

**(R) STATIC AND RECIPROCATING ELASTOMERIC TRANSMISSION SEALS**

**Foreword**—This Document has not changed other than to put it into the new SAE Technical Standards Board Format.

- 1. Scope**—This SAE Recommended Practice is intended as a guide to the design and use of static and reciprocating elastomeric transmission seals. It has been prepared from existing literature, which includes standards, specifications, and catalog data of both producers and users and includes generally-accepted information and data. The main reason for the preparation of the document is to make standard information available in one document to the users of static and reciprocating elastomeric transmission seals.
- 2. References**—There are no referenced publications specified herein.
- 3. Seals—Rectangular**—Rectangular seals (Reference Figures 1 to 4) are elastomeric seals confined to their sealing location by part of the application hardware. Rectangular seals are used where bi-directional sealing is required. Some caution should be exercised when using rectangular seals for low dynamic friction applications since excessive displacement of the seal may cause undesirable high seal drag. These seals are produced by lathe cutting either molded or extruded tubing.

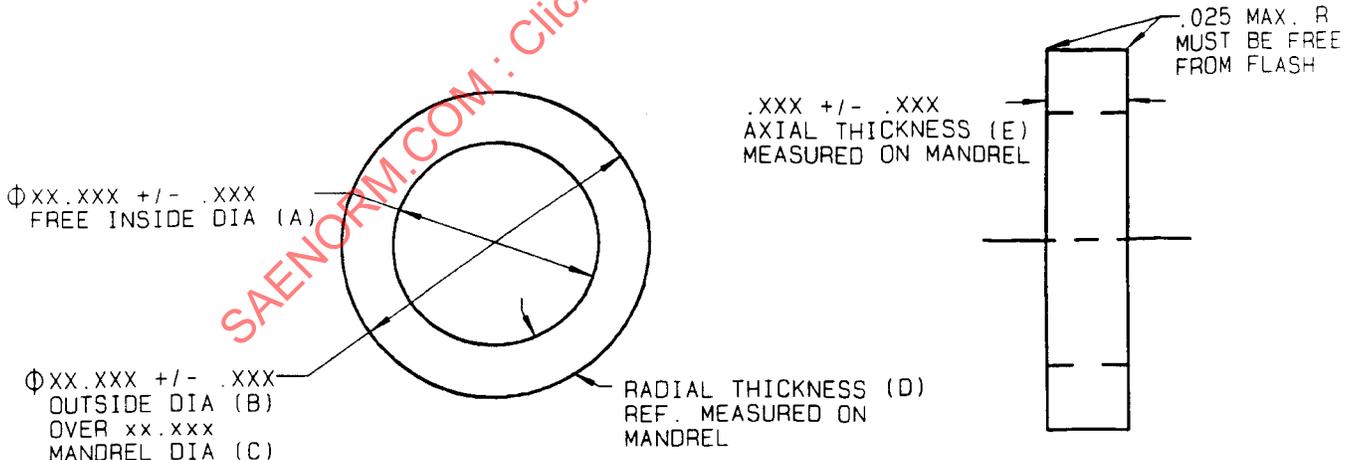
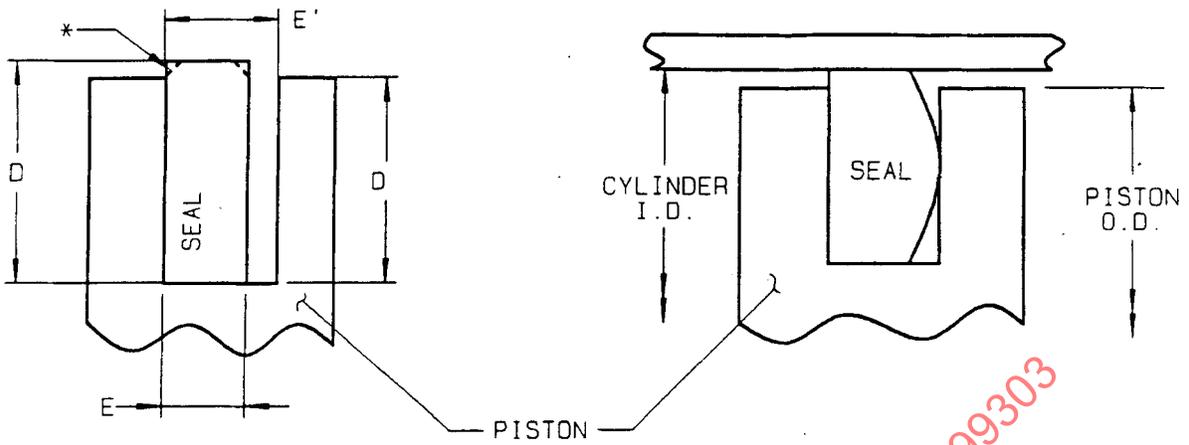


FIGURE 1—TYPICAL RECTANGULAR SEAL DESIGN

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\* OPTIONAL .75mm X 45° CHAM. TO AID ASSEMBLY OR REDUCE DYNAMIC FRICTION

FIGURE 2—RECTANGULAR SEAL—DYNAMIC SEAL APPLICATION

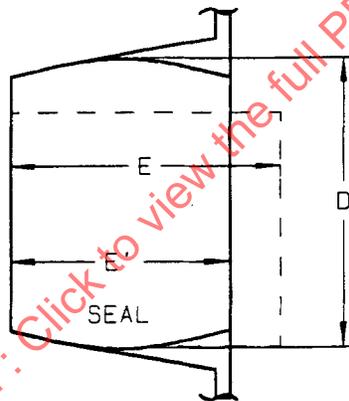


FIGURE 3—RECTANGULAR SEAL STATIC APPLICATION

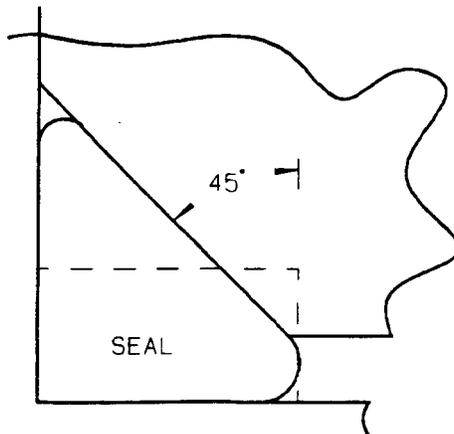


FIGURE 4—RECTANGULAR SEAL STATIC APPLICATION

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**3.1 Suggested Tolerances and Dimensioning Practices**—A typical design of a rectangular seal is shown in Figure 1. Table 1 lists the actual tolerances for different size ranges. The design parameters are:

- 3.1.1 Inspection mandrel diameter (C) should be equal to the external groove diameter and should be approximately 4% greater than the free inside diameter (A).
- 3.1.2 Outside diameter (B) is equal to mandrel diameter (C) plus twice the stretched radial thickness of the seal.
- 3.1.3 Variation of the total radial thickness tolerance shall not occur in less than 90 degrees of circumference and rate of change shall be uniform over this distance.
- 3.1.4 The tolerances in Table 1 apply to all nitrile rubber.
- 3.1.5 For post cured compounds, the tolerances in Table 1 also apply except for free inside diameter which has  $\pm 0.6\%$  applied with a minimum tolerance of  $\pm 0.2$  mm under 25 mm and a minimum tolerance of  $\pm 0.25$  mm over 25 mm.

**TABLE 1—RECTANGULAR SEAL TOLERANCES—mm**

A, ID or B, OD Size	A, Free ID	C, OD Over Mandrel	D, Radial Thickness	E, Axial Thickness
Up to 25 mm	$\pm 0.20$	$\pm 0.20$	$\pm 0.10$	$\pm 0.13$
25 mm to 75 mm	$\pm 0.25$	$\pm 0.20$	$\pm 0.10$	$\pm 0.13$
75 mm and Up	$\pm 0.4\%$	$\pm 0.20$	$\pm 0.10$	$\pm 0.13$

**3.2 Application Design Data**

- 3.2.1 DYNAMIC—The rectangular seal shown in Figure 2 represents a dynamic seal application. The design parameters are:
  - 3.2.1.1 The cross-sectional area of the seal (E x D) shall be approximately 20% less than the cross-sectional area of the groove (E' x D').
  - 3.2.1.2 The radial thickness (D) of the seal shall be approximately 10% greater than the groove depth (D') to place the seal under 10% radial displacement. In some applications, frictional drag may dictate reduction of the 10% radial displacement value.
  - 3.2.1.3 The axial thickness of the seal (E) must be at least two times the maximum possible clearance between the piston outside diameter and cylinder inside diameter.
  - 3.2.1.4 The radial thickness (D) of the seal typically is at least twice as great as the width (E).
  - 3.2.1.5 The maximum diametrical clearance between cylinder and piston must not exceed 0.5 mm.
  - 3.2.1.6 The seal shall have approximately 4% stretch when installed into an OD groove and 4% displacement when installed into an ID groove.
- 3.2.2 STATIC—The rectangular seals shown in Figures 3 and 4 represent static seal designs. The design parameters are:
  - 3.2.2.1 The maximum cross-sectional area of a rubber seal shall not exceed 95% of the minimum cross-sectional area of the groove for a completely constrained seal (Figure 3).

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- 3.2.2.2 The seal volume should not exceed groove volume even when the seal is not completely constrained (Figure 4).
- 3.2.2.3 The dimension (D) should not be less than, and preferably should be greater than, two times dimension (E) to reduce distortion and twist at assembly.
- 3.2.2.4 The axial displacement may vary from 10 to 30% of dimension (E) depending on material and hardness.
- 3.2.3 General application requirements are listed in Table 2.

TABLE 2—GENERAL APPLICATION REQUIREMENTS

Item	Nitrile	Premium Nitrile	Polyacrylate	Fluoro-elastomer	Ethylene Acrylic
Temp. Range	-40 °C to +110 °C	-40 °C to +130 °C	-40 °C to +130 °C	-40 °C to +200 °C	-40 °C to +150 °C
Pressure	2400 kPa	2750 kPa	2750 kPa	2750 kPa	2750 kPa
Bore/Shaft Tolerance	±0.03 mm				

4. Seals—Lip

- 4.1 **Homogeneous**—Lip seals (Reference Figures 5 and 6) are elastomeric seals confined to the sealing location by a specially designed groove in either the bore or piston. Lip seals are used in dynamic applications in place of rectangular seals where lower friction is required. These seals function by the deflection principle where the pressure forces the lip and lip base against the elements being sealed. The sealing effort is, therefore, proportional to the pressure being sealed. Lip seals can either be molded or machined from blanks.
  - 4.1.1 SUGGESTED TOLERANCES AND DIMENSIONING PRACTICES—The lip seals and grooves shown in Figures 5 and 6 are typical designs. These designs are dimensioned by use of bore diameters plus design constants to establish the lip diameters. The tolerances for these designs are typical for lip seals.
  - 4.1.2 APPLICATION DESIGN DATA—The lip seals shown in Figures 5 and 6 can operate with fluid or air pressure. The bore diameter tolerances are specified on the drawing. General application requirements are listed in Table 2.
- 4.2 **Seals—Bonded Lip**—Bonded lip seals (shown in Figures 7 and 8) are elastomeric lip seals bonded to metal. These seals function by the lip interference between the elements being sealed and by pressure acting on the lip. The sealing effort is, therefore, the combination of the designed-in lip interference and the effort proportional to the pressure being sealed. Bonded lip seals are molded to size and bonded to one of the sealed elements in one operation.

**LIP SEAL DESIGN**

FOR SERVO, ACCUMULATOR,  
OR CLUTCH APPLICATION

**EXTERNAL BASIC SHORT LIP DESIGN**

DYNAMIC

BORE DIA "B"  $\pm 0.05$   
FINISH 1.15 $\mu$ m AA MAX. FOR ALUMINUM  
0.70 $\mu$ m MAX. FOR STEEL  
(ALSO FOR ASSEMBLY CHAMFER)

OPTIONAL  
CONSTRUCTION

GROOVE DIA. "G"  
(B  $\pm 0.10$ )

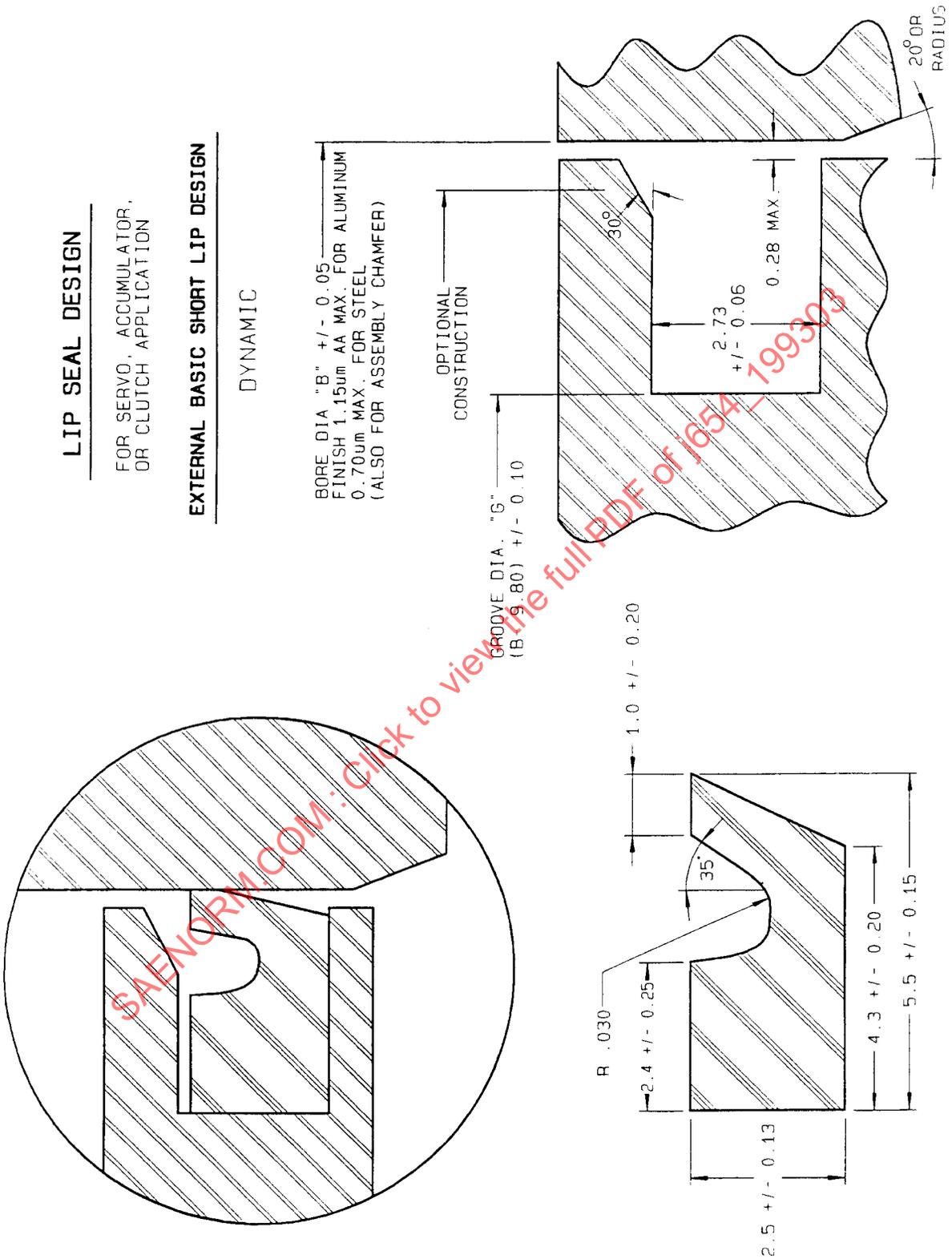


FIGURE 5—EXTERNAL BASIC SHORT LIP DESIGN

LIP SEAL DESIGN

FOR SERVO, ACCUMULATOR,  
OR CLUTCH APPLICATION

EXTERNAL BASIC SHORT LIP DESIGN

DYNAMIC

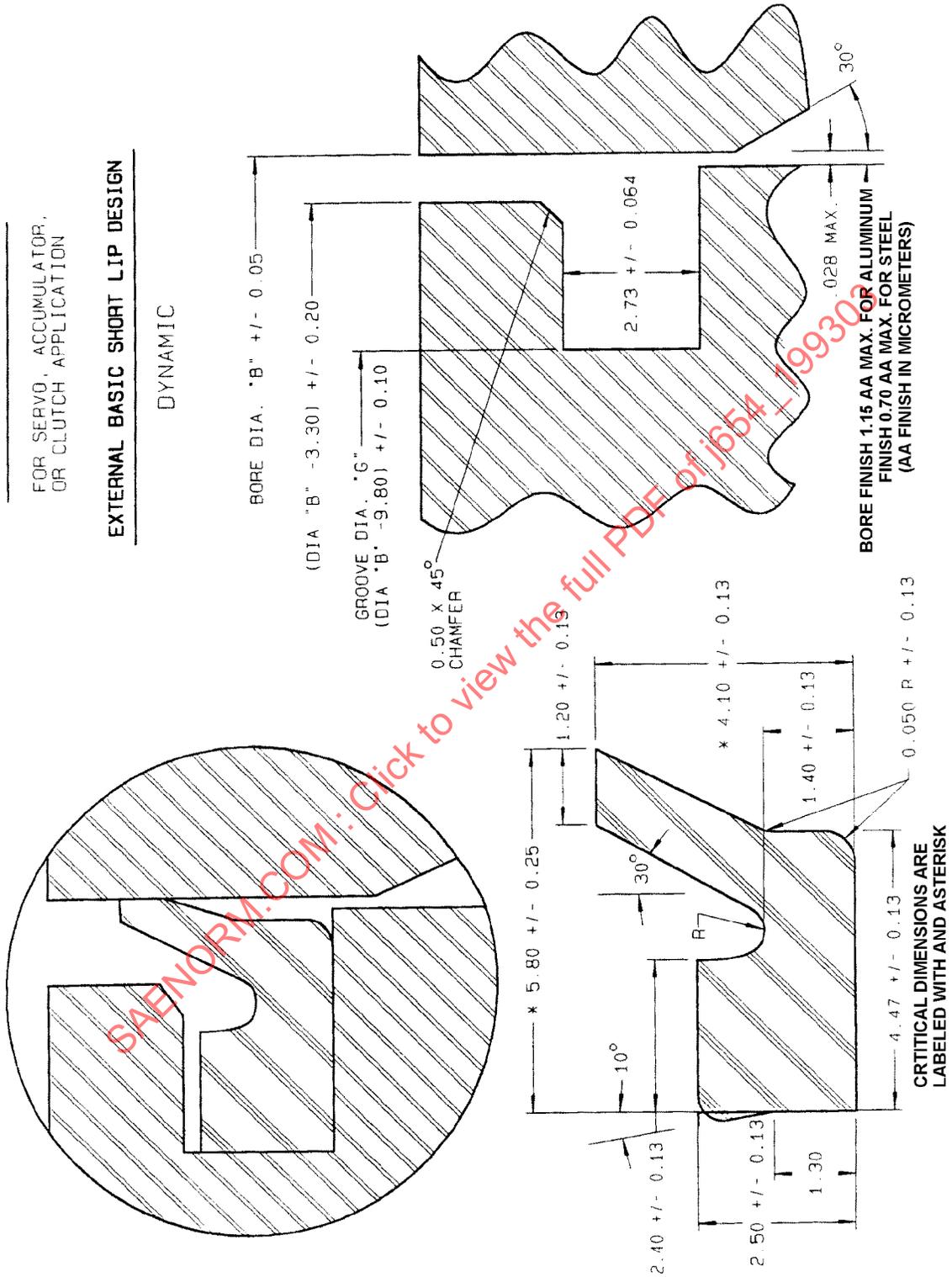


FIGURE 6—EXTERNAL BASIC LONG LIP DESIGN

**BONDED LIP PISTON DESIGN**

FOR SERVO, ACCUMULATOR,  
OR CLUTCH APPLICATION

**STANDARD DESIGN**

DYNAMIC

CRITICAL DIMENSIONS  
ARE LABELLED WITH  
AN ASTERISK

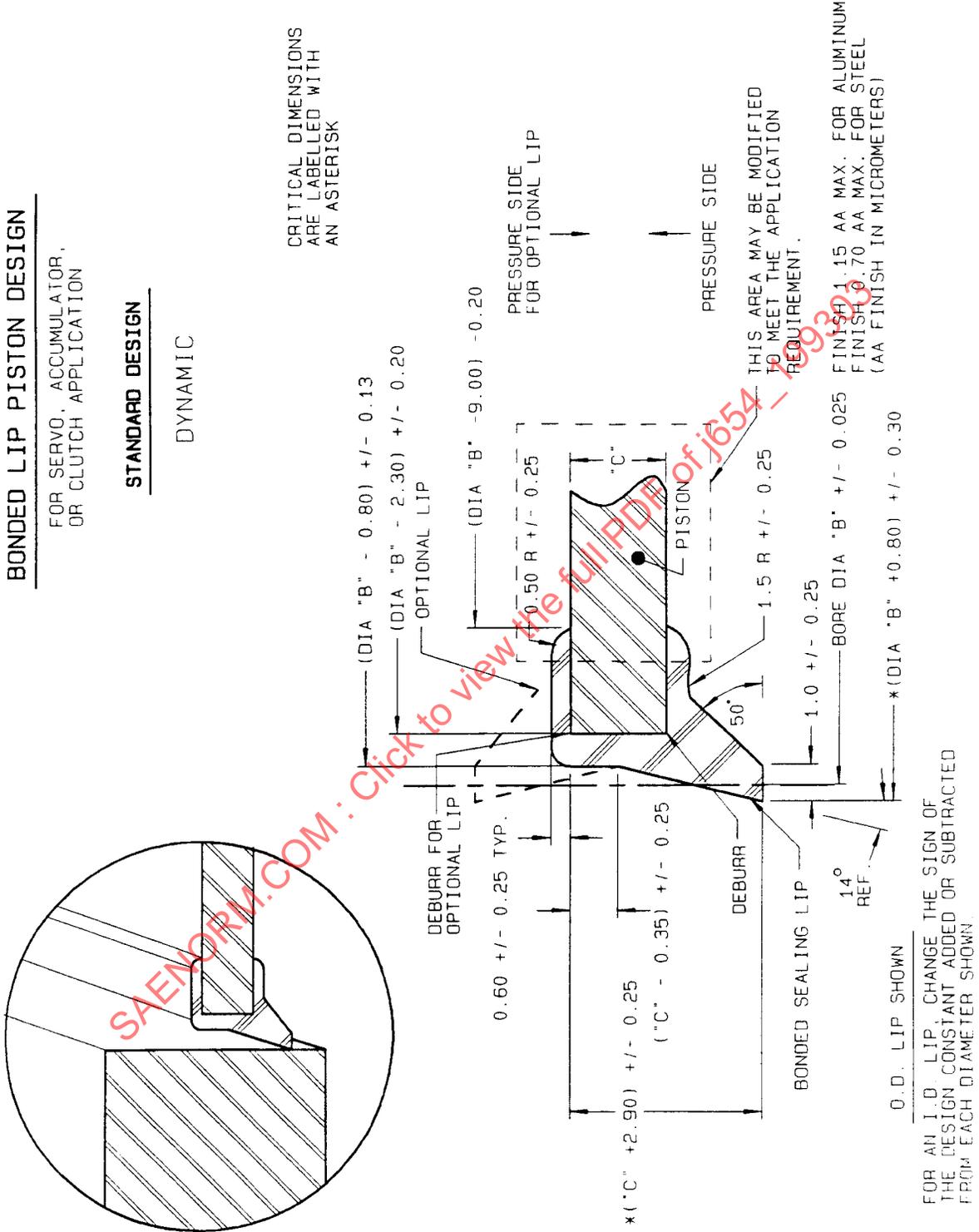


FIGURE 7—STANDARD DESIGN

**BONDED LIP PISTON DESIGN**

FOR SERVO, ACCUMULATOR, OR CLUTCH APPLICATION WHERE SPACE IS LIMITED.

**NARROW DESIGN**

DYNAMIC

CRITICAL DIMENSIONS ARE LABELLED WITH AN ASTERISK.

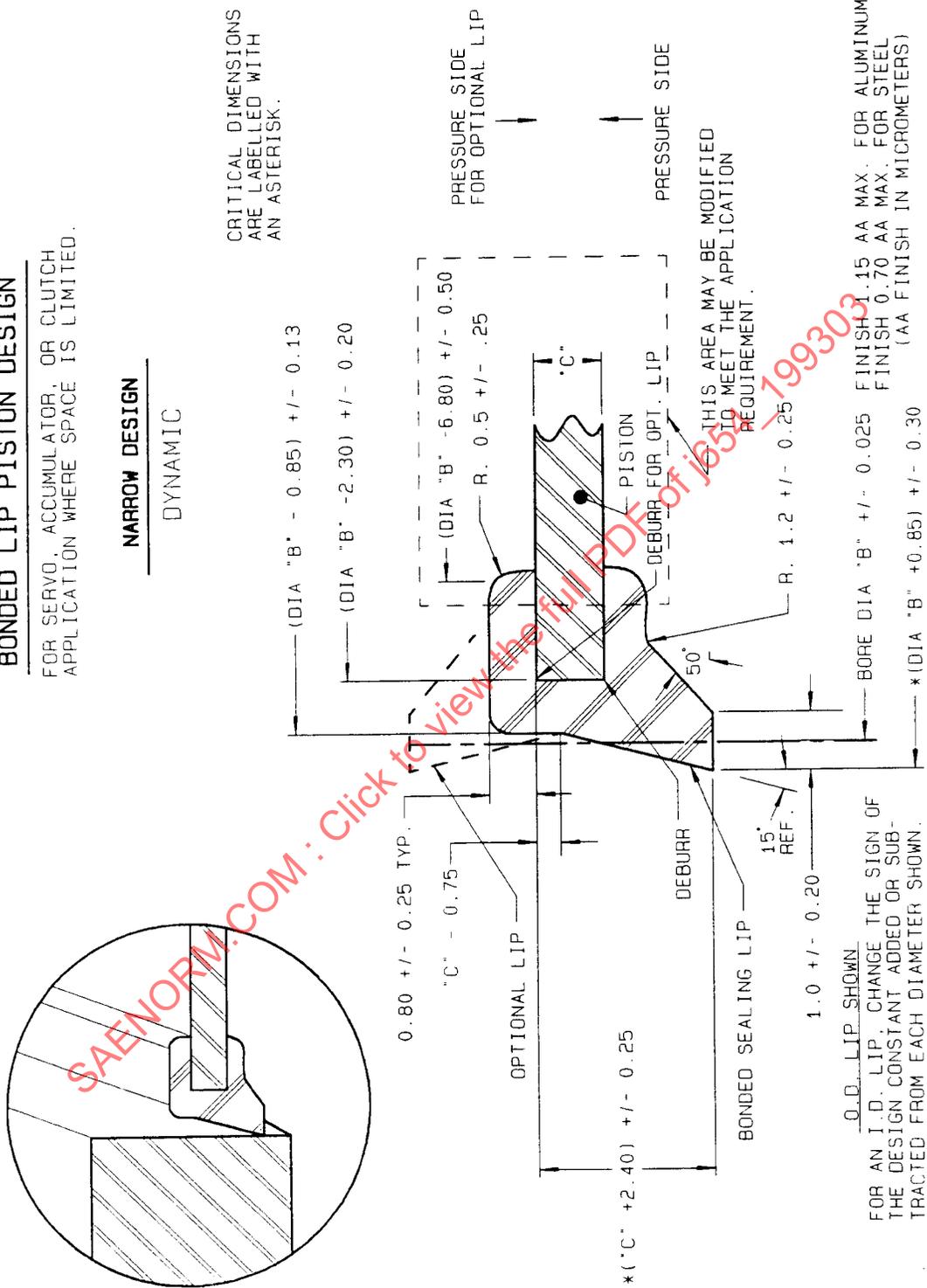


FIGURE 8—NARROW DESIGN