Carolina Seal

VSP Technologies

Six Sigma Fluid Sealing Management

FRA Region 8 - Billings, MT
September 2013

Jim Frew

Robert Aliota

Introduction/Goal of Training/NAR Data Review

- **Introduction**
  - Robert Aliota – President, Carolina Seal, Inc.
  - Jim Frew – Director Transportation, VSP Technologies
  - 50+ years of combined fluid sealing experience
- **Goal of Presentation**
  - Better understanding of best practices surrounding o-rings/gaskets/fastener materials
  - Importance of proper assembly procedures
  - Understanding o-ring & gasket failure modes
  - Better understanding of RideTight® Program
- **NAR Data Review**

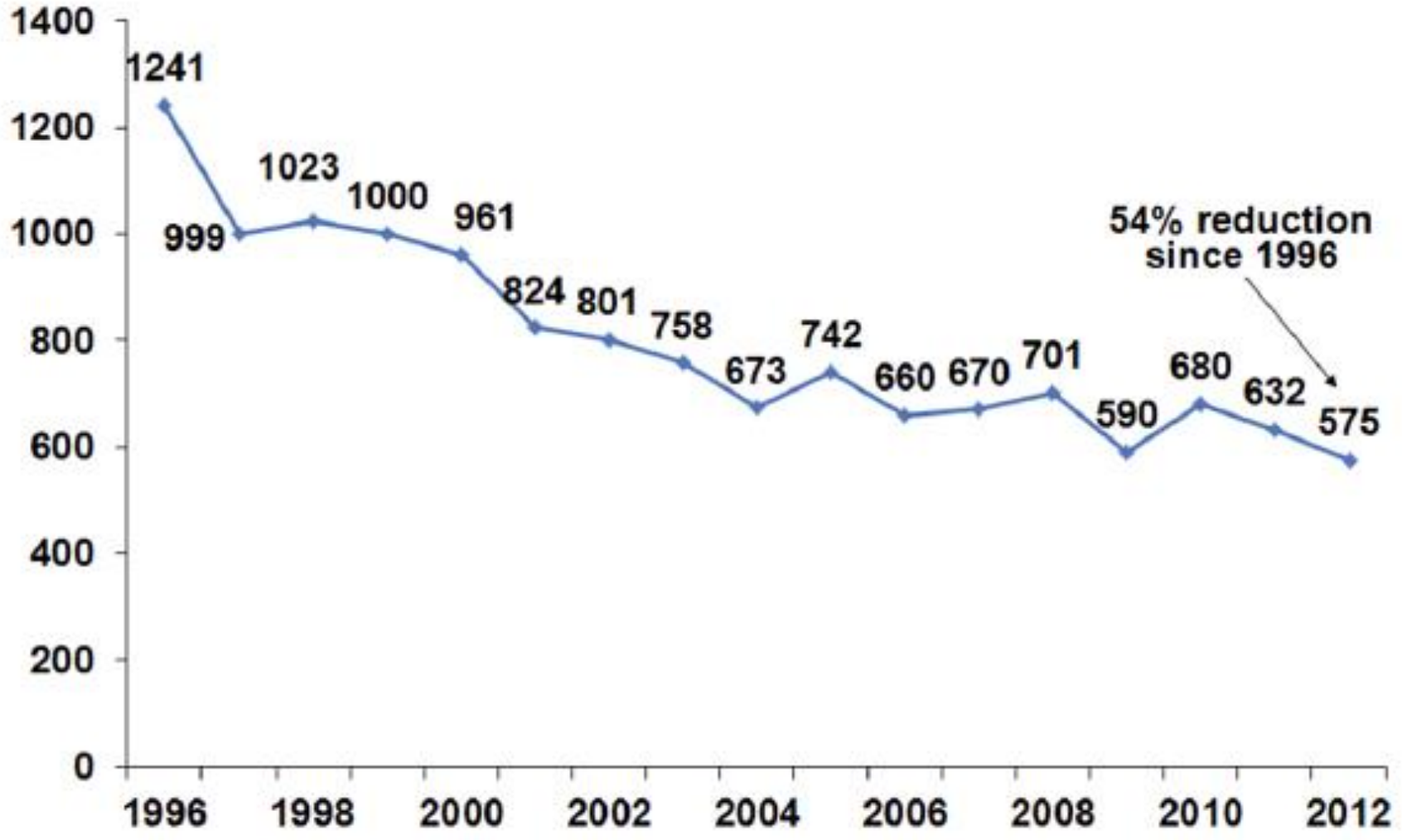
NAR Communications Team

Mission Statement

The NAR Communication Committee's overall objective is to provide an information exchange hub with conduits to Shippers, Leasing Companies, Railroads, FRA, AAR, Industry Associations, and Suppliers, allowing for exchange of best practices information within the rail tank car industry. Our primary focus is communicating this information to aid in the prevention of NAR's.

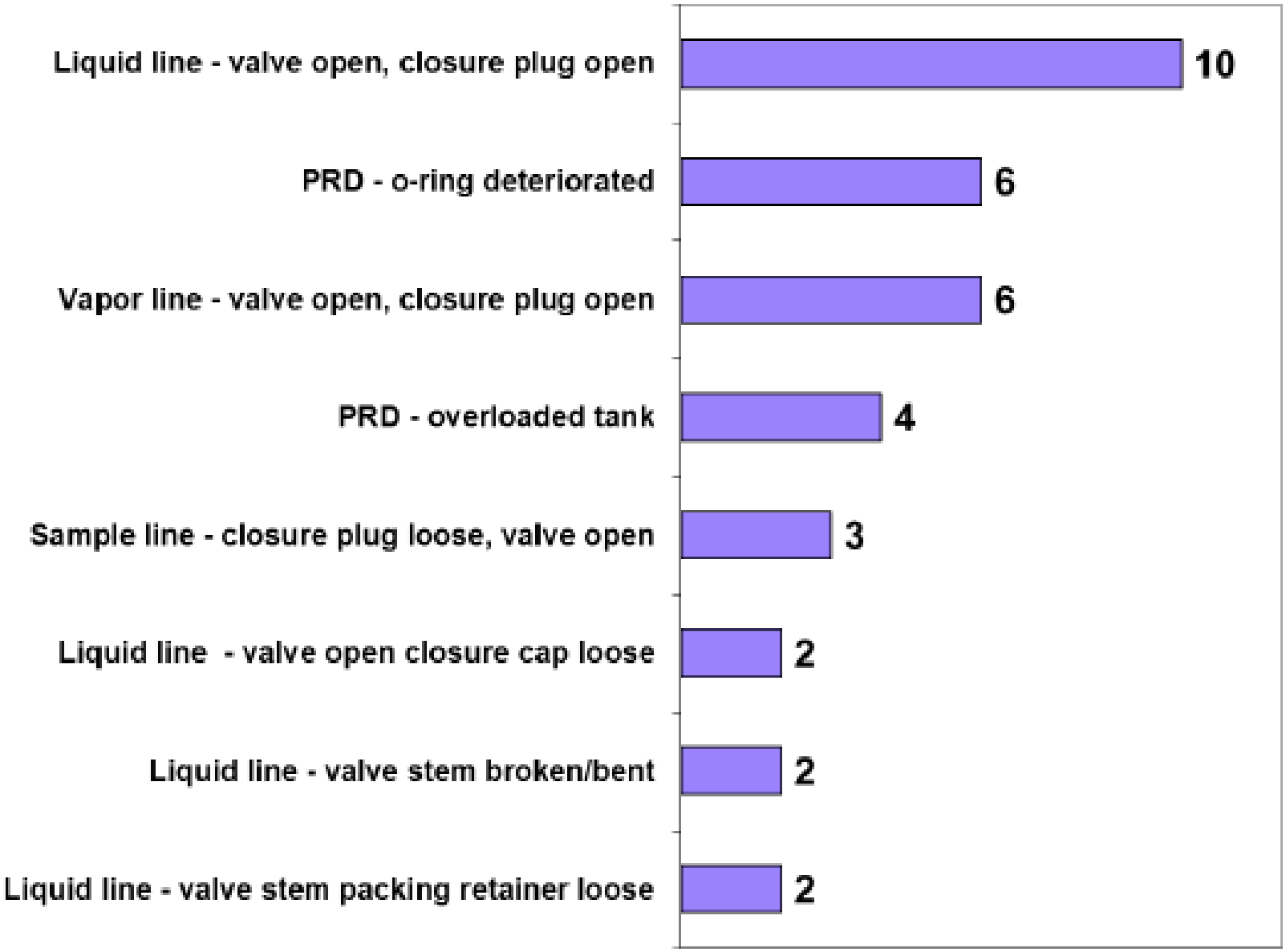
To Learn More About NAR Prevention Go To:
http://nar.aar.com

NARs by Year: US & Canada



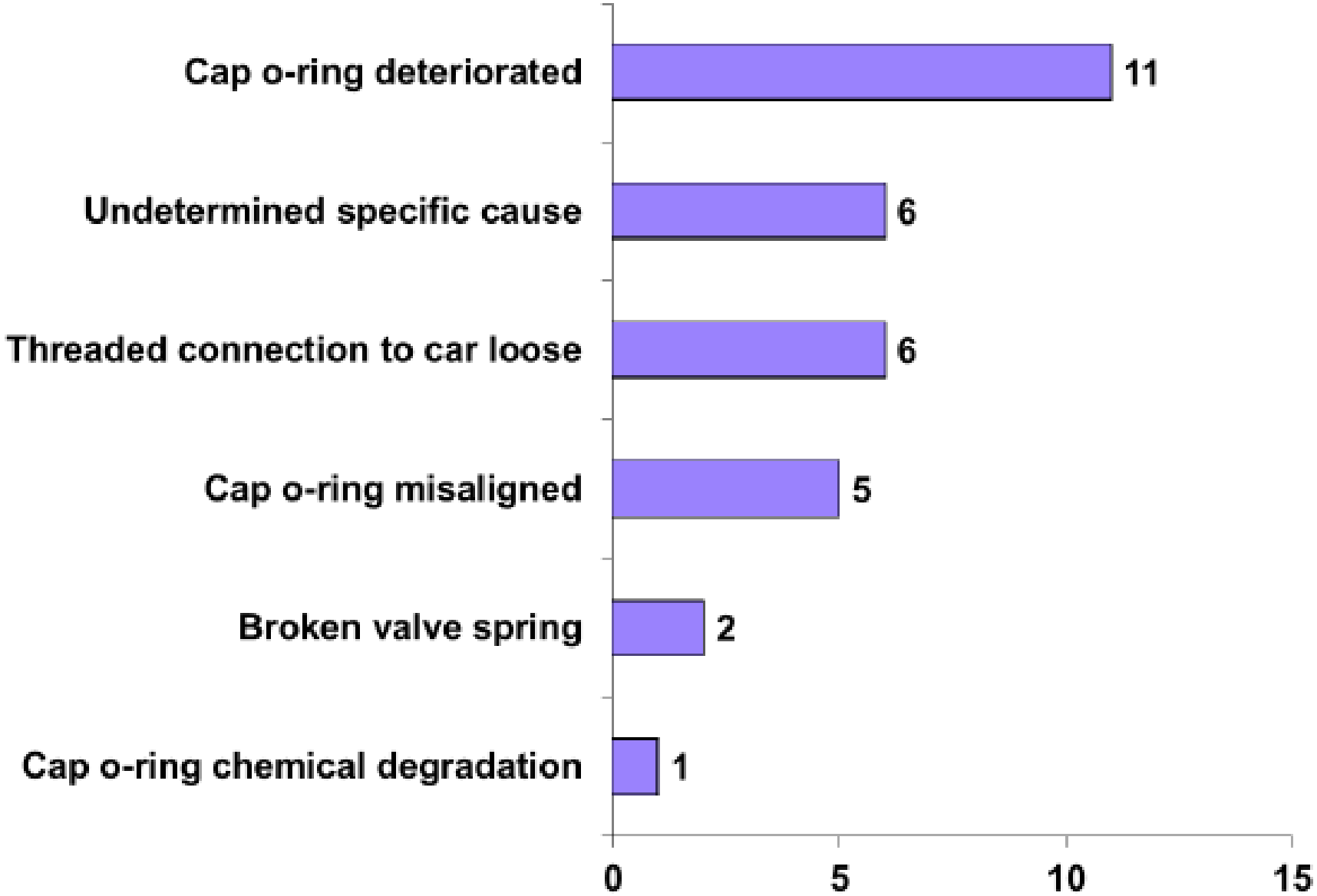
Source: AAR/BOE NAR data

2012 Top Specific Causes for Pressure Cars



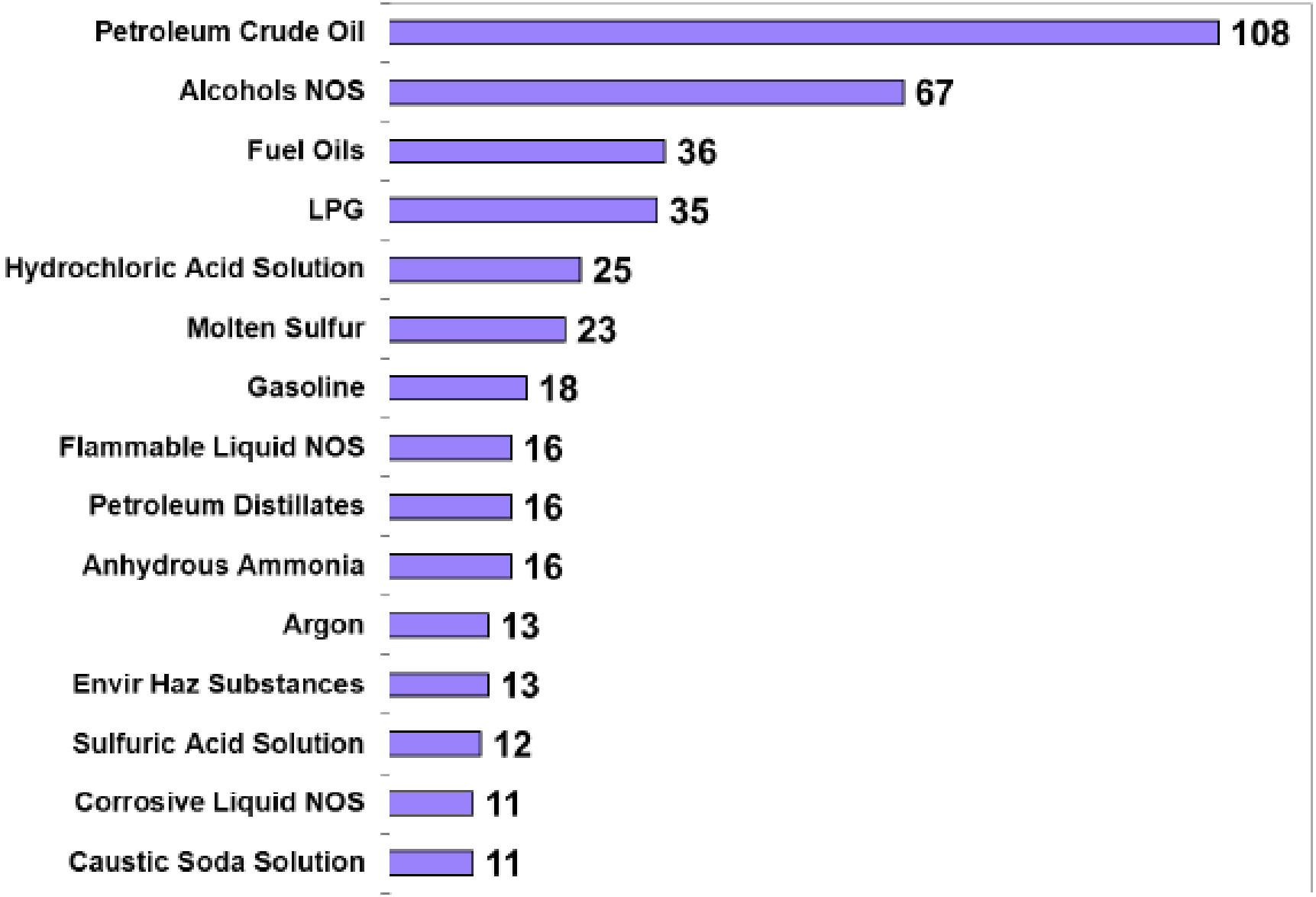
Source: AAR/BOE NAR data

2012 Vacuum Relief Valve NAR Causes



Source: AAR/BOE NAR data

2012 Top Commodities for NARs

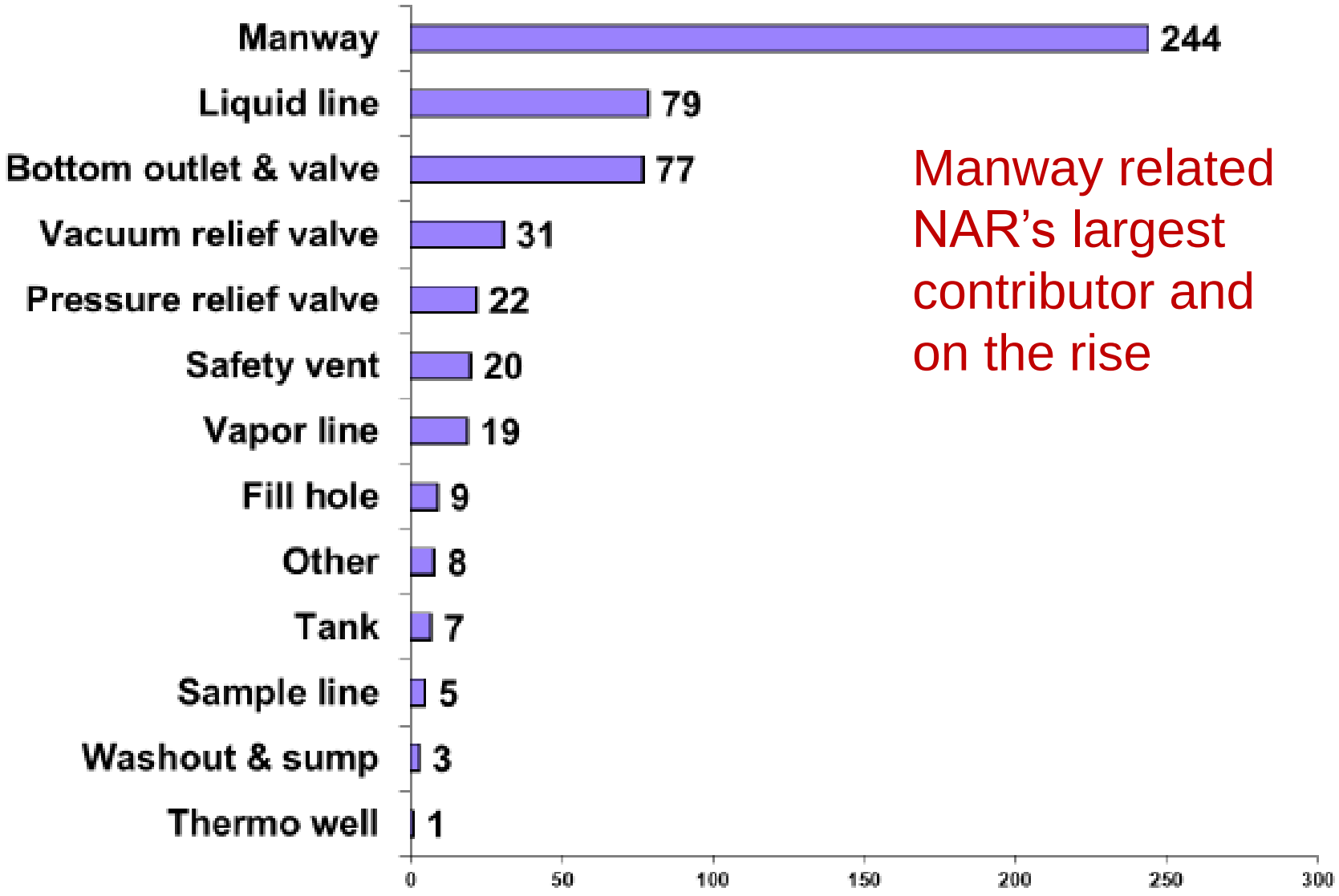


Source: AAR/BOE NAR data

VSP Technologies

- **Bolted Flange Joint System**
- **Gasket & Fasteners 101**

2012 Non-Pressure Car NARs By Component



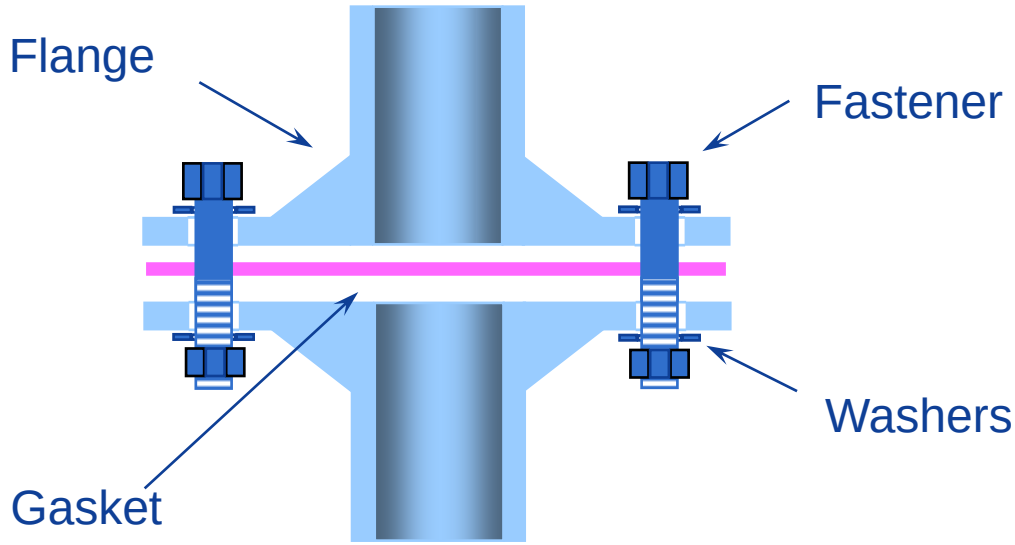
Manway related NAR's largest contributor and on the rise

Source: AAR/BOE NAR data

The Bolted Flanged Joint System

- Bolted Flanged Joint consists of
  - Flange
  - Fasteners
  - Gasket Material
    - Chemical Compatibility
    - Mechanical Requirements (Thermal, Pressure, Stress)
    - Assembly Considerations (assume controlled procedures are in use)

- All Three Must Work in Harmony



20” GP Manway

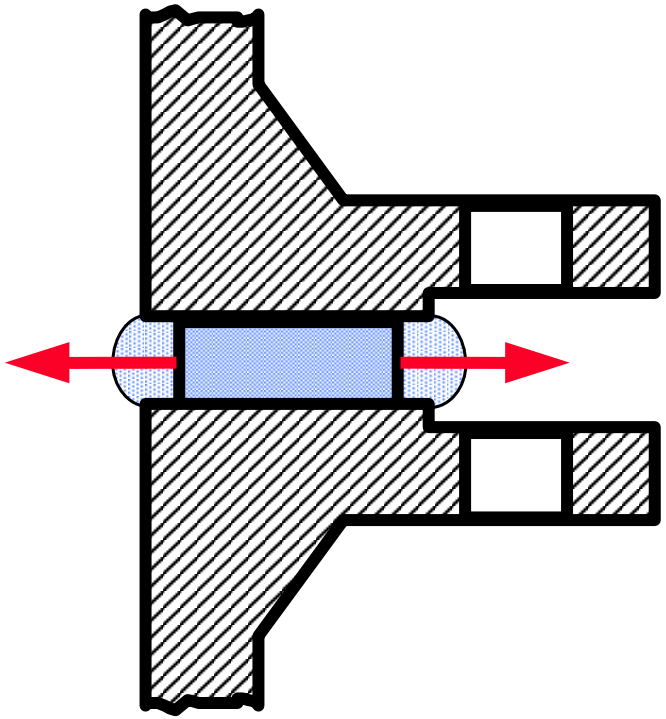
- 20” GP Manway typically 6 or 8 bolts 7/8” or 1”
- NPS 20 Class 150 has (20 1-1/8” bolts)
- Typical Torque Values for Manways

Minimum Required Gasket Assembly Stress

$$\text{Gasket Stress (psi)} = \frac{\text{Total Bolt Load (lb)}}{\text{Gasket Contact Area (in}^2\text{)}} = \text{psi}$$

Gasket Material	Minimum Gasket Stress to Seal (psi)	Maximum Gasket Stress (psi)	Re-Torque Required
1/8" Thick Rubber (Elastomer)	500	1,500	YES
Expanded PTFE w/Corrugated Insert	2,800	10,000 - 15,000	NO
1/8” Thick Compressed Non-Asbestos	4,800	15,000	NO
1/8” Filled PTFE	4,800	10,000 - 15,000	YES

Mechanical Requirements - Load Retention (Creep/Cold Flow)



- Gasket Creep/Cold Flow
  - Gasket Stress Decreases
  - Loss of Fastener Pre Load
  - Fasteners more susceptible to vibration loosening

- Ideally it is preferable to choose a materials that does not relax

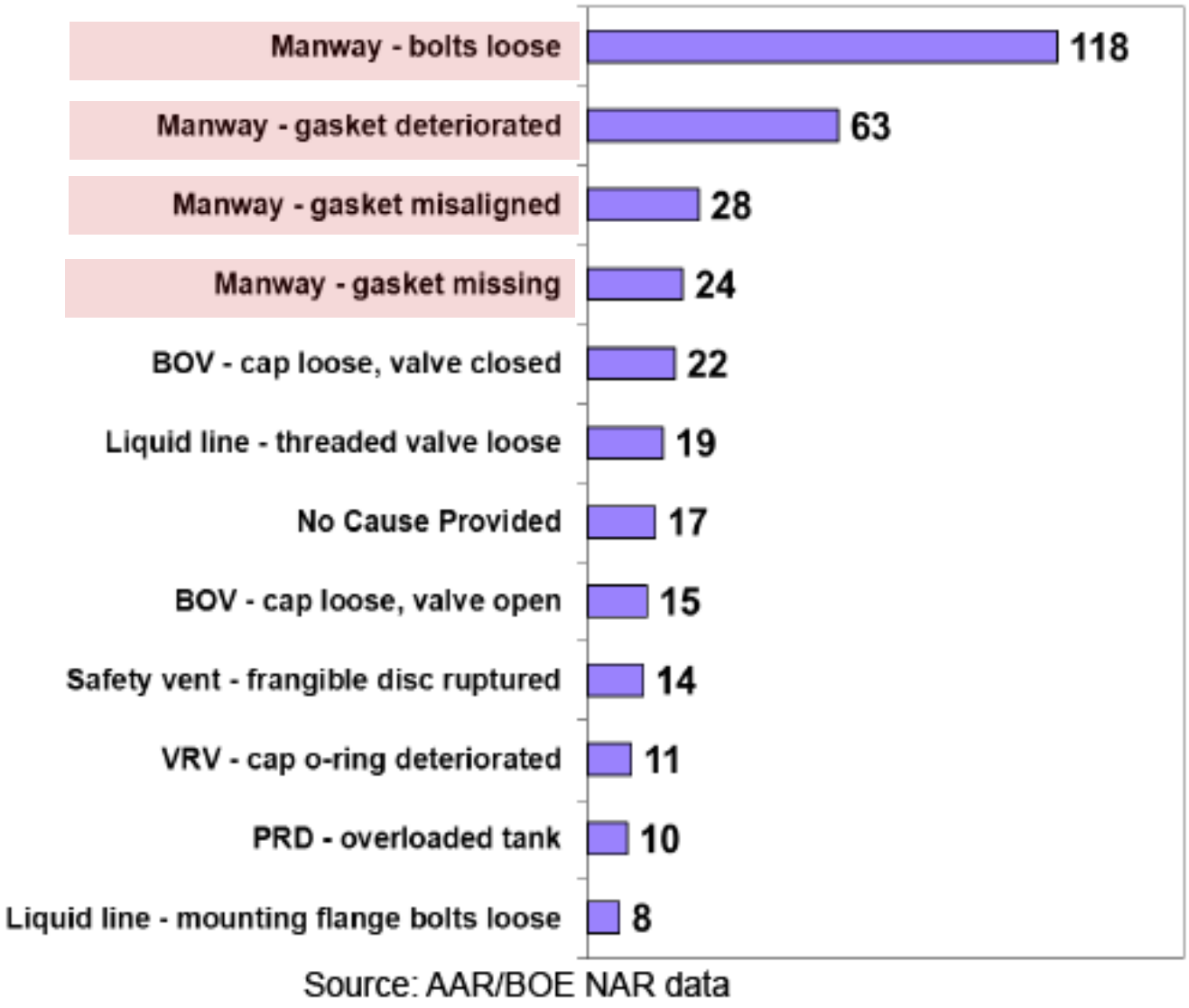
Fracture/Over Compression of Gasket

Typical GP Railcar Manway Gasket Damage

Buna-N (Nitrile) in Asphalt
[Buna-N = 200°F, Asphalt = 400°F]

Viton® in Asphalt [Viton® 450°F, Asphalt = 400°F]

Top Specific Causes: Non-Pressure Cars



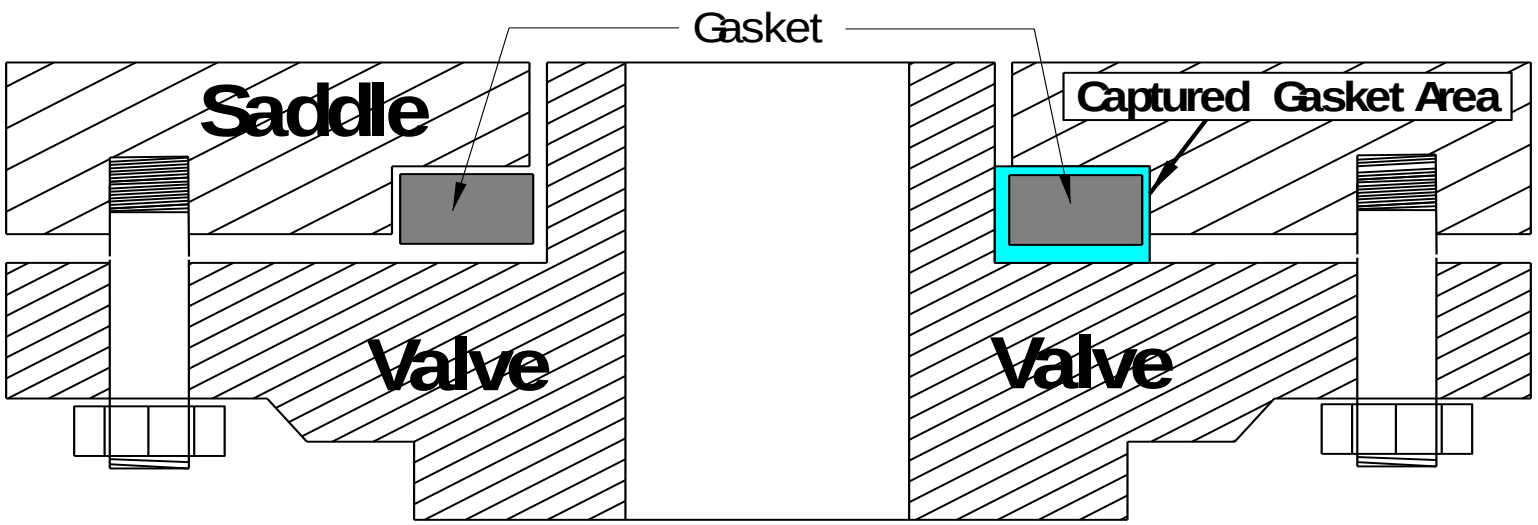
Source: AAR/BOE NAR data

Manway Related NAR's represent 65 % of Top Specific Causes

- Manway bolts loose is the leading cause of NAR's
- Elastomer gaskets are the most widely used
- Loose Bolts can be caused by the relaxation of elastomer (rubber) gaskets

Basic Understanding of Tank Car Flanges

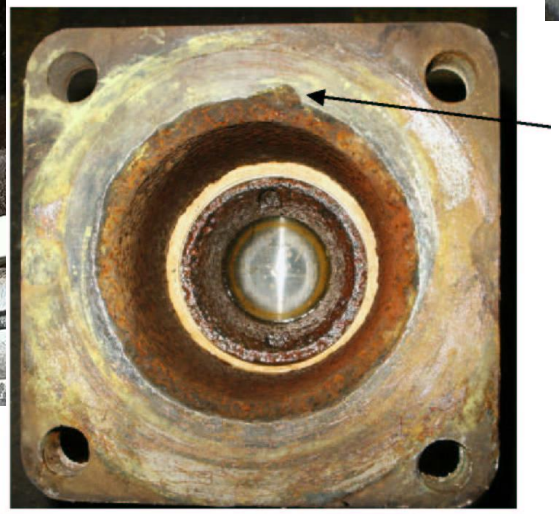
- Flange types (Raised face, flat face, tongue and groove (T&G))
  - Male to Female Flange
    - (ex., Jamesbury 5REB3)



NOTE: Sometimes a ¼" thick gasket is needed to ensure proper compression

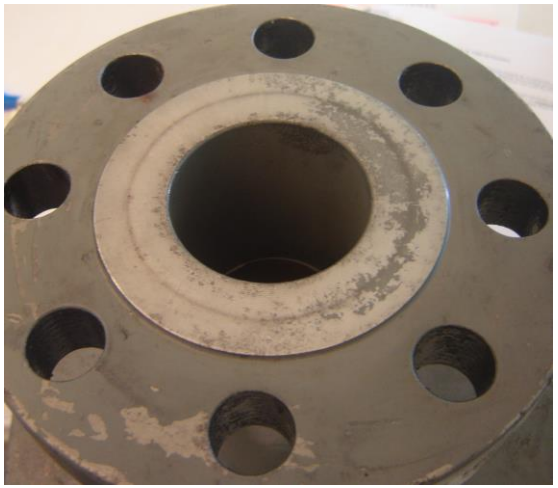
Flange Inspection and Cleaning

Before a flange can be reassembled a proper inspection must be performed to ensure the flanges are free of nicks, pits, and/or gouges that could prevent the gasket from performing its intended function reliably. The examples below illustrate flanges with damage that should be documented and reported to the customer to receive approval for reassembly.

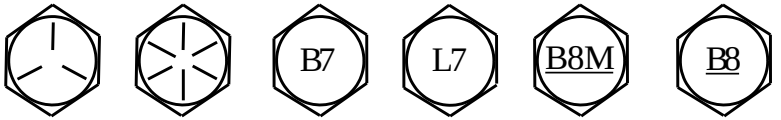


Flange Inspection and Cleaning

Before a flange can be reassembled a proper inspection must be performed to ensure the flanges are true and free of contamination. The presence of contamination on the flange sealing surface can prevent the gasket from performing its intended function reliably. The below examples illustrate a flange with contamination and how it should look after being cleaned adequately.



Basic Understanding of Fastener Specification



BOLT Description	Diameter Range	Yield Strength (ksi)	Tensile Strength (ksi)	3/4" Diameter Fastener Maximum Torque (ft-lbs)
ASTM A193 GRADE B8 Class 1	All Diameters	30	75	100
ASTM A193 GRADE B8 Class 2	1/4" thru 3/4"	100	125	335
	Over 3/4" thru 1"	80	125	
	Over 1" thru 1-1/4"	65	125	
ASTM A307 GRADE B	1/4" thru 4"	36 (1)	60	120
ASTM A320 GRADE L7	1/4" thru 2-1/2"	105	125	350
ASTM A193 GRADE B7	1/4" thru 2-1/2"	105	125	350
ASTM A320 GRADE L7	1/4" thru 2-1/2"	105	125	350
ASTM A449 TYPE 1	1/4" thru 1"	92	120	305
	Over 1" thru 1-1/2"	92	120	
SAE J429 GRADE 5	1/4" thru 1"	92	120	305
	Over 1" thru 1-1/2"	92	120	
SAE J429 GRADE 8	1/4" thru 1-1/2"	130	150	435
ASTM A574	1/4" thru 1/2"	162	180	435
	Over 1/2" thru 2"	153	170	

Note 1: 36 ksi is general accepted value to use for yield with ASTM A307 Grade B

Review of Torque Equation

TORQUE: What is Torque? How is it Calculated? How Accurate is Torque?

- Relationship Between Rotational Force and Axial Force

Torque = FkD/12 = (ft-lbs)

Where: F = Axial Bolt Force Desired (lbs)
D = Nominal Bolt Diameter (in)
k = Nut Factor (aka Friction Factor)
12 = Conversion from inches to feet

Example: F = 10,000 lbs, D = 0.75 in, k = 0.2 and k= 0.1

Torque (k= 0.1) = [(10,000 lbs) x (0.75 in) x (0.1)]/12 = 62.5 ft-lbs

Torque (k= 0.2) = [(10,000 lbs) x (0.75 in) x (0.20)]/12 = 125 ft-lbs

Tools Used to Tighten Manway

RAD® 350SL

Tools Used to Tighten Manway

Provides Controlled Assembly

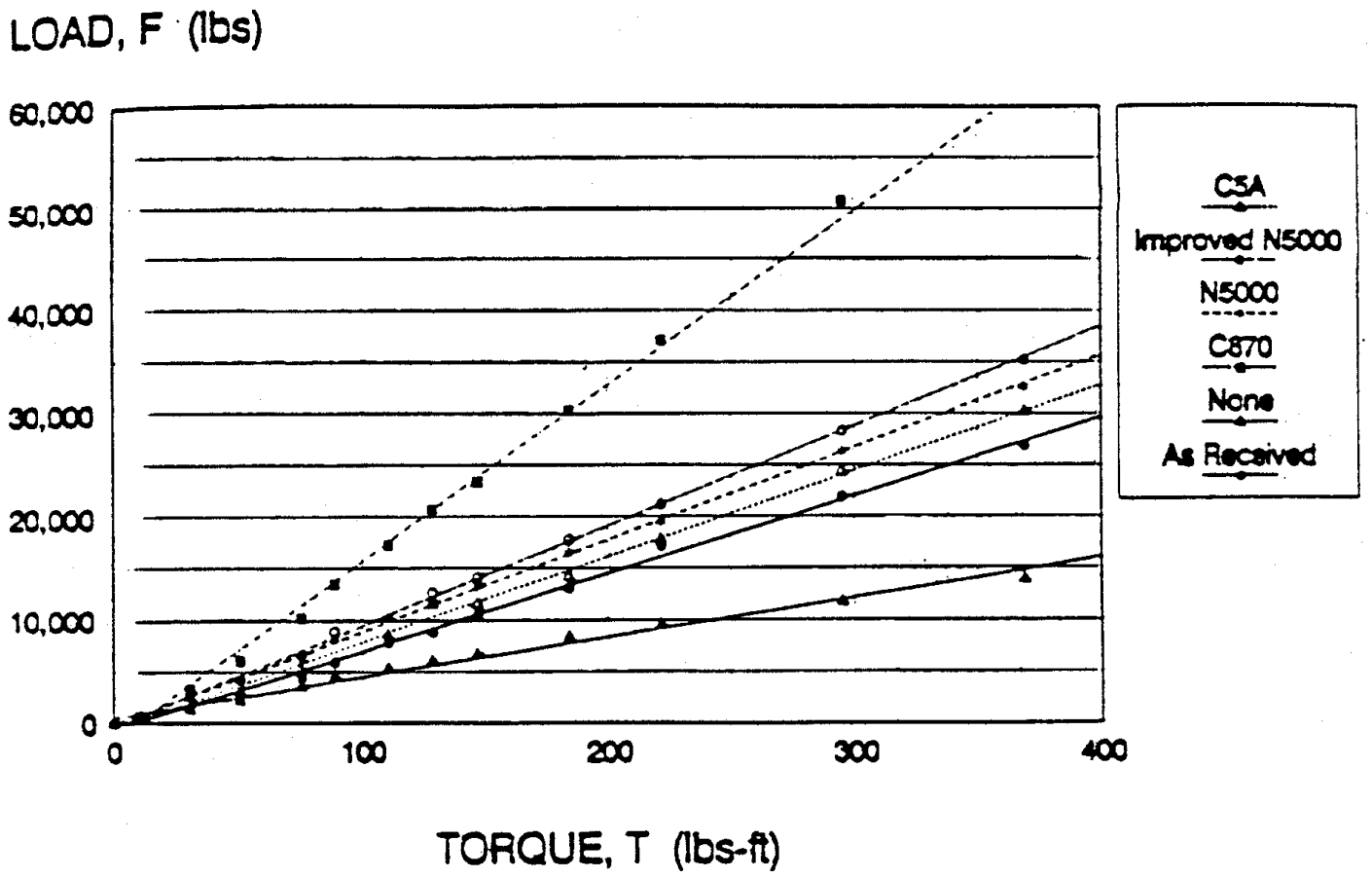
Zero Torque Wrench before storing

RAD® 350SL

Pneumatic Torque Wrench

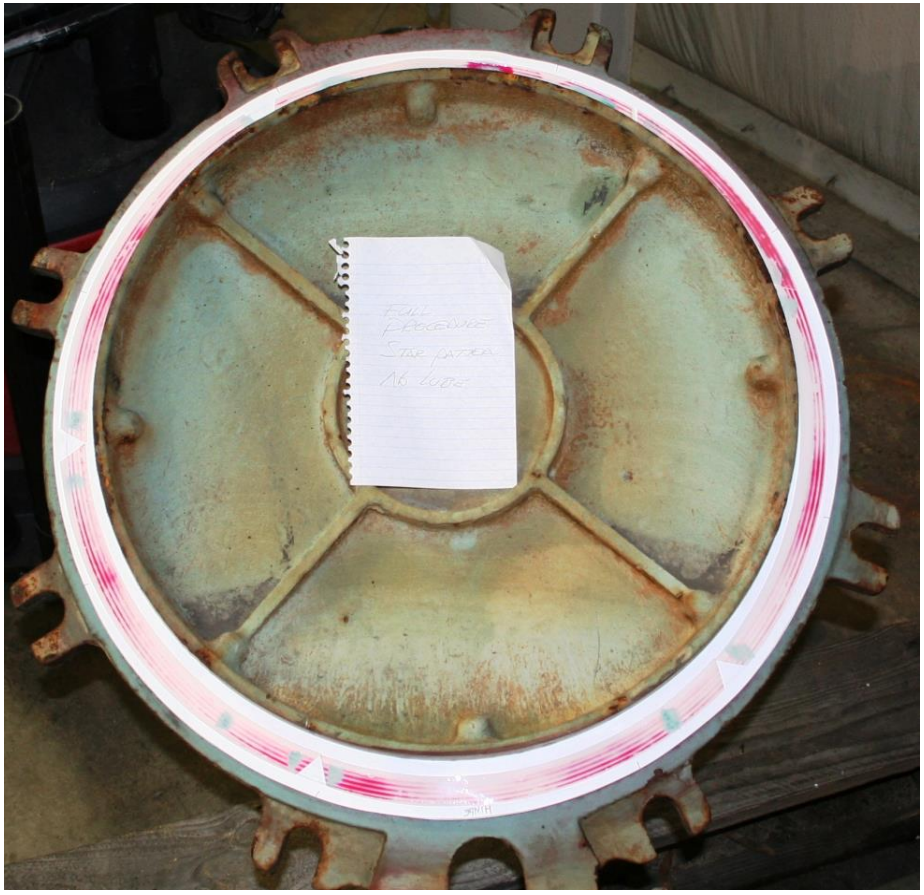
Uncontrolled Assembly

LOAD vs. TORQUE (DIFFERENT LUBRICANTS)



Reprinted from "Evaluation of torque coefficients and gasket stress distributions in a bolted flanged joint using different types of lubricants" Ecole Polytechnique of Montreal, Montreal, Quebec, Canada

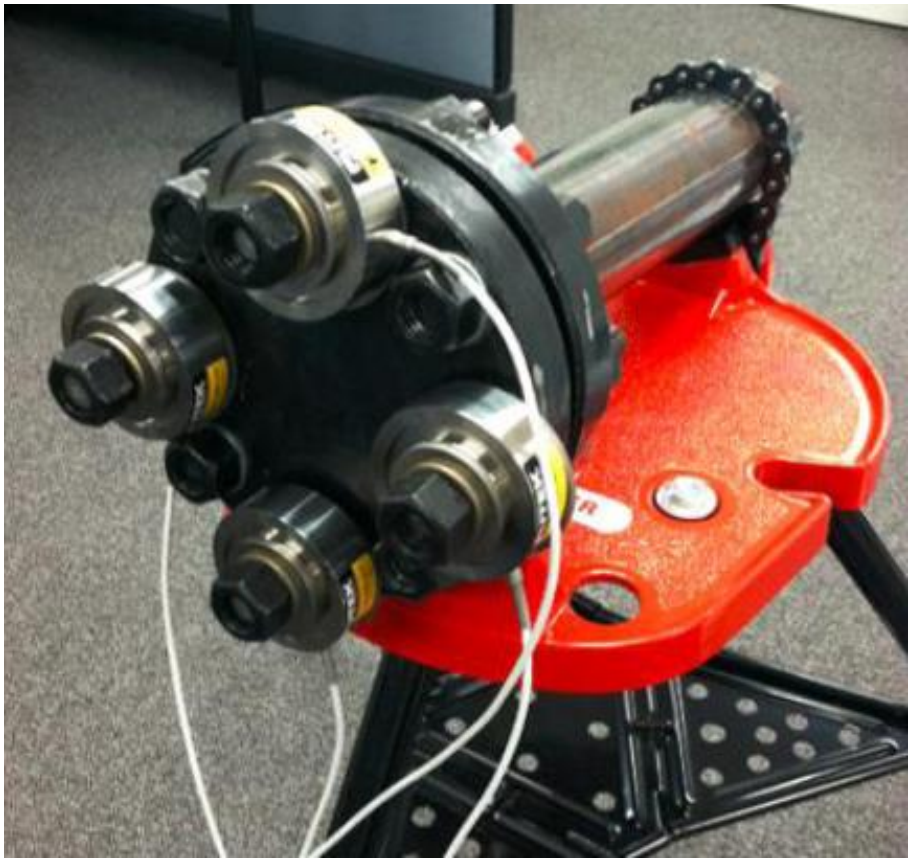
Gasket Stress with and without Lubrication

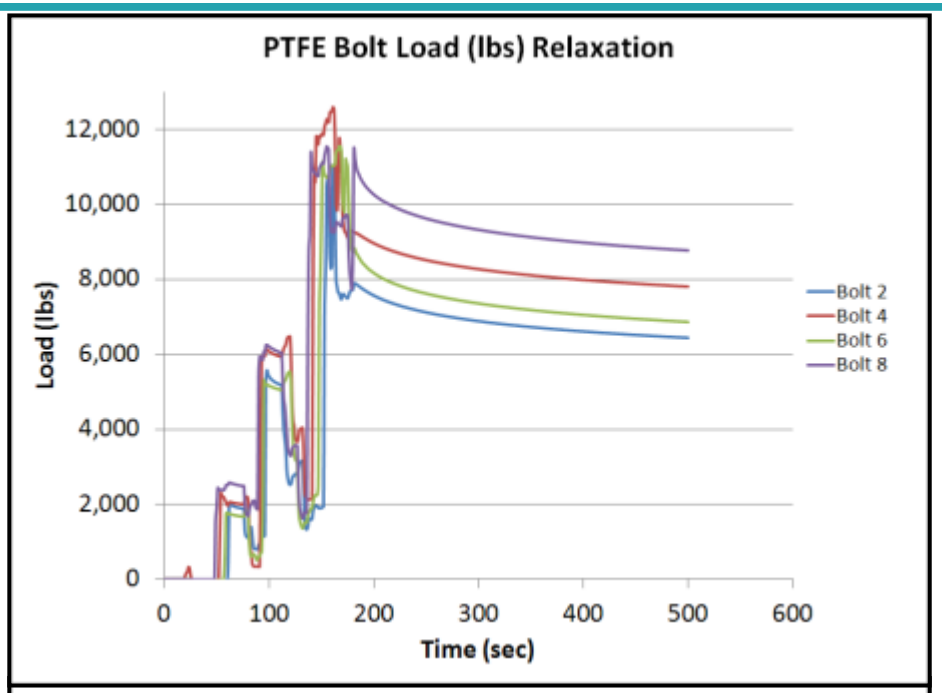


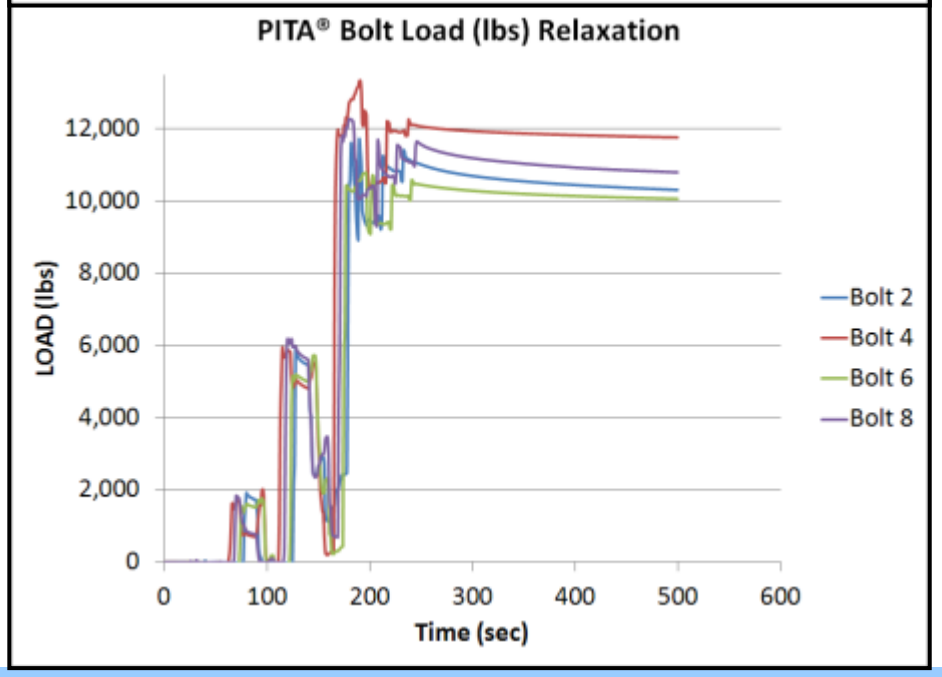
Unlubricated Eyebolts
Non-Uniform, Lower Overall Gasket Stress

Cleaned & Lubricated Eyebolts
More Uniform, Higher Overall Gasket Stress Developed

(MQA) Mechanic Qualification Assembly Unit







- Used as Training Tool
- Used for R&D Projects

Review Root Cause Examples

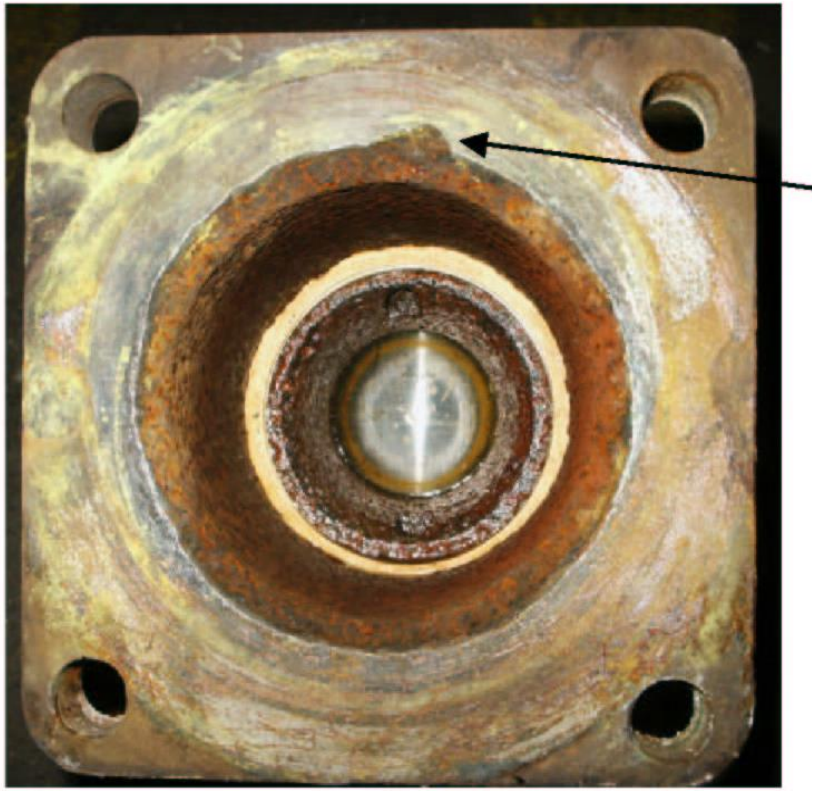
- Over Tightening of Manway
- Over Compression of Gasket (2)
- Gasket Material Not Compatible with Media
- Damaged Flange Mating Surface
- Excessive Gasket Stress Caused by Flange Rotation
- Insufficient Gasket Stress Caused by Flange Make Up
- Insufficient Gasket Stress Cause by Flange Assembly
- Insufficient Gasket Stress Caused by Flange Rotation
- Example of Poor Gasket Design/Choice of Material
- Gasket Creep/Cold Flow (2)

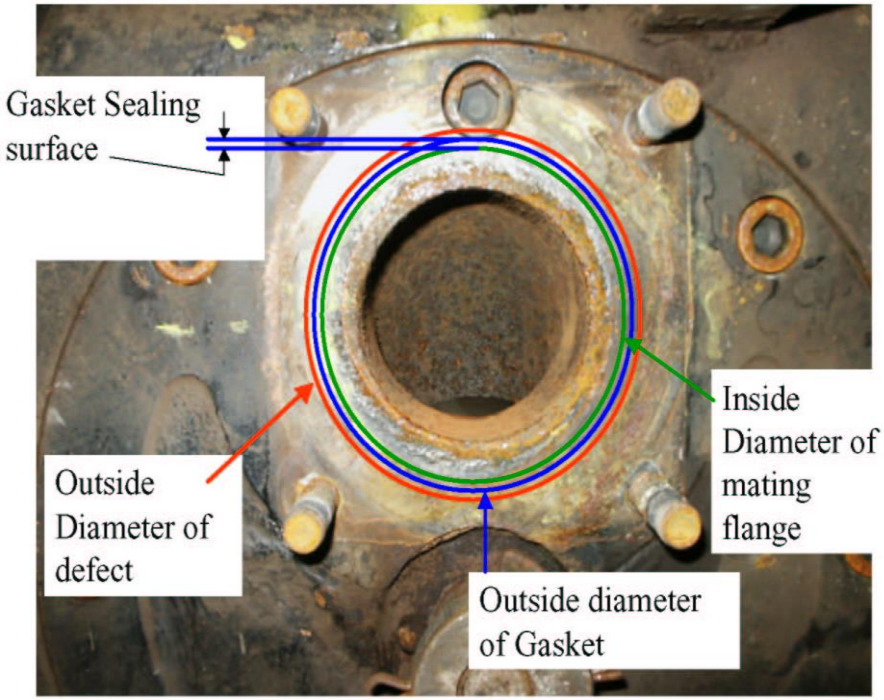
Over Tightening of Manway

Over Compression of Gasket

Gasket Material Not Compatible with Media being Transported

Damaged Flange Mating Surface





Over Compression of Gasket

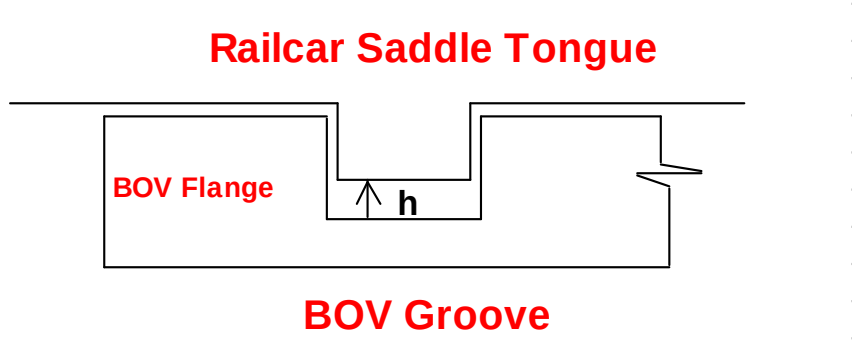
Excessive Gasket Stress Caused by Flange Rotation

Leak Path Created Due to Insufficient Gasket Compression

Properly Compressed Gasket

Following Proper Assembly Procedures will Ensure Flanges are Assembled Parallel Avoiding Flange Rotation

Insufficient Gasket Stress Caused by Flange Make Up



Car Number	Date Measured	BOV Groove Depth (in)	Saddle Tongue Length (in)	h (in)
A	Dec-03	0.313	0.219	0.094
B	Dec-03	0.313	0.250	0.063
C	Dec-03	0.219	0.219	0.000
D	Jan-04	0.219	0.156	0.063
E	Jan-04	0.219	0.281	-0.063
F	Jan-04	0.281	0.188	0.094
G	Jan-04	0.219	0.219	0.000

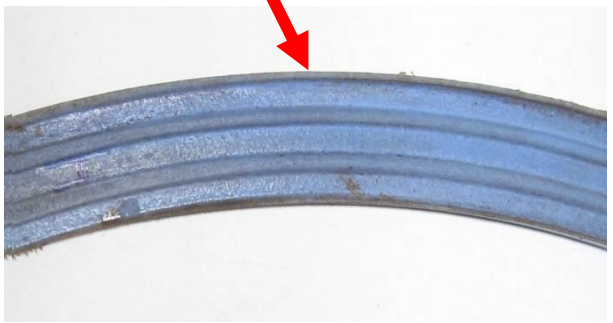
Depending on Gasket Thickness a Highly Compressible Gasket May Not be Compressed Sufficiently with Car Numbers A, B, D, and F

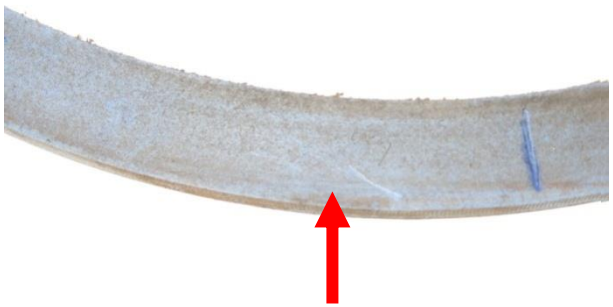
The Gaskets Compressed Thickness should be greater than “h”

Insufficient Gasket Stress Caused by Flange Assembly

This quadrant as shown is the area where the leak was observed. Note the lack of witness groove marks on the gasket

The witness grooves from the flange are clearly visible in this quadrant of the gasket

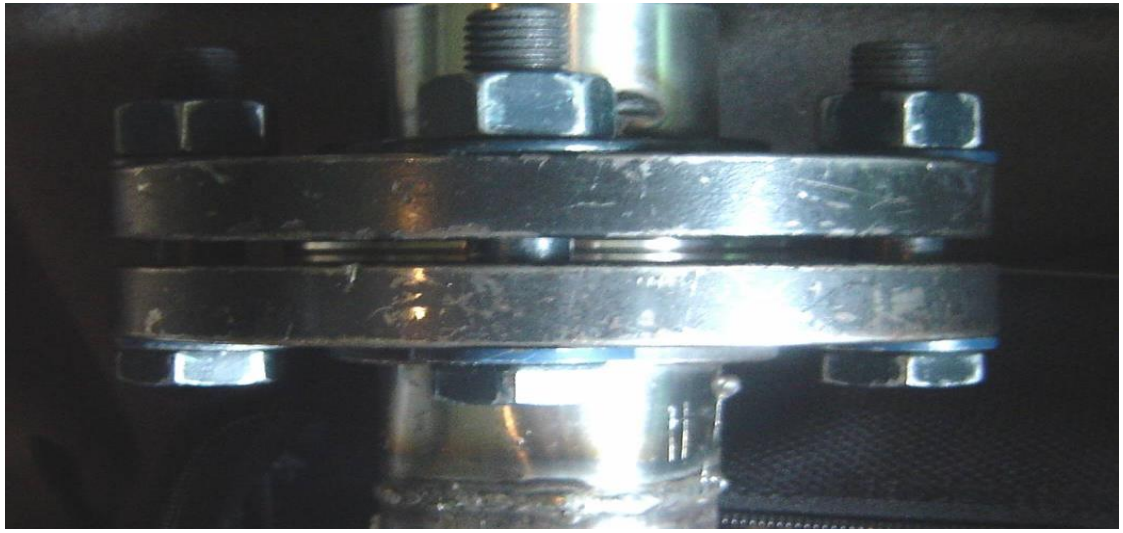




There are no corresponding imprints on this quadrant of the gasket

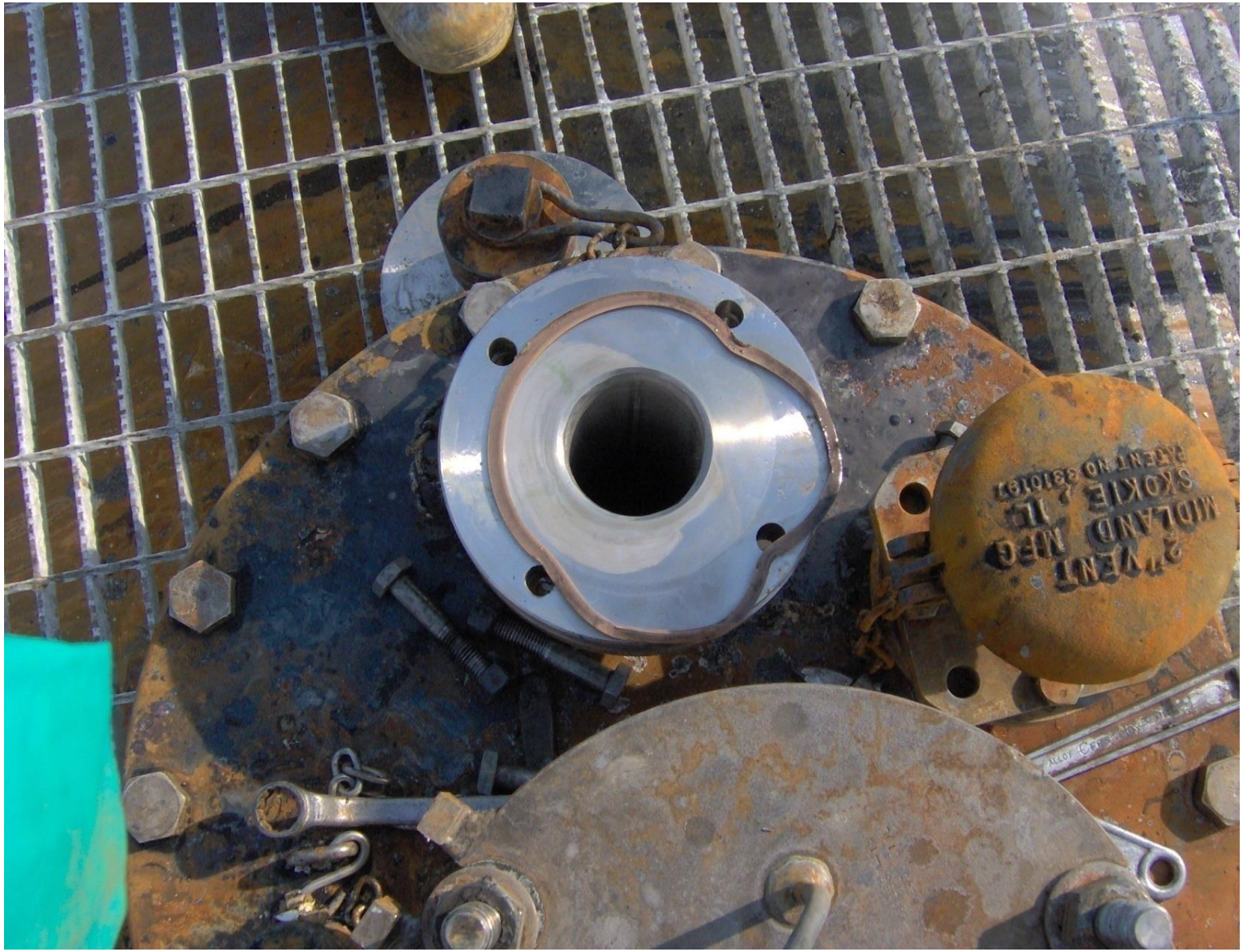
Insufficient Gasket Stress Caused by Flange Rotation

Example of a Flange assembled and Rotated

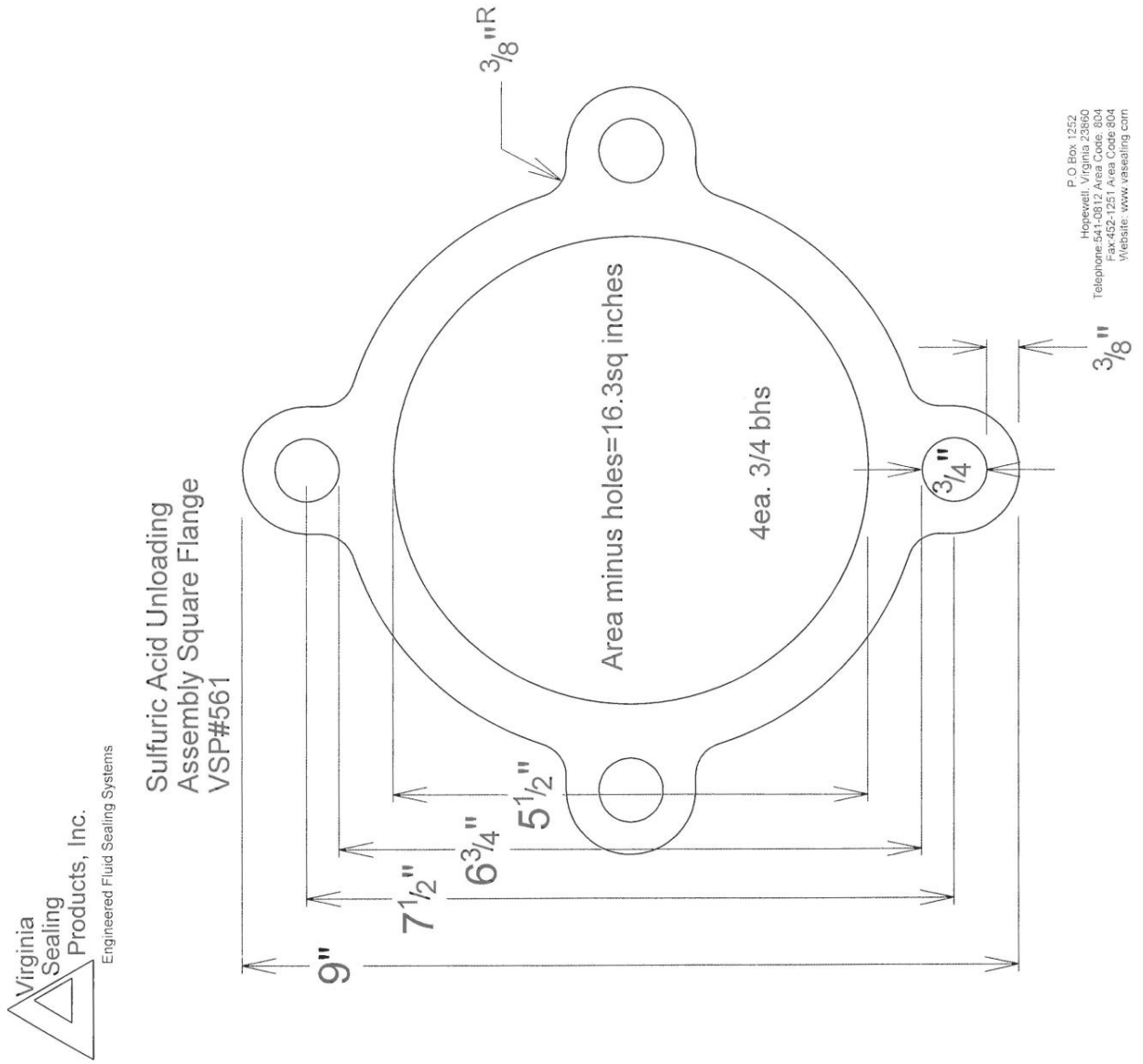


Example of a Flange assembled Parallel

Example of Poor Gasket Design/Material Choice



Example Solution



Carolina Seal

Commonly Used O-Ring compounds (Chemical Transportation)

- Buna-N (Nitrile)
- EPDM
- Neoprene
- Viton® A
- Viton® B
- Viton® GF-S
- Viton® GF-LT
- Viton® ETP (Extreme)

- Perfluoroelastomers (FFKM) - $$$
  - Simriz®
  - Kalrez®
  - Chemraz®
- FDA Sanctioned Grades

Material Selection Considerations

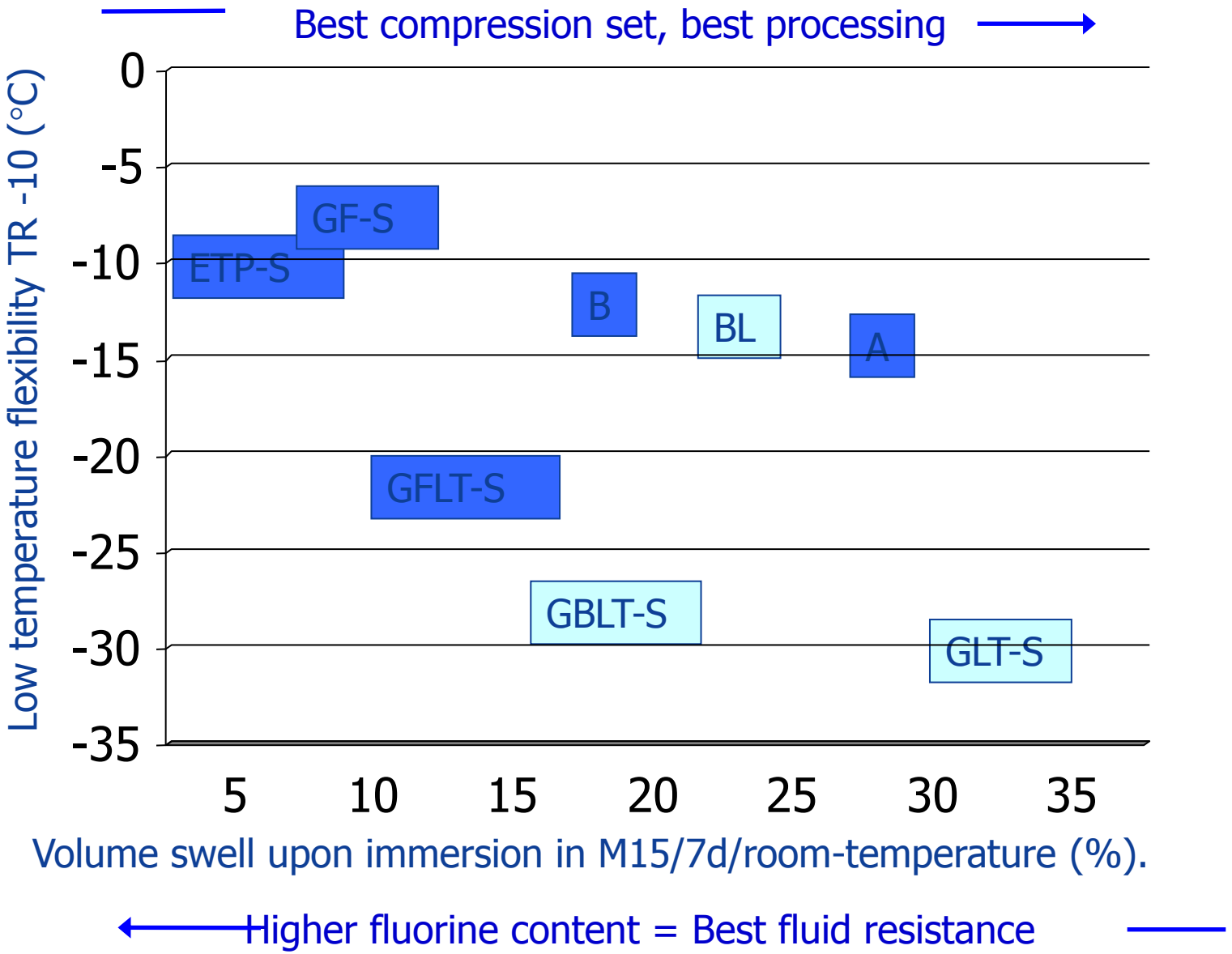
- Chemical Compatibility Rating?
- Physical Properties of the Elastomer (Pedigree)
- Pressure – High / Low / Constant?
- Temperature – High / Low / Constant?
- Operating Conditions – Static / Dynamic?
- Length of Service Expectations
- O-Ring Management Strategy – Consolidation of Materials v. Lowest Cost per Commodity
- Technical Information Available

Relative Performance of Viton®

Viton® Products	A	B	GF-S	GF-LT	ETP-S
Curing System	bisphenol	bisphenol	peroxide	peroxide	peroxide
Fluorine Content	66%	68.5%	70%	67%	67%
Heat Resistance	All Viton® products have outstanding thermal properties				
Chemical Resistance	O	✪	✪ ✪	✪ ✪	**BEST**
Base Resistance	X	X	O	✪	**BEST**
Low Temperature Properties	✪	✪	O	✪ ✪	O
Compression Set Resistance	**BEST**	✪ ✪	✪ ✪	✪ ✪	✪
Relative cost of polymer	Low	Low	Low	Medium	High

BEST = Excellent ✪ ✪ = Very Good ✪ = Good O = Fair X = Poor

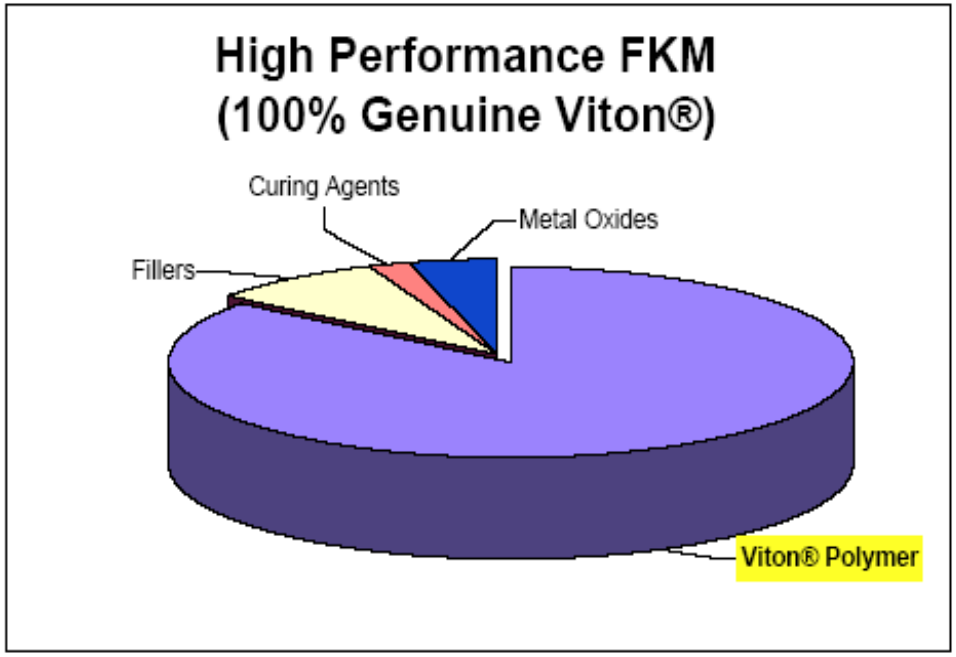
Viton® Material Properties

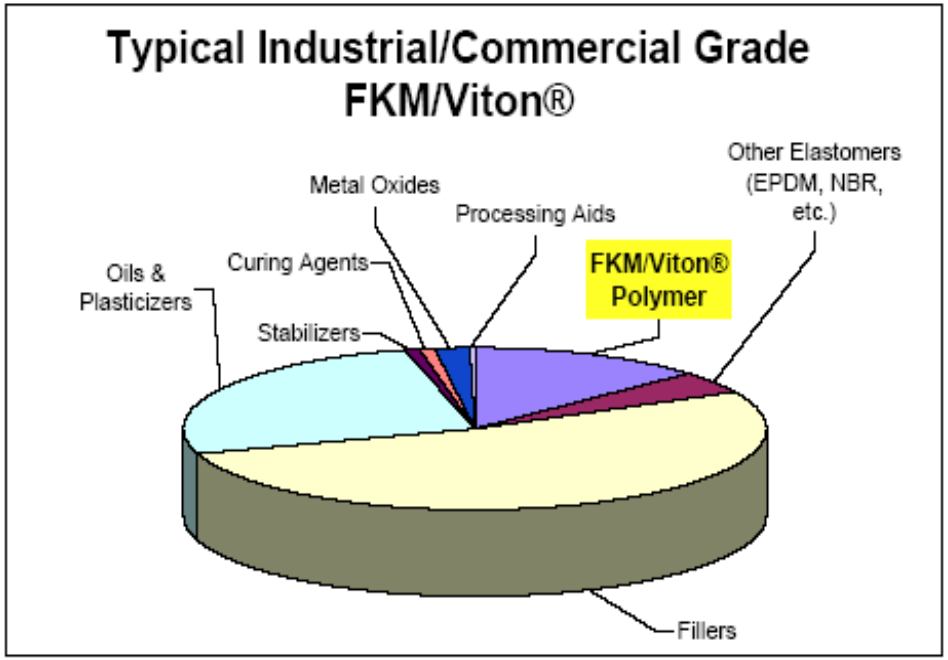


Supply Chain for Elastomers

- More concern with elastomer supply chain, FKM example below
  - FKM(Viton®) EPDM, Buna-N(Nitrile) Neoprene, etc

FKM (Viton®) fluoroelastomers are supplied to compounders in a "gum" (pure) state. These fluoroelastomer "gums" must be compounded with several other materials and "cured" to produce a properly cross-linked fluoro-elastomer sheet or o-ring. The relative ratio of FKM "gum" to all of the other materials in the compound should be in the range of 85% to 60% by weight, however to reduce cost, there are some grades with an FKM content as low as 1% to 17%. As a result, there can be considerable variation in chemical compatibility within the same grade of FKM elastomer products made by different compounders.



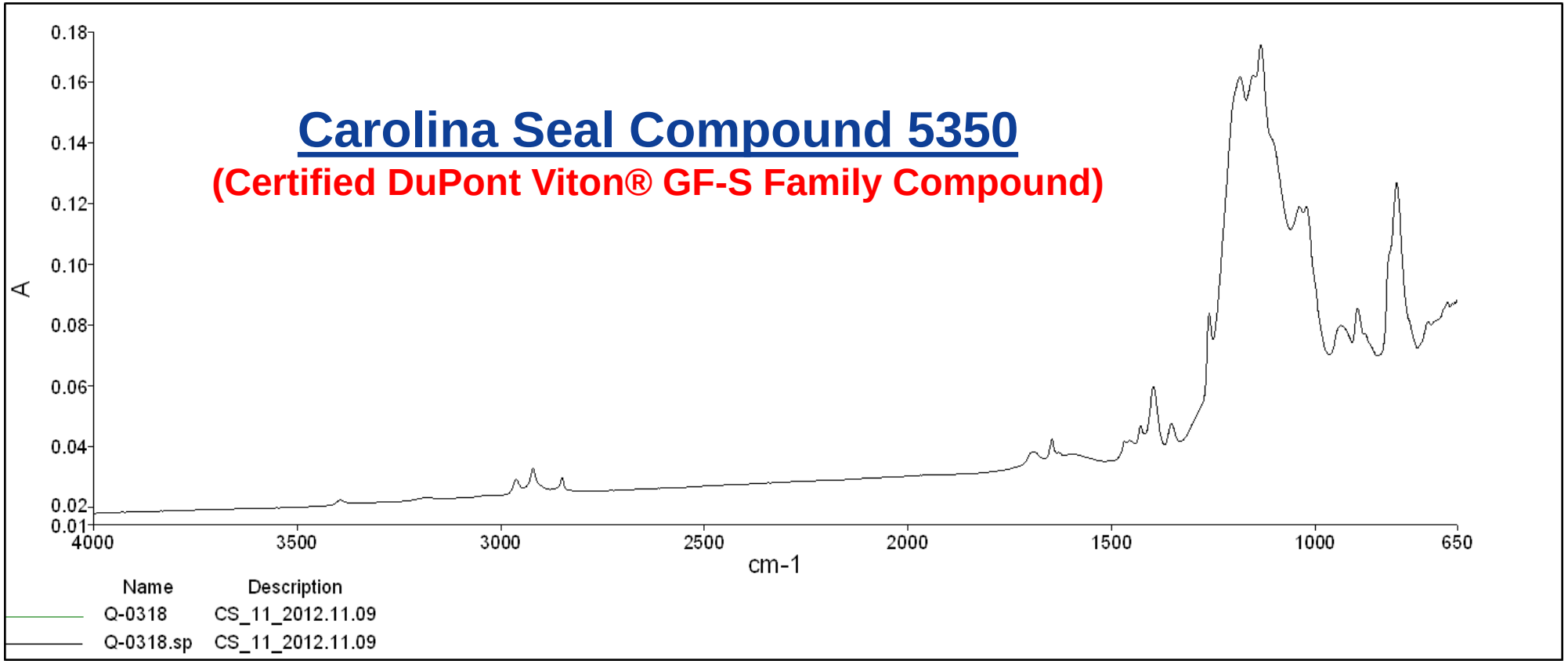


Lacking any industry compounding standards, elastomer compounders are free to vary the types and amounts of all consituents within the elastomer products they manufacture. The result is a wide, confusing array of different grades of Viton® and FKM sheets and o-rings identified as "Premium" grade, "Industrial" grade or "Commercial" grade. Typically, the lower "grades" of FKM or Viton® materials are compounded with minimal amounts of fluoroelastomer polymer, and an overabundance of processing aids, fillers and even other elastomers such as Neoprene or Nitrile. Users of low grade fluoroelastomer materials should be aware of the chemical compatibility limitations that are encountered with this grade of material.

CSI - Material Analysis (FTIR Spectrometer)

FTIR (DNA) Graphical Representation

- In-House FTIR Testing
- The ‘DNA’ of Each Incoming Shipment of O-Rings is verified



“Trace Elements” Can Impact Recommendations

Material Safety Data Sheet

Creation Date 21-Oct-2009 **Revision Date** 21-Oct-2009 **Revision Number** 1

1. PRODUCT AND COMPANY IDENTIFICATION

Product Name **Ethyl Alcohol Denatured**

Cat No. **A407-1; A407-4; A407-20; A407-200; A407-500; A407P-4; A407RB-19; A407RB-200; A407S-4; A407SK-4**

Synonyms Ethanol, denatured; Grain alcohol, denatured; Ethyl hydroxide, denatured

Recommended Use Laboratory chemicals

3. COMPOSITION/INFORMATION ON INGREDIENTS

Haz/Non-haz

Component	CAS-No	Weight %
Ethyl alcohol	64-17-5	92 - 93
Methyl alcohol	67-56-1	3.7
Methylisobutyl ketone	108-10-1	1.0 - 2.0
Ethylacetate	141-78-6	< 1.0
Toluene	108-88-3	0.07

A Thorough MSDS Review Is Required

Material Recommendation Chart

COMMODITY: Ethanol					CAS#:							
CSI MATERIAL # →	BUNA	EPDM	NEOP	Viton® A	Viton® B	Viton® GF-S	Viton® ETP	Chemraz® 505	Kalrez® 6375	Kalrez® 1050LF	Simriz® 7295	Other
RESOURCE ↓												
Resource 1	1	1	1	B	A	A	A	--	A	A	--	
Resource 2	3	1	1	3	--	--	--	--	--	--	--	
Resource 3	3	1	1	3	--	--	1	--	--	--	1	
Resource 4	A to 140* AB to 200* NR DYN.	A 100% to 200*	A 100% to150*	B 100% 70*-350*	A	A	A	A	A	A	A	
Resource 5	--	--	--	--	--	--	--	1	--	--	--	
Resource 6	1	1	1	3	--	--	--	--	--	--	--	
Resource 7	C	A	A	A	--	--	--	A	A	A	--	
Resource 8	1	1	1	1	--	--	--	1	A	A	--	

Note various ratings for Buna-N and Viton A

Also, note various ratings for Dynamic vs. Static applications

Specific Language is Important

Material Recommendation Chart

COMMODITY: Ethylene Oxide (EO)												
MATERIAL →	BUNA	EP-PC	NEOP	4273A	4273B	5350	5176	C505	K6375	K1050	7295	Other
RESOURCE ↓												
Resource 1	4	3	4	D	D	D	D	--	A	D	--	K 2035
Resource 2	4	3	4	4	--	--	--	--	--	--	--	
Resource 3	4	3	4	4	--	--	4	--	--	--	1	
Resource 4	NR	C / NR	NR	NR	NR	NR	NR	A / B	A	NR	A	
Resource 5	--	--	--	--	--	--	--	1	--	--	--	
Resource 6	4	4	4	4	--	--	--	--	--	--	--	
Resource 7	D	C / NR	D	D	--	--	--	C	A		--	
Resource 8	4	2	4	4	--	--	--	3	1		--	
Resource 9												
Resource 10												
Resource 11											7301	NOTE

Improper Material Selection Can Lead To

- Premature failure / leakage
- Property damage
- Excessive labor costs (tear downs & rebuilds)
- Costly down-time of tank car – no movement
- Environmental fines, penalties, clean-up cost
- Catastrophic injury or death
- Lowest priced part (could) = highest overall cost

O-ring Failure Modes

Chemical Degradation

Installation Damage

O-ring Failure Modes

Spiral Failure

Abrasion

O-ring Failure Modes

Contamination

Compression Set

Weathering/Ozone Can Deteriorate O-Rings

Informal Poll to Repair Shops

What are the most common types of O-Ring failures you see during disassembly?

- Missing O-Rings at Vacuum Relief Valves
- Cuts, gouges, pieces of the O-Rings missing
- O-Rings that get stuck to the unloading nozzle due to how tacky/sticky a material is. (I.e., Asphalt Service)
- O-Ring Degradation
- Getting them applied properly – slid over, sitting in grooves correctly….and that's with lubrication.
- Compression Set
- Contamination or mechanical failure due to valve discharge

Root Cause Failure Analysis Reporting

Root Cause Failure Analysis Report

REPORT Number: RCFA_[redacted]

Portion in between Red Lines to be filled out by customer

Name:	[redacted]	Email:	[redacted]	Ph:	[redacted]	Fax:	[redacted]
Company:	[redacted]	Address:	[redacted]				
Car#:	[redacted]	Date of Failure:	10-21-09	Part#:		Valve Model#:	[redacted]
Last contents:	Aromatic XXXX Gas	Temperature:	10°C	Pressure Car or GP Car:	GP		
Specified Material Compound: Viton B							

Describe Type of Failure:
Vapor Leak at Pressure Relief Valve

Service Requested: (Check Box Below)		PO Number (if required):
√	• FTIR Spectrometer Analysis/Material Identification	Fee: $300.00 (up to 5 items) please inquire if more are needed
√	• Visual Diagnosis Fee – No Charge	

Analysis Date:	11-18-09	Evaluated by:	A Diaz with assistance by Lab Personnel and PhD Chemist

Instruments used in Evaluation:

- High Magnification Digital Photography
- Perkins Elmer® FTIR Spectrometer
- Shore® Durometer Hardness Type "A2" Scale
- Various Chemical / Elastomer Compatibility Resources
- Mitutoyo Digital Calipers

Results of Analysis:

After reviewing the 16 items that were sent for analysis, there are several contributing factors to consider as modes of failure. This conclusion was based on visual and measurable data.

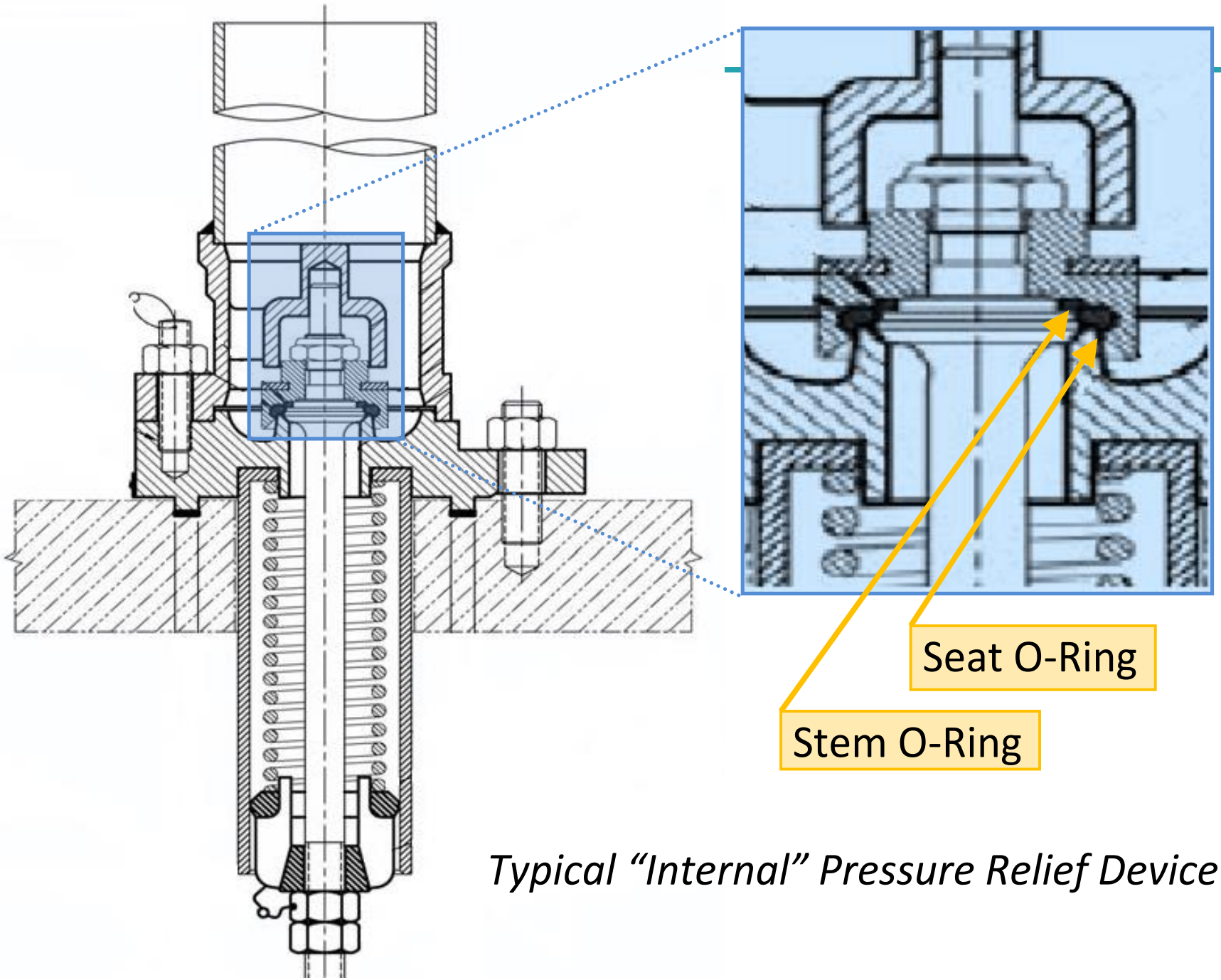
1. There are significant signs exhibiting Corrosion of the Valve Body Surface - (Cause Code 421*). Signs of the corrosion can be seen in the various photographs included with this report, and are evident in the red-rust composite material. Corrosion is most likely due to interaction between the Last Contents [redacted] and other unknown compounds.
2. Adhesion of the Seat rings to the face of the Seat can be seen in many photographs by the portion of the rings that have torn away from the Oring body (most likely during the valve releasing pressure). This would cause the O-Ring to not properly reseat upon the valve closing back after pressure has been relieved.

Reference Photos under the following names: [redacted]_1a(5), [redacted]_1a(2), [redacted]_1a(1), and [redacted]_1a(2)

[redacted] 1a(5)

[redacted] 1a(2)

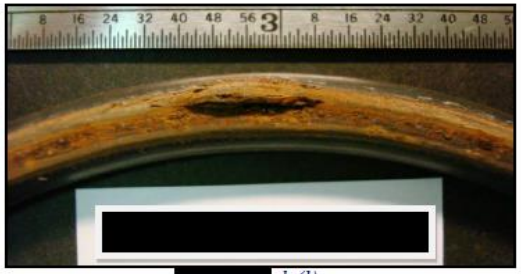
1



Typical "Internal" Pressure Relief Device

Results of Analysis (Cont'd):

[redacted]_1a(3)



[redacted]_1a(1)

4. Commodity residue, coupled with the adhesion, is also a contributor to the pitting and surface degradation seen in the following photographs of the Stem O-Rings. This is intensified by minor swell of the elastomer in the presence of the commodity vapors. The stem O-Rings do not exhibit the same level of degradation, but should be pointed out as contributing factors to the valve's failure.

Reference Photos under the following names: [redacted]_2b(1), [redacted]_2a(2), and [redacted]_2b(2)

[redacted]_2b(1)

[redacted]_2a(2)

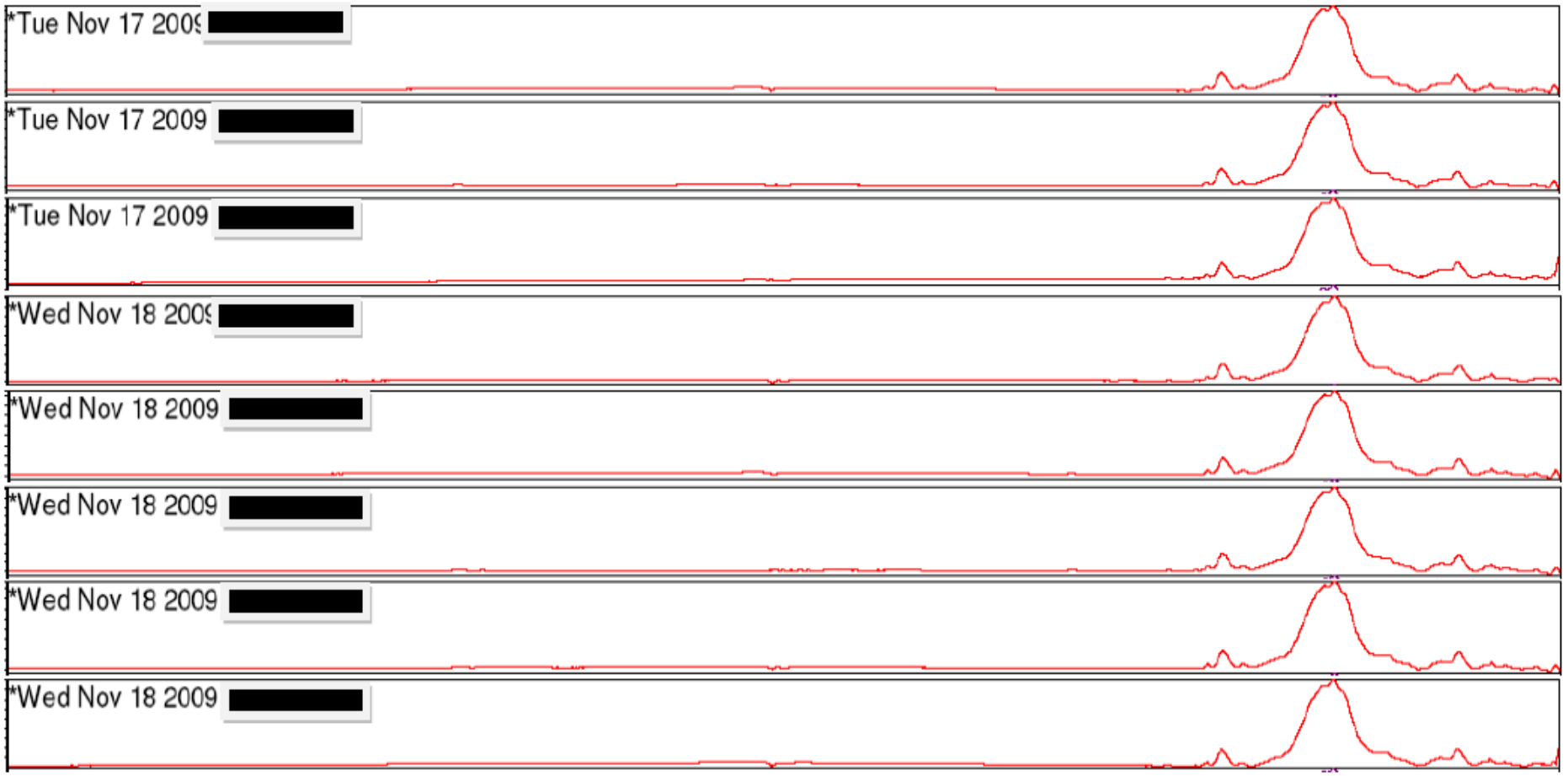
[redacted]_2b(2)

5. Based on the many resources that are used within Carolina Seal for determining suitable / recommended elastomers; Cyclopentadiene and Butadiene would receive an overall 'B' rating. 'B' rated elastomers are defined as having the potential for < 30% volume swell, < 30% loss of tensile strength, and minor chemical attack (based on immersion testing) causing chemical attack on the backbone of the elastomer. Dynamic applications such as PRVs can intensify the affects of chemical attack on elastomers. Chemical Degradation is defined under **Cause Code 664***.

***NAR Cause codes are AAR specific to Reclosing Pressure Relief Devices**

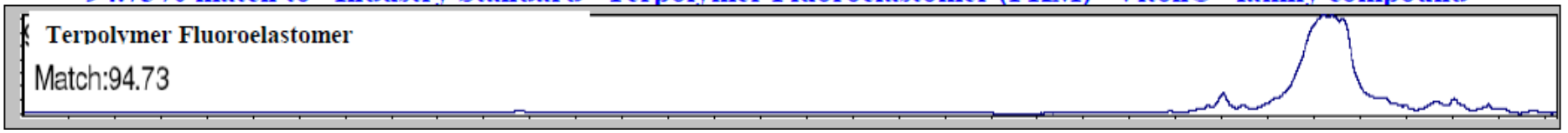
3

FTIR Results for 16 Items removed from [redacted] cars in [redacted] service



The Graph below is of an "Industry Standard" Terpolymer Fluoroelastomer (FKM) used as a cross reference to the above scanned elastomeric materials.

- **94.73% match to "Industry Standard" Terpolymer Fluoroelastomer (FKM) "Viton®" family compound**



Shore 'A' readings for [redacted]

Car Number	O-Ring	Reading 1	Reading 2	Reading 3	Average
[redacted]	Seat	51.0	51.0	50.5	**50.8**
	Stem	50.0	54.0	51.0	**51.7**
[redacted]	Seat	50.5	50.5	50.5	**50.5**
	Stem	50.5	50.5	50.5	**50.5**
[redacted]	Seat	50.5	52.5	51.0	**51.3**
	Stem	52.0	51.5	52.0	**51.8**
[redacted]	Seat	51.0	50.5	53.5	**51.7**
	Stem	52.0	51.0	51.0	**51.3**
[redacted]	Seat	51.0	52.0	50.5	**51.2**
	Stem	50.8	52.0	52.5	**51.8**
[redacted]	Seat	51.0	53.5	52.5	**52.3**
	Stem	51.0	51.5	52.5	**51.6**
[redacted]	Seat	53.0	53.5	54.5	**53.7**
	Stem	53.0	55.0	56.5	**54.8**
[redacted]	Seat	50.5	50.5	51.0	**50.7**
	Stem	55.5	52.0	51.5	**53.0**
70 Duro Base		70	72	71	**71**

NAR GUARD™ Carolina Seal's "Risk Management Solution for the Tankcar Industry"

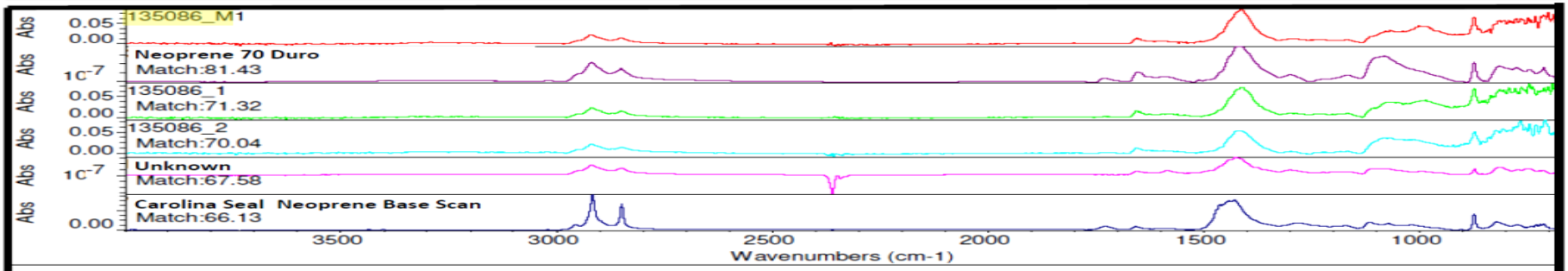
7

Verifying the “DNA” of an O-Ring Material:

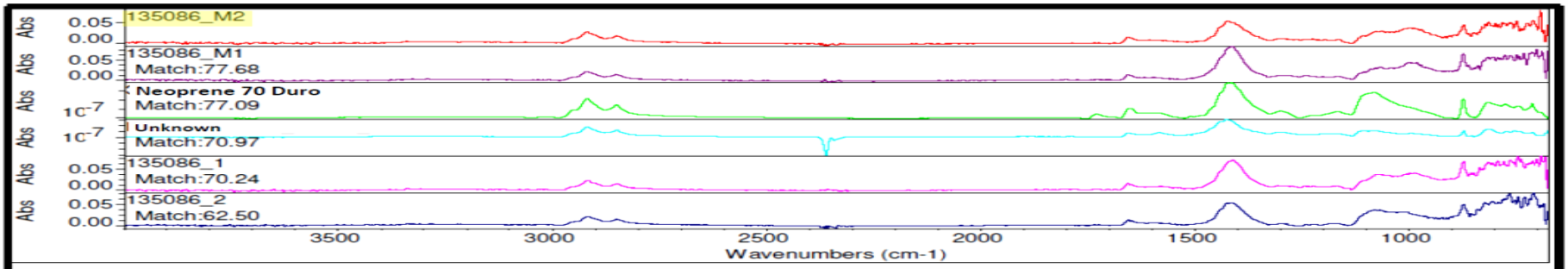
FTIR Analysis Results for [redacted]
RCFA_[redacted]_A35280 PRD

Item Definitions:

135086_M1 Seat O-ring for Midland A35280
135086_M2 Stem O-ring for Midland A35280



Match	Compound Name
81.43	Neoprene_70 Duro
71.32	Item 135086_1 Seat O-ring for 1000 Series PRD
70.04	Item 135086_2 Stem O-ring for 1000 Series PRD
66.13	Carolina Seal Compound Consistency Test_ Neoprene 70 Duro
42.73	Previous Carolina Seal FTIR Scan ~ Nitrile (NBR)
40.48	Hydrogenated Nitrile (HNBR)
37.19	Neoprene_80 Duro



Match	Compound Name
77.68	135086_M1 Seat Oring for A35280 PRD
77.09	Neoprene_70 Duro
70.24	Item 135086_1 Seat O-ring for 1000 Series PRD
62.50	Item 135086_2 Stem O-ring for 1000 Series PRD
58.43	Carolina Seal_Neoprene Base Scan
48.78	Neoprene_80 Duro
46.87	Neoprene_70 Duro
46.68	Neoprene
45.02	Neoprene

Failure Analysis Investigation

- Seek expertise – Root Cause Failure Analysis
- Understand most common types O-Ring failure
- “Specific” language needed to describe actual failure
- Improve documentation and data collection
- Create Corrective Action Plans to prevent recurring break-downs
- Adjust S.O.P.s to put corrected procedures in place
- Request supplier assistance for o-ring design, selection & material compatibility issues

Importance of Documentation & Traceability

- Seek supplier assistance if there is missing data
- Documentation & Traceability data for:
  - Cure Dates
  - Batch #s
  - Specific Material Identification
  - Part #s
  - Origin of material (cradle to grave)
- Audit Trail – Documentation is Key
- **Committing to new disciplines on the front end leads to less pain and headaches on the back end for everyone!**

Carolina Seal – Repair Kit Packaging

Each Component Individually Bagged w/ Color Coded Label

All Components Packaged Together for each Kit

CSI - Individual Component Labeling

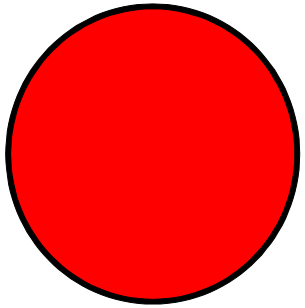
CSI Part Number

Last portion is the compound identification number

OEM Component Number

Correlates to OEM Drawings and Prints

M-545-11-5350
(545-11)
Tracing No. A-5177
Expiration: 1Q2027



Color Coded Material Identifier
Tankcar compounds will have specific colors to help eliminate variables and lessen the chances for mistakes

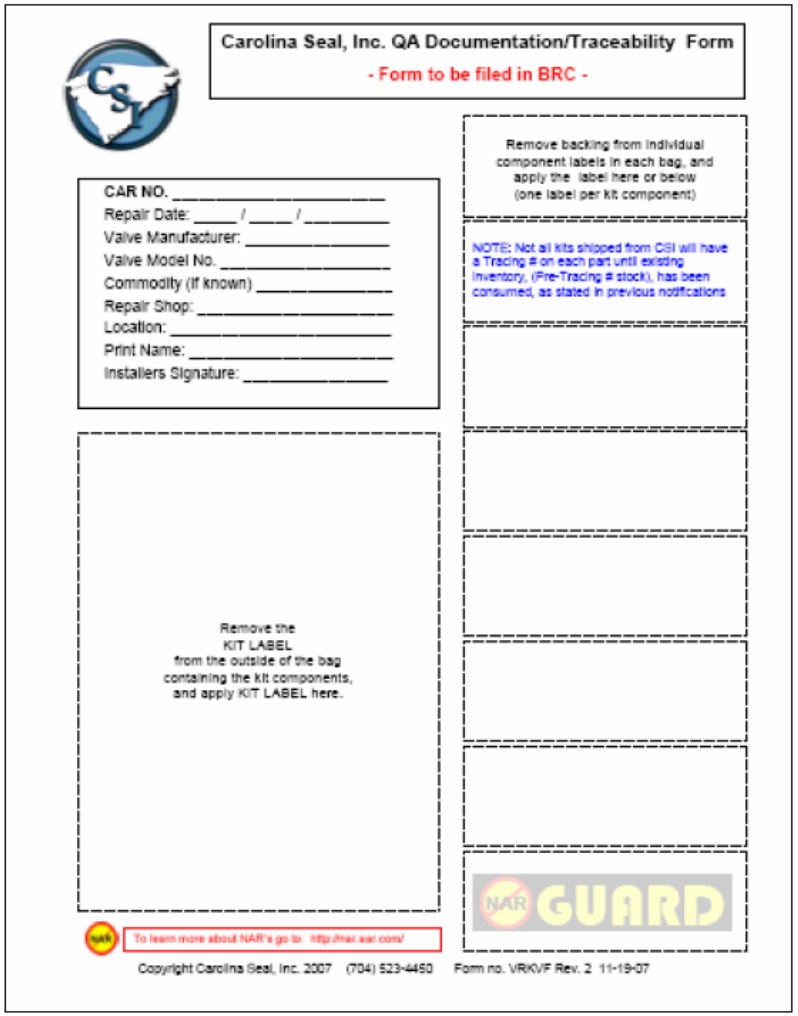
Tracing Number
Held in CSI's internal database to capture information such as:

- **Purchase Order**
- **Supplier and Location of Plant**
- **Date Items Received**
- **Qty's Received**
- **Cure Date / Batch**

Expiration Date
This timeframe is a "Best Practices" methodology based on SAE ARP5316 and informed judgments

Label is backed with Adhesive
These labels are provided with each component and designed to be used with Carolina Seal's "QA Documentation / Traceability Form"

CSI - Sample QA / Traceability Form for BRC Filing



Carolina Seal, Inc. QA Documentation/Traceability Form

- Form to be filed in BRC -

CAR NO. _____
Repair Date: ____ / ____ / _____
Valve Manufacturer: _____
Valve Model No. _____
Commodity (If known) _____
Repair Shop: _____
Location: _____
Print Name: _____
Installers Signature: _____

Remove backing from individual component labels in each bag, and apply the label here or below (one label per kit component)

NOTE: Not all kits shipped from CSI will have a Tracing # on each part until existing inventory, (Pre-Tracing # stock), has been consumed, as stated in previous notifications

Remove the KIT LABEL from the outside of the bag containing the kit components, and apply KIT LABEL here.

To learn more about NAR's go to: http://nar.aar.com/

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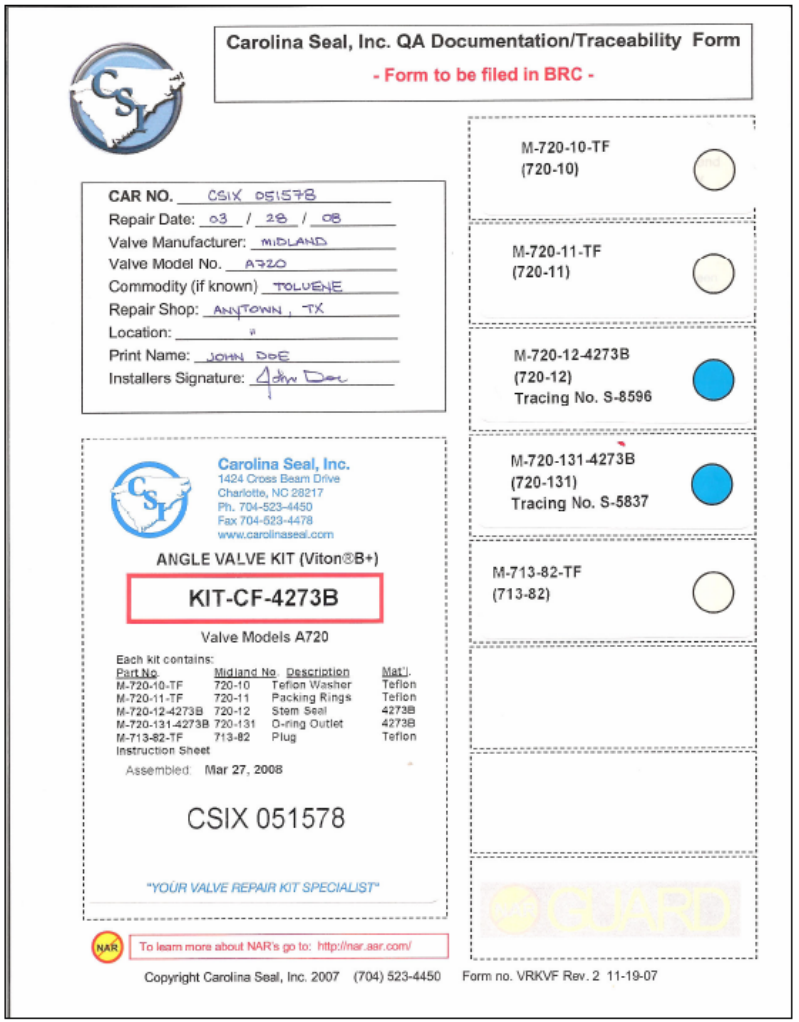

Carolina Seal, Inc. QA Documentation/Traceability Form

- Form to be filed in BRC -

CAR NO. CSIX 051578
Repair Date: 03 / 28 / 08
Valve Manufacturer: MIDLAND
Valve Model No. A720
Commodity (if known) TOLUENE
Repair Shop: ANYTOWN, TX
Location: "
Print Name: JOHN DOE
Installers Signature: John Doe

M-720-10-TF (720-10)
M-720-11-TF (720-11)
M-720-12-4273B (720-12) Tracing No. S-8596
M-720-131-4273B (720-131) Tracing No. S-5837
M-713-82-TF (713-82)

Carolina Seal, Inc.
1424 Cross Beam Drive
Charlotte, NC 28217
Ph. 704-523-4450
Fax 704-523-4478
www.carolinaseal.com

ANGLE VALVE KIT (Viton®B+)

KIT-CF-4273B

Valve Models A720

Each kit contains:

Part No.	Midland No.	Description	Mat'l.
M-720-10-TF	720-10	Teflon Washer	Teflon
M-720-11-TF	720-11	Packing Rings	Teflon
M-720-12-4273B	720-12	Stem Seal	4273B
M-720-131-4273B	720-131	O-ring Outlet	4273B
M-713-82-TF	713-82	Plug	Teflon
Instruction Sheet			

Assembled: Mar 27, 2008

CSIX 051578

"YOUR VALVE REPAIR KIT SPECIALIST"

To learn more about NAR's go to: http://nar.aar.com/

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Uncompleted QA/Traceability Form

Completed QA/Traceability Form w/Color Coded Labels

Shelf Life/Packaging / Storage Considerations

(Per ARP5316, Rev.B)

- Polyethylene , (Ideally heat sealed), or Kraft bags
- Relative humidity of storage area to be < 75% r h.
- Avoid contamination by oil, grease, debris, dirt
- Storage temperature < 100°F (38°C).
- Store away from direct sources of heat such as boilers, radiators and direct sunlight.
- Exclusion of ozone generating electrical devices.
- Store O-Rings free from superimposed tensions and compressive stresses or deformation.
- Avoid contact with liquids or semi-solid materials like gasoline, greases, acids, cleaning fluids…
- Avoid storing different O-Ring materials with one another unless material type clearly noted.
- Ideally you should apply the FIFO principle, (First In- First Out), to keep inventory turning.
- Parts should be properly labeled to prevent misuse.
- Anything you can do to prevent dust, dirt, debris, oil, grease, etc. from being introduced onto to the o-ring before installation should be done.
- Quality Assurance Documentation & Traceability is suggested to log type of o-ring was used.

Controlling the “Controllables”

- **Things you have control over up front:**
  - Supply Chain Selection – Partnering with Experts in the Field
  - Selection of Pedigree Materials – Proper Chemical Compatibility Analysis & MSDS Review
  - Proper storage, handling and packaging of stored materials to prevent contamination…
  - Establishing a consistent plan and adhering to your own “Business Rules” for success
- **Things you have control over when using the parts:**
  - Adhering to proper FIFO Inventory Methods when pulling parts from stock
  - Proper installation methods being applied
  - Proper Quality Assurance , Documentation & Traceability forms kept on file
- **Things you have control over after use:**
  - Properly identifying Root Cause Failures to help establish Corrective Action steps
  - Adjust Standard Operating Procedures to reflect the new procedures to be followed
  - Continuing Education for Process Improvements and Best Practices