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A PRACTICAL APPROACH TO EVALUATING FASTENER PRELOAD RETENTION WITH ELASTOMERIC GASKETS

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Why study gasket materials and their performance?

Effects of failure

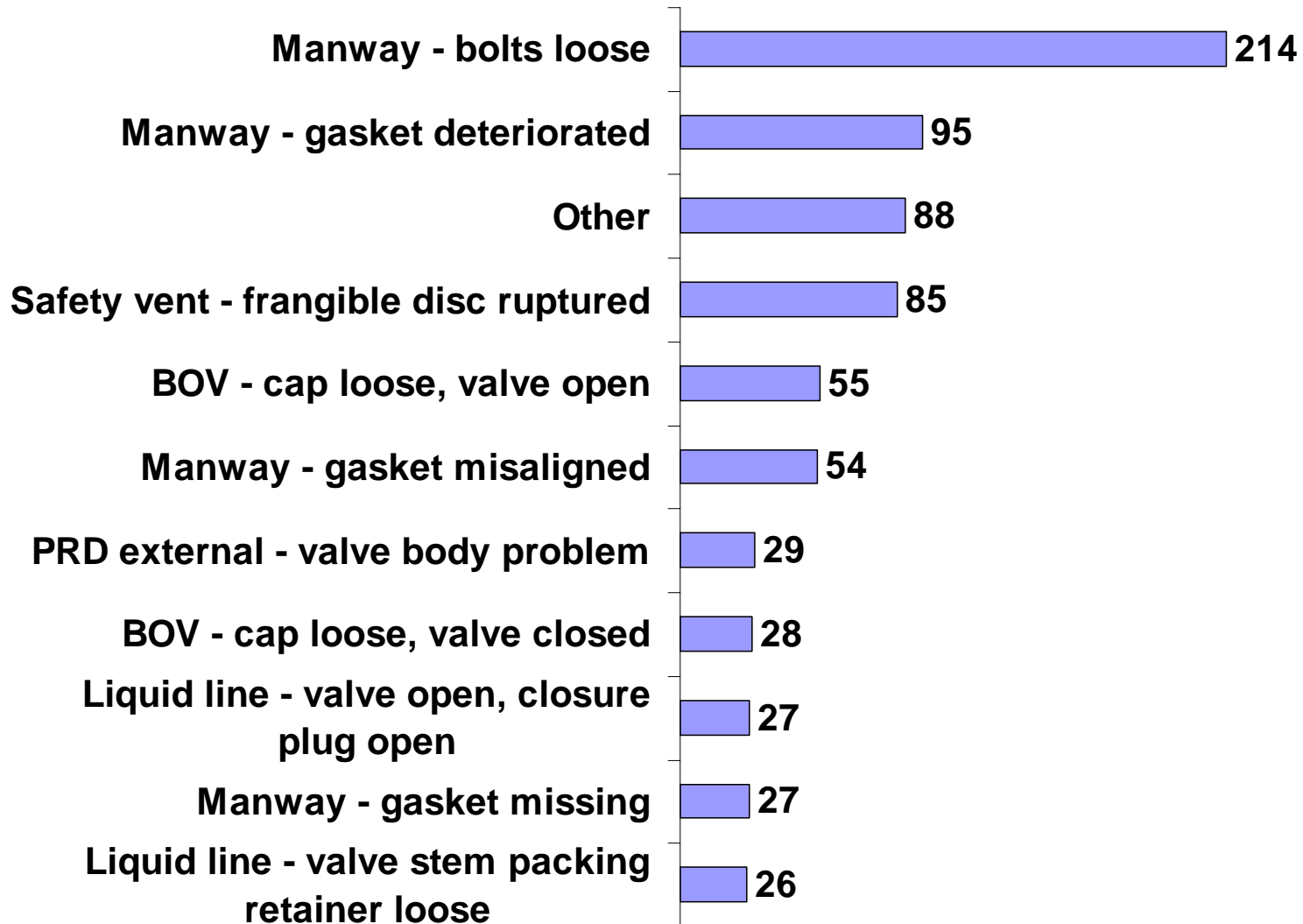
Fixed Base Operations:

- Throughput
- Maintenance
- Opportunity Costs

Railcar

- Mobile Crews, Repair Facility
- Health/Environmental Impact
- NAR

Top Specific Causes: Non-Pressure Cars 2004-06



Railcar Manway – Elastomer Gasket



Background

- Diverse Applications:
 - Industrial
 - Automotive
 - Household
- Increasing Challenges:
 - More Aggressive Chemicals
 - Higher Temperatures/Pressures
- Developments
 - Compounding-Chemical Service
 - Limitations on Temperature and Pressure

Observations

Relatively low stress to create a seal

Gasket Material	Minimum Gasket Stress (psi) to Seal	Maximum Gasket Stress (psi)
1/8" Elastomer	600	1,200
1/8" Filled-PTFE	4,800	15,000

Practical Application

Effective Stress Envelope: Gasket and Fastener:

Elastomer Gasket: 500 – 1200 psi

Fasteners: 25 – 70 ksi

GP Manway w/(8) $\frac{3}{4}$ " Eyebolts:

500 psi = 28 ft-lb, Bolt Stress = 6.7 ksi

1200 psi = 68 ft-lb, Bolt Stress = 16.2 ksi

Decision Time: Over-compress the gasket, or under-stress the bolts?

Answer Typically: Over-stress the gasket

Testing

This protocol examined the effects of flange configuration, both confined and non-confined, on high and low durometer materials

Skidmore Wilhelm Test Fixture



- Measures force applied by fastener
- With test plates, measures creep relaxation

Test Plates

Non
Confined



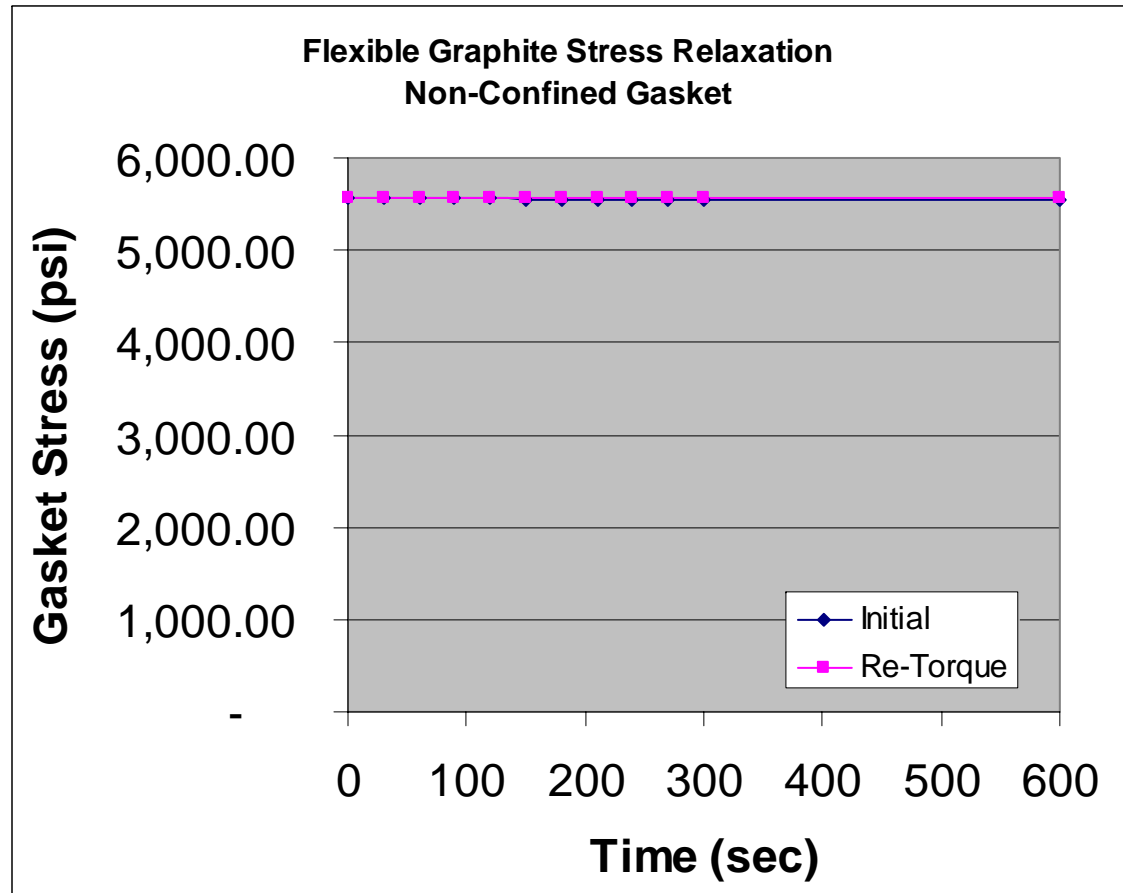
Confined



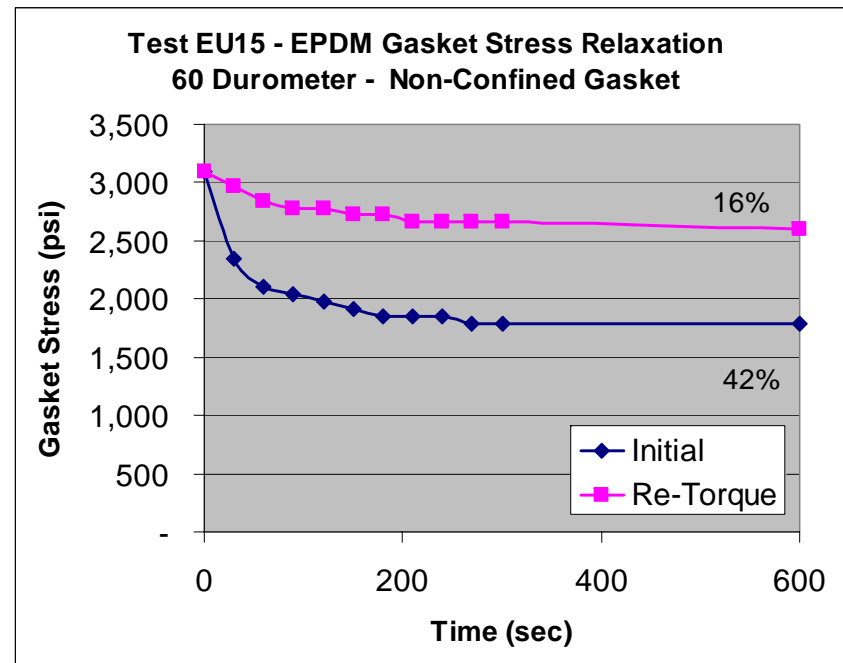
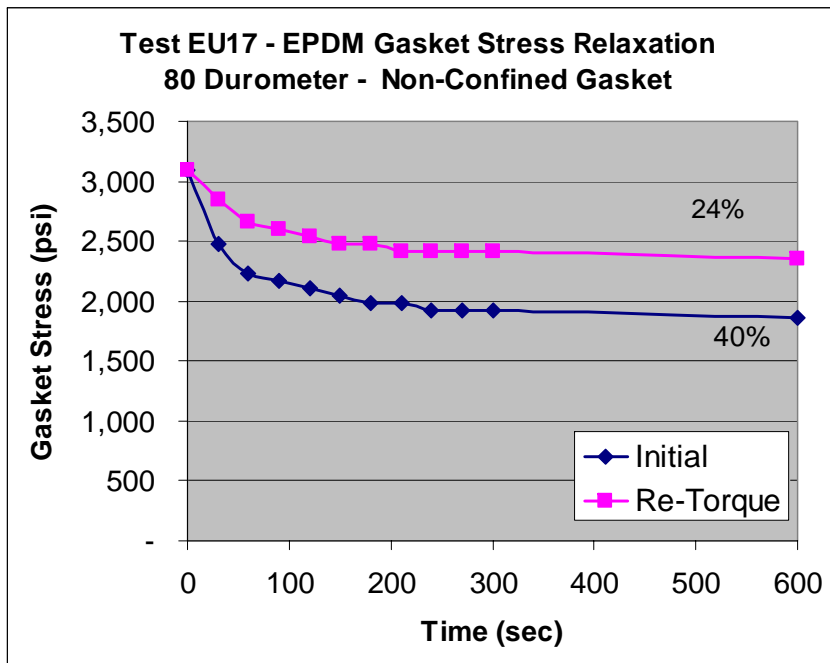
Test Setup



Baseline Comparison



Relaxation of Non-Confined Gasket



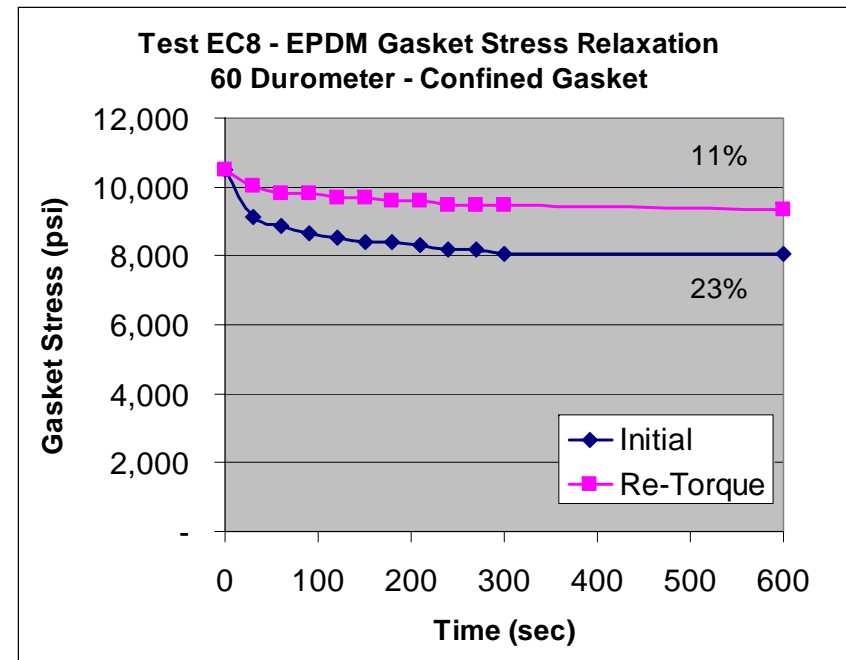
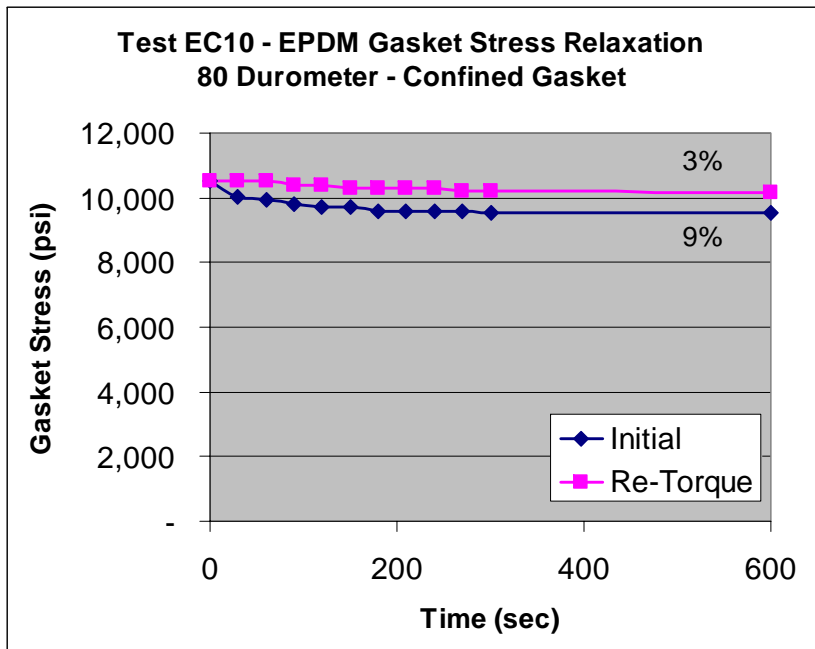
Note:

Initial relaxation

relaxation after re-torque

Lower re-torque relaxation w/higher durometer

Relaxation of Confined Gasket



Note:
Initial relaxation
relaxation after re-torque
Lower re-torque relaxation w/higher durometer

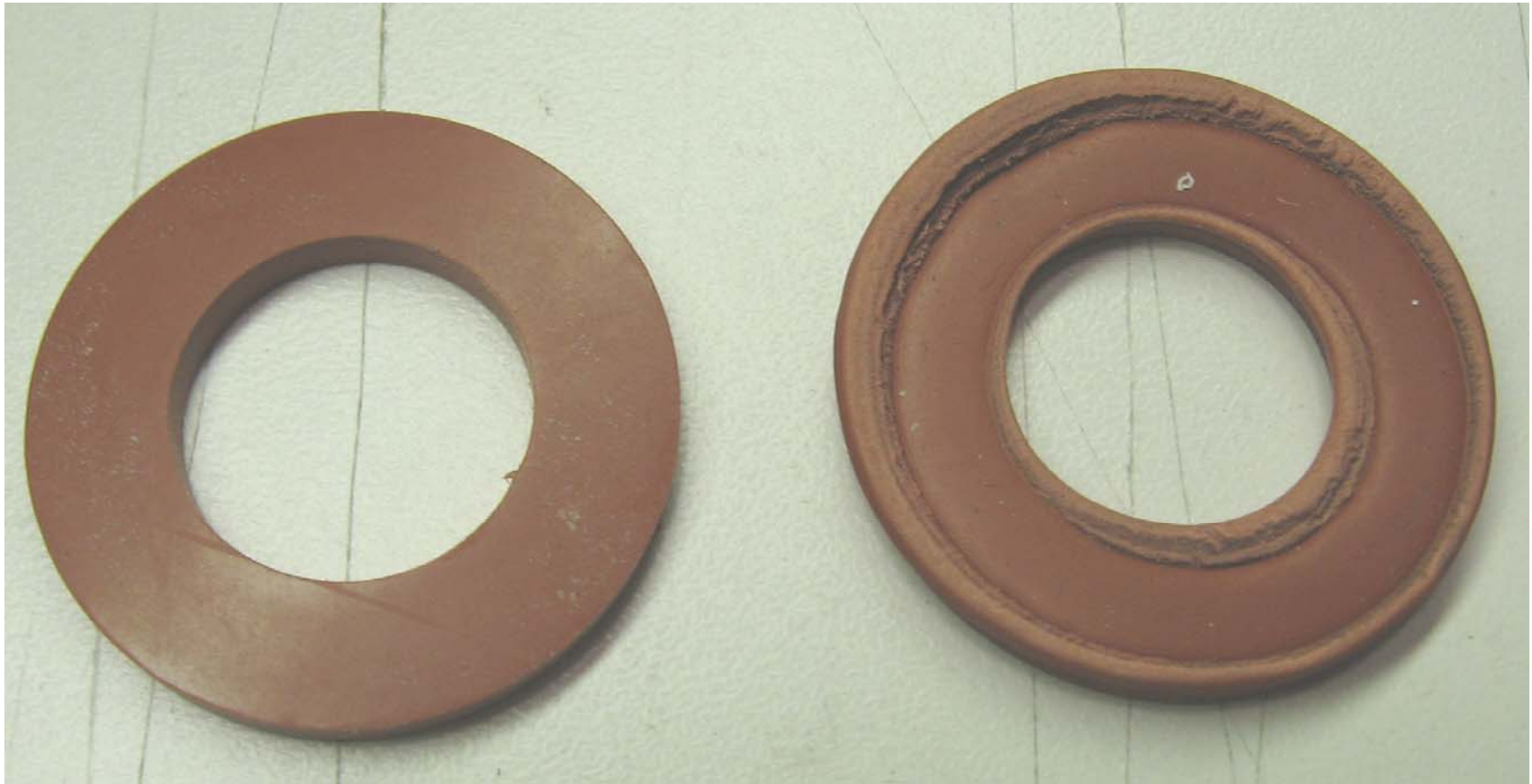
Summary Table

Table 1 - Phase 1, Phase 2, and Phase 5 Test Results							
PHASE 1 - CONFINED GASKET STRESS RELAXATION DATA – TEST SAMPLE, 0.125” X 0.688” X 1.250”							
Test#	Gasket Material	Durometer	Flange Type	Initial Stress	Initial Gasket Stress (psi)	% Change - Initial	% Change - ReTorque
NIC7	Nitrile(Buna-N)	60	Confined	High	10,500	32%	16%
EC8	EPDM	60	Confined	High	10,500	23%	11%
EC9	EPDM	60	Confined	Low	2,900	20%	8%
EC10	EPDM	80	Confined	High	10,500	9%	3%
EC11	EPDM	80	Confined	Low	2,900	12%	4%
RC12(1-3)	Red Rubber	75	Confined	High	10,500	18%	8%
VC13	Viton® B	75	Confined	High	10,500	16%	6%
PHASE 2 - NON-CONFINED GASKET STRESS RELAXATION DATA – TEST SAMPLE, 0.125” X 0.438” X 1.500”							
Test#	Gasket Material	Durometer	Flange Type	Initial Stress	Initial Gasket Stress (psi)	% Change - Initial	% Change - ReTorque
EU14	EPDM	60	Non-Confined	High	5,550	42%	19%
EU15	EPDM	60	Non-Confined	Low	3,100	42%	16%
EU16	EPDM	80	Non-Confined	High	5,550	41%	20%
EU17	EPDM	80	Non-Confined	Low	3,100	40%	24%
NEU18	Neoprene	35	Non-Confined	High	5,550	39%	16%
RU19(1-3)	Red Rubber	75	Non-Confined	High	5,550	49%	22%

Unconfined Test Samples



Confined Test Samples



Application

- Confined Gasket
- Bottom Outlet Valve
 - Gasket contact area: 12.57 sq in
 - Gasket stress @ 30 ksi bolt stress: 6.0 ksi.

**PHASE 3 - CONFINED FIELD GASKET COMPRESSION TESTING –
TEST SAMPLE, 0.125” x 7.500” x 8.500”**

Test#	Gasket Mat'l	Durometer	Flange Type	Torque (ft-lbs)	Gasket Stress (psi)	Damage?	Extruded
VC5(1-2)	Viton® A	75	Confined	165	8,400	No	No
EC6(1-3)	EPDM PC	60	Confined	165	8,400	Yes	Yes

Application

Railcar connections



Extrusion

Bottom Outlet Valve

Application

- Non-Confined Gasket
- NPS 2 Class 150 Raised Face Flange
 - Gasket contact area: 5.88 sq in
 - Gasket stress @ 30 ksi bolt stress: 5.8 ksi.

**PHASE 4 - NON-CONFINED FIELD GASKET
COMPRESSION TESTING – TEST SAMPLE, 0.125” x
2.375” x 4.125”**

Test#	Gasket Material	Durometer	Flange Type	Torque (ft-lbs)	Gasket Stress (psi)	Visible Damage	Extruded
VNC1	Viton® A	75	Non-Confined	40	3,700	Yes	No
VNC2	Viton® A	75	Non-Confined	75	7,000	Yes	Slight
VNC3	Viton® A	75	Non-Confined	80	7,450	Yes	Slight
VNC4	Viton® A	75	Non-Confined	125	11,650	Yes	Yes

Application

Railcar connections



Air Inlet Valve

Conclusions

- Challenges with use of Elastomer gaskets
 - Limited stress envelope for effective use
 - High creep rate
- Areas of greater concern
 - Unconfined joints
 - Lower durometer materials

Thank You