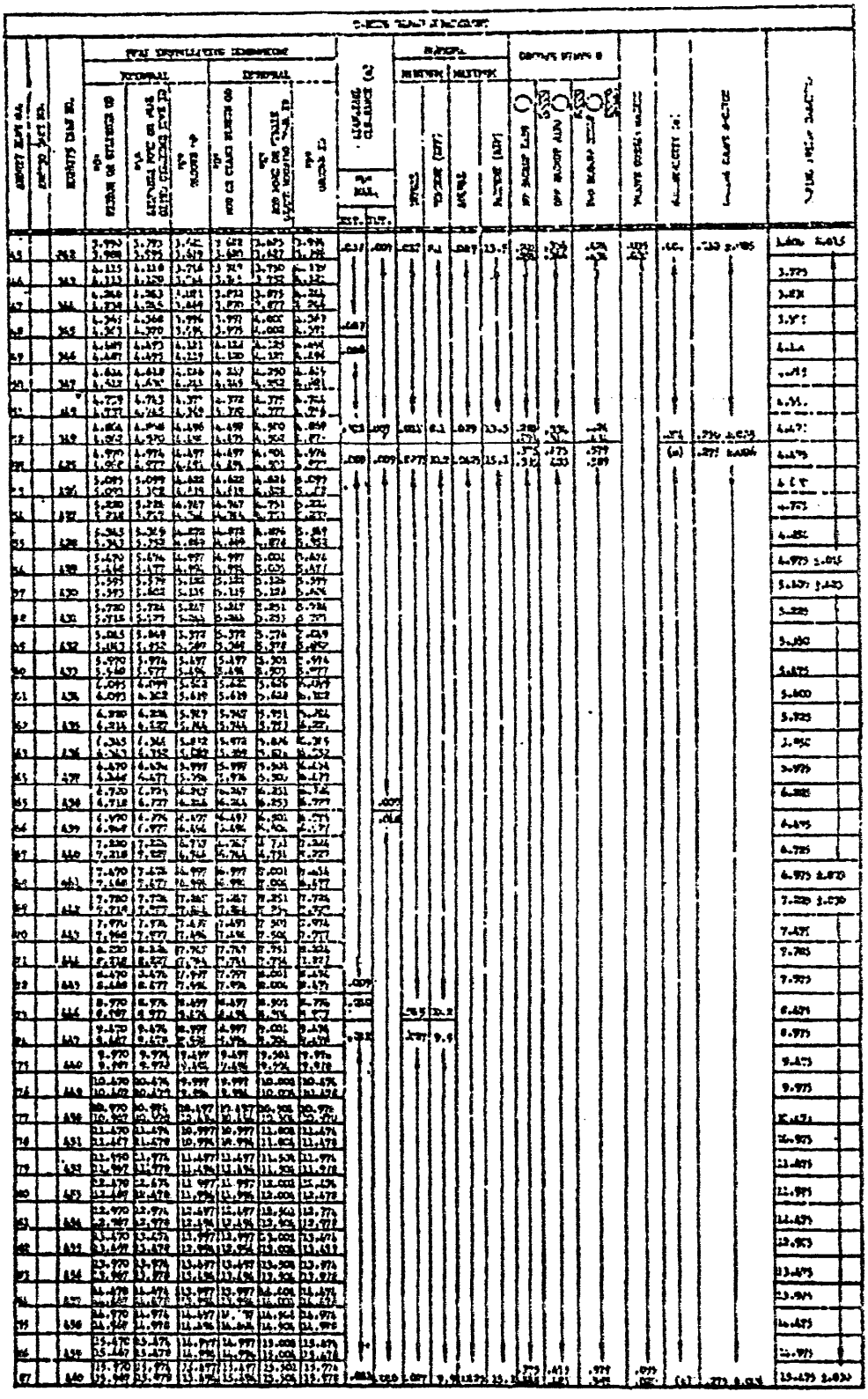
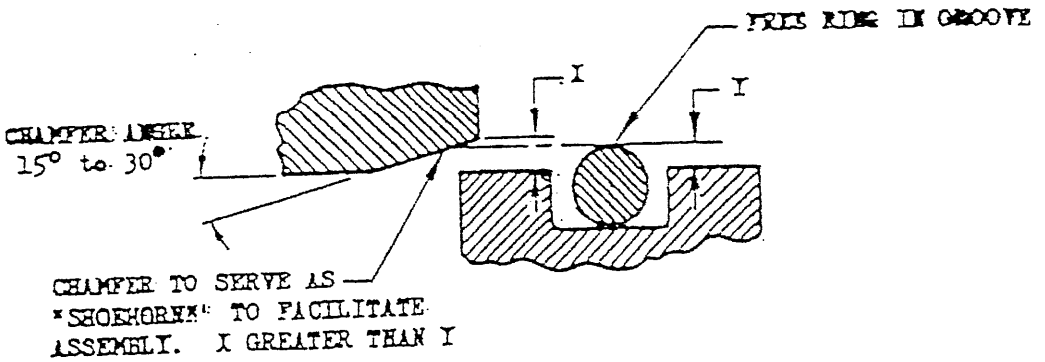


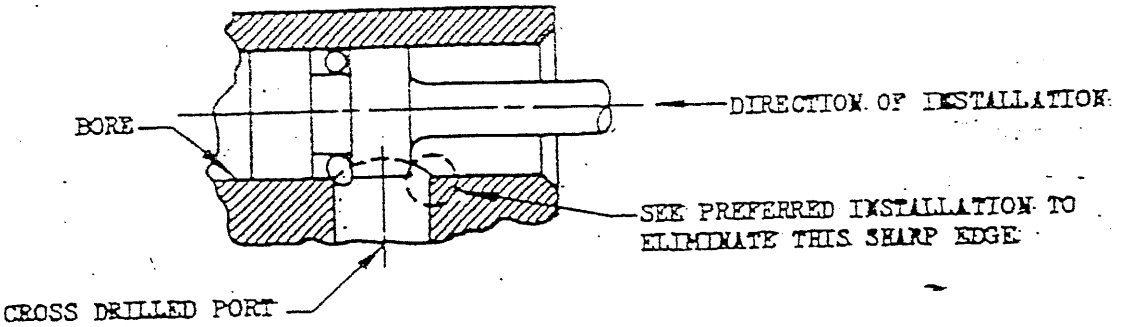
TABLE II. D-Ring gland width dimensions

Dash Number	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	0.579 .589	0.729 .739	0.854 .864

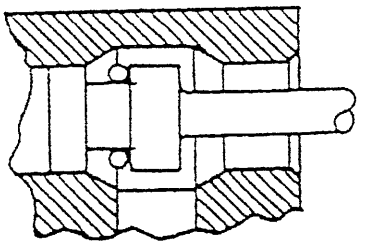
1 See (d) of Figure 2



BEVEL ON PACKING INSTALLATION

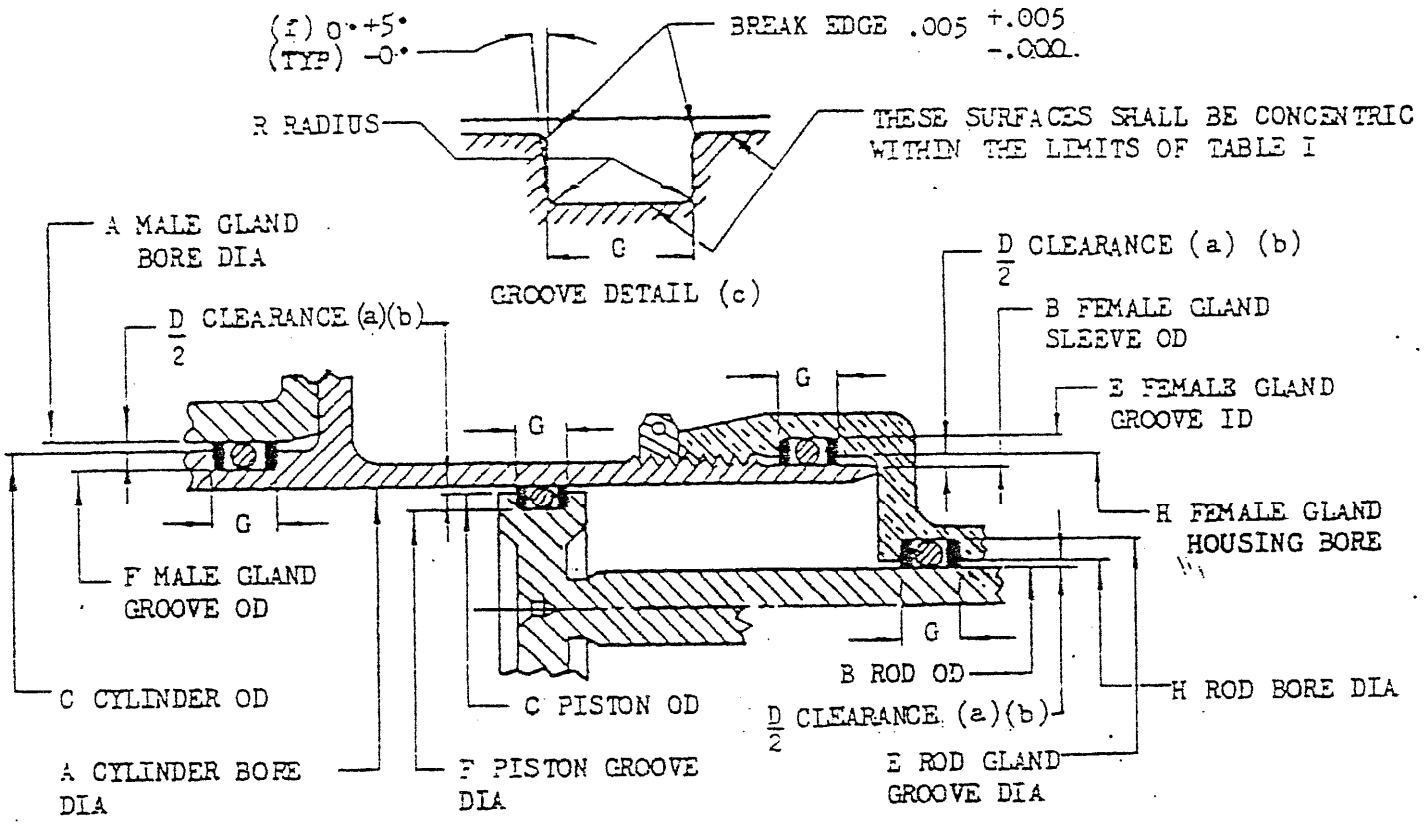


PREFERRED INSTALLATION



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

FIGURE 2. Gland design.

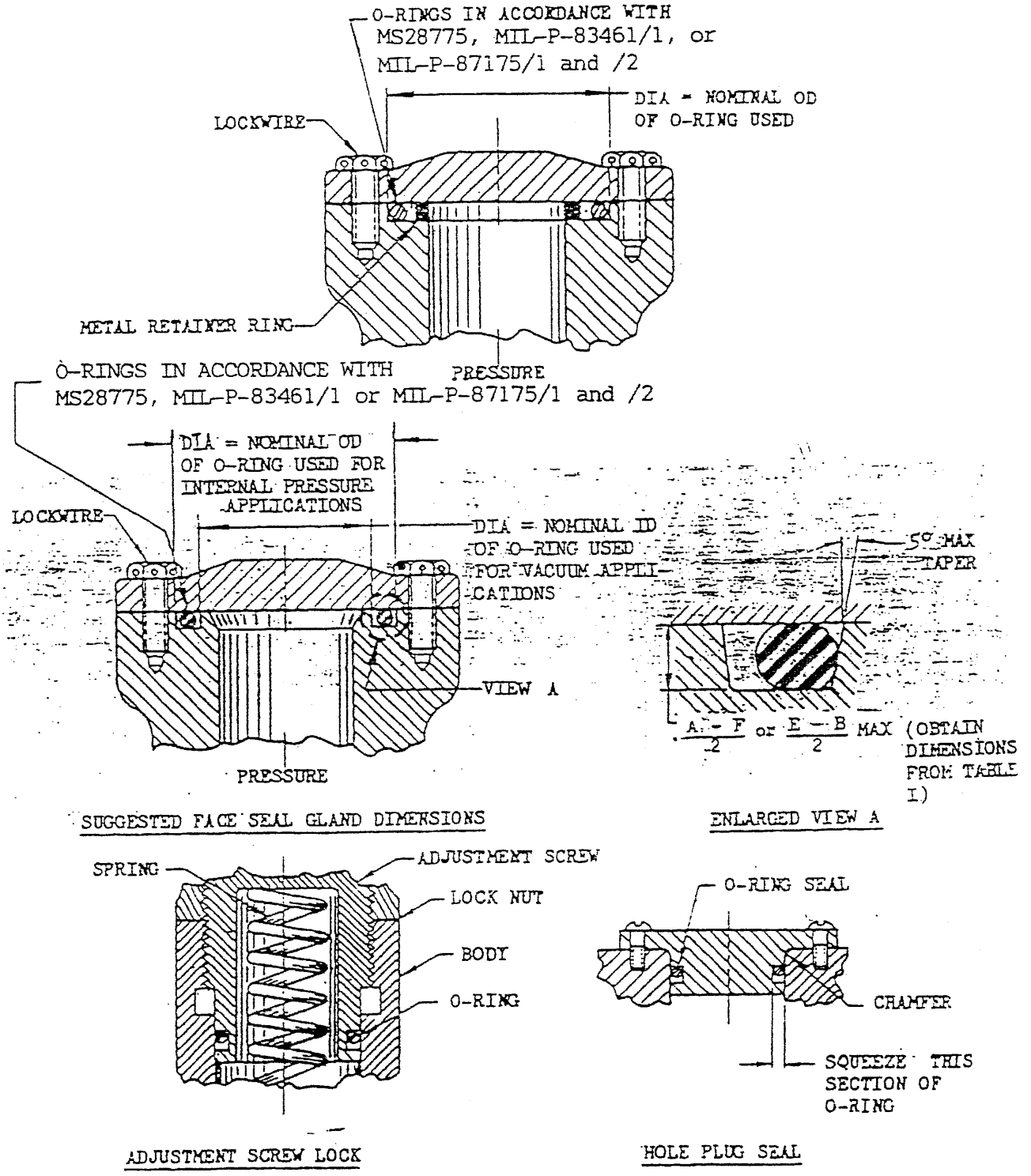


FIGURE 3. Typical installation of static seals.

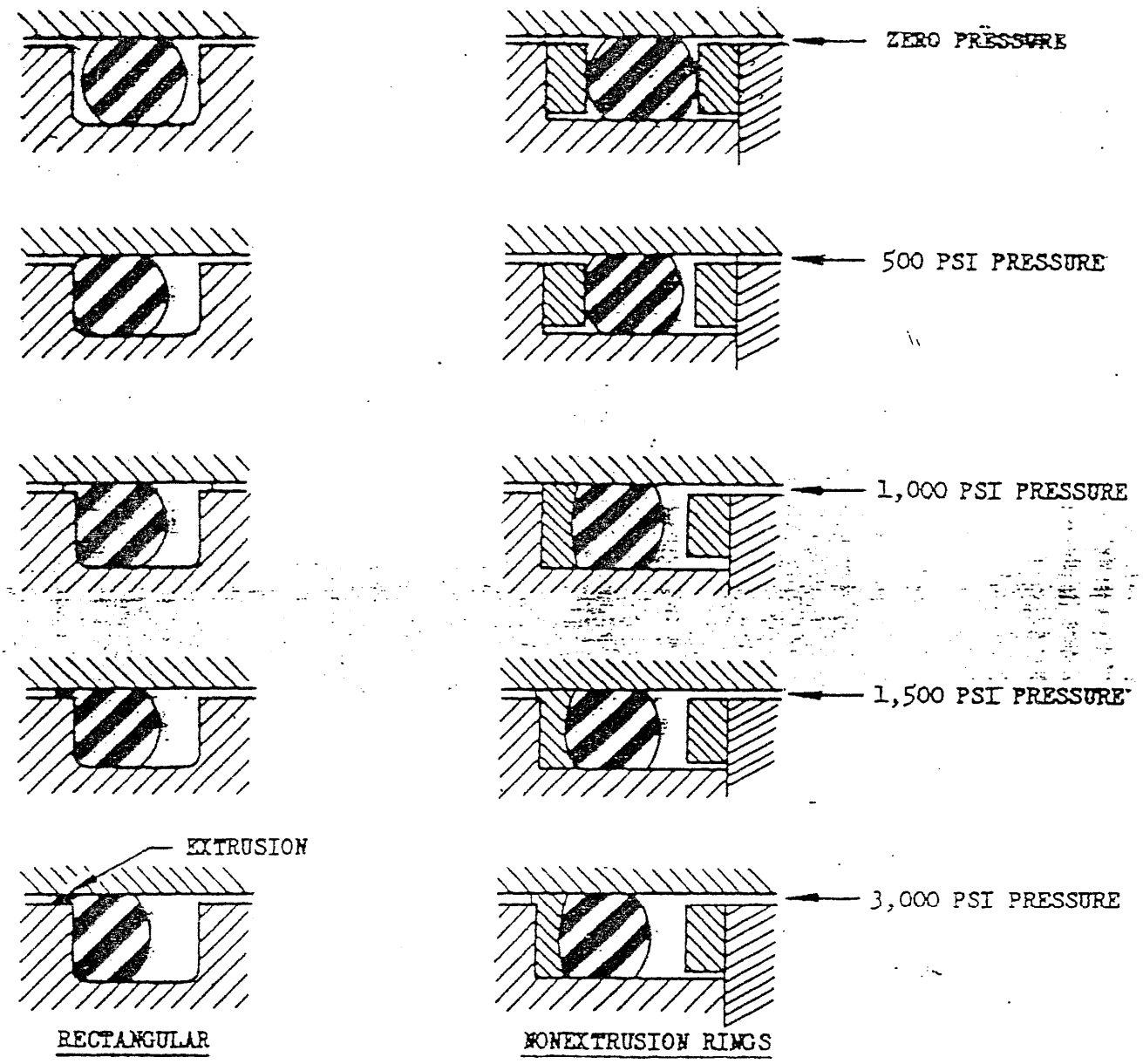


FIGURE 4. Relative positions of O-Ring packings in different grooves at increasing pressures.

STANDARDIZATION DOCUMENT IMPROVEMENT PROPOSAL

INSTRUCTIONS

1. The preparing activity must complete blocks 1, 2, 3, and 8. In block 1, both the document number and revision letter should be given.
2. The submitter of this form must complete blocks 4, 5, 6, and 7.
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I RECOMMEND A CHANGE:	1. DOCUMENT NUMBER	2. DOCUMENT DATE (YYMMDD)
	MIL-G-5514G	93-11-01

3. DOCUMENT TITLE

GLAND DESIGN; PACKINGS, HYDRAULIC, GENERAL REQUIREMENTS FOR

4. NATURE OF CHANGE *(Identify paragraph number and include proposed rewrite, if possible. Attach extra sheets as needed.)*

5. REASON FOR RECOMMENDATION

6. SUBMITTER

a. NAME (Last, First, Middle Initial)	b. ORGANIZATION	
c. ADDRESS (Include Zip Code)	d. TELEPHONE (Include Area Code) (1) Commercial (2) AUTOVON (If applicable)	7. DATE SUBMITTED (YYMMDD)

8. PREPARING ACTIVITY

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