GPT Industries

Technical Corner: Q & A Special

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November 16, 2022

Agenda

Questions to be Addressed Today

1. **A background on corrosion –** Why does it Occur? How Does Electrical Isolation Prevent Corrosion?

2. **Torque Values –** Why is this so Important? What should I be considering?

3. **Testing Isolation –** What Should I be Aware Of?

4. **Why do Isolation Gaskets Fail?**

5. **What is the difference between FIK's and MIJ's?**

6. **Time for any further questions that you have!**

Question 1

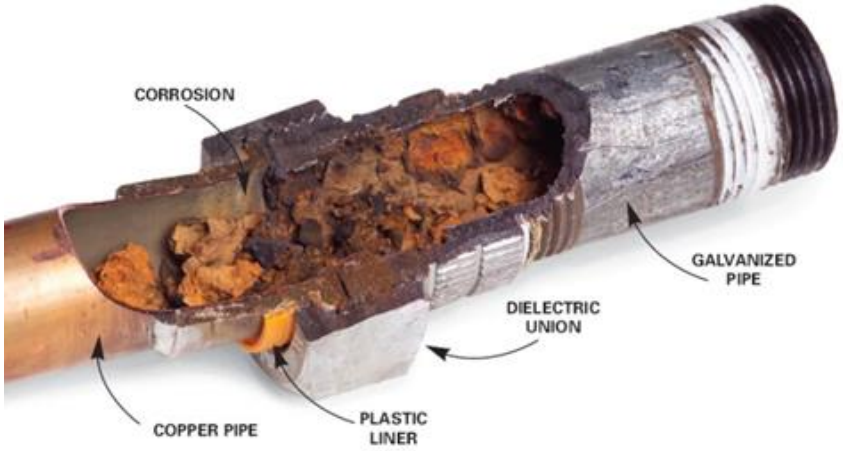
A BACKGROUND ON CORROSION

A Background on Corrosion

- What is Corrosion?

Deterioration of a substance (usually a metal) or its properties because of a reaction with its environment, due to an imbalance of energy that equalizes during the corrosion process.

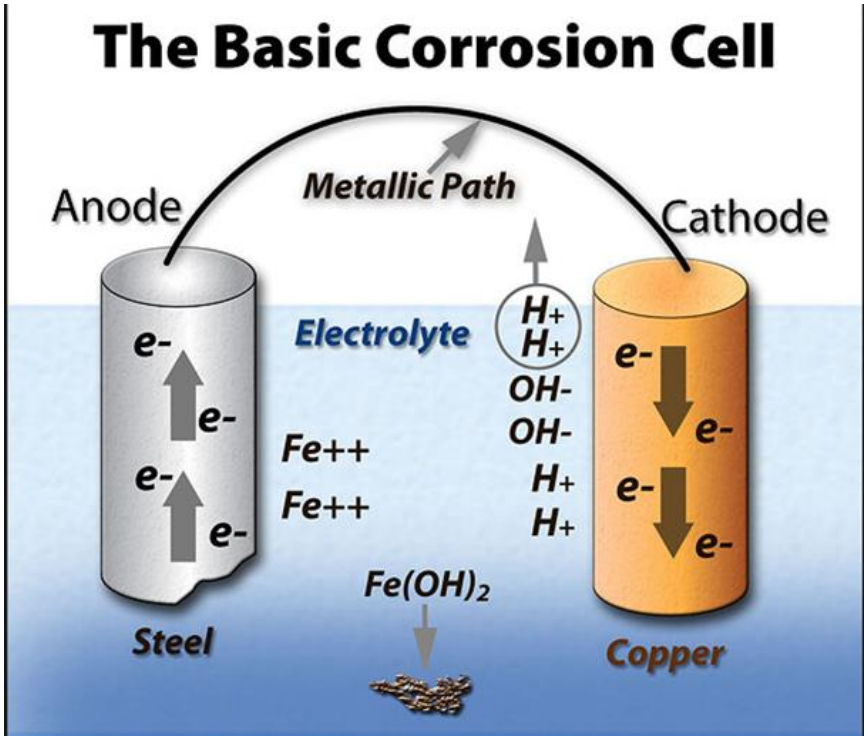
Bonus: Where does the energy imbalance come from?



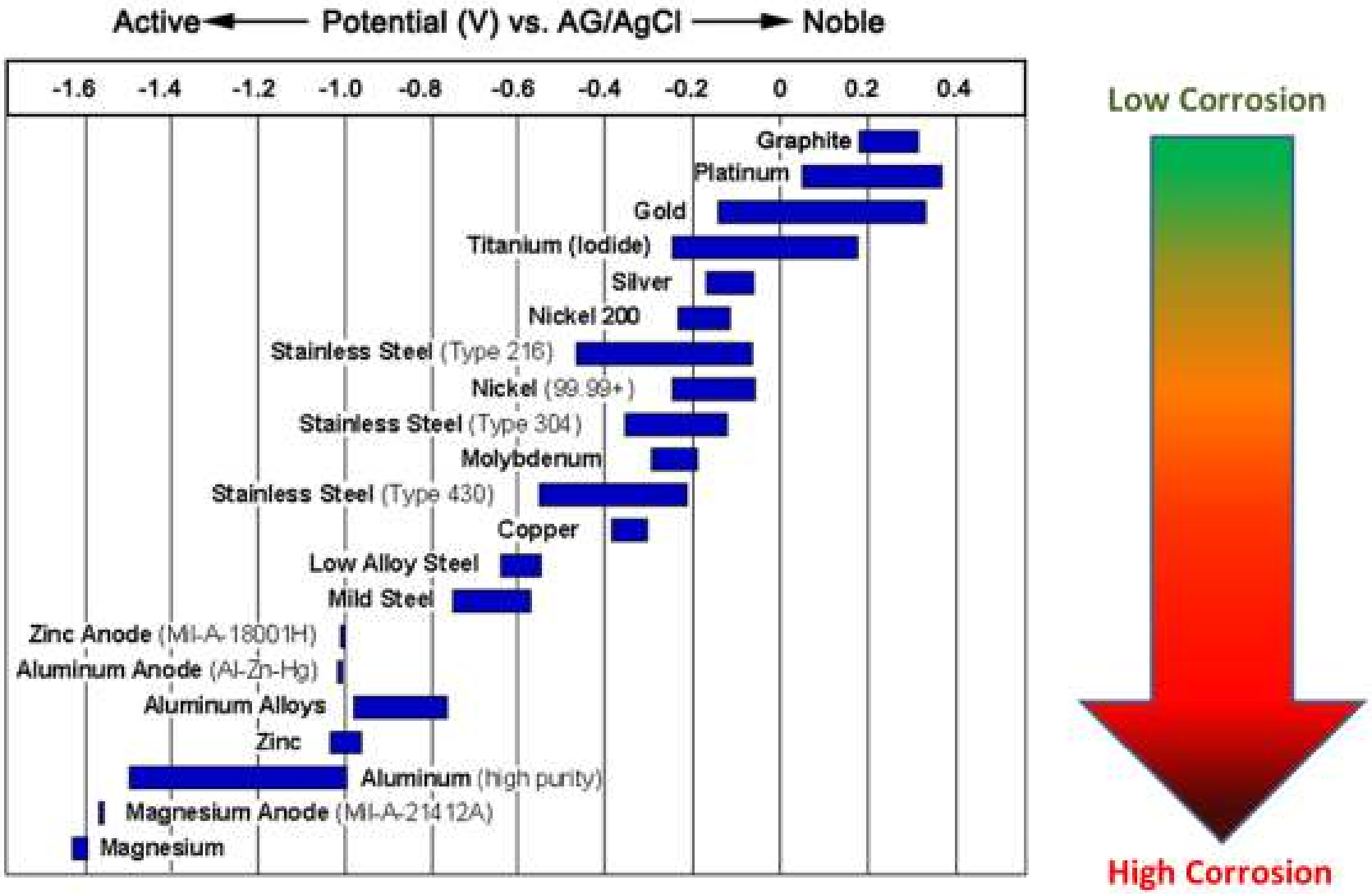
What is the Corrosion Cell?

- What are the 4 Elements that MUST be present for corrosion to occur are:

1. Anode
   - The site where metal is lost
2. Cathode
   - Site where electrons from the anode are consumed
3. ***Metallic Path***
   - ***This conducts electrons from the anode to the cathode***
4. Electrolyte
   - Provides reactants for the cathodic reactions and allows the flow of ions



- If any of these processes can be slowed or stopped, corrosion can be slowed or stopped!

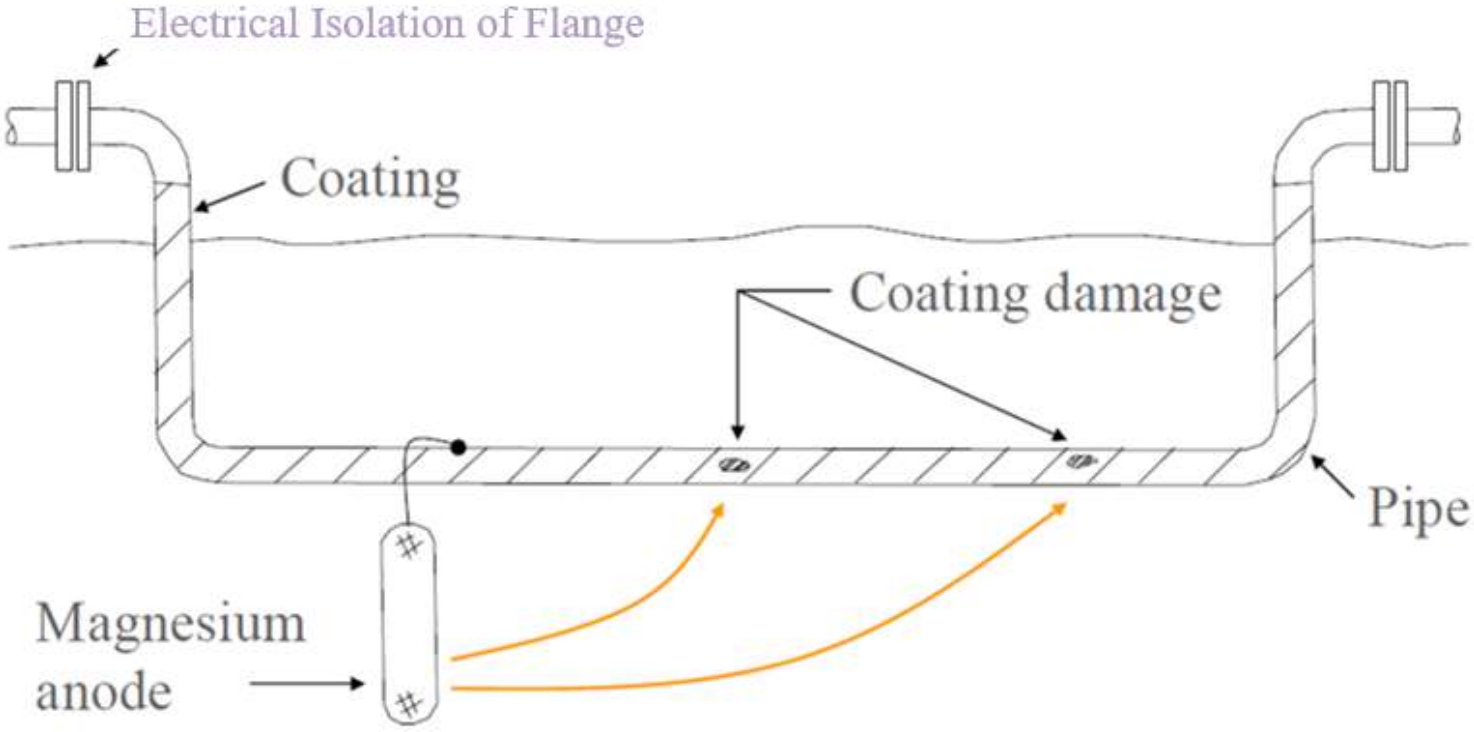

Active ← Potential (V) vs. AG/AgCl → Noble
-1.6
-1.4
-1.2
-1.0
-0.8
-0.6
-0.4
-0.2
0
0.2
0.4
Graphite
Platinum
Gold
Titanium (Iodide)
Silver
Nickel 200
Stainless Steel (Type 216)
Nickel (99.99+)
Stainless Steel (Type 304)
Molybdenum
Stainless Steel (Type 430)
Copper
Low Alloy Steel
Mild Steel
Zinc Anode (MIL-A-18001H)
Aluminum Anode (Al-Zn-Hg)
Aluminum Alloys
Zinc
Aluminum (high purity)
Magnesium Anode (MIL-A-21412A)
Magnesium
Low Corrosion
High Corrosion

What are some Ways to control Galvanic corrosion

- Electrical Isolation
  - Eliminate the metallic path (GPT Flange Isolation Kit)
- Materials selection
  - Avoid combinations of metals or alloys widely separated in the galvanic series
  - Not always possible
- Barrier coatings
  - Isolation of the metals from the environment
  - “Holidays” or pores pose very serious problems
- Cathodic Protection
  - Introduce a very active metal (Zinc, Magnesium etc…) into the system.
  - This metal will corrode to protect the rest of the system

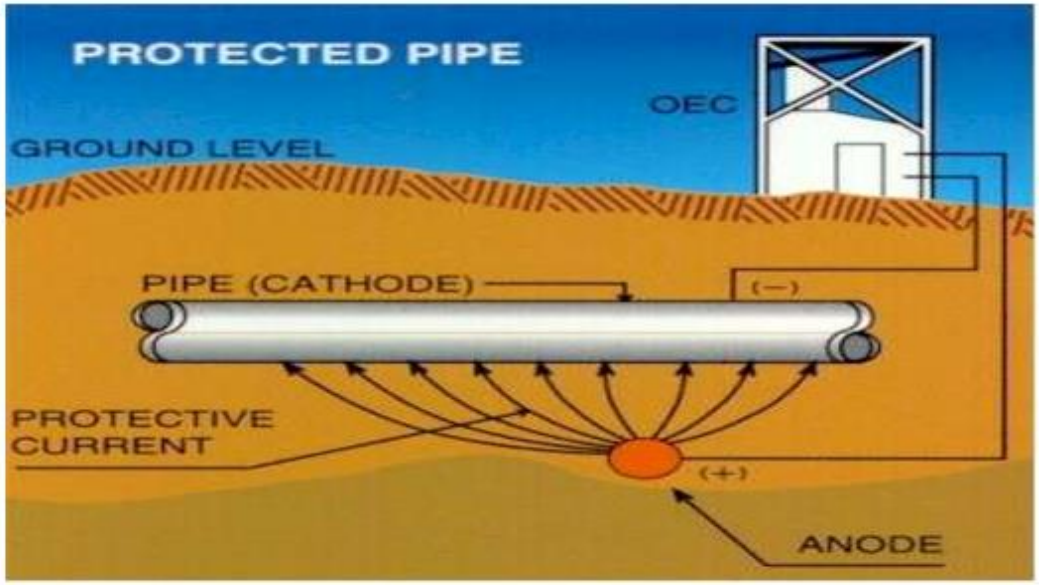
Cathodic Protection

Galvanic CP



Cathodic Protection

Impressed Current CP



- MUST have good isolation
  - between sections of pipe to be protected
  - between protected pipe and other structures.
- If no isolation - CP system is much less affective and could be protecting the wrong structures

Question 2

AN INSIGHT INTO TORQUE

Bolt Torque – Where do I find the values?

GPT
an EnPro Industries company

NOTES:

1. All values are calculated assuming a 0.11 coefficient of friction and new nuts and studs using non-metallic lubrication.
2. "M" maintenance factor = 0 "Y" minimum design seating stress = 7500 [psi]. For EVOLUTION™ isolating gasket "Y" = 0.
3. Recommended values are based on 30,000 psi bolt stress.
4. If using both lubricated and coated studs or uncoated bolts with no lubricant, contact GPT for recommended torque values.

NOTE: On isolating testing - any isolation testing should be completed prior to hydro testing in order to prevent media in line from causing false readings. It is suggested that isolation be checked with the use of an RF meter as per NACE SP0288-2007 standard practice.

It should be noted that humidity and other environmental effects can cause false isolation readings.

For additional assistance please contact our engineering office at GPT.engineering@gptindustries.com

Garlock Pipeline Technologies
303.988.1242
www.gptindustries.com

FOR METRIC TORQUE VALUES - divide ft-lb value by 0.73756 $Nm = \frac{ft\text{-}lb}{0.73756}$

* For fire risk service please consider using max values

Please note that Max torque values are based on 50ksi bolt stress and using a B7, or equivalent studs, Grade 2H hex nuts, and A105 or equivalent flange material. For lower strength flanges or bolts contact GPT Engineering for torque recommendations.

The GPT gasket torque calculator is available at
www.gasketcalculator.gptindustries.com

RECOMMENDED BOLT TORQUE VALUES

Torque Table for GPT Isolating Gaskets - ASME B16.5 and B16.47 A Flanges

NPS	150#	MAX* [ft-lb]	300#	MAX* [ft-lb]	400#	MAX* [ft-lb]	600#	MAX* [ft-lb]	900#	MAX* [ft-lb]	1500#	MAX* [ft-lb]	2500#	MAX* [ft-lb]	NPS
	ASME B16.5 Recommended Values in [ft-lb]														
½	30	45	30	45	30	45	30	45	95	120	95	120	95	120	½
¾	30	45	55	90	55	90	55	90	95	140	95	140	95	140	¾
1	30	45	55	90	55	90	55	90	155	220	155	220	155	220	1
1¼	30	45	55	90	55	90	55	90	155	255	155	255	230	350	1¼
1½	30	45	05	160	95	160	95	160	230	380	230	380	335	530	1½
2	55	90	55	90	55	90	55	90	155	255	160	245	230	380	2
2½	55	90	95	160	95	160	95	160	230	380	230	380	335	530	2½
3	55	90	95	160	95	160	95	160	155	255	335	560	470	785	3
3½	55	90	95	160	155	255	155	255	N/A	N/A	N/A	N/A	N/A	N/A	3½
4	55	90	95	160	155	255	155	255	335	560	470	785	840	1400	4
5	95	160	95	160	155	255	230	380	470	785	840	1400	1370	2170	5
6	95	160	95	160	155	255	230	380	335	560	640	1065	2080	2995	6
8	95	160	155	255	230	380	335	560	640	1065	1085	1805	2080	3155	8
10	155	255	230	380	335	560	470	785	640	1065	1700	2830	4165	6005	10
12	155	255	335	560	470	785	470	785	640	1065	2080	3465	5595	8090	12
14	230	380	335	560	470	785	640	1065	840	1400	3005	4390	N/A	N/A	14
16	230	380	470	785	640	1065	840	1400	1085	1805	4165	6105	N/A	N/A	16
18	335	560	470	785	640	1065	1085	1805	1700	2830	5595	8900	N/A	N/A	18
20	335	560	470	785	840	1400	1085	1805	2080	3465	7320	10730	N/A	N/A	20
22	470	785	840	1400	1085	1805	1370	2280	N/A	N/A	N/A	N/A	N/A	N/A	22
24	470	785	840	1400	1370	2280	1700	2830	4165	6945	11765	18060	N/A	N/A	24
	ASME B 16.47 Series A														
26	470	785	1085	1805	1370	2280	1700	2830	5595	9325	N/A	N/A	N/A	N/A	26
28	470	785	1085	1805	1700	2830	2080	3465	7320	12200	N/A	N/A	N/A	N/A	28
30	470	785	1370	2280	2080	3465	2080	3465	7320	12200	N/A	N/A	N/A	N/A	30
32	840	1400	1700	2830	2080	3465	3005	5005	9370	15615	N/A	N/A	N/A	N/A	32
34	840	1400	1700	2830	2080	3465	3005	5065	11765	19610	N/A	N/A	N/A	N/A	34
36	840	1400	2080	3465	2080	3465	4165	6945	11765	19610	N/A	N/A	N/A	N/A	36
38	840	1400	840	1400	1370	2280	3005	5005	11765	19610	N/A	N/A	N/A	N/A	38
40	840	1400	1085	1805	1700	2830	3005	5005	11765	19610	N/A	N/A	N/A	N/A	40
42	840	1400	1085	1805	1700	2830	4165	6945	11765	19610	N/A	N/A	N/A	N/A	42
44	840	1400	1370	2280	2080	3465	4165	6945	14540	24235	N/A	N/A	N/A	N/A	44
46	840	1400	1700	2830	2080	3465	4165	6945	17720	29535	N/A	N/A	N/A	N/A	46
48	840	1400	1700	2830	3005	5005	5595	9325	17720	29535	N/A	N/A	N/A	N/A	48
50	1370	2280	2080	3465	3005	5005	7320	12200	N/A	N/A	N/A	N/A	N/A	N/A	50
52	1370	2280	2080	3465	3005	5005	7320	12200	N/A	N/A	N/A	N/A	N/A	N/A	52
54	1370	2280	3005	5005	4165	6945	7320	12200	N/A	N/A	N/A	N/A	N/A	N/A	54
56	1370	2280	3005	5005	4165	6945	9370	15615	N/A	N/A	N/A	N/A	N/A	N/A	56
58	1370	2280	3005	5005	4165	6945	9370	15615	N/A	N/A	N/A	N/A	N/A	N/A	58
60	1370	2280	3005	5005	5595	9325	11765	19610	N/A	N/A	N/A	N/A	N/A	N/A	60

Torque table for VCS®, VCFS®, VCS-ID®, PGE, and LINEBACKER®

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Bolt Torque – What Assumptions are Being Made?

GPT

an EnPro Industries company

NOTES:

1. All values are calculated assuming a 0.11 coefficient of friction and new nuts and studs using non-metallic lubrication.
2. "M" maintenance factor = 0 "Y" minimum design seating stress = 7500 [psi]. For EVOLUTION™ isolating gasket "Y" = 0.
3. Recommended values are based on 30,000 psi bolt stress.
4. If using both lubricated and coated studs or uncoated bolts with no lubricant, contact GPT for recommended torque values.

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* For fire risk service please consider using max values

Please note that Max torque values are based on 50ksi bolt stress and using a B7, or equivalent studs, Grade 2H hex nuts, and A105 or equivalent flange material. For lower strength flanges or bolts contact GPT Engineering for torque recommendations.

The GPT gasket torque calculator is available at www.gasketcalculator.gptindustries.com

Important to understand the assumptions that GPT must make, and how they may differ from Company specific torque specifications

Bolt Torque – Friction Coefficient and Nut Factor

1. All values are calculated assuming a 0.11 Coefficient of Friction and new nuts and studs using non-metallic lubrication

GPT assumes EITHER **uncoated, lubricated** (Piko-lub) studs OR **coated, unlubricated** studs

Bolt Torque – Friction Coefficient and Nut Factor

4. If using lubricated and coated studs or uncoated studs with no lubricant, contact GPT for recommended torque values

Please reach out in this case and I will work with you to get the values needed!

The coefficient of friction will need to be changed.

+

Bolt Torque – Gasket Creep and Seating Stress

2. "M" Maintenance Factor = 0 "Y" minimum design seating stress = 7500 psi. For Evolution "Y" = 0 psi

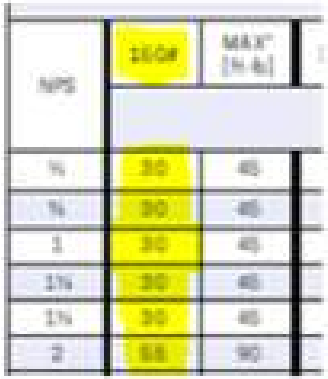
- GPT Isolation gaskets do not experience any creep/relaxation.
  - This allows for lower torque values than many other gaskets
- GPT Gaskets can seal in a very wide range of seating stresses.

- Please reach out with any torque value differences/concerns, and we can work with you on adjusting torque to meet what you need and have our gasket work as intended.

Bolt Torque – Bolt Grade and Yield

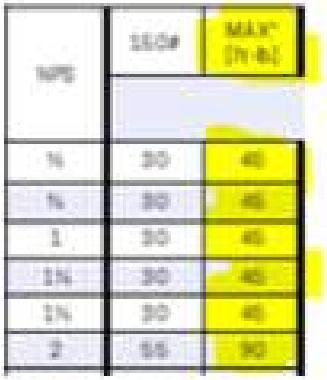
3. Recommended values are based on 30,000 psi bolt stress

- GPT assumes an ASTM A193 B7 stud (or any stud with yield strength of 100 ksi) is being used



NPS	150#	MAX* [N-m]
½	30	45
¾	30	45
1	30	45
1½	30	45
1½	30	45
2	55	90

Recommended values are based of 30% bolt yield, or 30 ksi bolt stress



NPS	150#	MAX* [N-m]
½	30	45
¾	30	45
1	30	45
1½	30	45
1½	30	45
2	55	90

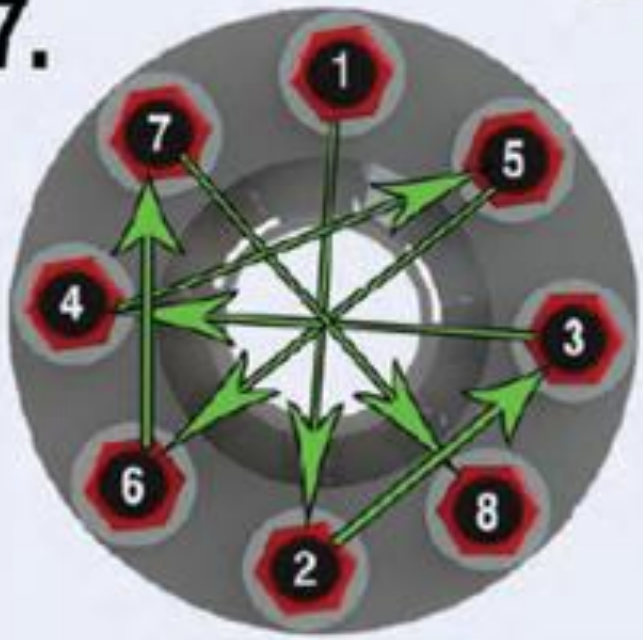
Max values are based of 50% bolt yield, or 50 ksi bolt stress

These max values are not the max of the gasket itself, but reach the 50% bolt yield

We recommend using max values for fire safe kits

Bolt Torque - Procedures

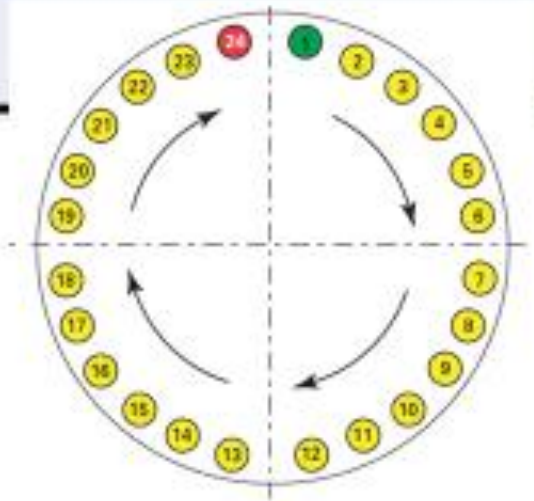
7.



TORQUE IN LEGACY STAR PATTERN

1. SNUG EACH BOLT TO 10-20 [ft-lb]
2. TIGHTEN TO 30% OF TARGET TORQUE
3. TIGHTEN TO 70% OF TARGET TORQUE
4. TIGHTEN TO 100% OF TARGE TORQUE
5. FINAL TORQUE TO 100% IN CIRCULAR PATTERN

- Legacy Star Pattern
- Ramp up in intervals



Question 3

METHODS OF TESTING ISOLATION

Electrical Isolation Testing

- RF (Radio Frequency) isolation tester
- Ohm-Meter
- Potential (voltage) measurements with reference electrode

RF Isolation Tester

PRO

- Easy to use
- Removes external factors that can affect test results
- Measures isolation and not resistance

CON

- Specific equipment cost
- BEEP, BEEP, BEEP

Ohm-Meter

PRO

- Easy to use
- Direct measurement of resistance at a given test voltage
- Laboratory testing – controlled environment

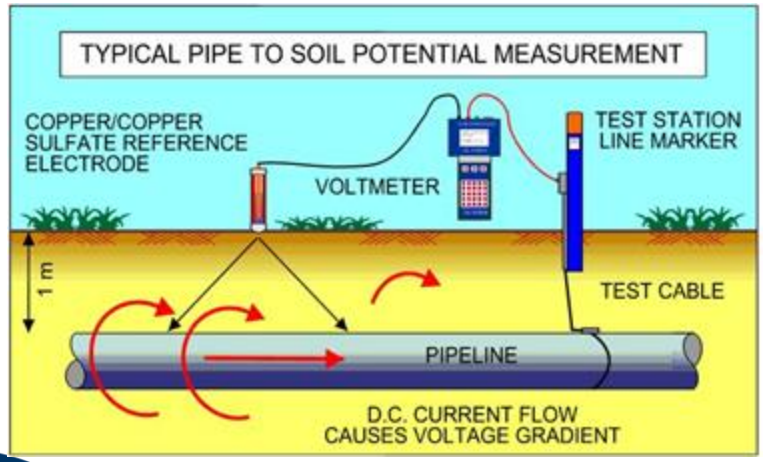
CON

- Specific equipment cost
- Test results are greatly affected by environmental conditions

Flange to Soil Potential Measurements

PRO

- Removes external factors that can affect test results
- Measures specific voltage on either flange. 0.1V difference means fully isolated

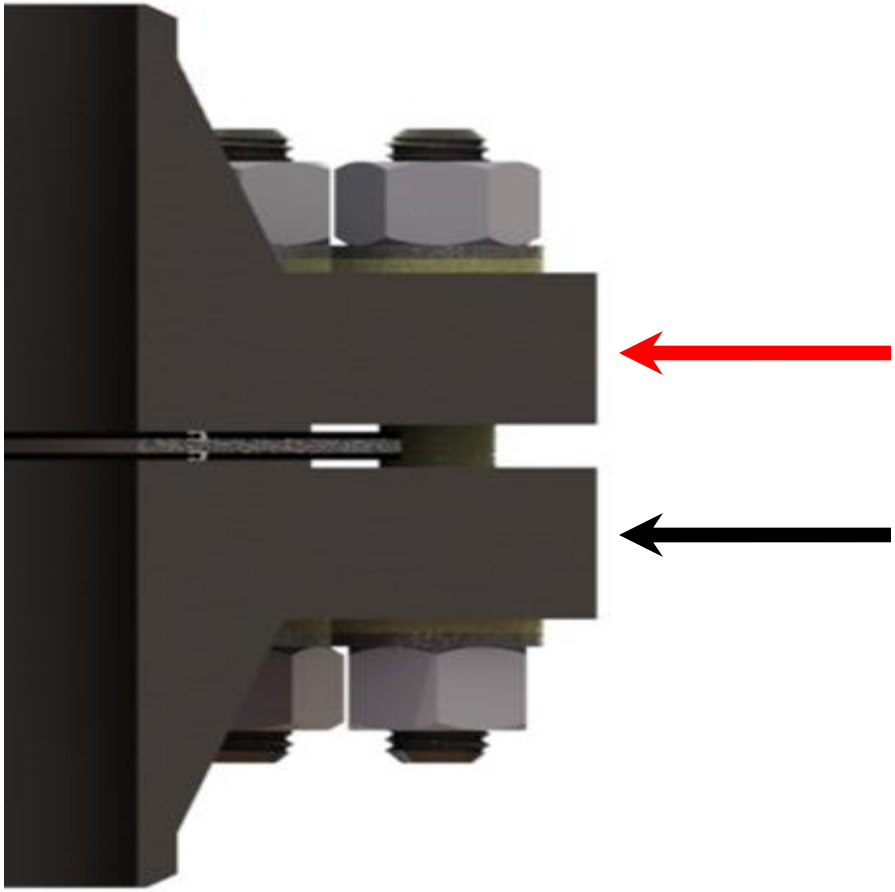


CON

- Specific equipment
- Usually requires voltage to already be on the pipeline. Unless the flange material is not the same and the difference between native potential of each material is 0.1V.
- Results must be used in calculations

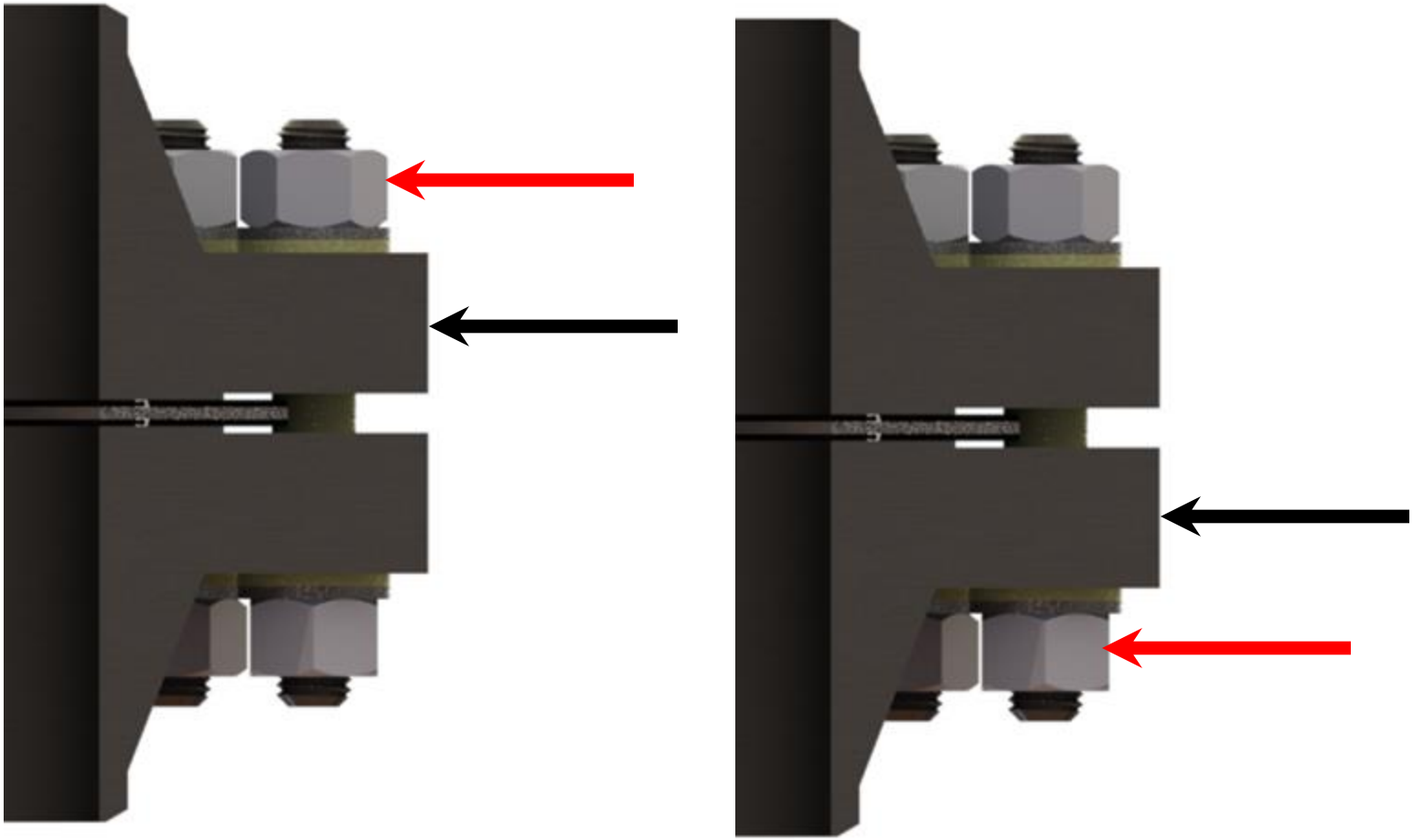
Isolation Testing RF Tester and Ohm-Meter

Flange-to-Flange



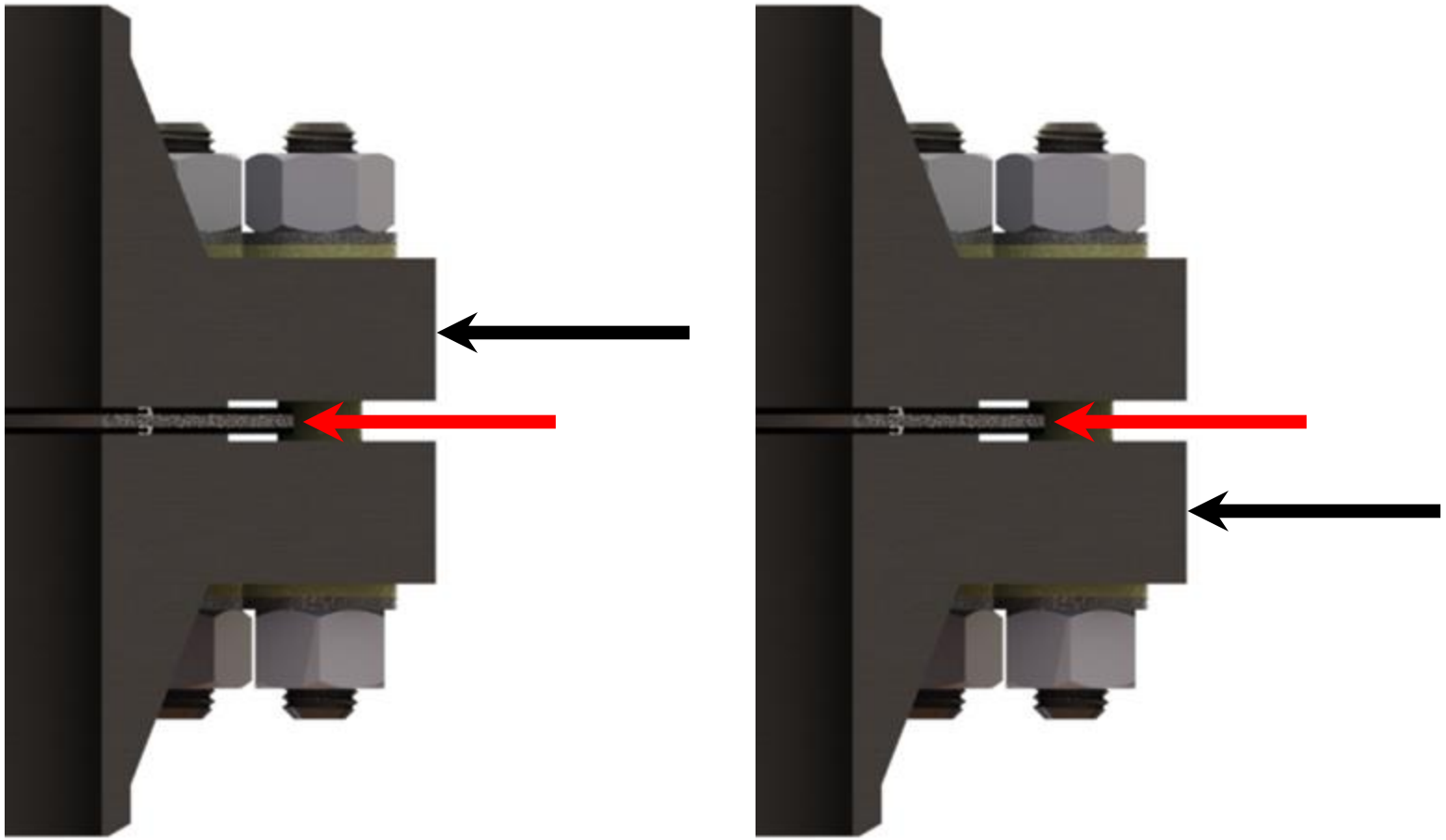
Isolation Testing RF Tester and Ohm-Meter

Flange-to-Bolt



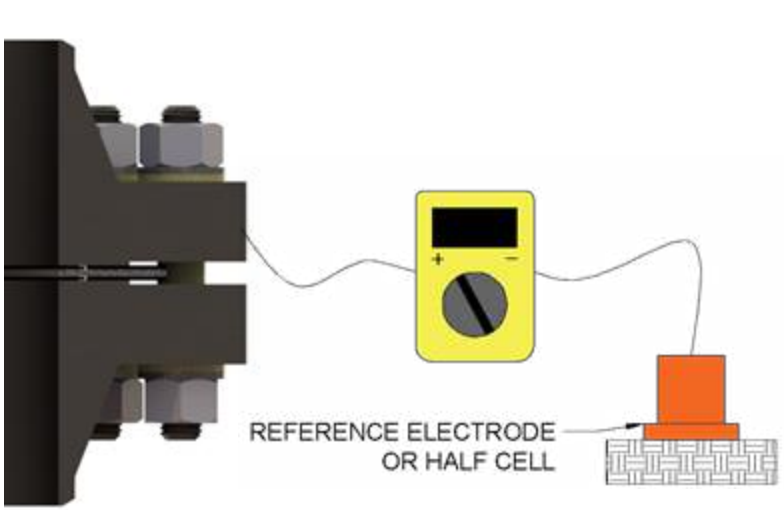
Isolation Testing RF Tester and Ohm-Meter

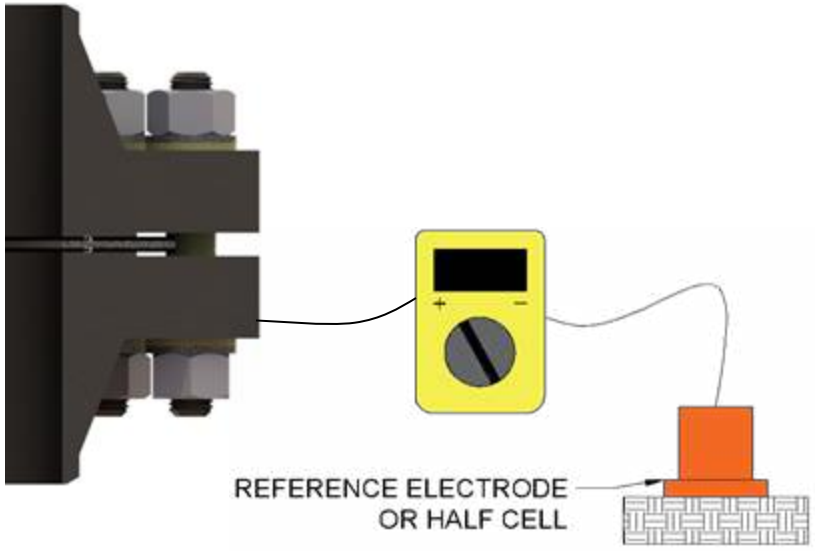
Flange-to-Steel Gasket Core



Isolation Testing Reference Electrode

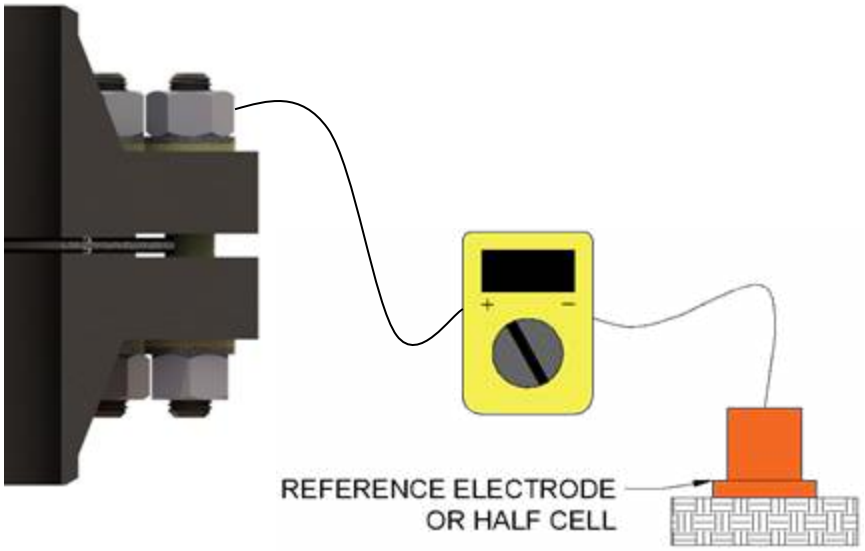
- Flange to reference electrode
  - 0.1V difference between two measurements

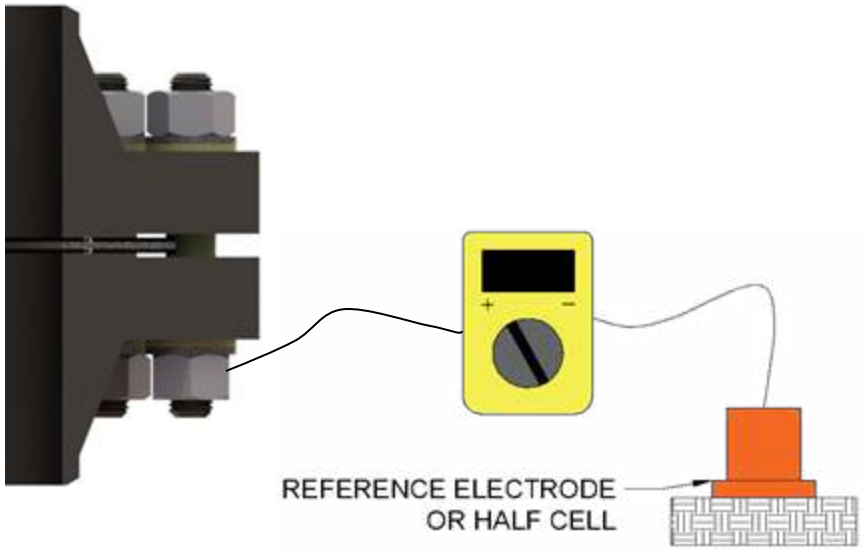




Isolation Testing Reference Electrode

- Flange to reference electrode
  - 0.1V difference between flange and bolt measurements





Question 4

WHY ISOLATION GASKETS FAIL

Why Isolation Gaskets Fail

Common Reasons:

- Installation issues – Number one problem
- Re-Use of Flange Isolation Kit
- Chemical Attack
- Over-Pressure Permeation
- High Temperature

What do we think?

Most Important Aspects of Installing an Isolation Kit?

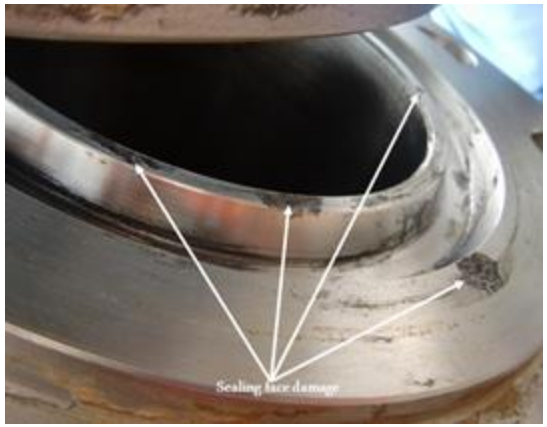
1. Flange condition and preparation
2. Flange Alignment
3. Washer/Sleeve/Bolt Assembly

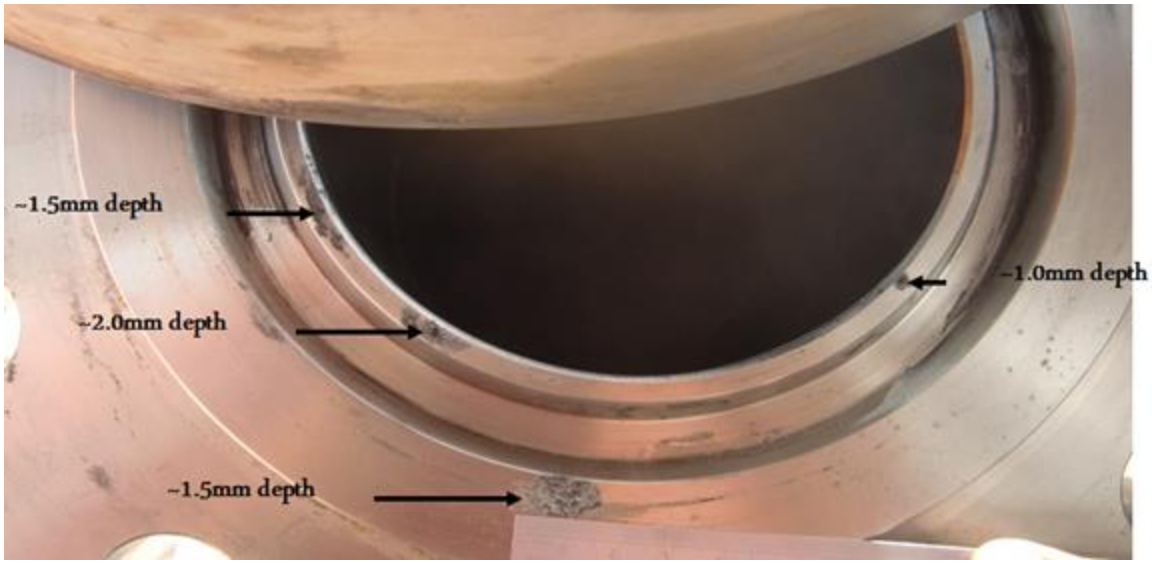
Inspection

Flange and isolation kit inspection
BEFORE disassembling flange connection.

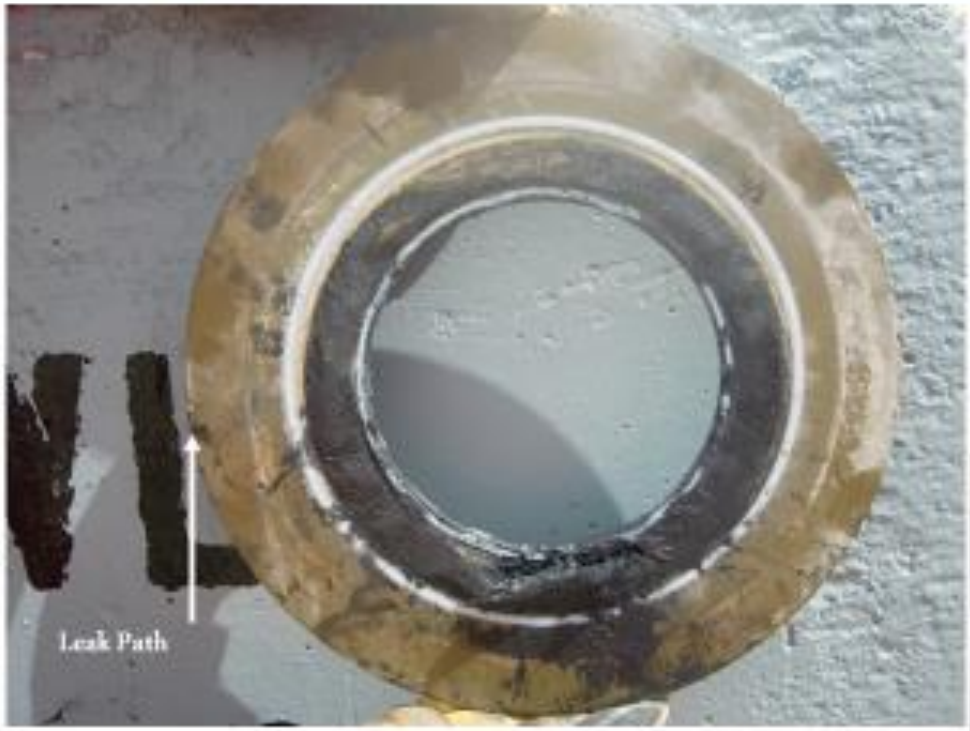
- Inspect flanges
- Inspect new isolation kit
- Do we have the correct isolation kit

Flange Face Condition



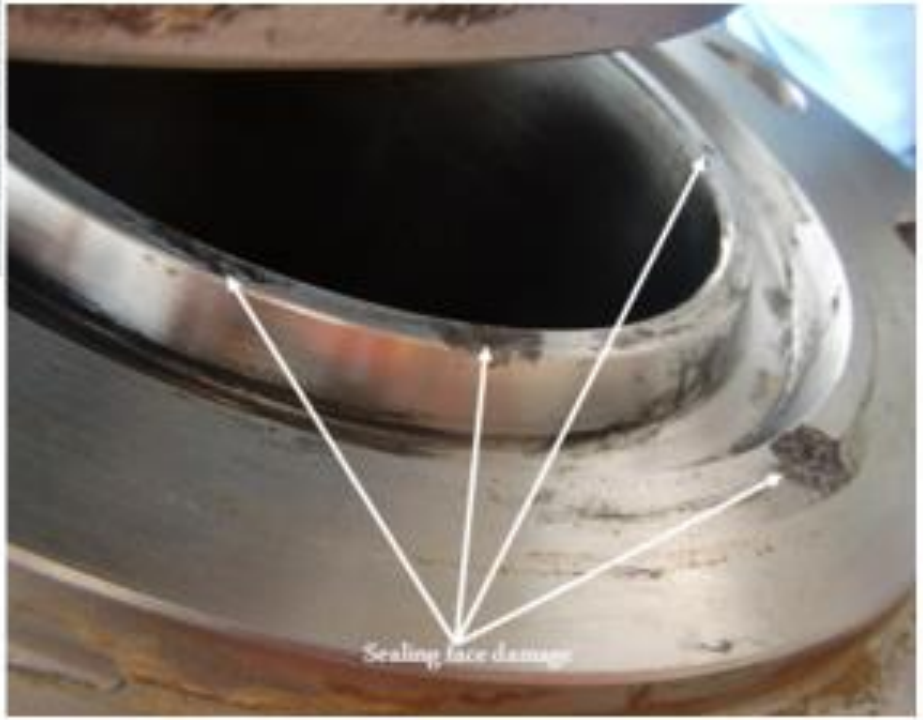


Flange Face Corrosion Cont.



- Secondary PTFE (Teflon) seal likely failed after the primary seal failed
- What most likely caused the seals to fail?

- Primary PTFE (Teflon) seal likely failed first
- Where are the seals located on the flange face?



Residue Needs to be Removed

Flange with Metallic Debris

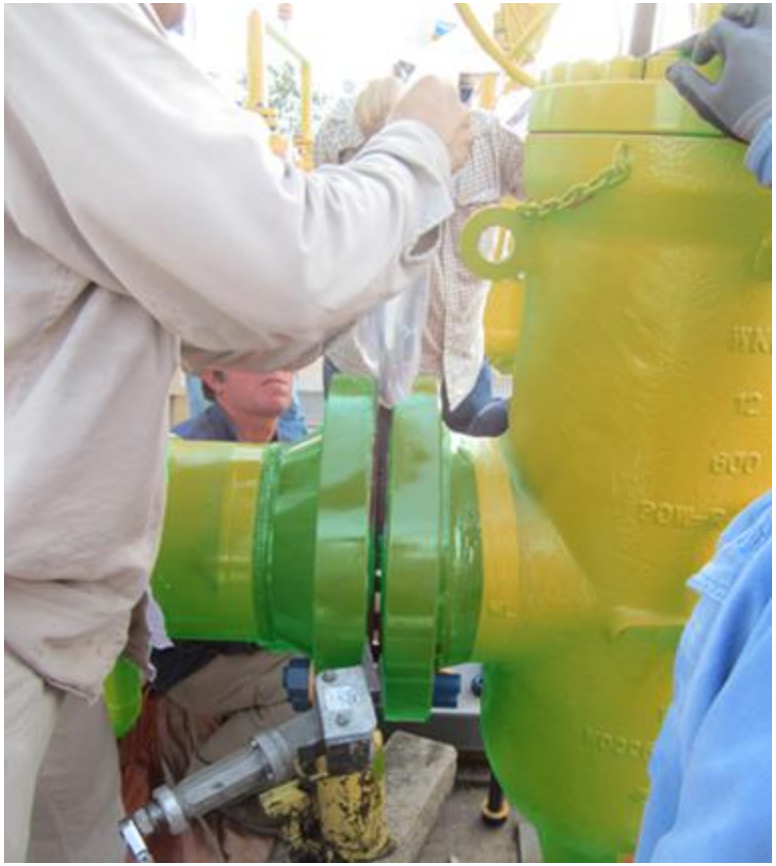
Gasket with Corrosion Residue

Clean the Surface of the Flange Face

- Use Scotch Brite or a wire brush to clean the face of a flange
- Removes previous corrosion

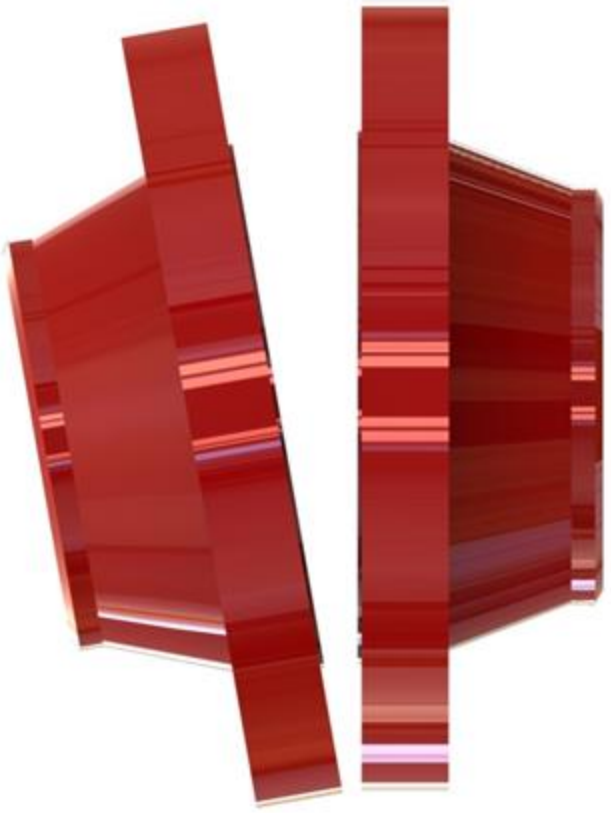
Flange Alignment

- Axial Alignment
- Parallel flange faces
- Bolt holes
- Gap between flanges



Flange Alignment

Lateral Mis-Alignment



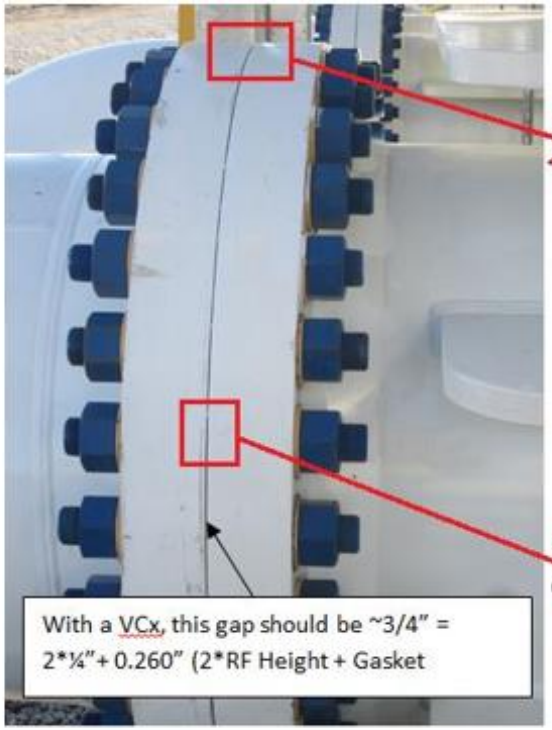
Angular Mis-Alignment

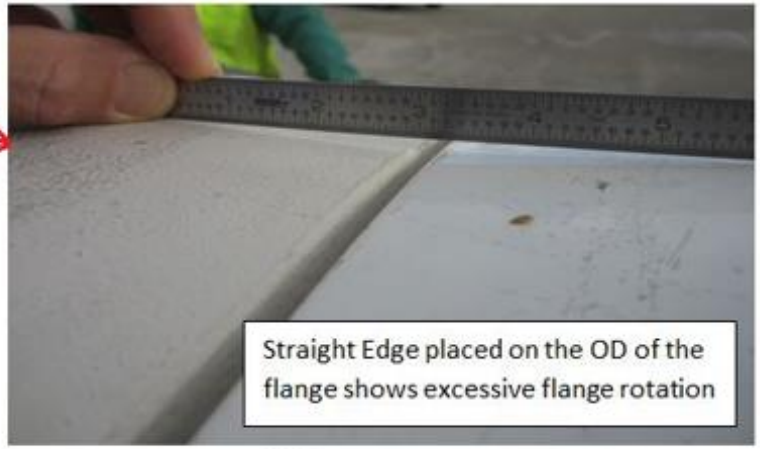
Installation Cont.

36" 600# Flange

Isolation breakdown flange to flange and bolt to flange

Over torqued causing flanges to be Over-rotated





Installation Cont.

- Isolating sleeves were shredded during bolting
- PTFE coated studs and lubricant were used, reducing the C.O.F. & k factor.
- T = kFD

- Threaded studs permanently deformed during bolting
- Bend angle in the studs corresponds with rotation of the flanges.

Chemical Attack

- Competitors G-10 gasket was used in service for 6 months before failure
- Media: Ethylene Oxide (C_2H_4O)

Material Selected:
Epoxy

Chemical	Compatibility
Ethylene Oxide	D-Severe Effect

Material Selected:
PTFE

Chemical	Compatibility
Ethylene Oxide	A-Excellent

http://www.coleparmer.com/Chemical-Resistance

Explanation of Footnotes
1. Satisfactory to 72°F (22°C)
2. Satisfactory to 120°F (48°C)

Ratings -- Chemical Effect

A = **Excellent.**
B = **Good** -- Minor Effect, slight corrosion or discoloration.
C = **Fair** -- Moderate Effect, not recommended for continuous use. Softening, loss of strength, swelling may occur.
D = **Severe Effect,** not recommended for ANY use.
N/A = Information not available.

What do you think happened?

Chemical & Temperature Attack

Material Selected:
Epoxy

WHY DID THIS FAILURE OCCUR??

Chemical	Compatibility
Carbonic Acid	A[2]-Excellent

http://www.coleparmer.com/Chemical-Resistance

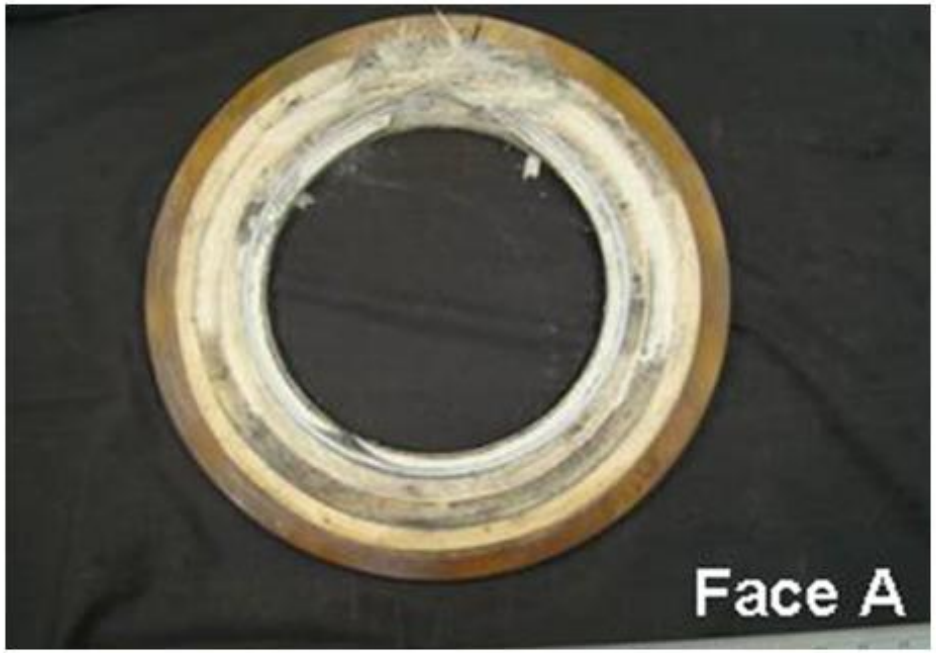
Explanation of Footnotes
1. Satisfactory to 72°F (22°C)
2. Satisfactory to 120°F (48°C)

Ratings -- Chemical Effect

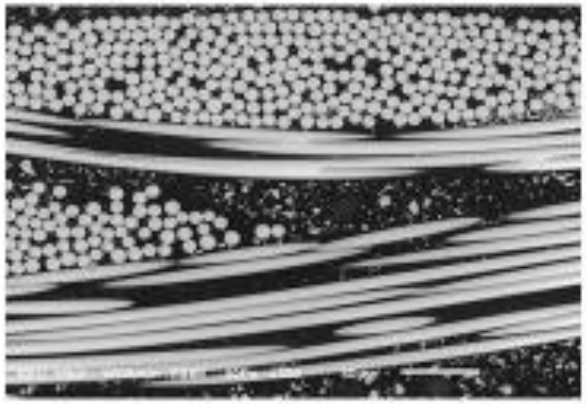
A = Excellent.

pikotek

- Conoco Dayung Multiple VCS Failures in 2012
- Operating Temp: 270°F (G-11 is good to 392°F)
- Service Time: 34 weeks before blowout
- Media: Carbonic Acid H_2CO_3 & Hydrocarbons
  - CO_2 (mole %): 28.6
  - H_2S (mole %): 0.006
  - Water (mole %): 7.644
  - Hydrocarbons (mole %): 63.75



Some Examples of GRE Permeation



GRE Glass Fibers Act Like Straws

Found in Lab and Field Conditions

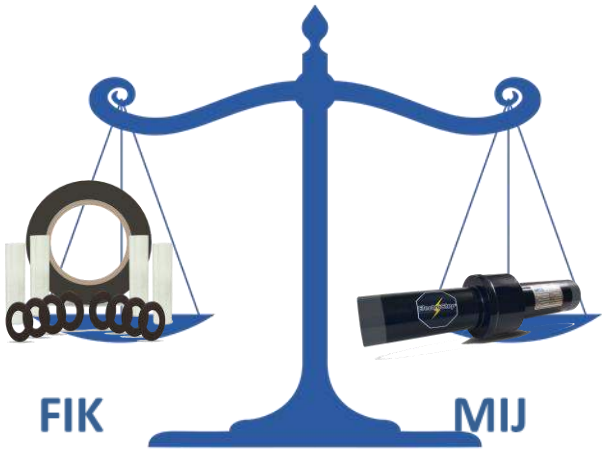
Even Liquids Can Permeate GRE

Question 5

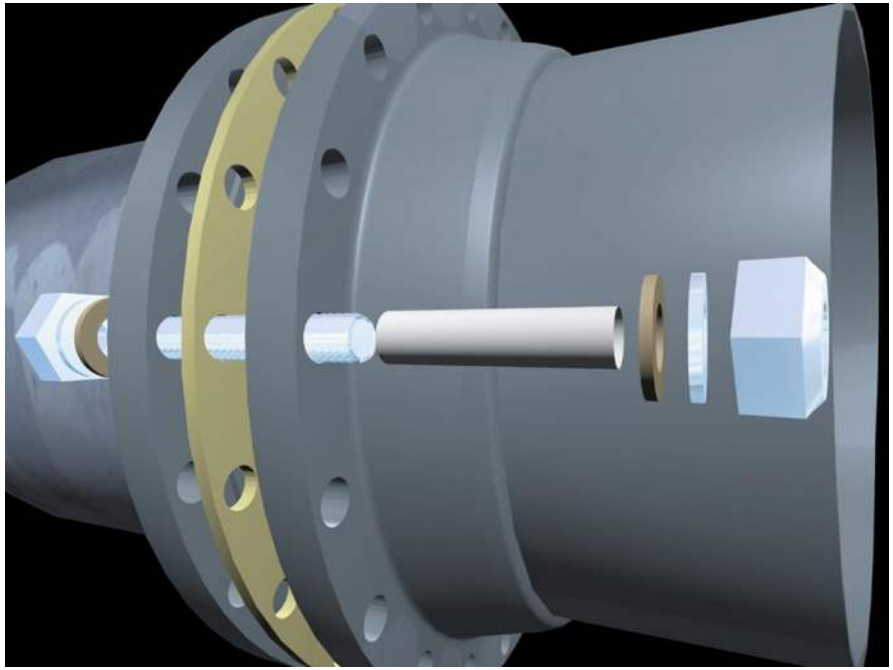
FIK VS MIJ

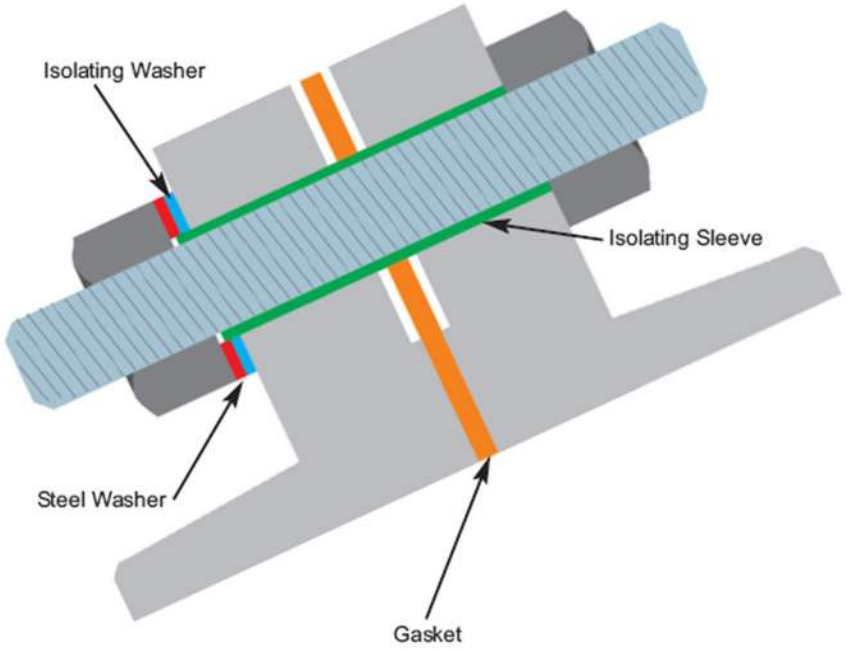
Areas of Discussion

- Selection Criteria – How do you decide what will work best?
- The benefits of using an FIK vs MIJ and vice-versa
- Recommended Pre and Post installation practices for MIJ and FIK



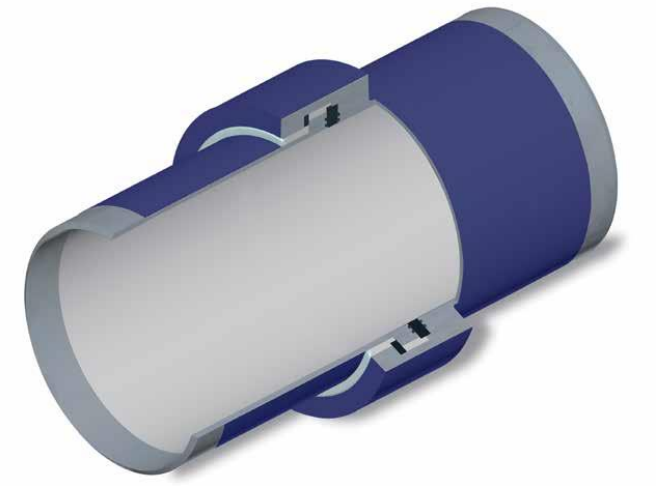
Flange Isolation Kit (FIK)

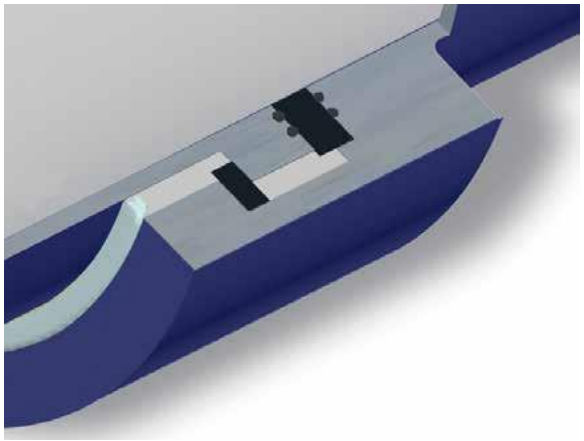




Monolithic Isolation Joints

- GPT ElectroStop®

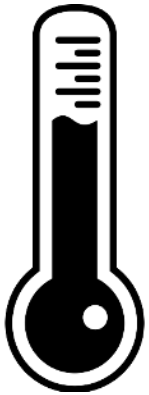




Selection Criteria – How do you decide what will work best?

TAMPS

- Temperature
- Application
- Media
- Pressure
- Size



The benefits of using an FIK vs MIJ

FIK Benefits:

- Lower cost – Average 5X-10X less
- Easily accessible – Bolted connection
- Short lead-time – 20X – 40X quicker
- Comfort level – Widely accepted/used
- Wide range of applications- Many variations
- Wide size range – ½" to 144" is common
- Higher temp isolation – 392F/500F/770F are common ratings
- Fire safe

The downside of using an FIK vs MIJ

FIK Limitations:

- Installation issues – Number one problem
- Short path isolation – Increasing in number
- Many parts – 24”/600# has 193 pieces
- Shouldn’t be buried – Nuts and bolts corrode
- Many variables – Easy to install wrong product

The benefits of using an MIJ vs FIK

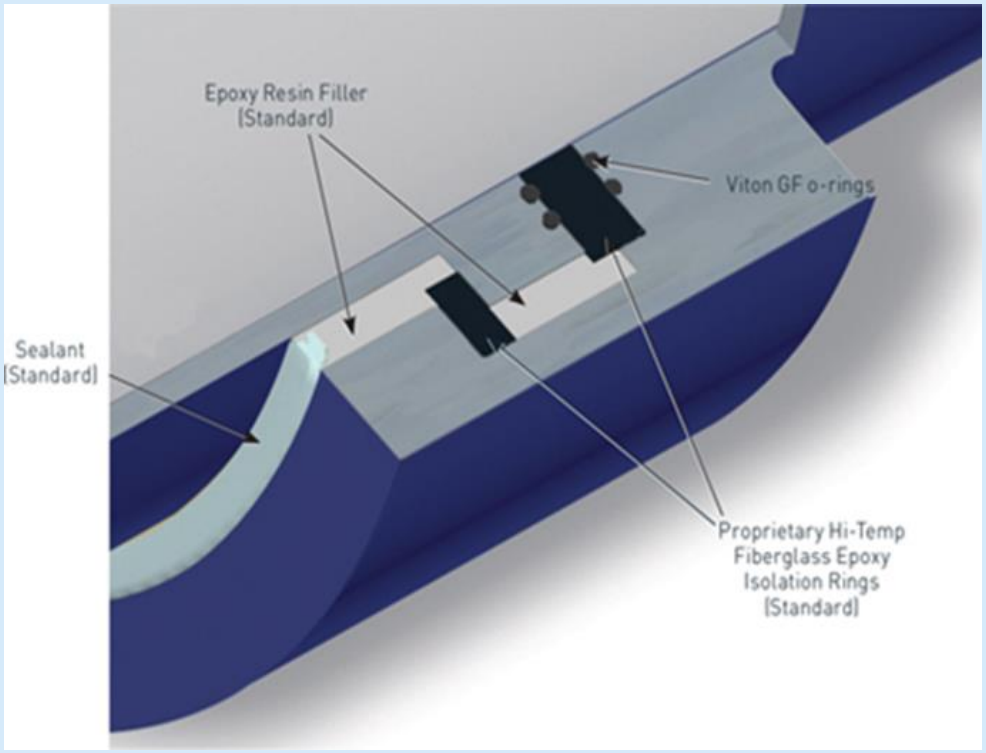
MIJ Benefits:

- Long path isolation – coated IDs seal the internal components (consider high pressure "breach of coating")
- 20-year design life
- Easy installation – welders who weld line pipe are qualified to do this welding, so no special labor is needed
- Ideal for buried apps
- A place to mount other equipment (SSDs, CP test nodes)
- One-piece visible design – instead of hundreds of pieces
- Higher de-electric strength

The downside of using an MIJ vs FIK

MIJ Limitations:

- Higher upfront cost
- Not easily accessible
- Narrow range of applications
- Long lead-time
- Typically used up to 30''
- Internal parts are hidden



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QUESTIONS

Thank you for your time and attention