

**PVP2009-77422**

# **Analysis Of The Compression Behavior Of Spiral Wound Gaskets**

**Jerry Waterland  
VSP Technologies, Inc.**

**Hakim Bouzid  
Ecole de Technology Superieure**

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PVP2009-77422

# Spiral Wound Gasket Styles



Windings-Only



Windings With Outer Guide Ring



Windings With Inner  
And Outer Guide Rings



Anti-Buckling

# ASME Section VIII, Appendix 2, Table 2-5.1

Design m & Y Factors:  
Spiral Wound Metal,  
Asbestos Filled

Wire Metal	M	Y (seating)
Carbon Steel	2.5	10,000 psi
Stainless, Monel, Nickel Base	3.0	10,000 psi

No Differentiation Between:

- Fillers
  - PTFE, Flexible Graphite (FG)
- Pressure Class
  - Class 150, Class 300, Class 600, Class 900, Class 1500, Class 2500
- Construction
  - Windings-Only
  - Windings With Outer Ring
  - Windings With Inner and Outer Ring
  - Anti-Buckling

Research Project:

**DESIGN**

Is  $Y = 10,000$  psi For All Spiral Wound Gaskets A Reasonable Value?

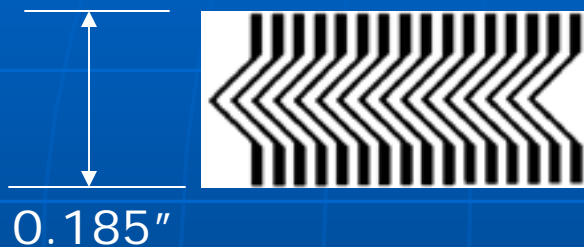
**Assembly Torque:**

Is 10,000 psi Compression For All Spiral Wound Gaskets The Most Accurate Value?

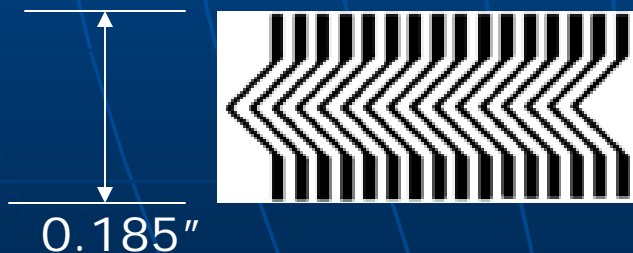
Considering BOTH Leakage Performance and Compression Requirements

# Compression Requirements

#1) ASME B16.20, Para. 3.2.6 Compression Requirement:  
0.130" +/- 0.005" @ 25-30 ksi bolt stress (~0.050")



#2) Assembly Compression:  
~0.060" (Compress To Guide Ring Nominal Thickness)



# ASME B16.20 Standard

## Establishes Manufacturing Specifications:

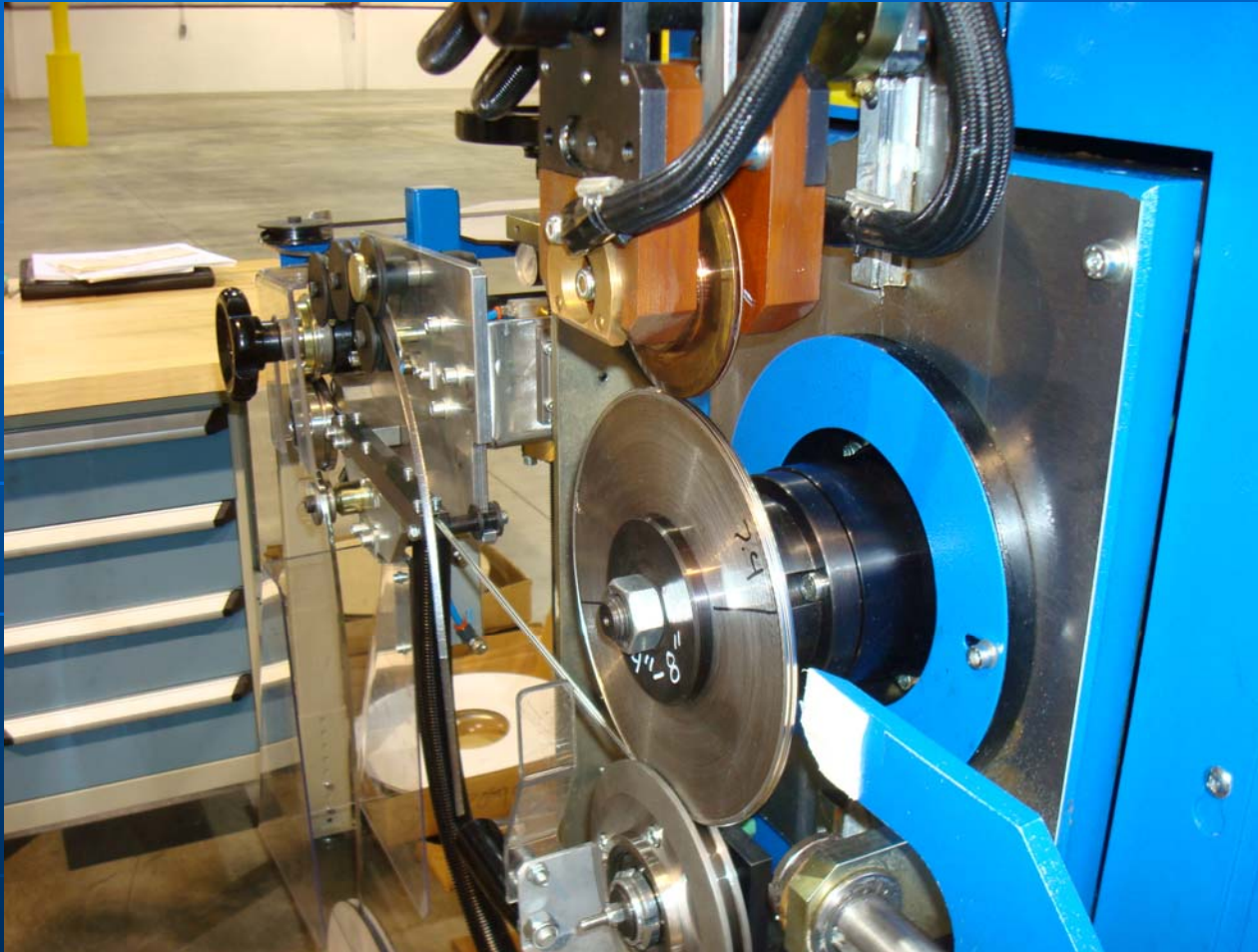
- Dimensions & Tolerances
- Wire thickness
- Color coding & markings
- Spot Welding (minimum # and min. spacing)
- Min. # Metal Plies at OD and ID
- Formed Metal Wire Height
- Filler Height Relative To Metal Height

## Establishes Compression Requirements:

- 0.130" +/- 0.005" compressed height at 25-30 ksi bolt stress  
(~0.050" Compression)

***Does Not Specify Key Manufacturing Criteria***

# Key Manufacturing Criteria



- Filler Thickness
- # Filler/Metal Plies
- Guide Ring "Fit"
- Filler Compression during manufacturing

PVP2009-77422

# Potential For Variation In Compression and Leakage Behavior:

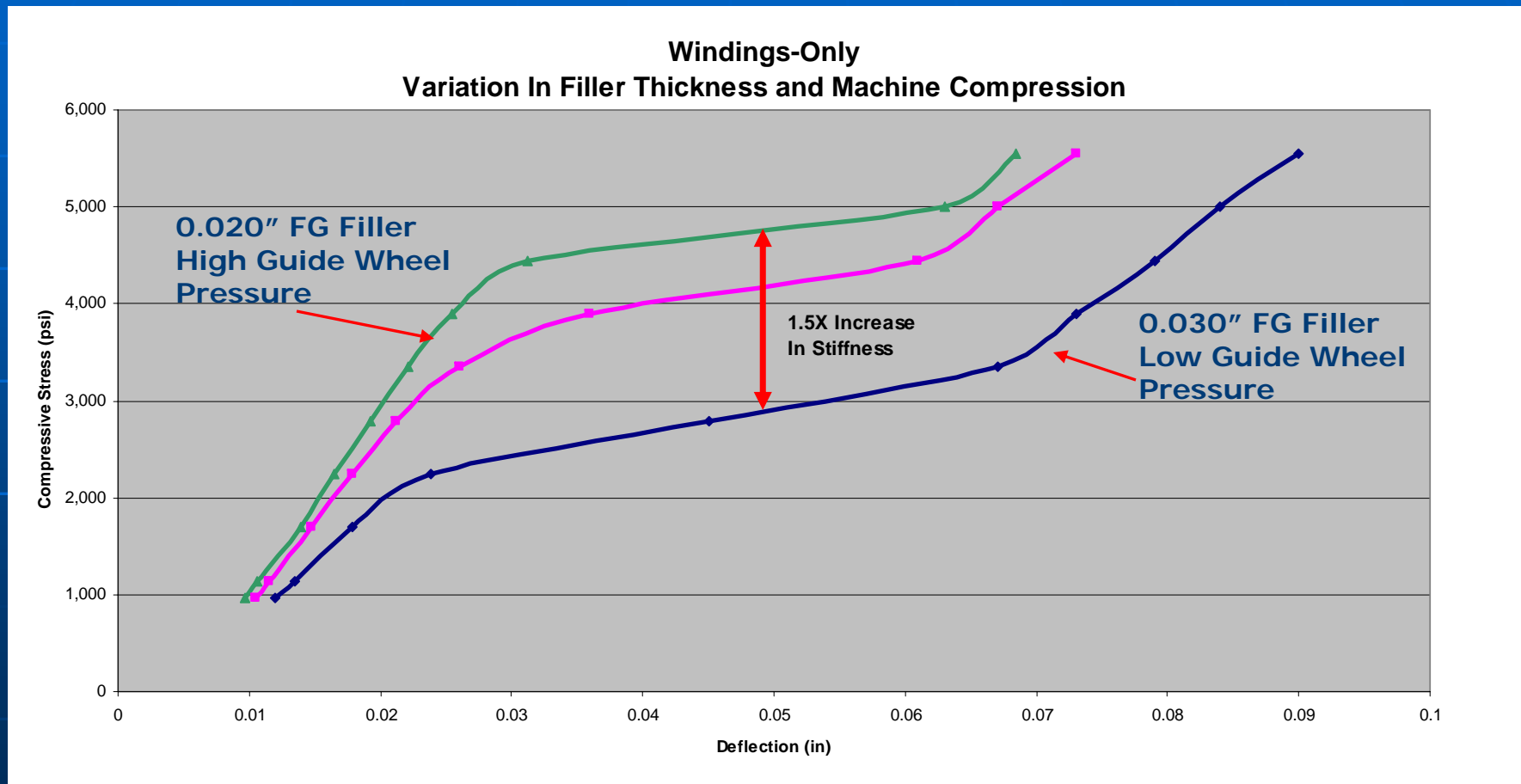
- Between gaskets of same size
- Between gaskets of same manufacturer
- Between gaskets of different manufacturers
- Between gaskets with different fillers
- Between different flange pressure classes
- Between gaskets of different construction

Variables  
Studied

Data Sources: (40) Gaskets, (4) Manufacturers, (2) NPS  
1999 TTRL Spiral Wound Gasket ROTT  
2008 VSP Load/Compression Testing  
2009 ETS Load/Compression/Sealing/Tightness Evaluation

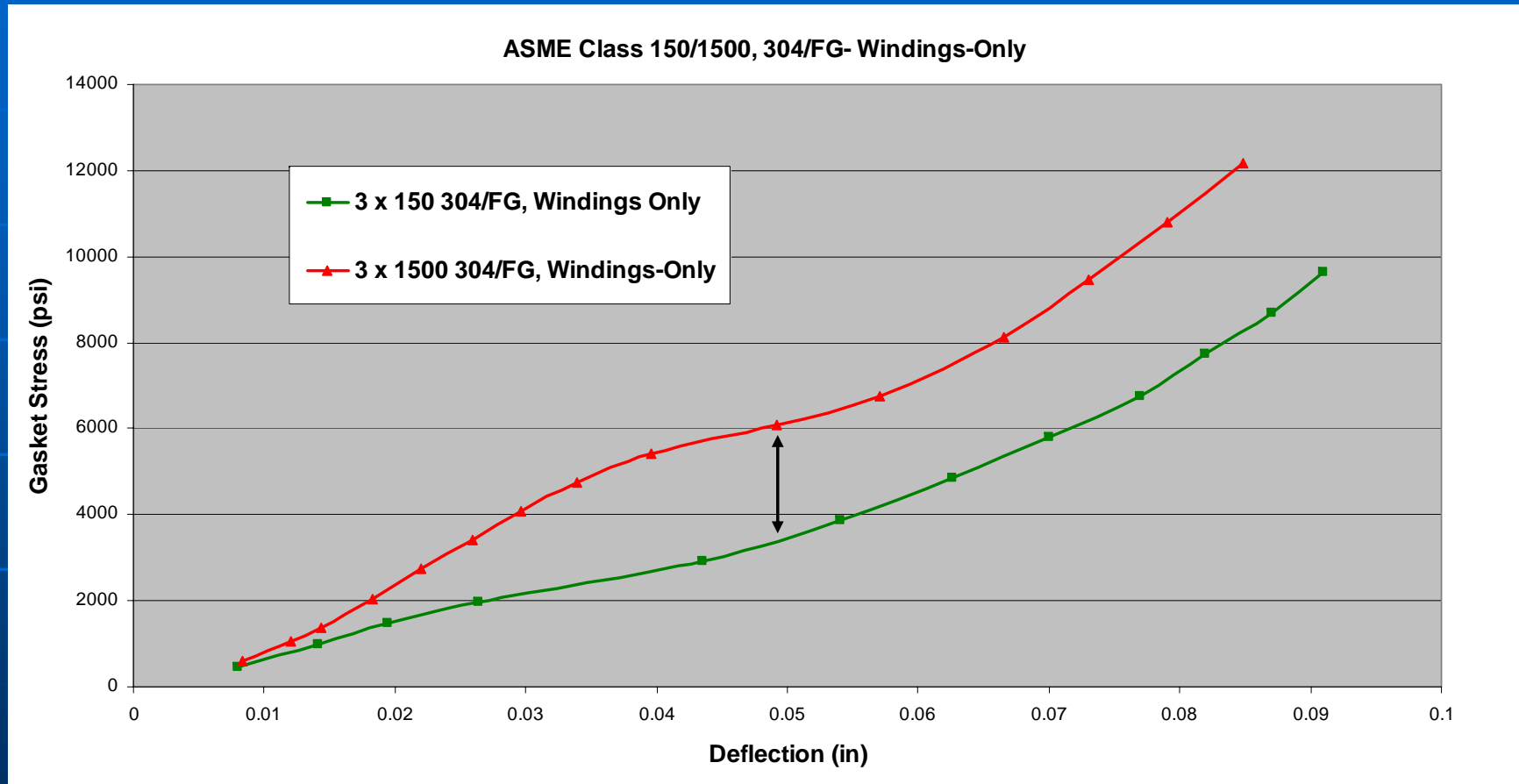
# Windings-Only:

## Effect Of Variation In Filler Thickness & Machine Compression On Winding Stiffness



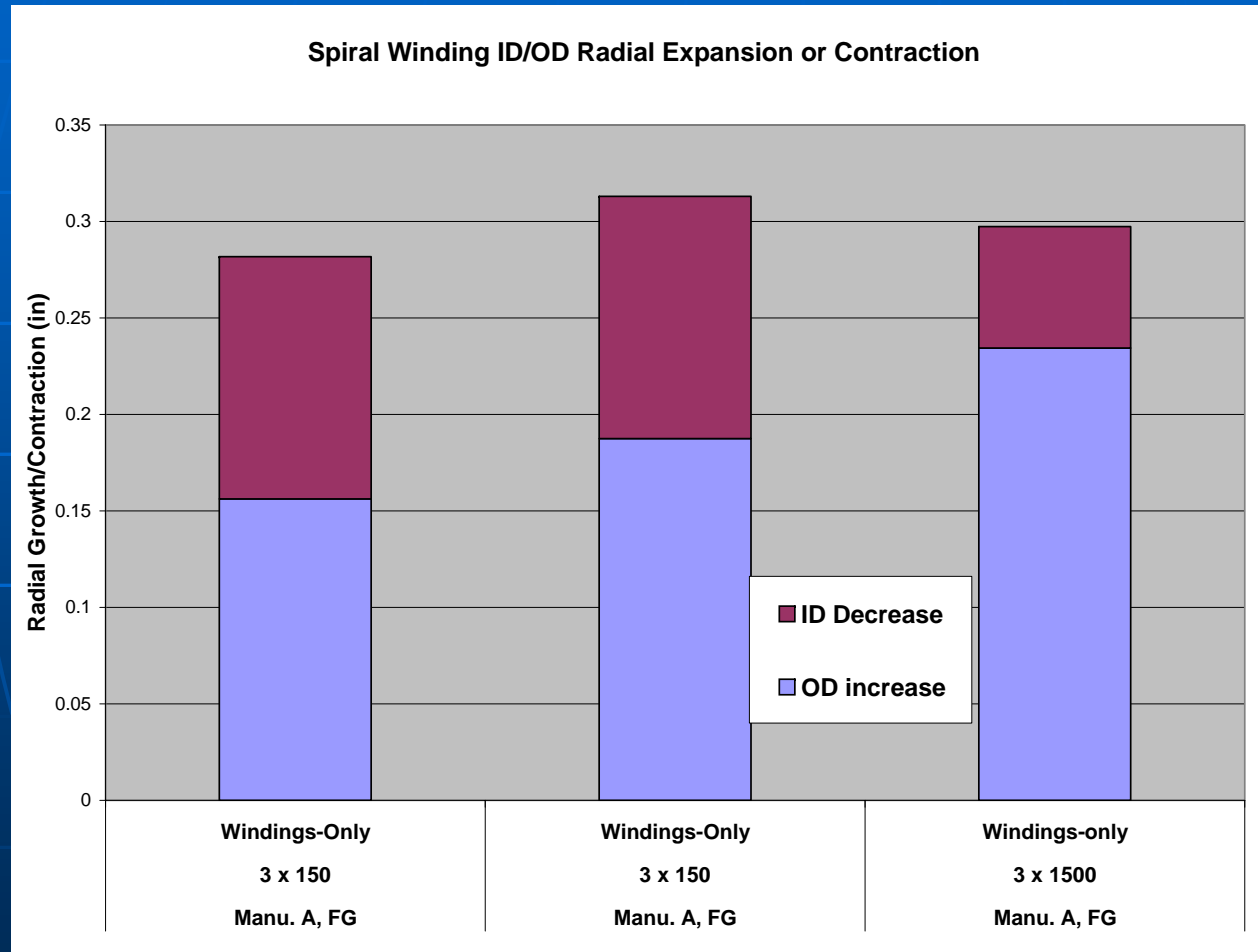
# Windings-Only:

Winding Stiffness Class 150 versus Class 1500: FG Filler



0.050" Compression @ 3.5 ksi (Class 150), @ 6 ksi (Class 1500)

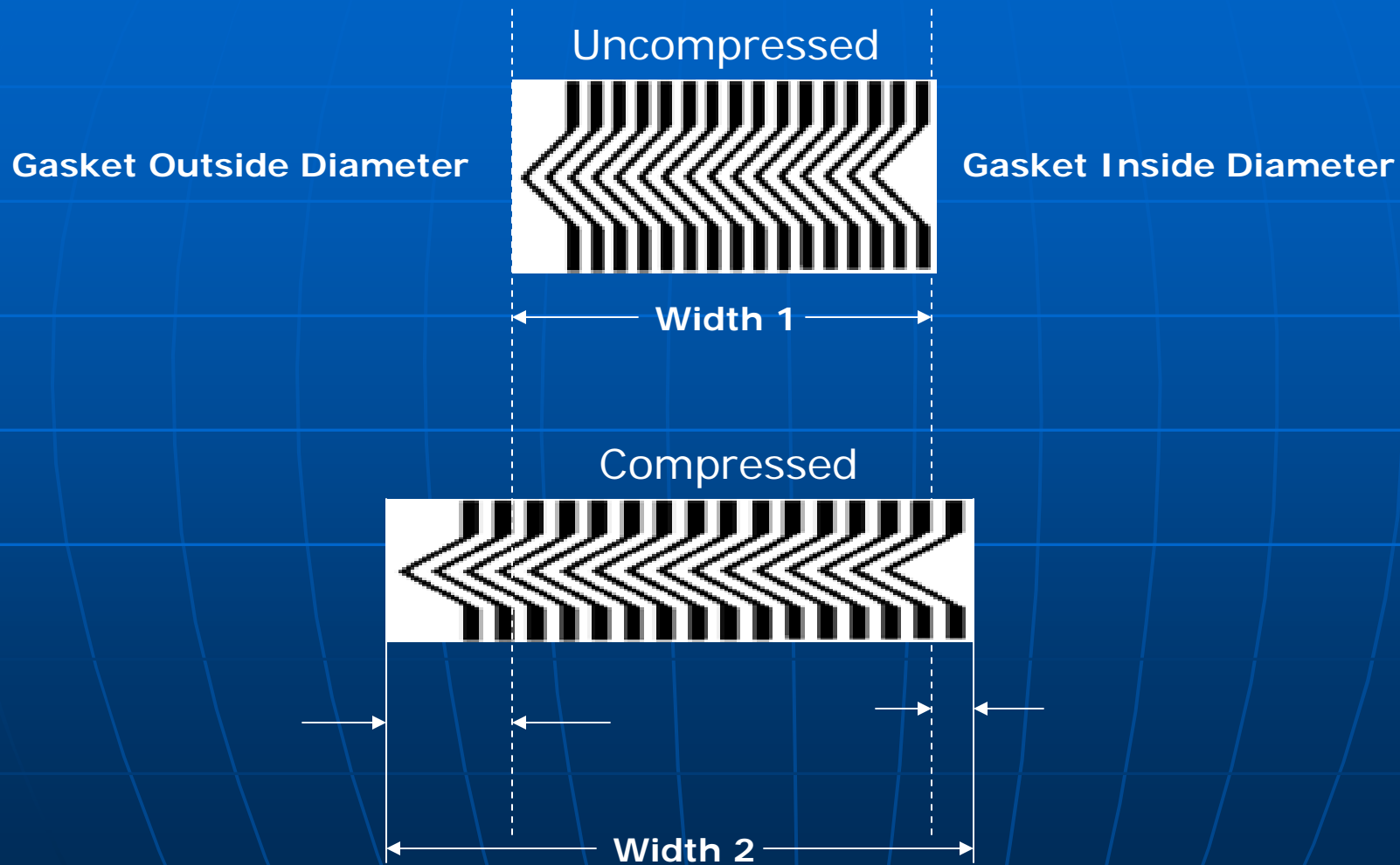
# Radial Expansion/Contraction During Compression



Unrestrained:

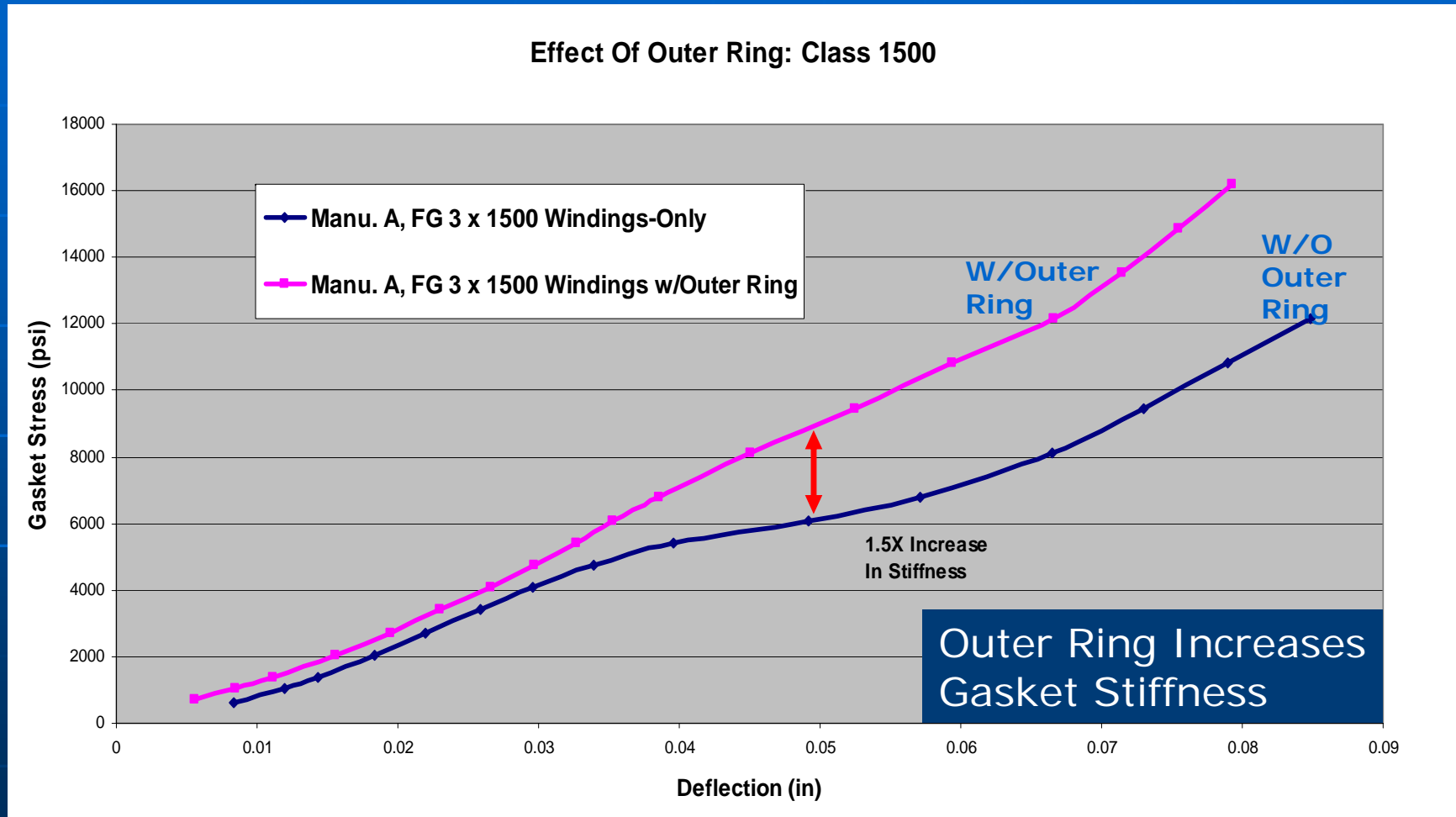
- 60-80% of Flow Is Towards OD
- Higher Pressure Class= More Flow Towards OD

# Direction of Radial Expansion/Contraction During Compression



# Effect Of Outer Ring On Winding Compression:

Windings-Only Versus Winding With Outer Ring, FG Filler

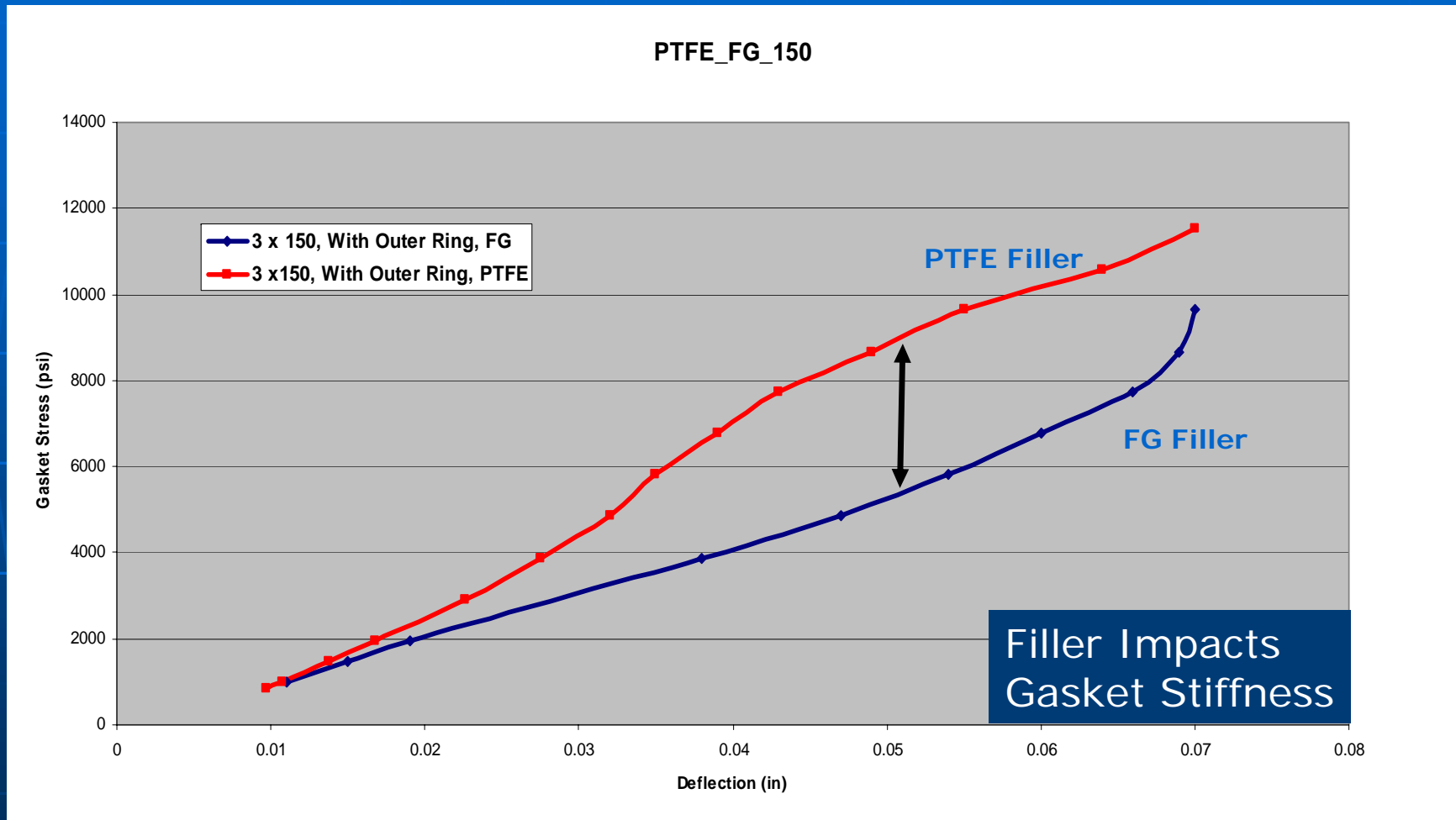


0.050" Compression @ 6 ksi (Winding-Only), @ 9 ksi (w/Outer Ring)

PVP2009-77422

# Effect Of Filler On Winding Compression:

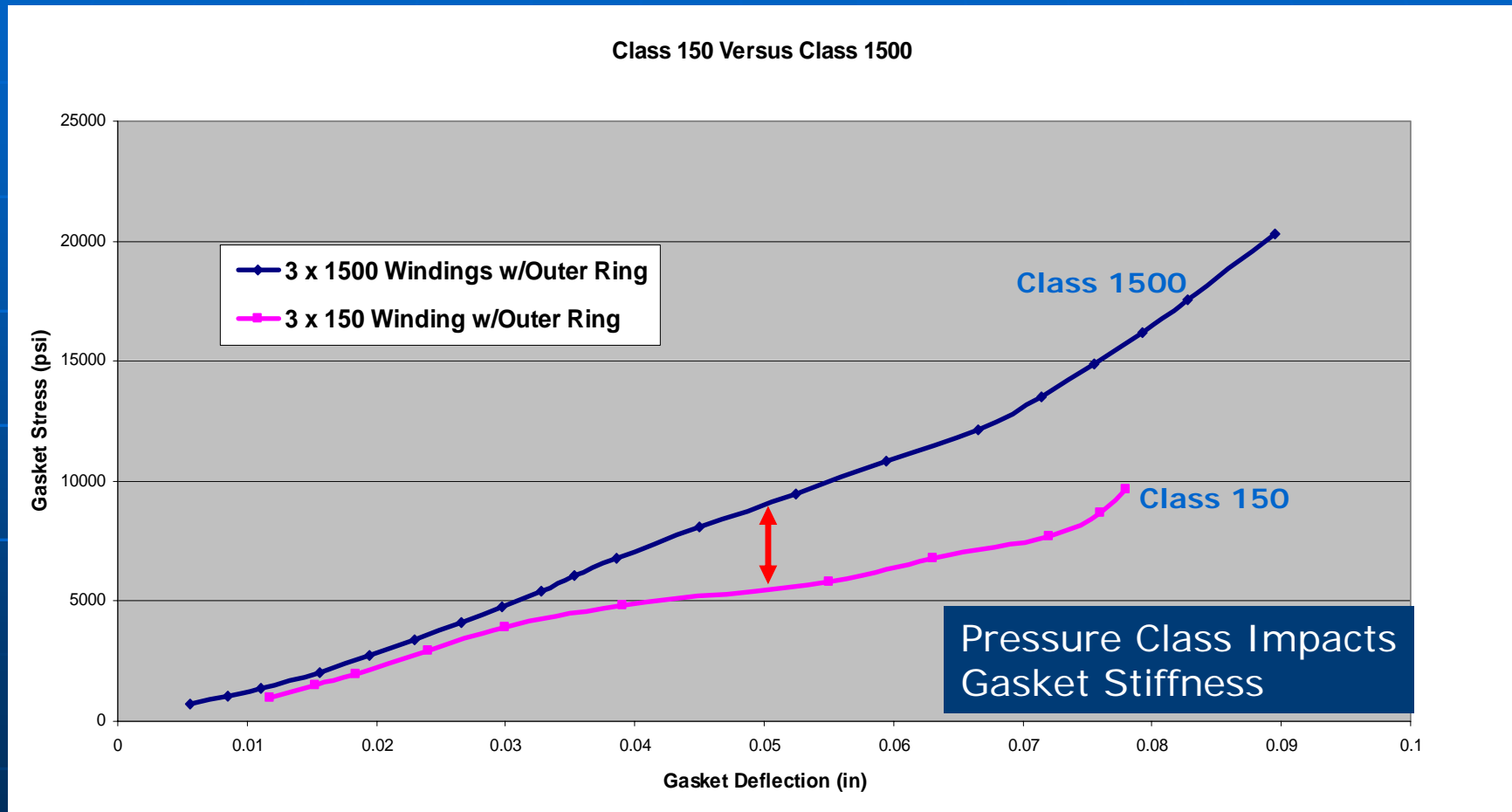
## Winding With Outer Guide Ring



0.050" Compression @ 5.5 ksi (FG Filler), @ 9 ksi (PTFE Filler)

# Effect Of Pressure Class On Winding Compression

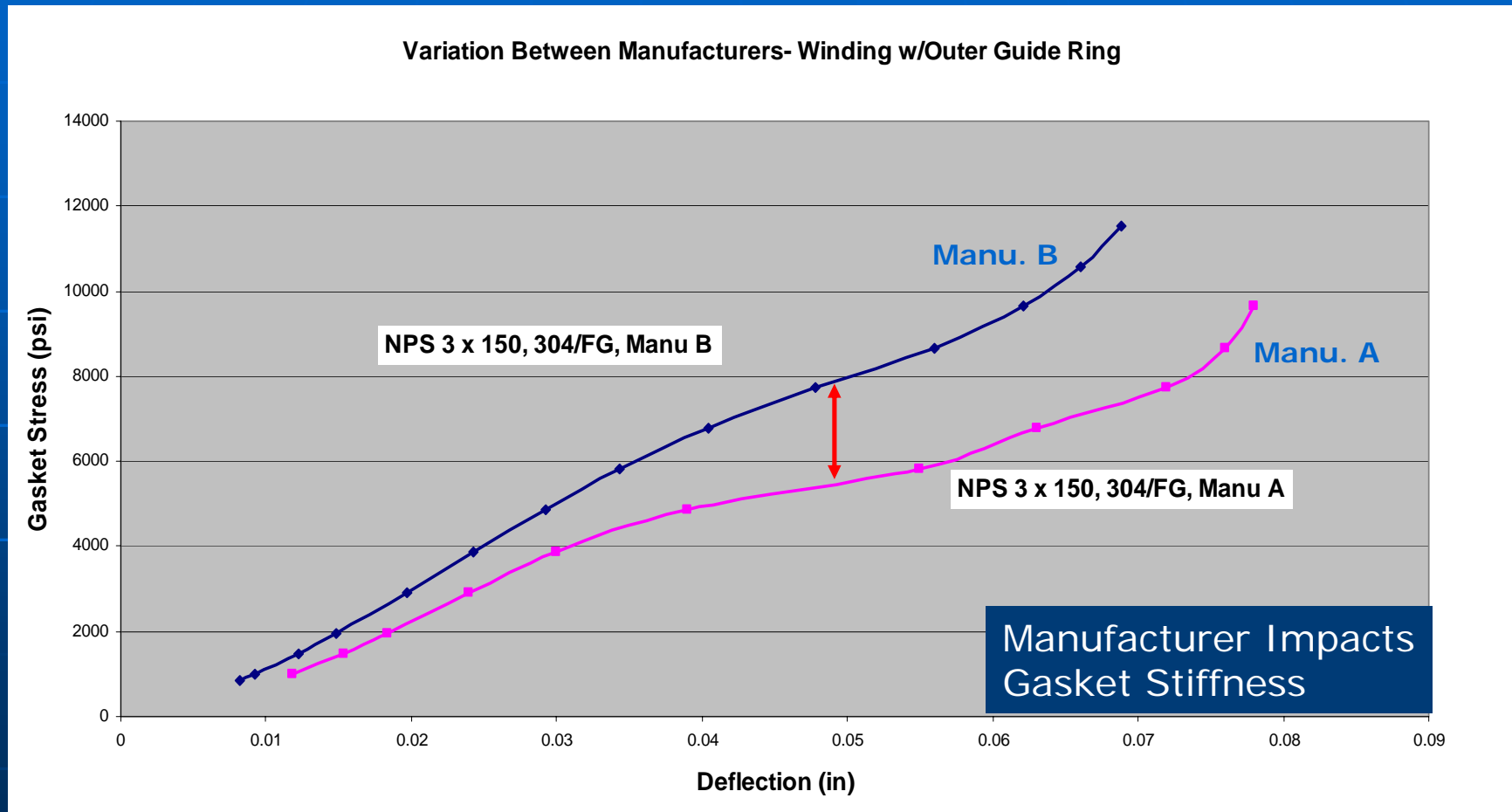
Winding With Outer Ring, Class 150 Versus Class 1500: FG Filler



0.050" Compression @ 5.5 ksi (Class 150), @ 9 ksi (Class 1500)

# Effect Of Manufacturer On Winding Compression

Winding With Outer Ring, Class 150, Manu. A & Manu. B, FG Filler



0.050" Compression @ 5.5 ksi (Manu. A), @ 8 ksi (Manu. B)

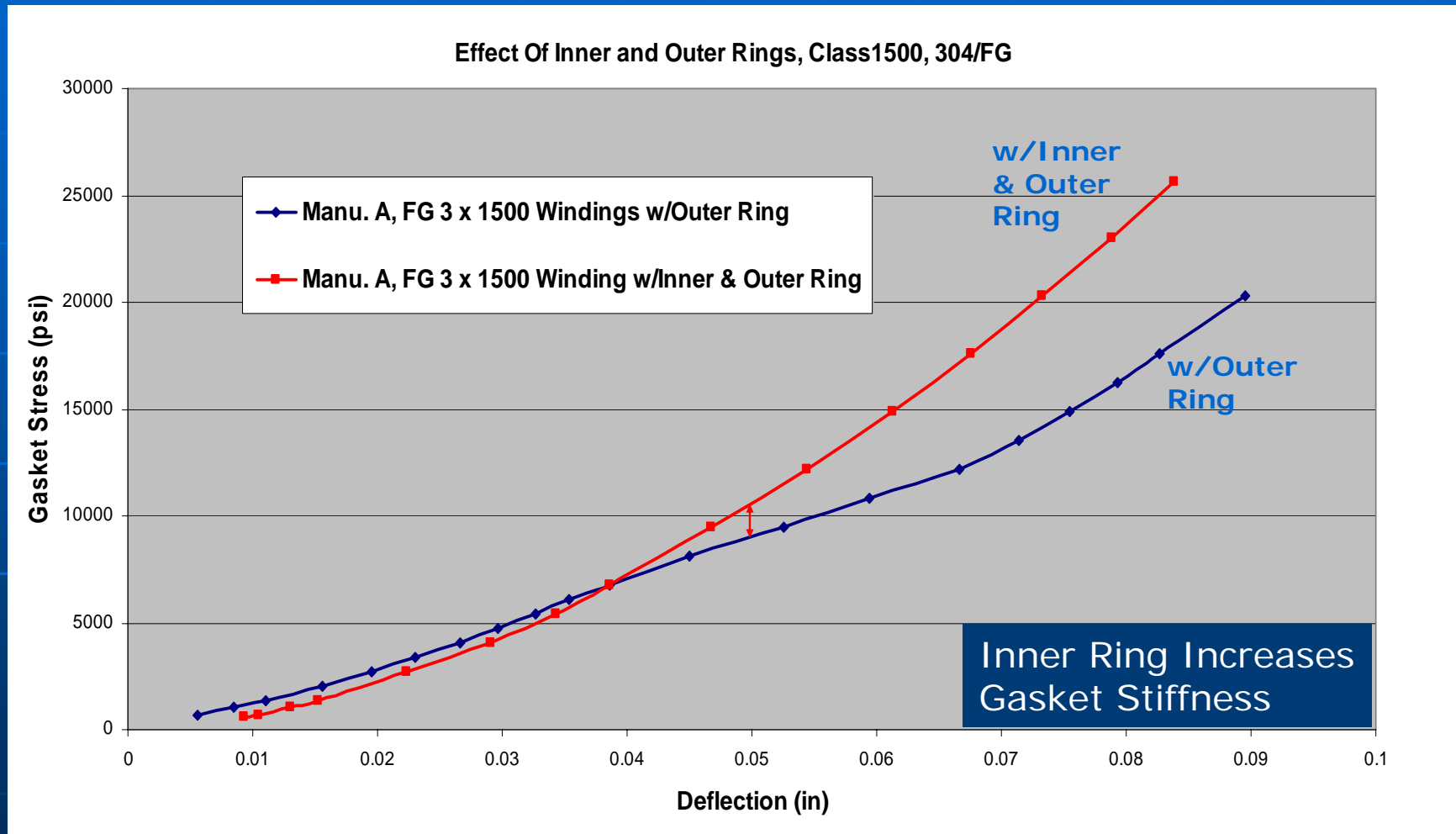
# ASME B16.20: Inner Rings To Eliminate Radial Buckling



PVP2009-77422

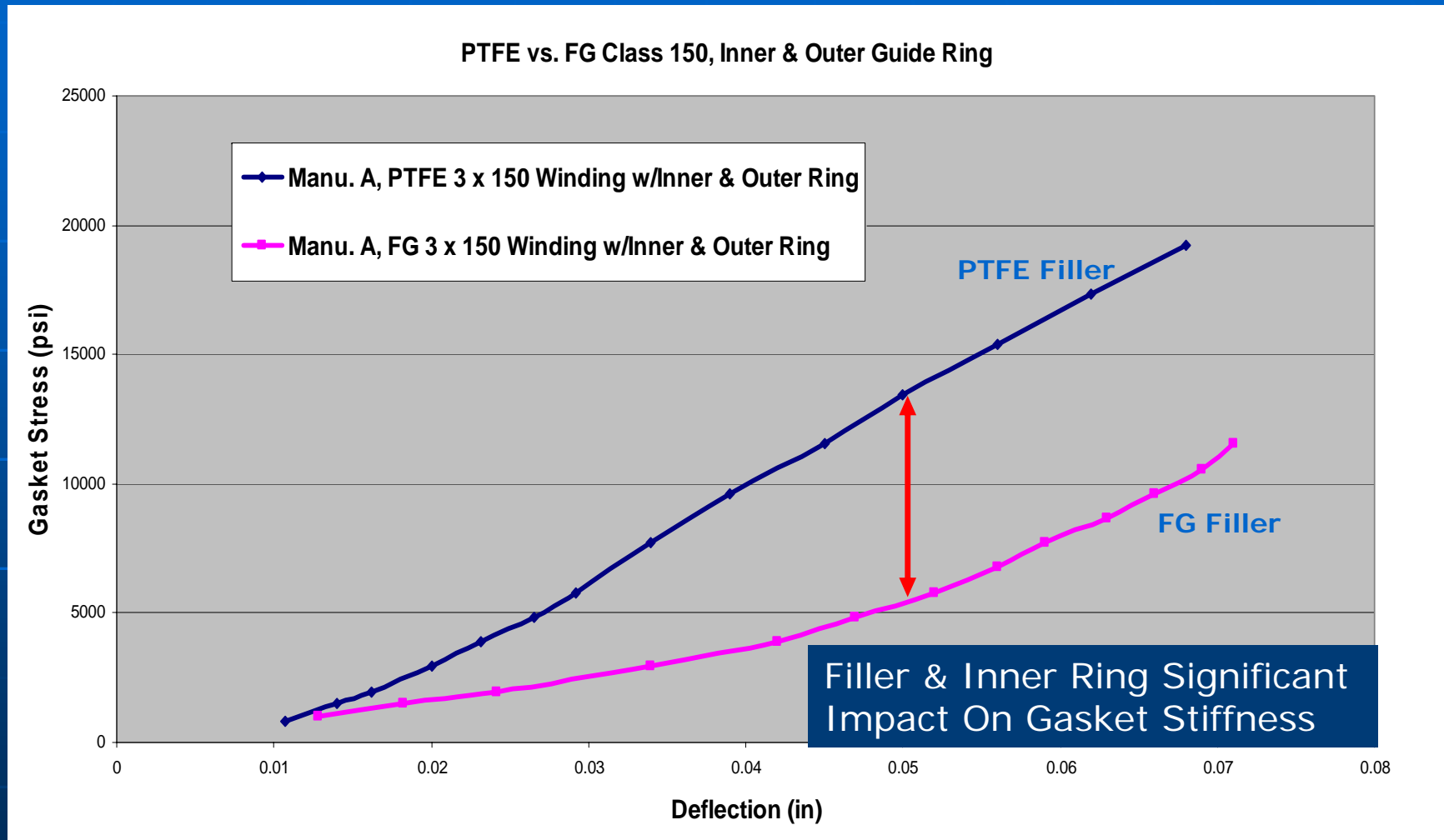
# Effect Of Inner Ring On Winding Compression

Winding With Inner & Outer Class 1500: FG Filler



0.050" Compression @ 9 ksi (Outer Ring), @ 11 ksi (Inner & Outer Ring)

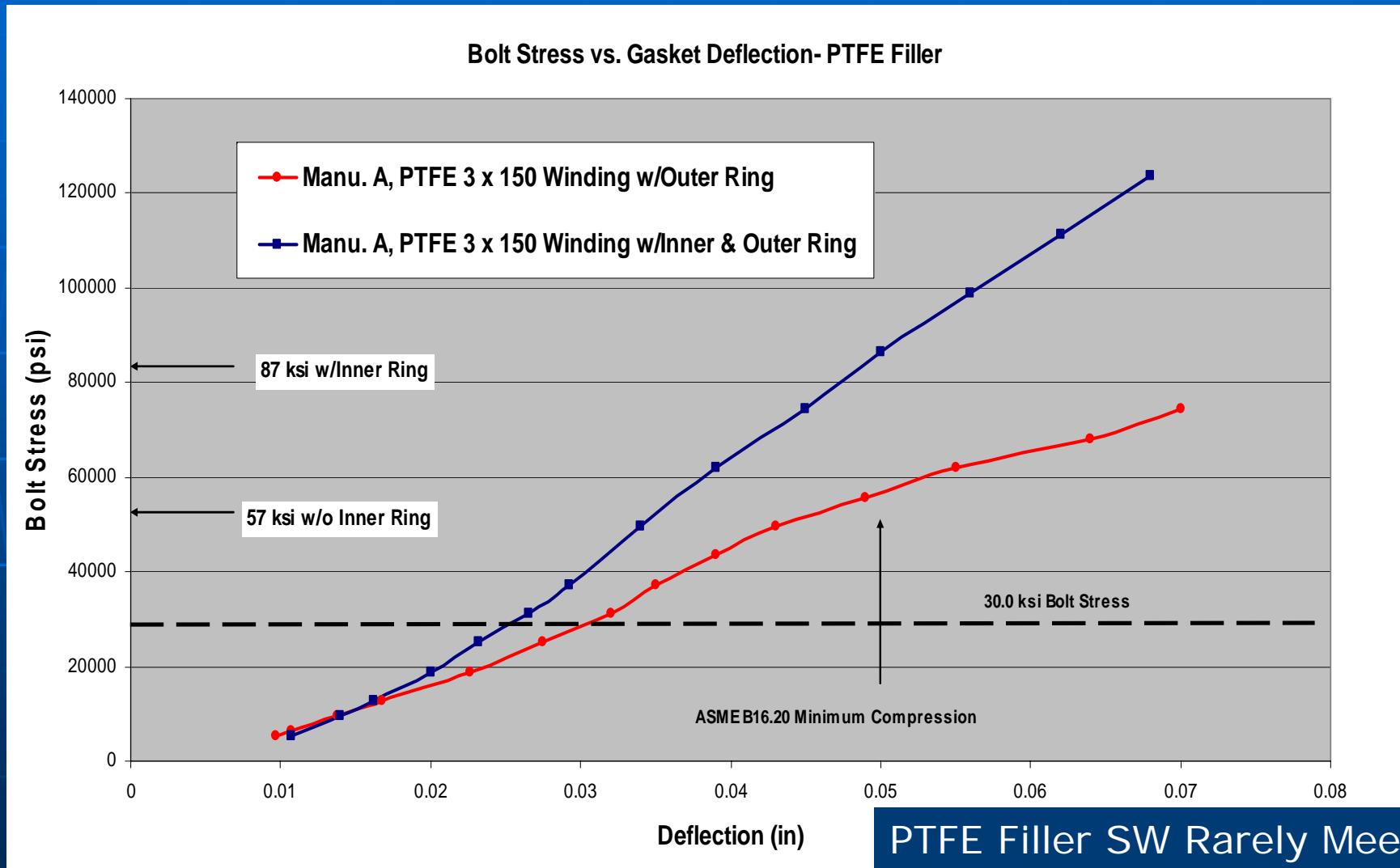
# Effect Of Filler On Winding Compression: Winding With Inner and Outer Guide Ring



**0.050" Compression @ 5.5 ksi (FG Filler), @ 14 ksi (PTFE Filler)**

# ASME B16.20 Compliance

## Para. 3.2.6 Compression

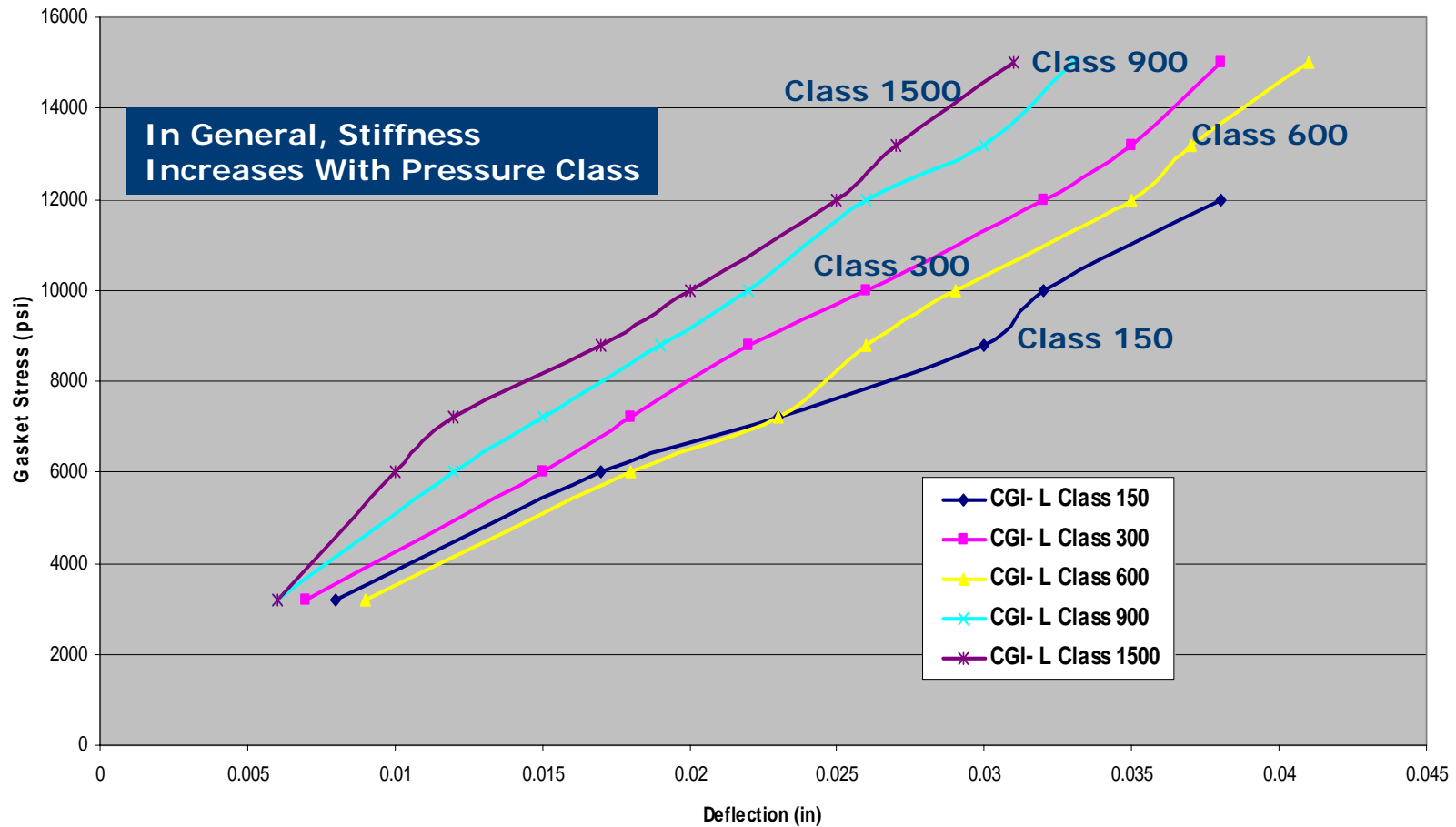


**PTFE Filler SW Rarely Meet  
Compression Requirements**

# Compression: Class 150 – Class 1500

Inner/Outer Ring, FG Filler One Manu.

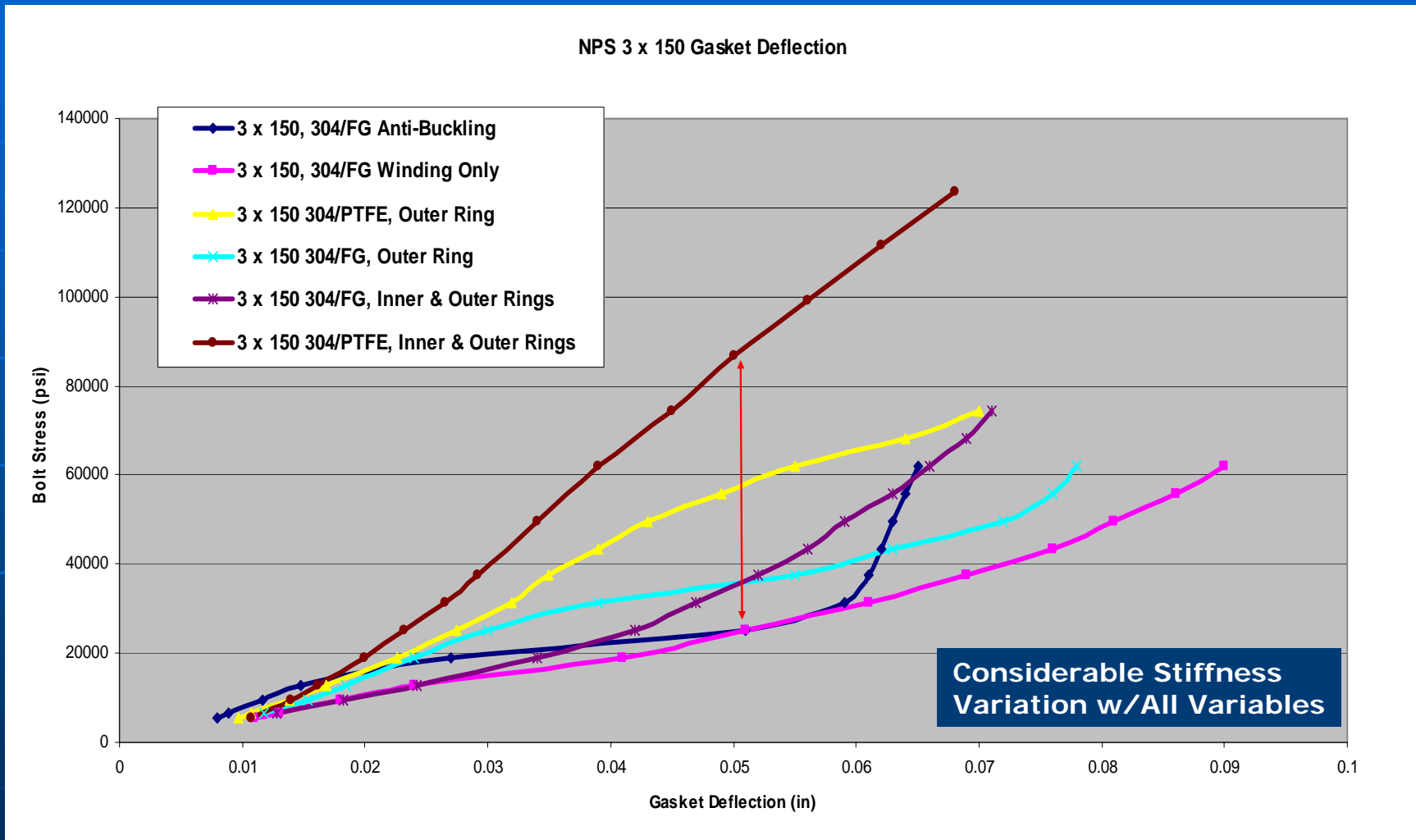
Class 150-1500, Manufacturer #2



In General, Stiffness  
Increases With Pressure Class

# Range Of Compression Variation

## Effects Of Filler, Pressure Class, Construction: Bolt Stress

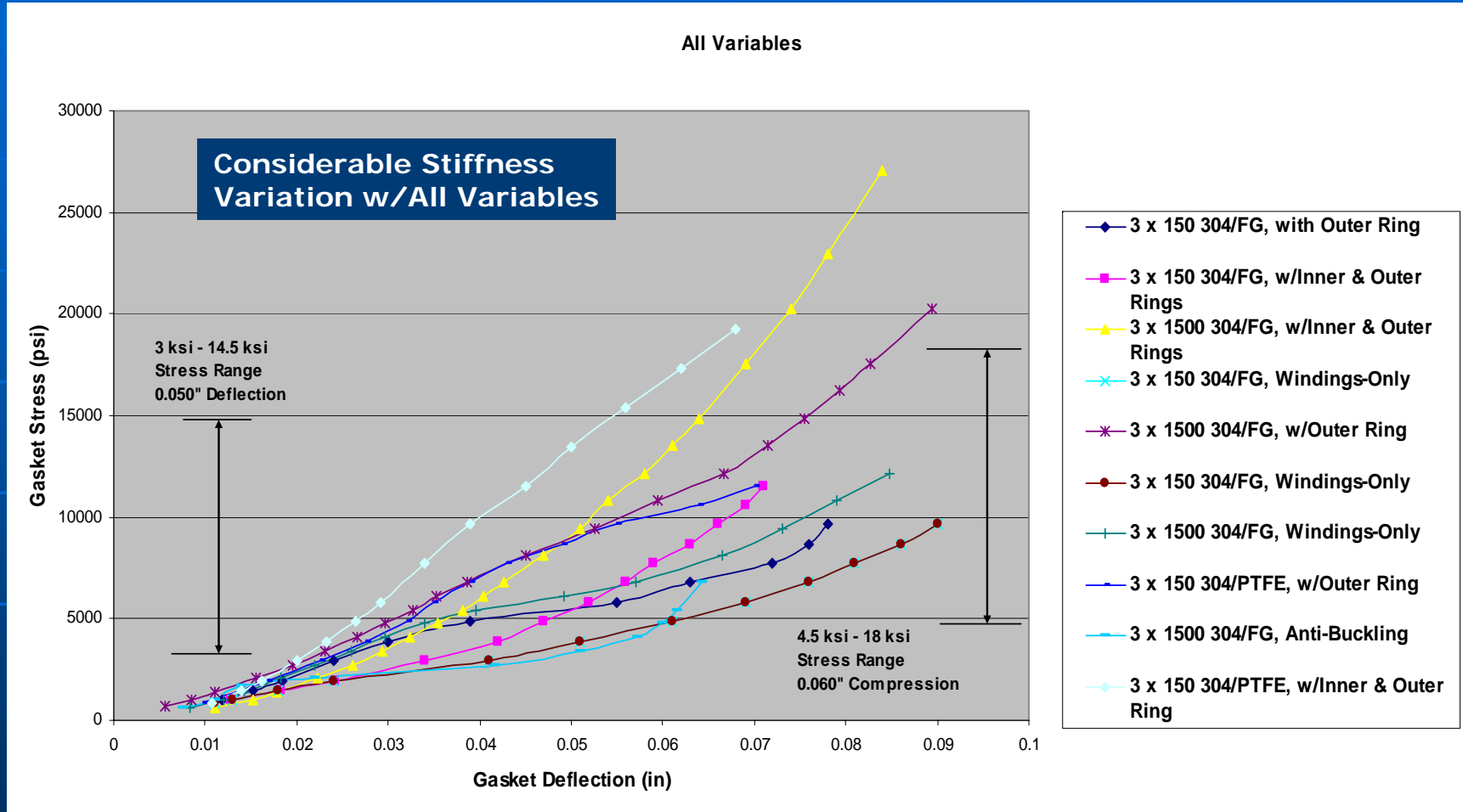


0.050" Compression @ 25 ksi to 87 ksi Bolt Stress

PVP2009-77422

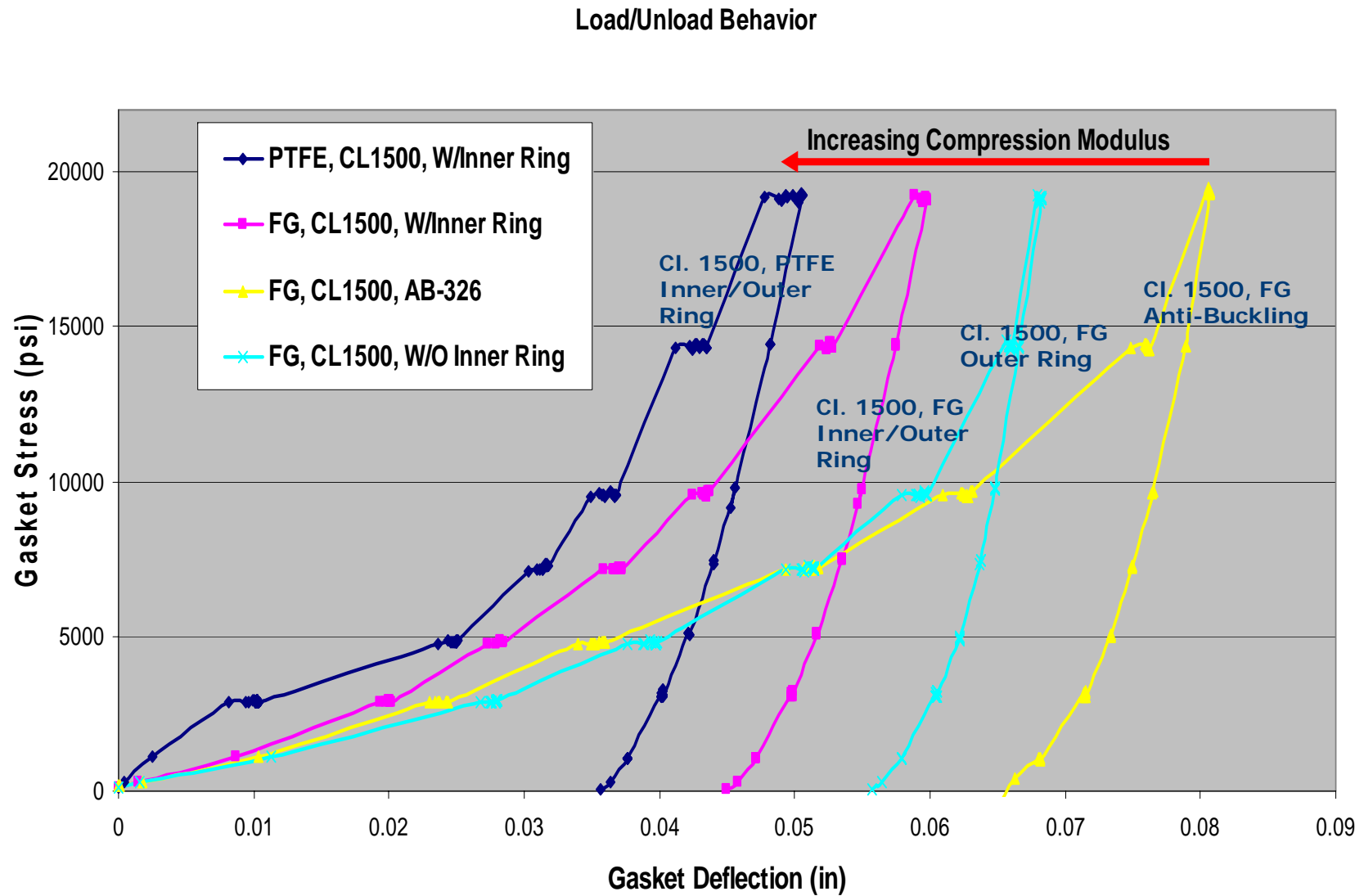
# Range Of Compression Variation

## Effects Of Filler, Pressure Class, Construction: Gasket Stress

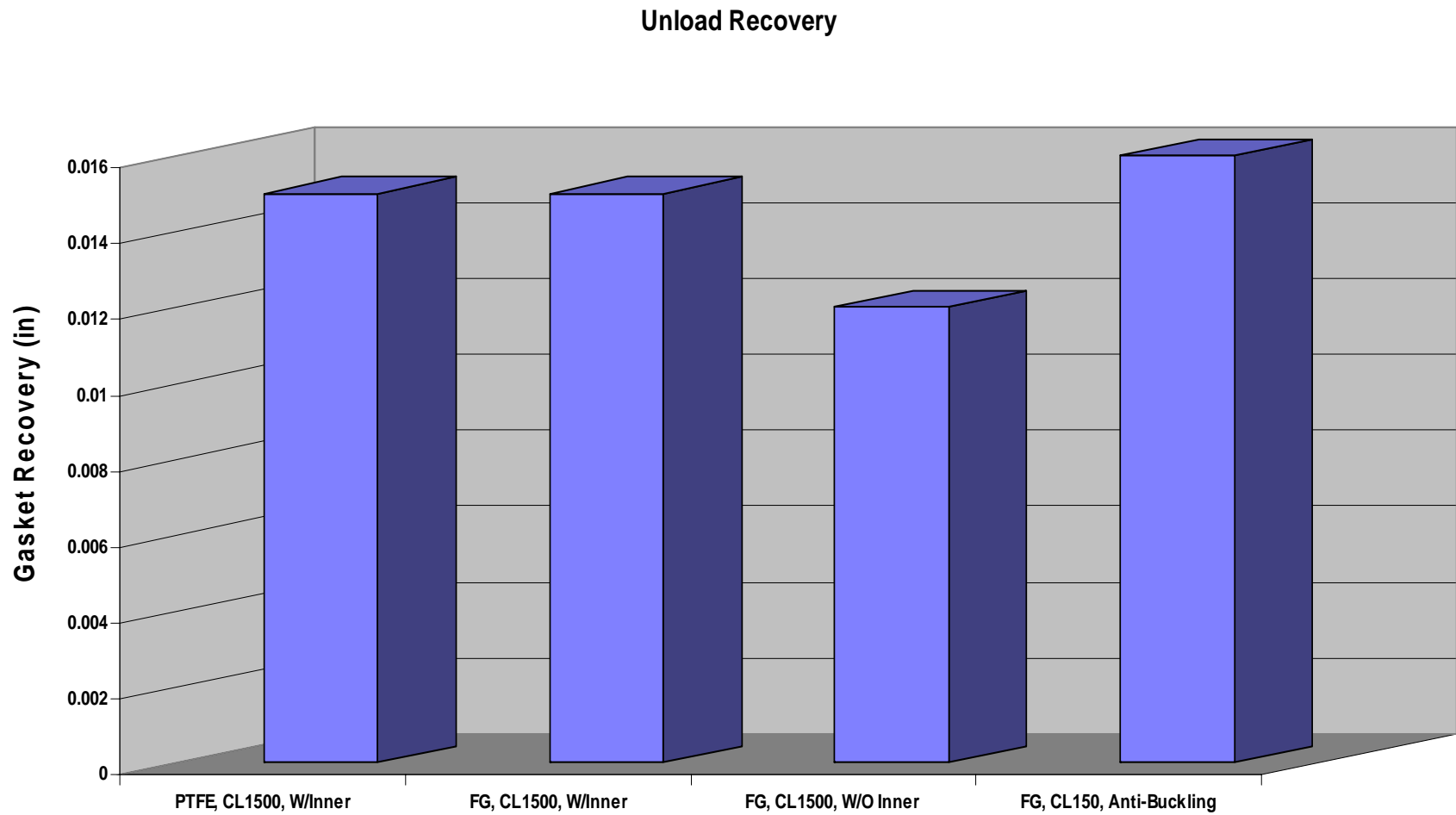


0.050" Compression @ 3 ksi to 14.5 ksi Gasket Stress  
 0.060" Compression @ 4.5 ksi to 18 ksi Gasket Stress

# Load/Unload Behavior



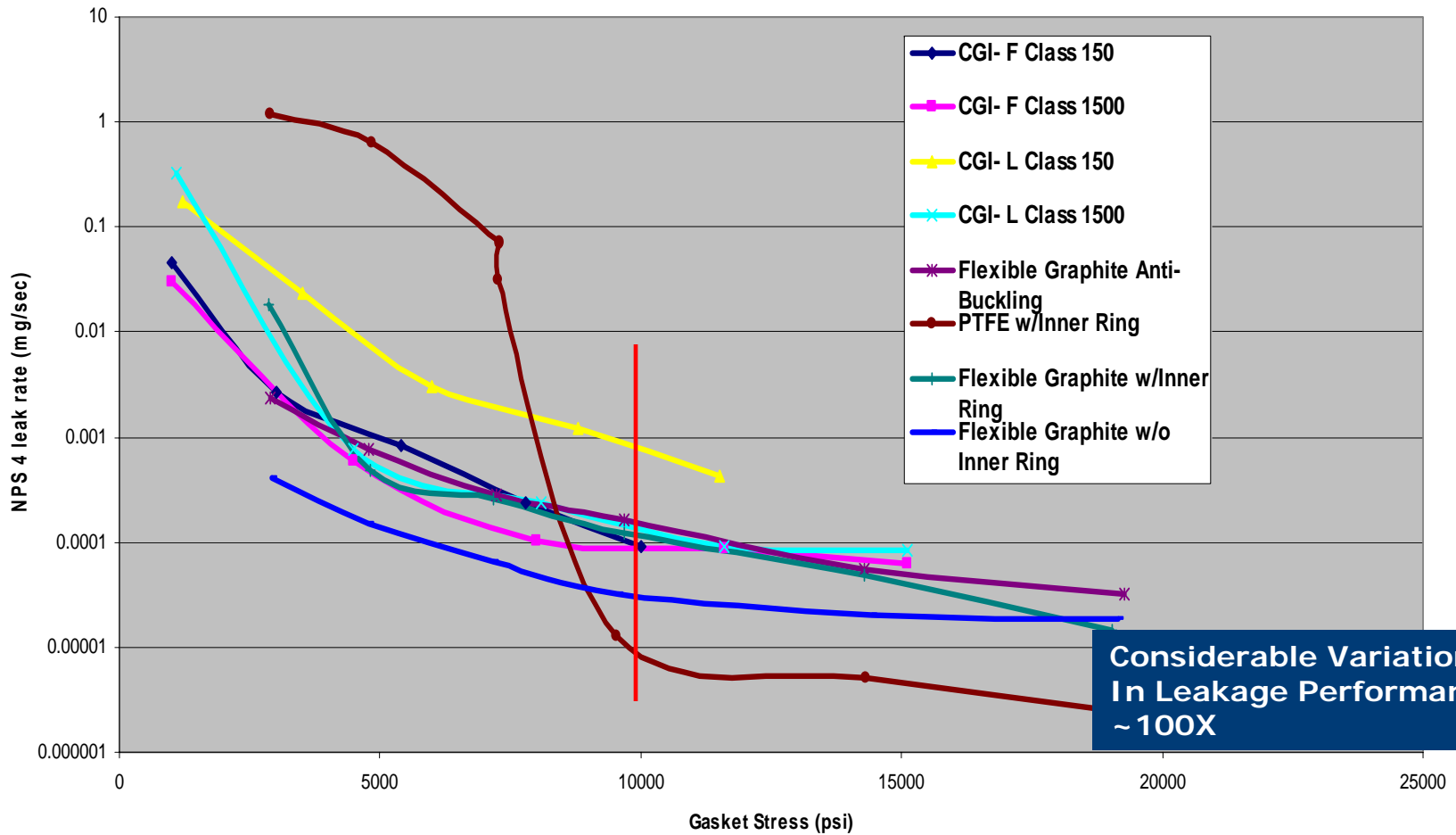
# Unload Behavior



# Leakage Range @ 10,000 psi Stress

## Outer Ring, Inner/Outer Ring, Anti-Buckling, PTFE & FG Filler

ROTT Leakage, 304/FG, 400 psig,



# Table 1: Design/Assembly Stress Requirements: Compression

Construction	Gasket Stress To Compress 0.050" (ASME B16.20 Spec)	Gasket Stress To Compress 0.060" (To Guide Ring)
Flexible Graphite, Class 150, Windings-Only	3,000 psi	4,500 psi
Flexible Graphite, Class 150/1500, Anti-Buckling	3,500 psi	5,300 psi
Flexible Graphite, Class 150, Outer Ring	5,000 psi	6,600 psi
Flexible Graphite, Class 150, Outer and Inner Ring	5,500 psi	8,000 psi
Flexible Graphite, Class 1500, Windings-Only	6,000 psi	7,000 psi
PTFE, Class 150, Outer Ring	9,000 psi	10,500 psi
Flexible Graphite, Class 1500, Outer Ring	9,200 psi	11,000 psi
Flexible Graphite, Class 1500, Outer and Inner Ring	10,500 psi	13,500 psi
PTFE, Class 150, Outer and Inner Ring	14,500 psi	18,000 psi

## Table 2: Design/Assembly Stress Requirements: Sealability

Construction	Gasket Stress To Develop Tp = 1,000	Gasket Stress To Develop Tp = 3,000	Gasket Stress To Develop Tp = 10,000
Flexible Graphite, Class 150/1500, Anti-Buckling	2,800 psi - 12,600 psi	6,800 psi - 19,500 psi	20,000 psi – 31,600 psi
Flexible Graphite, Class 150, Outer and Inner Ring	5,700 psi – 10,900 psi	10,600 psi – 18,000 psi	16,000 psi – 35,000 psi
Flexible Graphite, Class 1500, Outer Ring	3,000 psi – 10,300 psi	4,000 psi – 14,400 psi	10,000 psi – 20,600 psi
Flexible Graphite, Class 1500, Outer and Inner Ring	4,000 psi – 5,600 psi	6,800 psi – 9,600 psi	16,000 psi – 21,000 psi
PTFE, Class 150, Outer and Inner Ring	7,500 psi – 11,800 psi	7,700 psi – 13,800 psi	8,000 psi – 16,300 psi

# Summary

## Design/Assembly Stress Range:

Compression-Based: 3,000 psi – 18,000 psi

Tightness-Based: 2,800 psi – 35,000 psi (+)

- Determine Compression Basis or Tightness Basis
- Determine Appropriate Stress Requirement Considering:
  - Pressure Class
  - Filler Type
  - Construction