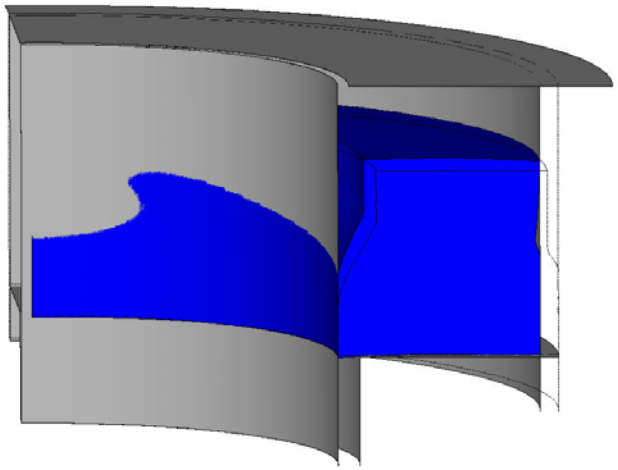
Appendix 2

Width prediction of installed Kalsi Seals



Revision 3 September 30, 2020

Individual chapters of the Kalsi Seals Handbook™ are periodically updated. To determine if a newer revision of this chapter exists, please visit https://www.kalsi.com/seal-handbook/.

1. Introduction

The installed width of a Kalsi Seal ™ varies as a function of thermal expansion, seal and hardware tolerances, and any media-induced swelling that may be present. A large matrix of finite element analyses (FEA) was conducted to evaluate the installed axial width of basic Kalsi Seals® in cross-sectional sizes ranging from 0.145" to 0.415" (3.68 to 10.54 mm) in order to gain a better understanding of the axial groove width requirements for such rotary seals. The results can also be used with reasonable accuracy for other styles of Kalsi Seals that use the "standard" lip width, and with Wide Footprint Seals[1]™.

The FEA models were axi-symmetric, representing the average wave height. Variables included radial compression, temperature, tolerance, inside diameter, and coefficient of thermal expansion. A portion of the results are presented graphically in this Appendix; information for alternate compression is available by request.

The results labeled "MMC" are not true MMC conditions; only the overall axial and radial cross-sectional dimensions were at true MMC, the rationale being that these are the only dimensions affected by mold closure relationships, and the only significant dimensions that are affected by molding shrinkage variations.

The seal temperature for each FEA was varied from 72 to 450°F (22 to 232°C). The conservatively selected 13 x 10^{-5} in/in/°F coefficient of thermal expansion is based upon the upper bound reported in the literature for NBR. In limited testing, the coefficient of thermal expansion of the Kalsi Engineering -10 HNBR material was measured at 9.2 x 10^{-5} in/in/°F.

LMC seal width was not modeled, but can be approximated by subtracting an adjustment factor from the predicted nominal rotary seal width. The adjustment factor is equal to 0.005" (0.13 mm) plus the seal radial depth tolerance.

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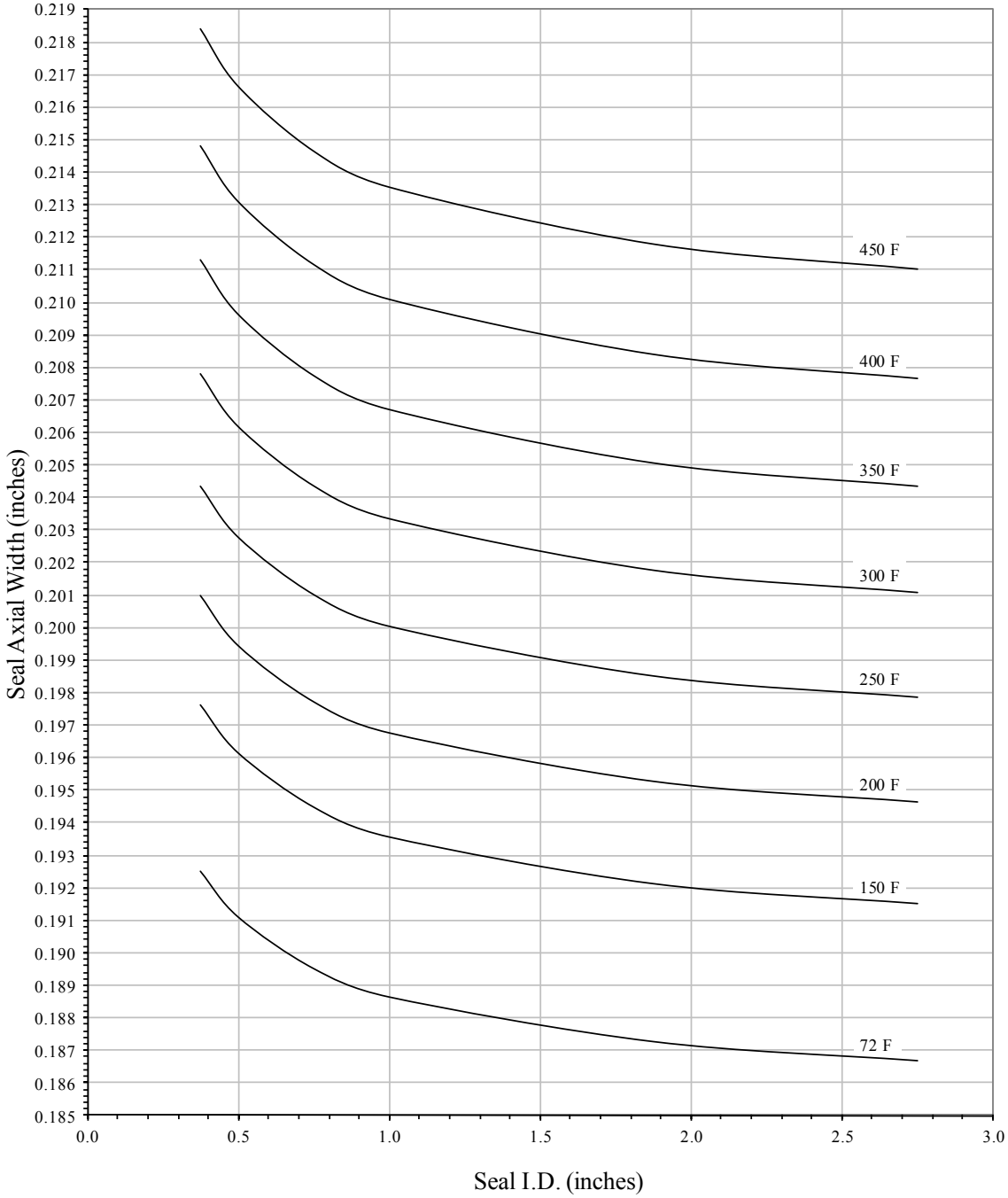
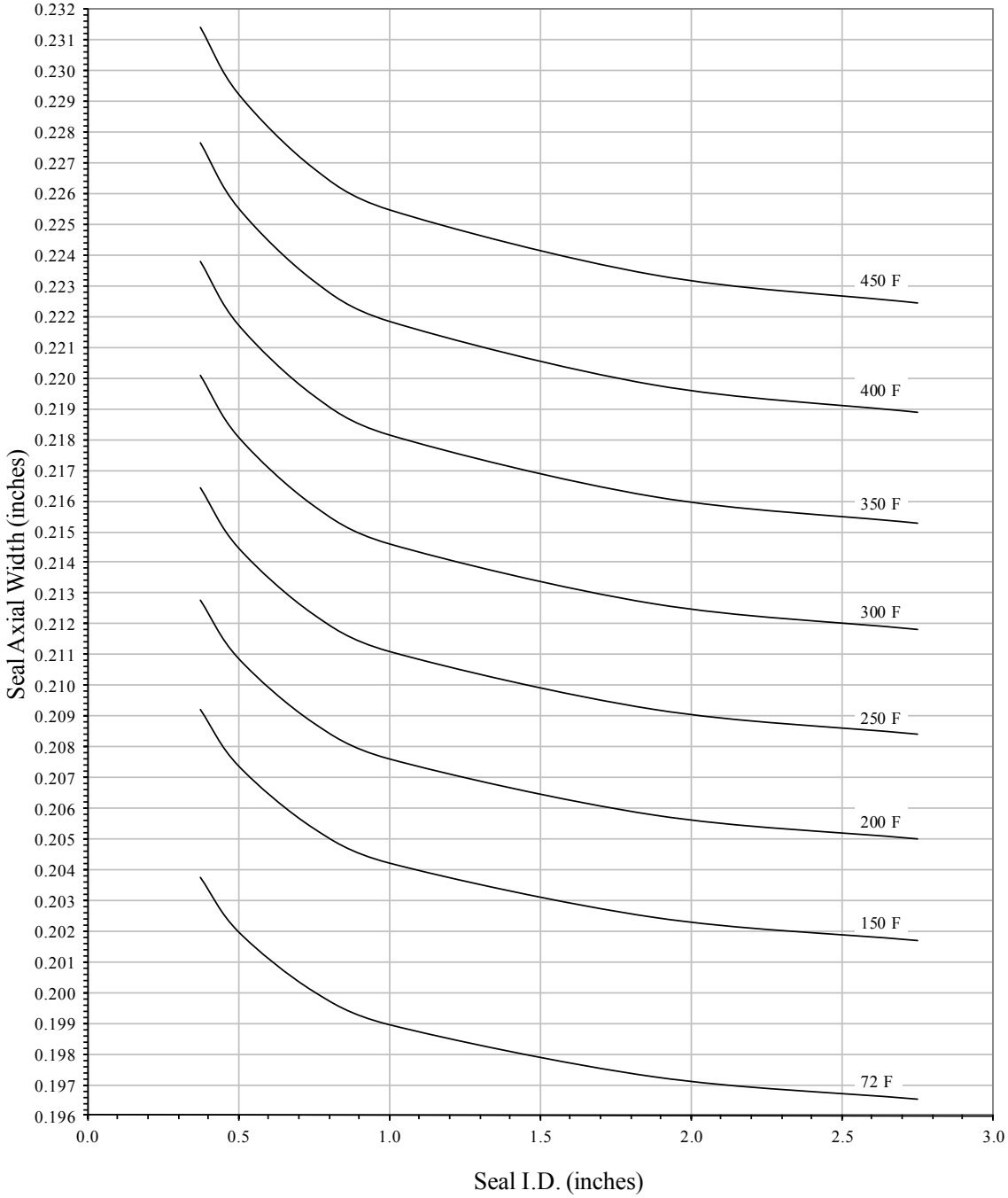
1 Wide Footprint Seals were designed to have about the same installed width as Standard Kalsi Seals.

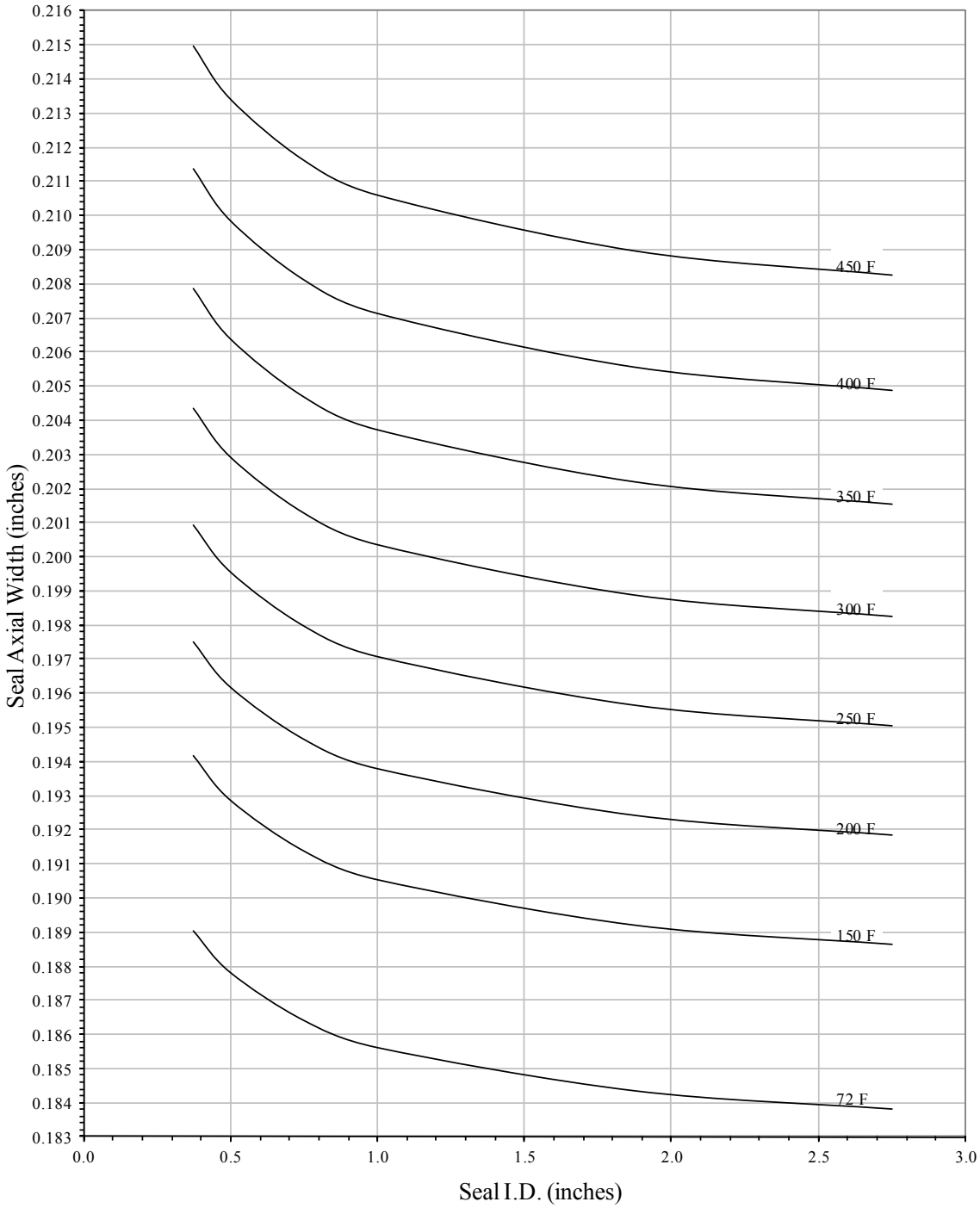
Axial Widths of **Nominal** 0.145" X 0.170" Cross Section
Standard Kalsi Seals with a **13E-5 in/in/°F** Coefficient of Thermal
Expansion in a **0.125"** Radial Gland



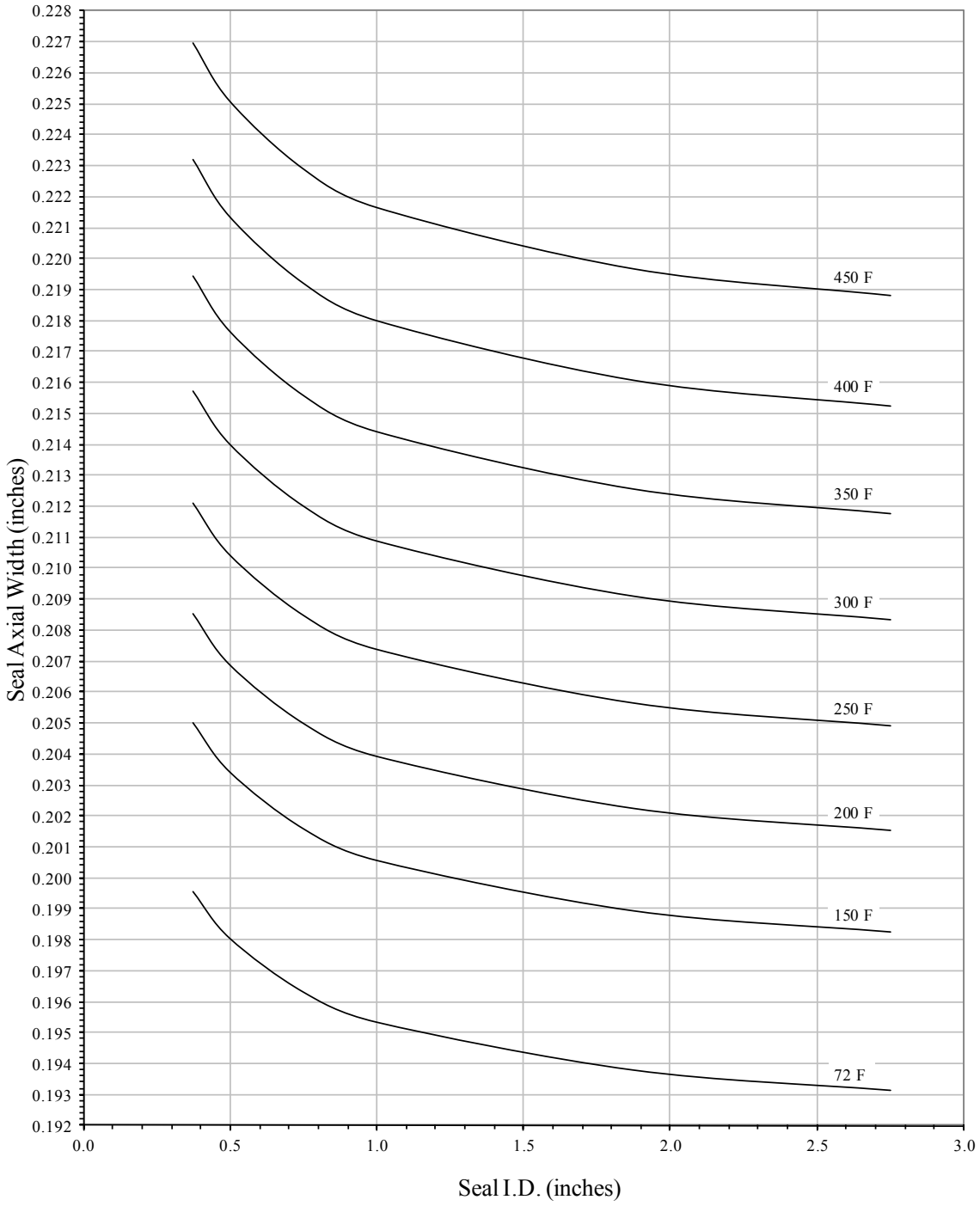
Axial Widths of **MMC** 0.145" X 0.170" Cross Section
Standard Kalsi Seals with a **13E-5 in/in/°F** Coefficient of Thermal
Expansion in a **0.125"** Radial Gland (Actual Seal Cross Section 0.148" X 0.177")



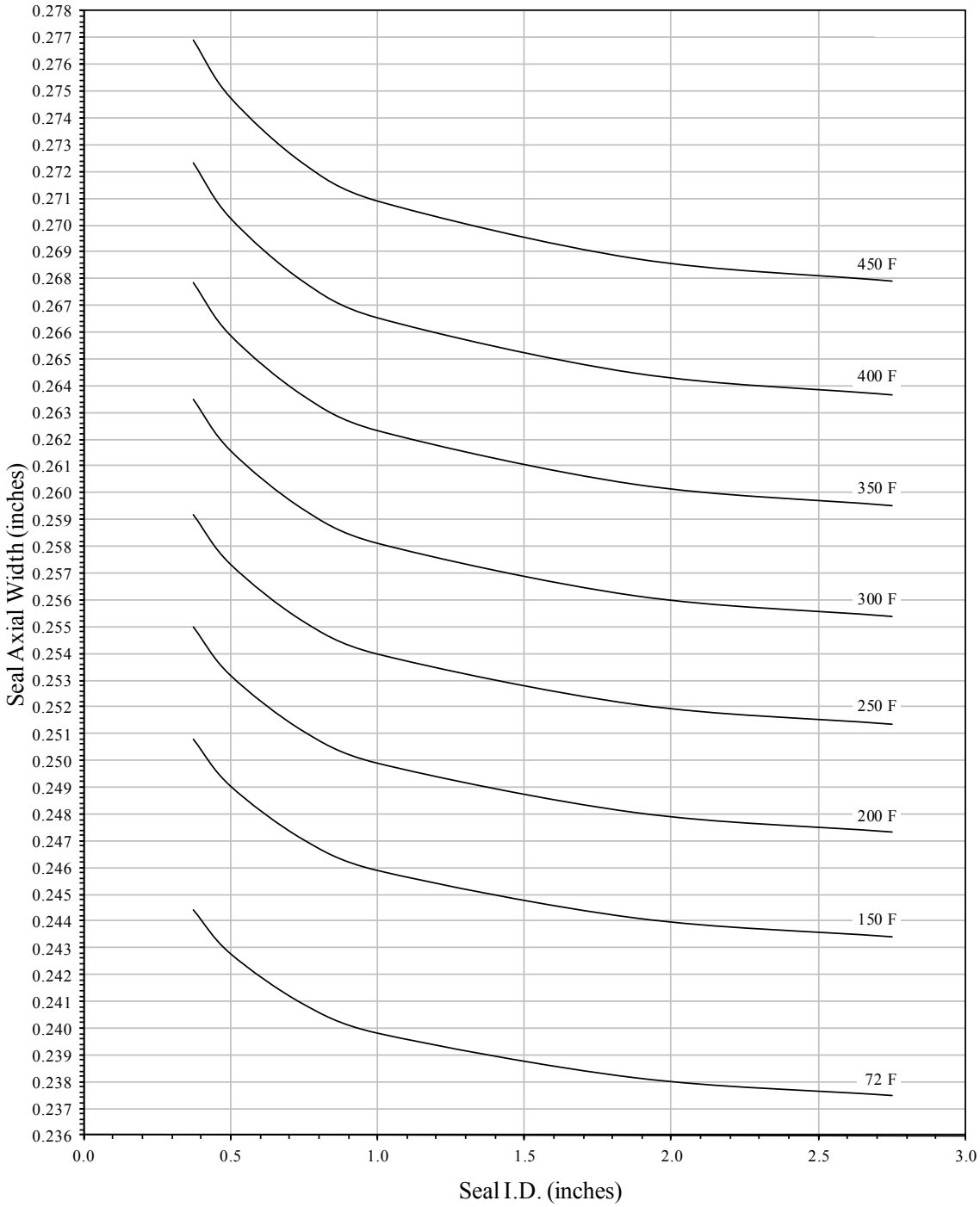
Axial Widths of **Nominal** 0.186" X 0.170" Cross Section
Standard Kalsi Seals with a **13E-5 in/in/°F** Coefficient of Thermal Expansion in a **0.166"** Radial Gland



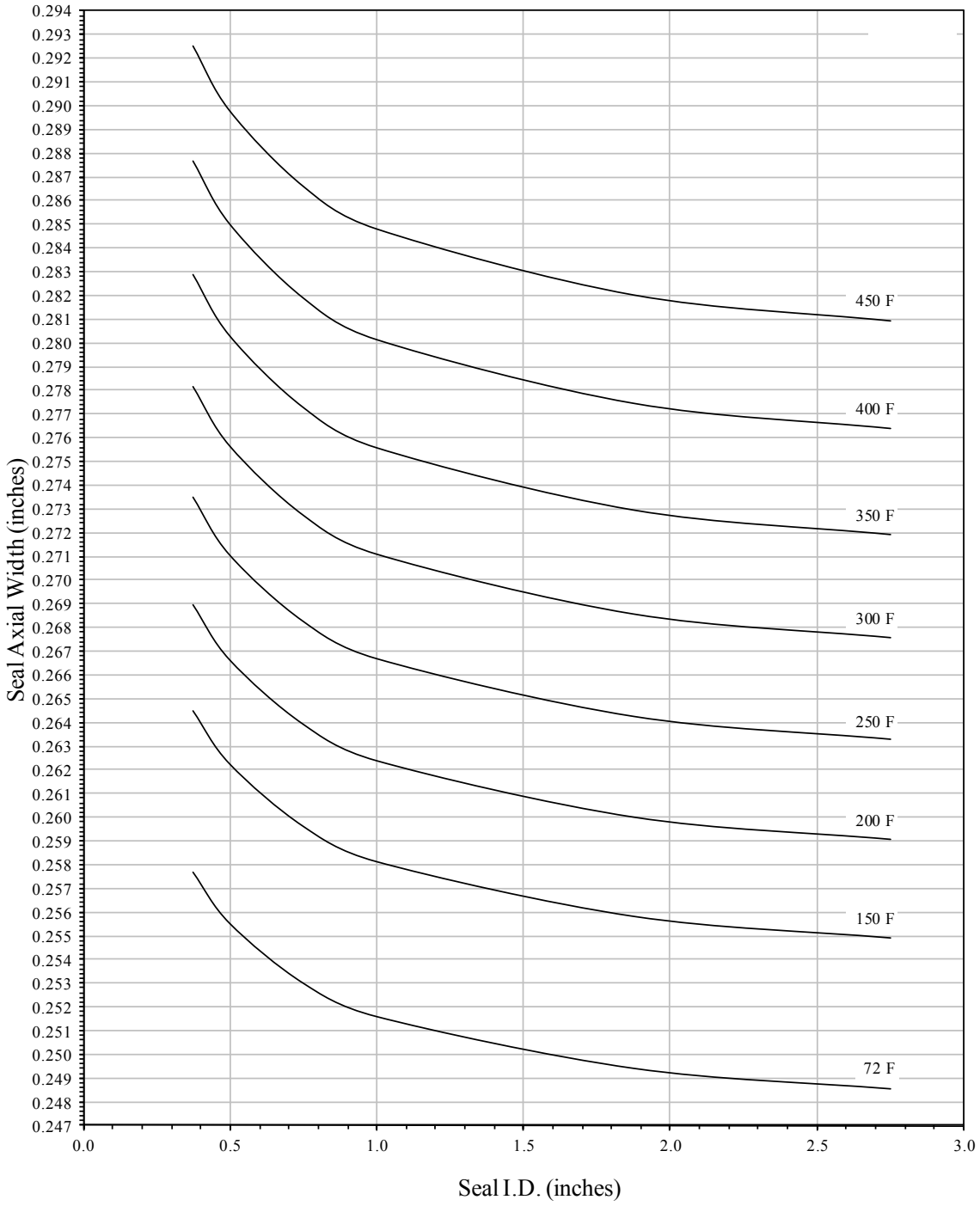
Axial Widths of **MMC** 0.186" X 0.170" Cross Section
Standard Kalsi Seals with a **13E-5 in/in/°F** Coefficient of Thermal
Expansion in a **0.166"** Radial Gland (Actual Seal Cross Section 0.189" X 0.177")



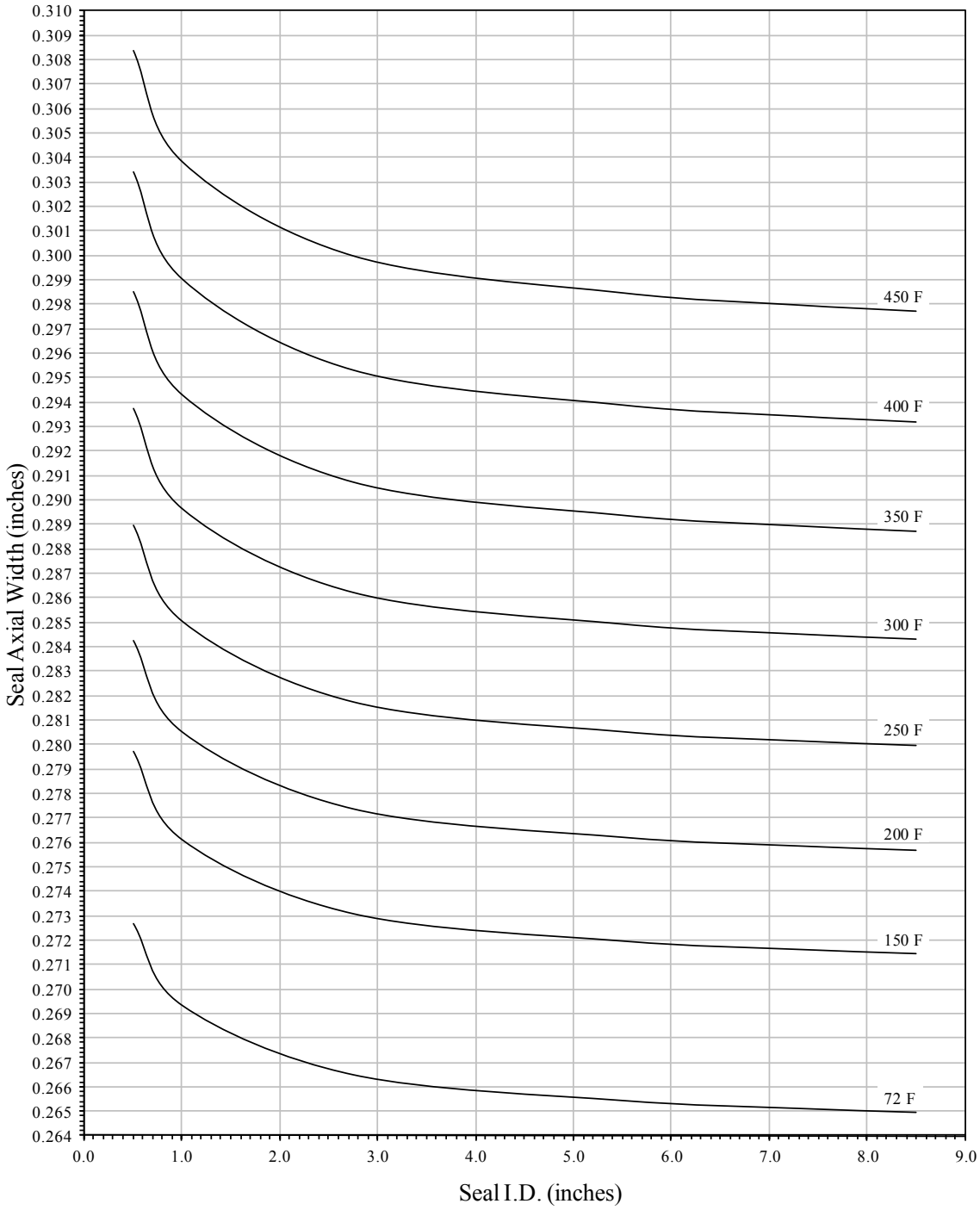
Axial Widths of **Nominal** 0.212" X 0.220" Cross Section
Standard Kalsi Seals with a **13E-5 in/in/°F** Coefficient of Thermal
Expansion in a **0.189"** Radial Gland



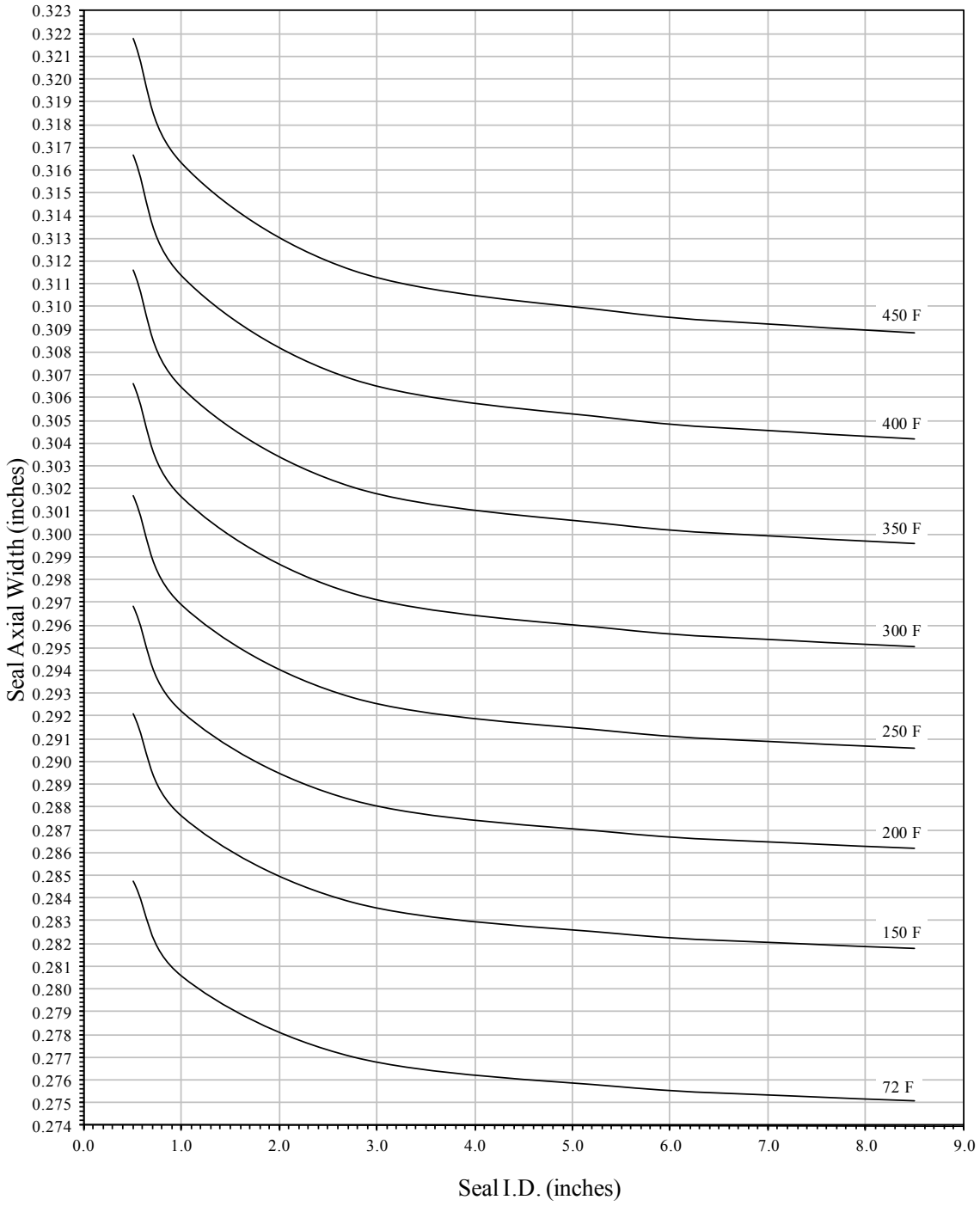
Axial Widths of **MMC** 0.212" X 0.220" Cross Section
Standard Kalsi Seals with a **13E-5 in/in/°F** Coefficient of Thermal
Expansion in a **0.189"** Radial Gland (Actual Seal Cross Section 0.217" X 0.227")



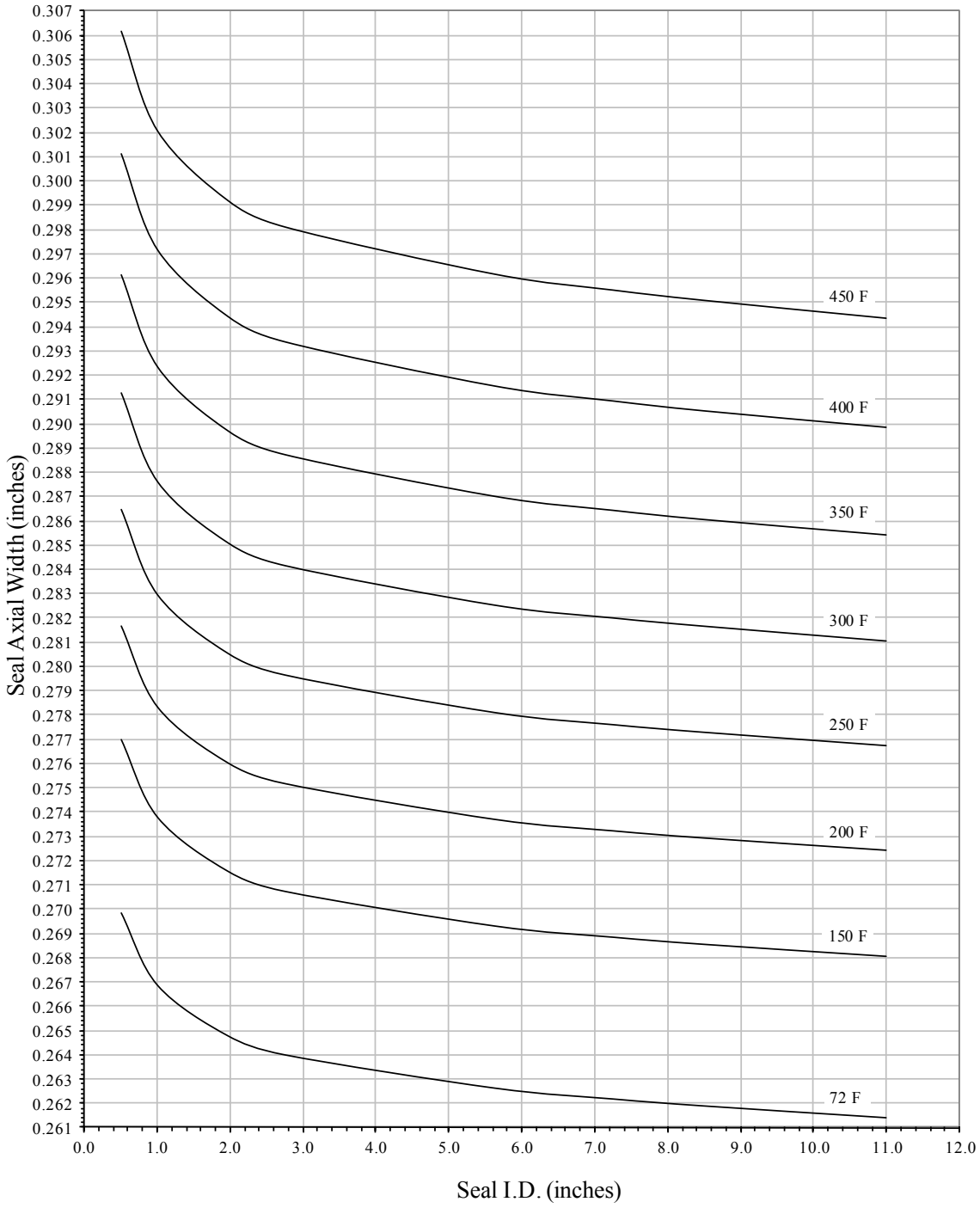
Axial Widths of **Nominal** 0.270" X 0.250" Cross Section
Standard Kalsi Seals with a **13E-5 in/in/°F** Coefficient of Thermal
Expansion in a **0.244"** Radial Gland



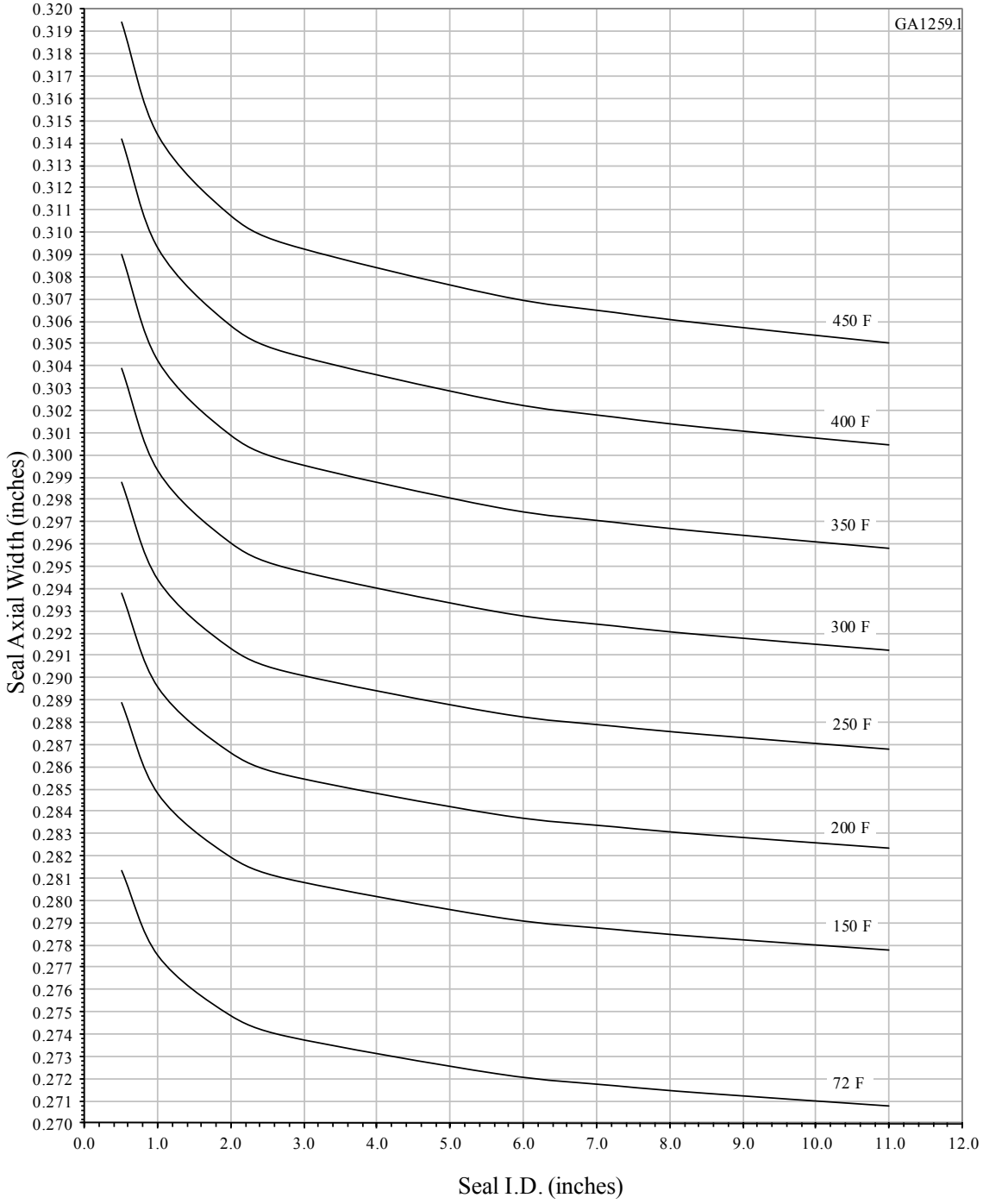
Axial Widths of **MMC** 0.270" X 0.250" Cross Section
Standard Kalsi Seals with a **13E-5 in/in/°F** Coefficient of Thermal
Expansion in a **0.244"** Radial Gland (Actual Seal Cross Section 0.275" X 0.257")



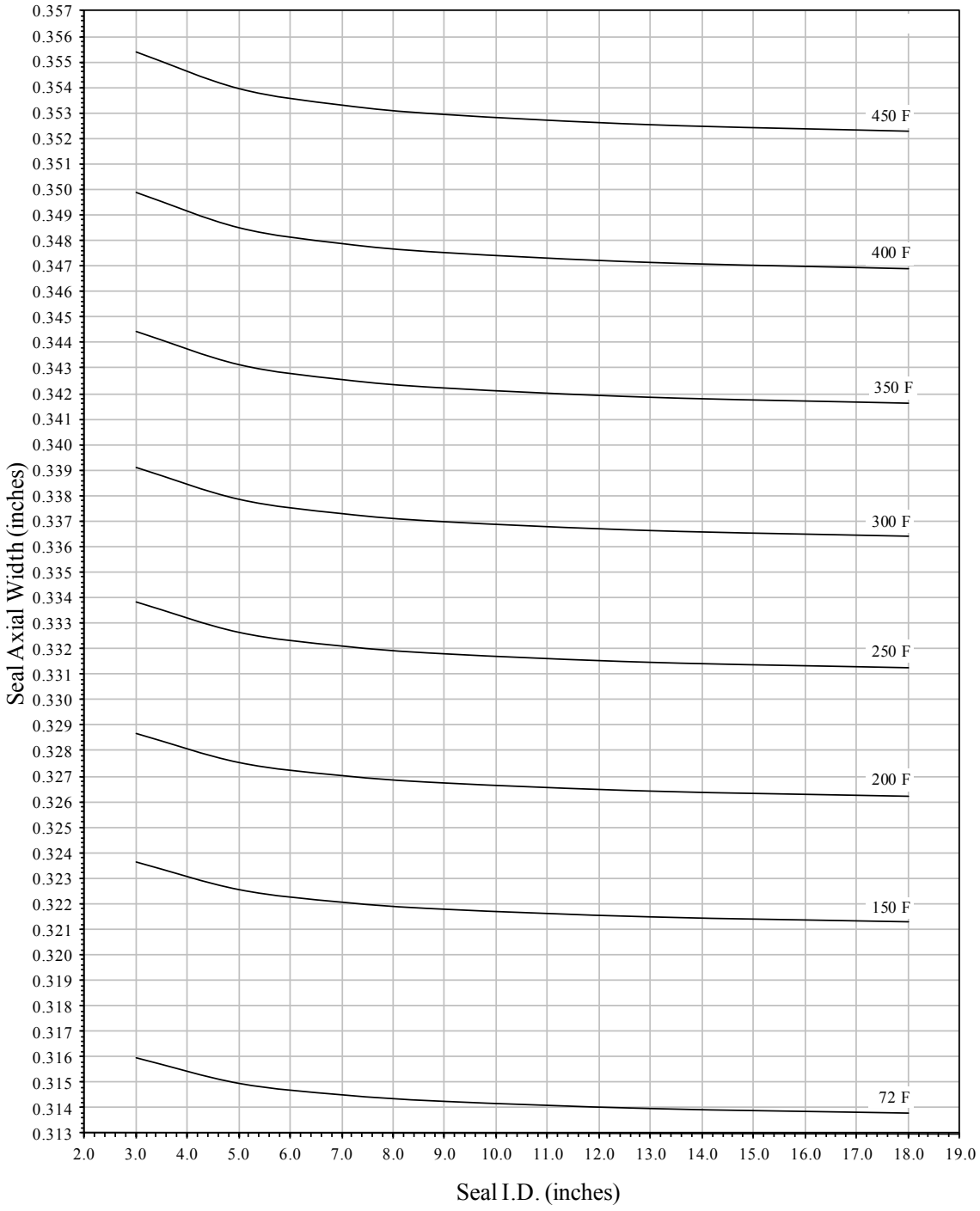
Axial Widths of **Nominal** 0.335" X 0.25" Cross Section
Standard Kalsi Seals with a **13E-5 in/in/°F** Coefficient of Thermal
Expansion in a **0.309"** Radial Gland



Axial Widths of **MMC** 0.335" X 0.25" Cross Section
Standard Kalsi Seals with a **13E-5 in/in/°F** Coefficient of Thermal Expansion
in a **0.309"** Radial Gland (Actual Seal Cross Section 0.340" X 0.257")



Axial Widths of **Nominal** 0.415" X 0.300" Cross Section
Standard Kalsi Seals with a **13E-5 in/in/°F** Coefficient of Thermal
Expansion in a **0.380"** Radial Gland



Axial Widths of **MMC** 0.415" X 0.300" Cross Section
Standard Kalsi Seals with a **13E-5 in/in/°F** Coefficient of Thermal
Expansion in a **0.380"** Radial Gland (Actual Seal Cross Section 0.421" X 0.307")