THE COLT GROUP
POWER SERVICES DIVISION

SF6 Leak Reduction Using On-line Leak Sealing

Presented by:

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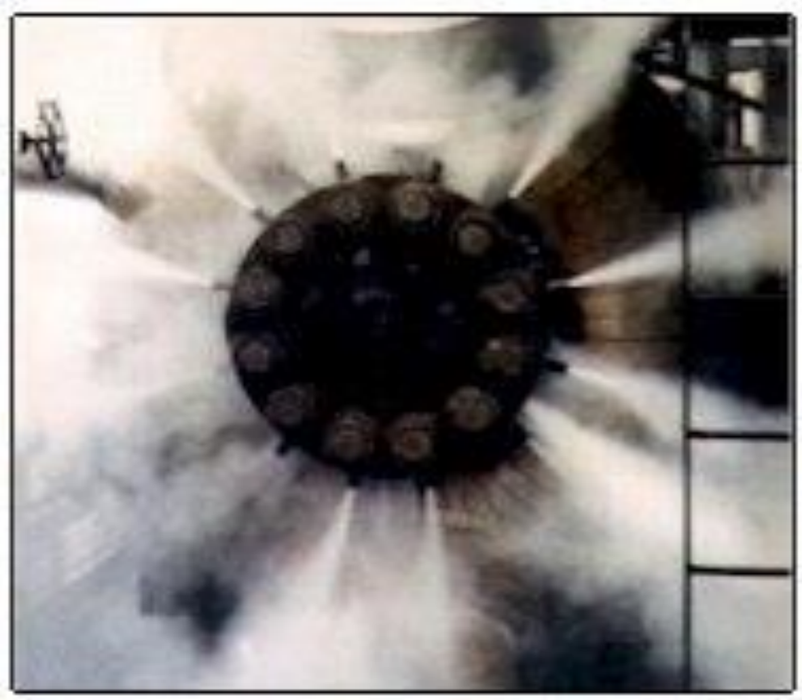
THE COLT GROUP

On-line Leak Sealing

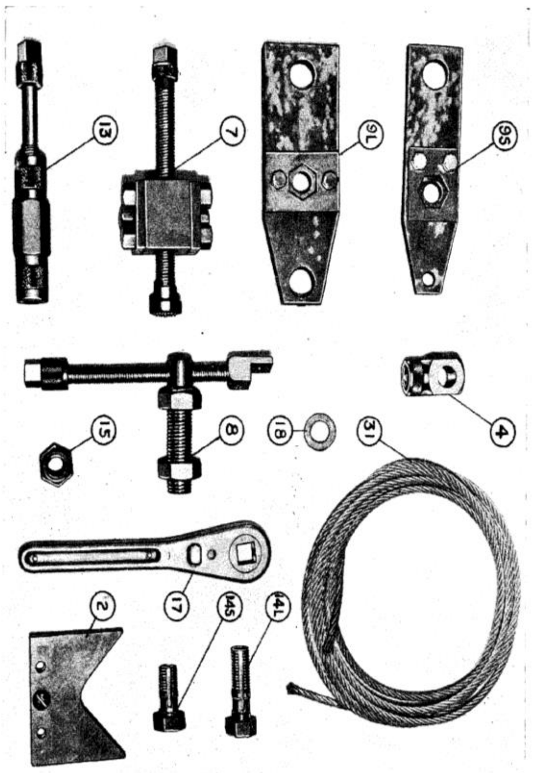
Temps: Cryogenic – 1,500 F

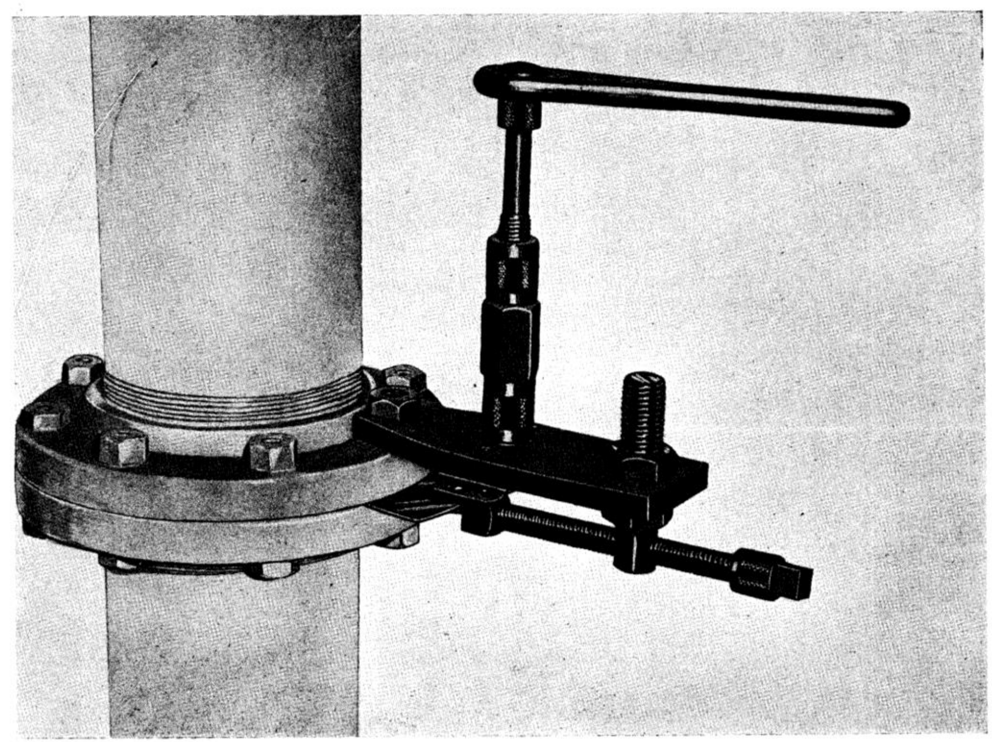
Under pressure: Vacuum up to 5000 PSI

The History of Leak Sealing



Early On-Line Steam Leak Repair





PHOTOGRAPH NO. 1 — SET UP NO. 1
THE FURMANITE SALES COMPANY
NORFOLK, VA.

Sealing Leaks in Transformers and Circuit Breakers

Thirty+ Years Later

Statistically proven process

12,484 repairs completed as of 8/01/13

- 5,482 Flanges
- 5,007 Packings
- 813 Drain plugs
- 799 Custom clamps & enclosures
- 230 Cover plates
- 153 Misc.

- 93.1% sealed on first visit. 6.9% repump rate

Benefits of online leak repair

- A cost-effective option
- Should not be used to replace re-gasketing
- No need to drain the oil or depressurize
- Some repairs can be made while energized

Comparison: OCB Bushing Flange Leak		
	Leak Repair	**Conventional Repair**
Personnel Resources	20 hours, including switching and grounding	96 hours
Parts	Repair: $ 2,000	Replacement: $ 5,000
Other	None	Oil tanker, gaskets, etc
Total Cost	$ 3,000 - $ 5,000	$ 10,000 - $ 12,000

Your options for dealing with leaks

- Let it leak
  But if oil or gas are getting out, air and moisture are getting in. Also environmental concerns and regulations.

- Regasket or replace
  Your number one choice in a perfect world.
  Requires outage time, budget and personnel resources.
  Replacement parts not always available

- In-house Repair
  Not always effective

- On-line Leak Repair Specialists
  An alternative worth considering in certain situations

A good case for on-line leak repair

Leak repair methodology

- Drill and Tap Technique (oil leaks)
- Custom enclosures (oil, nitrogen, SF6)
- Sealant is not an epoxy. Easy to remove

  Specially formulated for use with electrical apparatus – allows for movement due to temperature changes and vibration.

1) Drill and Tap technique

- Four bolt flapper valve
- O-Ring / Packing type seal

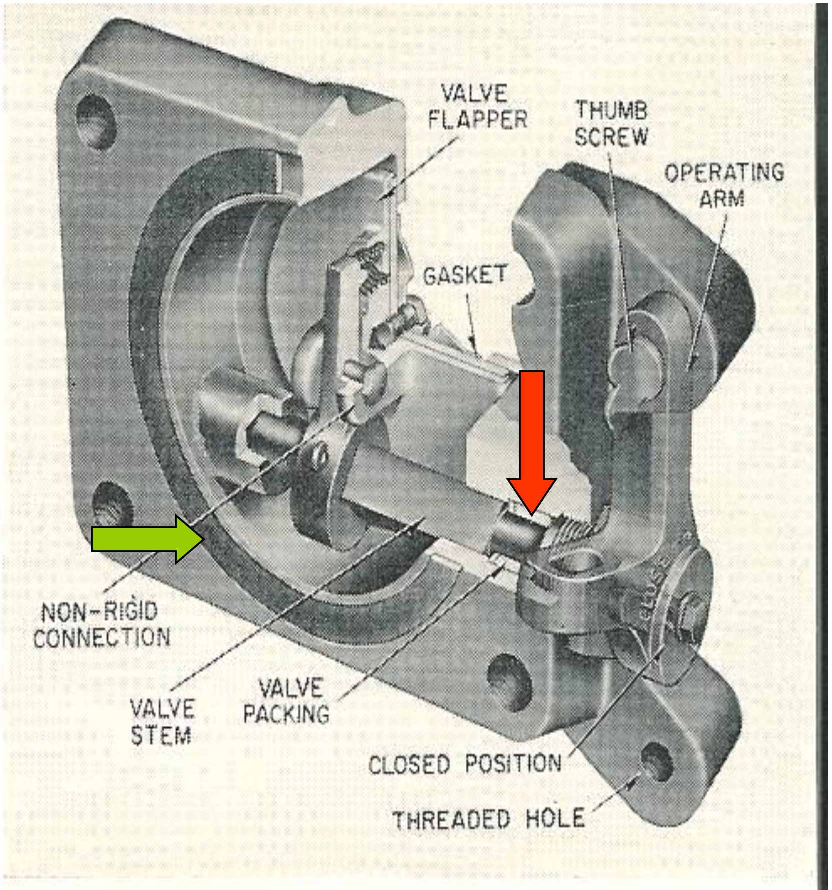


FIG. 2. Cutaway View of Valve in Closed Position.

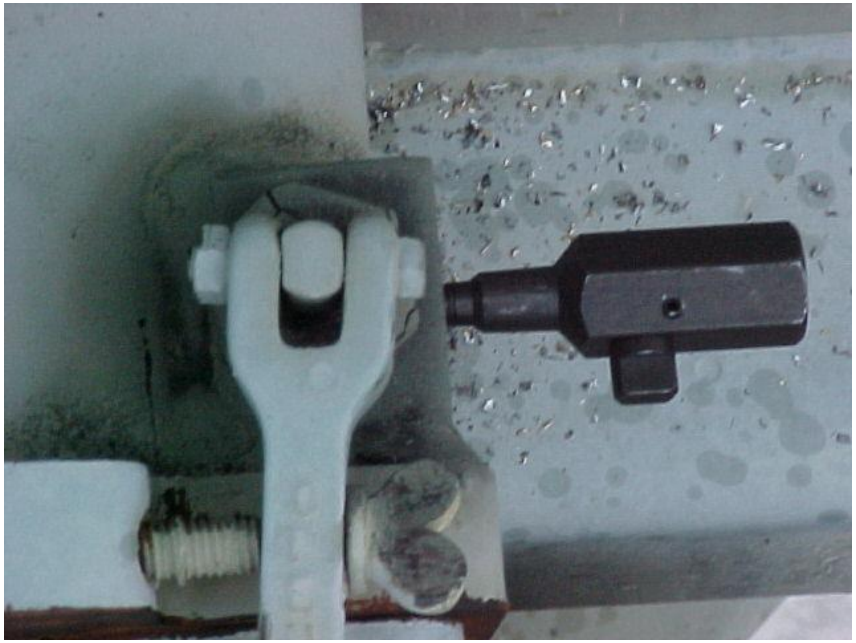
On-Line Repair of Flapper Valve Flange using Drill & Tap Technique

A Flapper Valve Flange That Has Been Drilled & Tapped - Ready For Injection

- Injection valves are placed into the gasket area
- A two part sealant is injected and cures
- Injectors are removed after sealant cures
- Teflon coated pipe plugs are installed

Flapper Valve Packing

Injector will be removed



Valve still operates

- Follower nut is backed out.
- Valve remains operable.

Radiator flanges

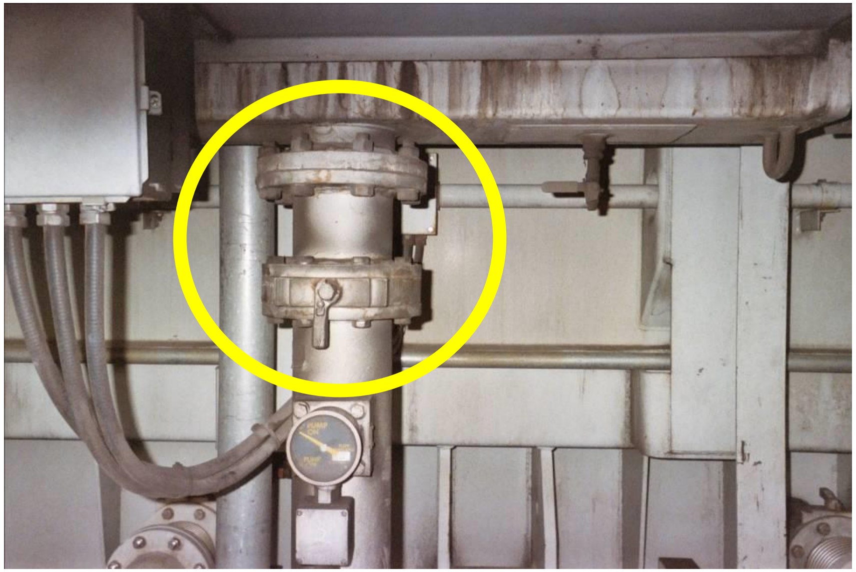
Cover plates

Bushing Flange

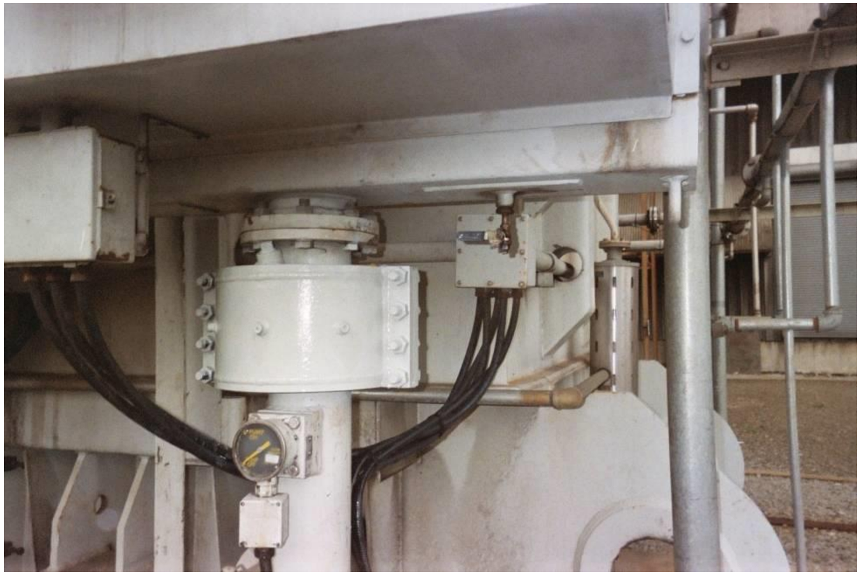
2) Custom Enclosures

Damaged/Cracked Flange

Before



After

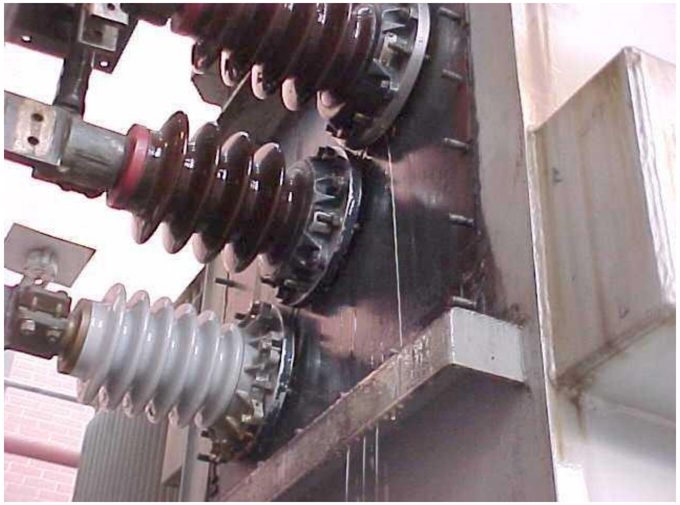


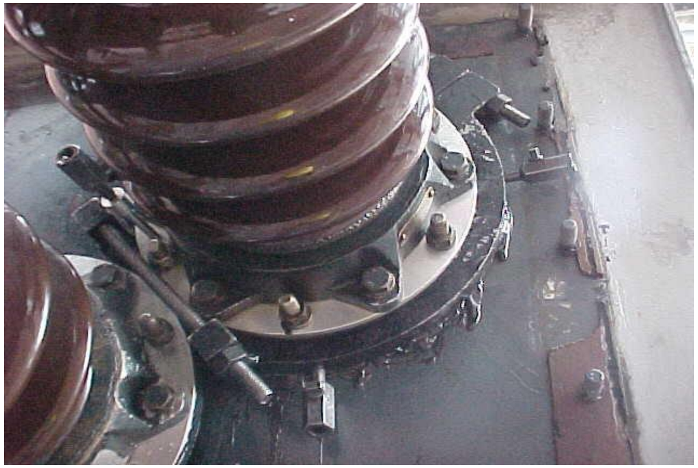
Custom Enclosure Job Examples: Drain/Fill/Sample valves

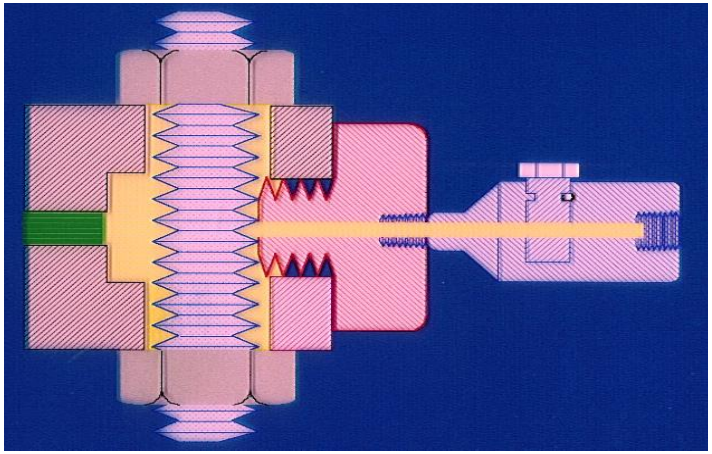
Before

After

Offset Bushing Flange Clamp







SF6 Leak Repairs

Typical SF6 Leak Locations:

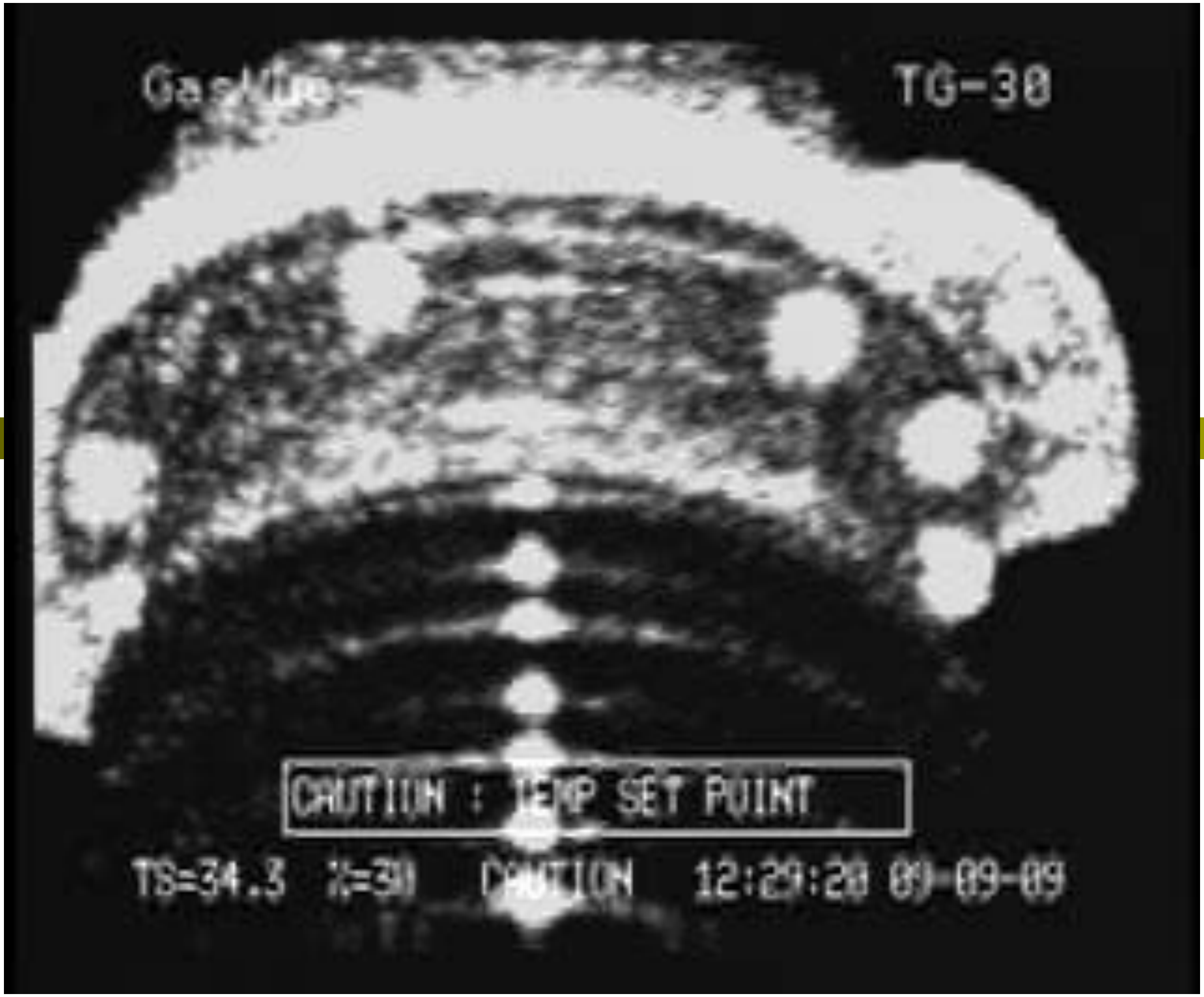
- Between the porcelain and aluminum
- Between the flange ID and the porcelain
- Tank flanges
- Tanks
- Instrument lines, fittings and valves
- Pores in the casting

The SF6 Leak Repair Process

- Determine point of leak
- Technician takes precise measurements for a containment device
- Engineer designs a clamp or enclosure
- Clamp/enclosure is bolted around the leak and hydraulically injected with sealant

SF6 Leak Repair Case Story

Eddyville Substation 69 kv SF6 Breaker

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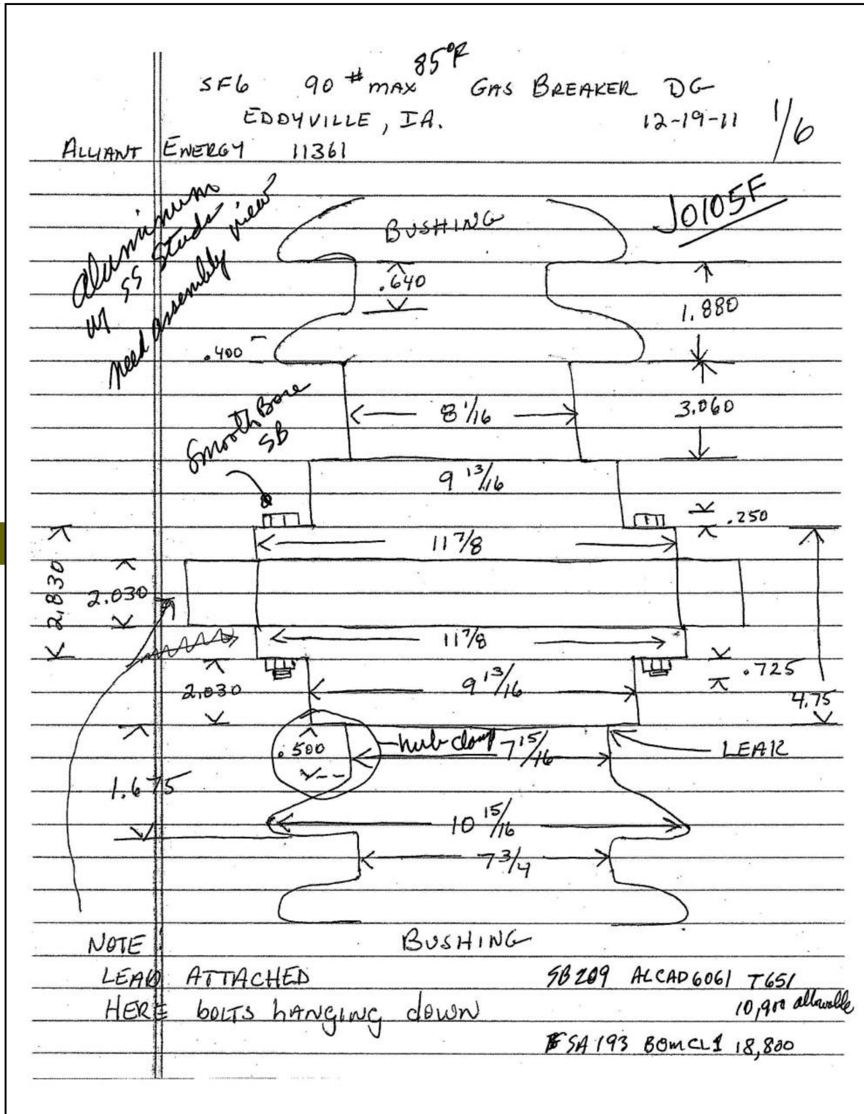
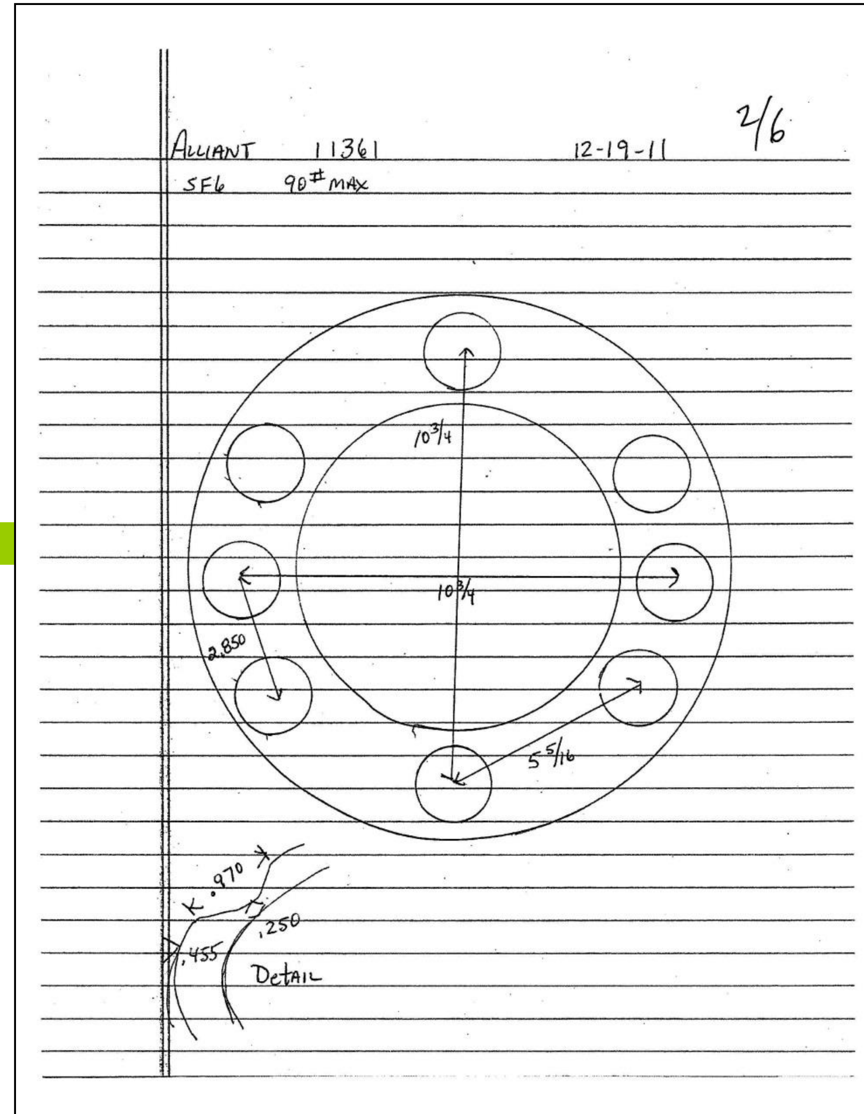
Alliant SF6 Case Story

1. Leave as is – not an option
2. Re-gasket – time to take the breaker out of service was the primary issue
   5 days of down time, loss transmission & $20,000.00 due to placement of breaker
3. Repair – Installing custom enclosure and injecting sealant was determined optimal solution

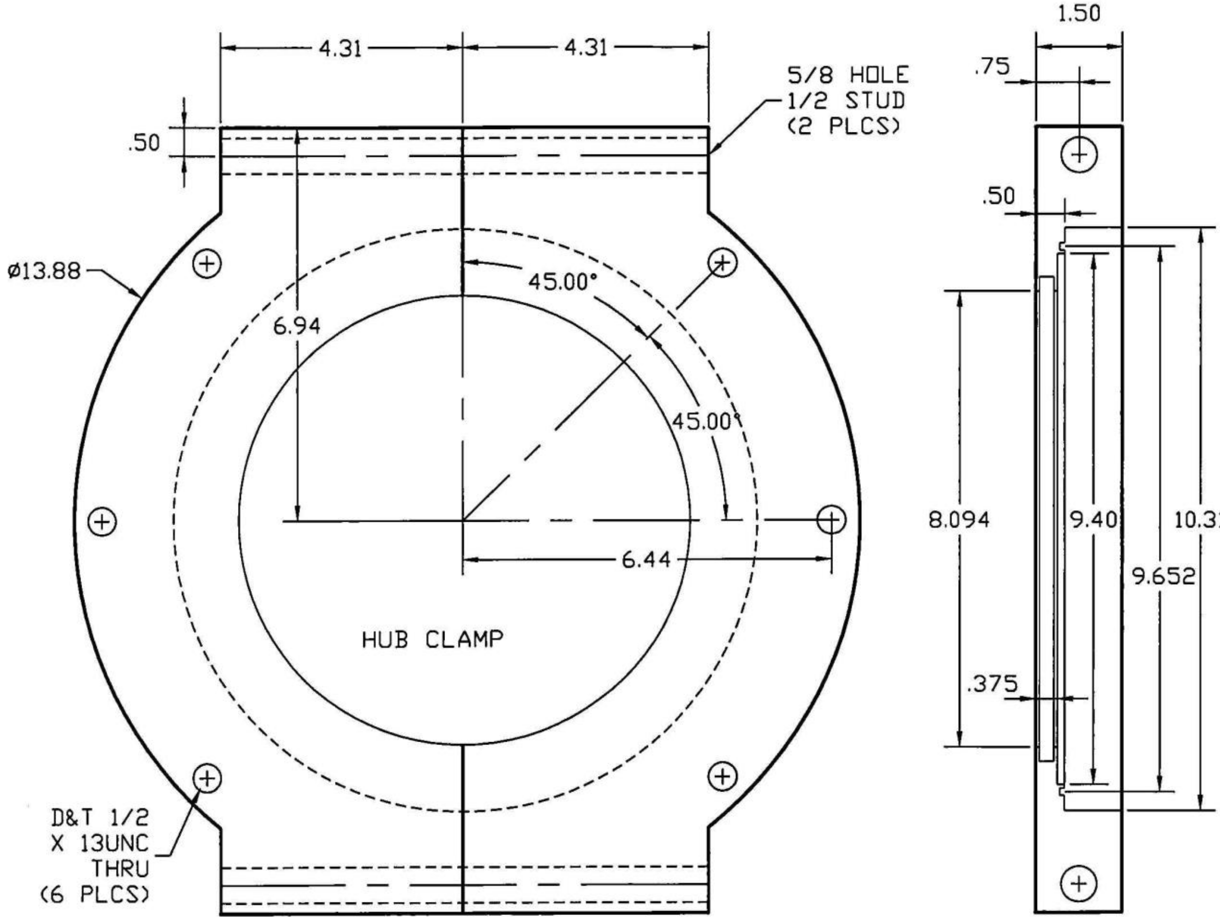
Justification: Reduced downtime for critical apparatus. Just 1 day of down time and $20,860.00 to fix all leaking components

Precise measurements taken






LUFKIN
3
2
1
INCHES



MACHINE 1/4 X 1/4 DP PACKING GROOVE IN Ø8.094 BORE INSTALL (4) 1/16 NPT INTO PACKING GROOVE MACHINE 1/8 X 1/16 DP PACKING GROOVE IN Ø9.652 BORE

CLAMP NO. J0105F	JOB NO.

UNLESS OTHERWISE SPECIFIED:
ALL DIMENSIONS IN INCHES
MACHINED SURFACES 250
BREAK SHARP CORNERS .005 .020
TOLERANCES:
3 PLACE DECIMAL .005
2 PLACE DECIMAL .01
1 PLACE DECIMAL .1
ANGLES ± 1/2
FRACTIONS ± 1/32

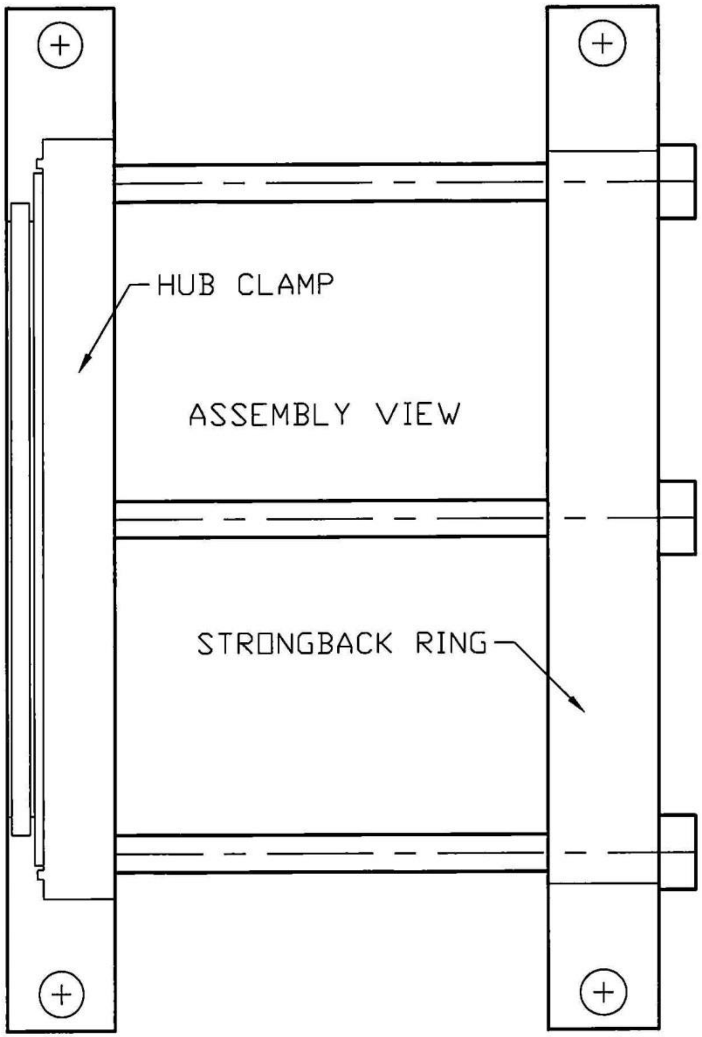
J-DWG#: J0105F	WGT. ~ LBS
WELD. SPEC.	VOL. ~ CU.IN.
DRAWN VF	DATE 01/05/12
CHECKED/APPROVED	DATE

BUSHING HUB CLAMP/SB

COLT ATLANTIC SERVICES
4135 INDUSTRY WAY
FLOWERY BRANCH, GA 30542
PH# 1-(804)-674-0031

MATERIAL:
PLATE: SB209 ALCAD 6061 T651
PIPE:
EARS:
STUDS: SA-193 B8MCL1
NUTS: SA-194 GR8M

SHEET 1 OF 3



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MATERIAL:
PLATE: SB209 ALCAD 6061 T651
PIPE:
EARS:
STUDS: SA-193 B8MCL1
NUTS: SA-194 GR8M

J0105F

DESIGN SUMMARY/CALCS

SHEET 1 OF 2

DESIGNED BY:	VF	DATE:	01/05/12	CLIENT:	CSA
CHECKED BY:		DATE:		CLAMP#:	J0105F
DSGN TEMP.:	85 °F	OPER TEMP:		JOB NO:	
DSGN PRESS:	90 PSI	OPER PRESS:		SERVICE:	SF6

ALLOWABLE STRESSES

PIPE:

PLATE: SB209 6061 T651 10900 PSI

BAR:

BOLTS: SA193 B8MCL1 18800 PSI

MAWP: 90 PSI @ 85 °F

DESIGN IS FOR INTERNAL PRESSURE LOADINGS ONLY
CORROSION ALLOWANCE .125 IN. UNLESS OTHERWISE SPECIFIED
MATERIAL STRESS ARE FROM ASME BPVC SECT II PART D (2010)
FORMULAE ARE FROM ASME BPVC SECT VIII DIV 1 OR
STANDARD ENGINEERING PRACTICES

COVER THICKNESS

P = DESIGN PRESSURE
OD = OUTSIDE DIAMETER
S = ALLOWABLE STRESS
E = JOINT EFFICIENCY
CA = CORROSION ALLOW.
T(furn) = COVER THICKNESS
MT = MILL TOLERANCE
T(req) = MINIMUM THICKNESS

$$T(req) = \frac{P[OD/2-MT(Tfurn)+CA]}{(S*E)-(.6*P)} + CA$$

$$= \frac{90[13.880/2-1.00(1.780)+.125]}{(10900*1.0)-(.6*90)} + .125$$

$$T(req) = \boxed{.169 \text{ IN.}}$$

$$T(furn) = \boxed{1.780 \text{ IN.}}$$

Cover calculations are from ASME BPVC Sect. VIII, Div. 1, UG-27(c)(1)
and allowable stresses from ASME BPVC Sect. II, Part D.(2010)

WORKING LOAD PER STUD

CLAMP BOLTING

TL = TOTAL LOAD
P = DESIGN PRESSURE
A = AREA IN SQ. IN.
WL = LOAD PER BOLT
N = NUMBER OF STUDS

$$TL = P * A = 90 * 2.41$$

$$= \boxed{216.54 \text{ LBS.}}$$

$$WL = \frac{TL}{N} = \frac{216.54}{2}$$

$$= \boxed{108.27 \text{ LBS/BOLT}}$$

MAX ALLOWABLE LOAD PER STUD

S = MAX ALLOW. STRESS/STUD
A = TENSILE OR ROOT AREA/STUD
ML = MAX ALLOW LOAD/STUD

$$ML = A * S = .126 * 18800$$

$$= \boxed{2363.16 \text{ LBS/BOLT}}$$

STUD SIZE: 1/2 X 13UNC B8MCL1

THRUST ON ENCLOSURE DUE TO UNEQUAL BORES

P = PRESSURE
D = LARGE BORE DIA.
d = SMALL BORE DIA.
T = THRUST ON ENCLOSURE

T = P [(D)^2-(d)^2] .7854 = 90 [(9.65)^2-(8.09)^2] .7854

$$= \boxed{1954.35 \text{ LBS.}}$$

DESIGN CALCULATIONS

WORKING LOAD PER STRONGBACK STUD

T = THRUST
N = NUMBER OF BOLTS
WL = LOAD/BOLT

$$WL = \frac{T}{N} = \frac{1954.35}{6}$$

$$= \boxed{325.73 \text{ LBS/BOLT}}$$

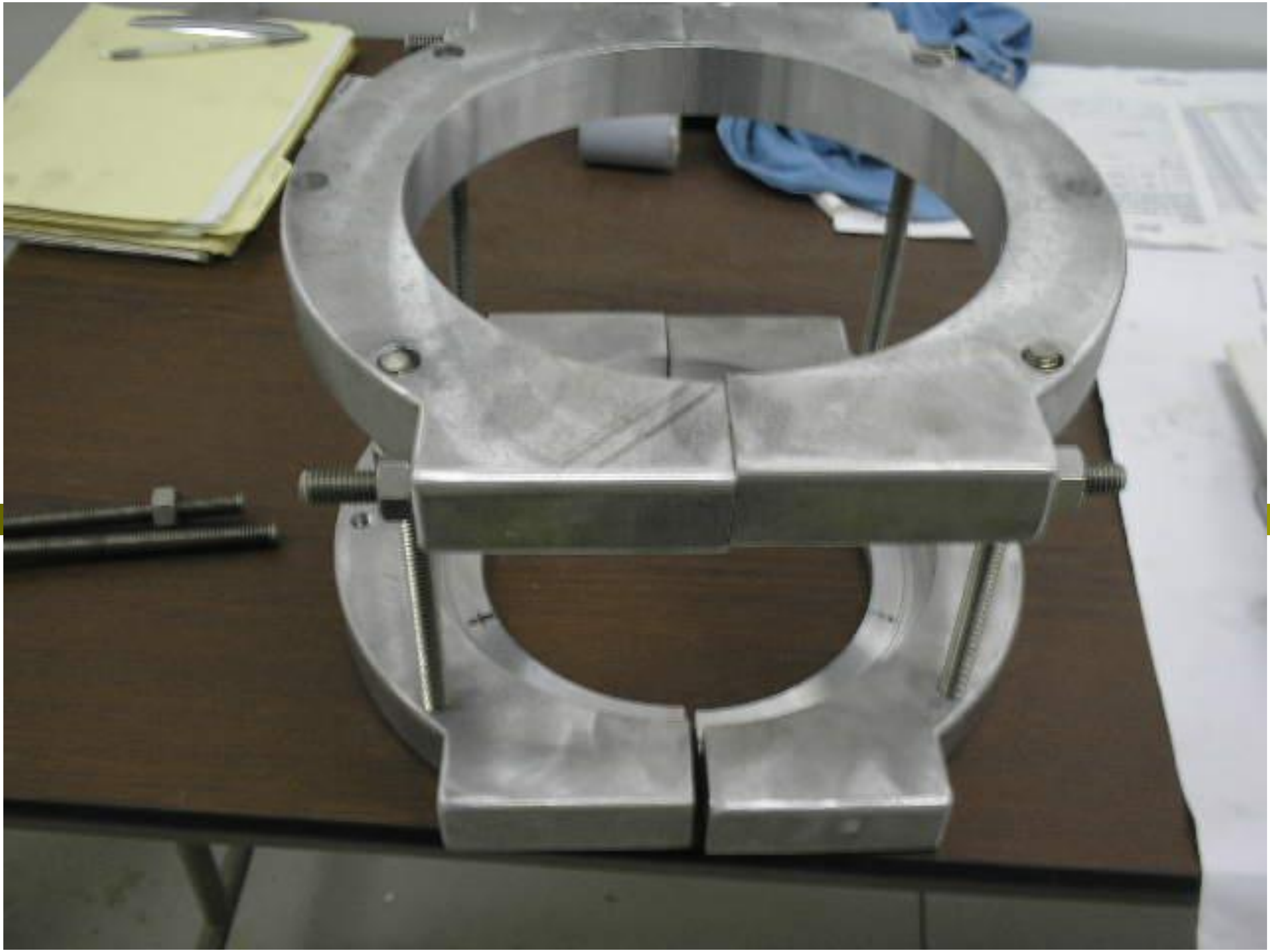
MAX ALLOWABLE LOAD PER STUD

S = MAX ALLOW. STRESS/STUD
A = TENSILE OR ROOT AREA/STUD
ML = MAX ALLOW LOAD/STUD

$$ML = A * S = .126 * 18800$$

$$= \boxed{2363.16 \text{ LBS/BOLT}}$$

STUD SIZE: 1/2 X 13UNC B8MCL1



Other examples:
345 KV SF6 Breaker Leak - Before

SF6 Leak – After

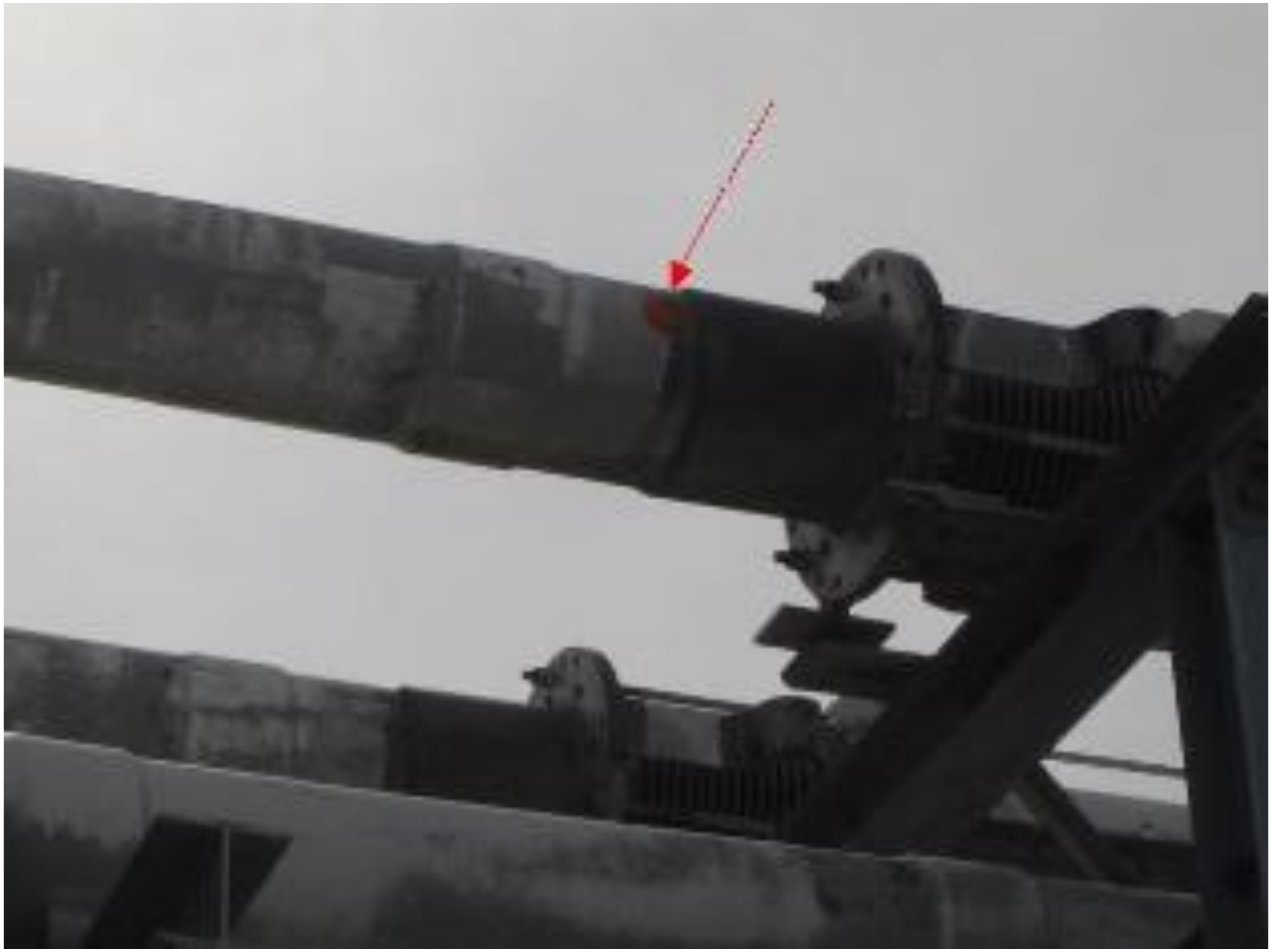
Other SF6 Repairs Before…

After

Before

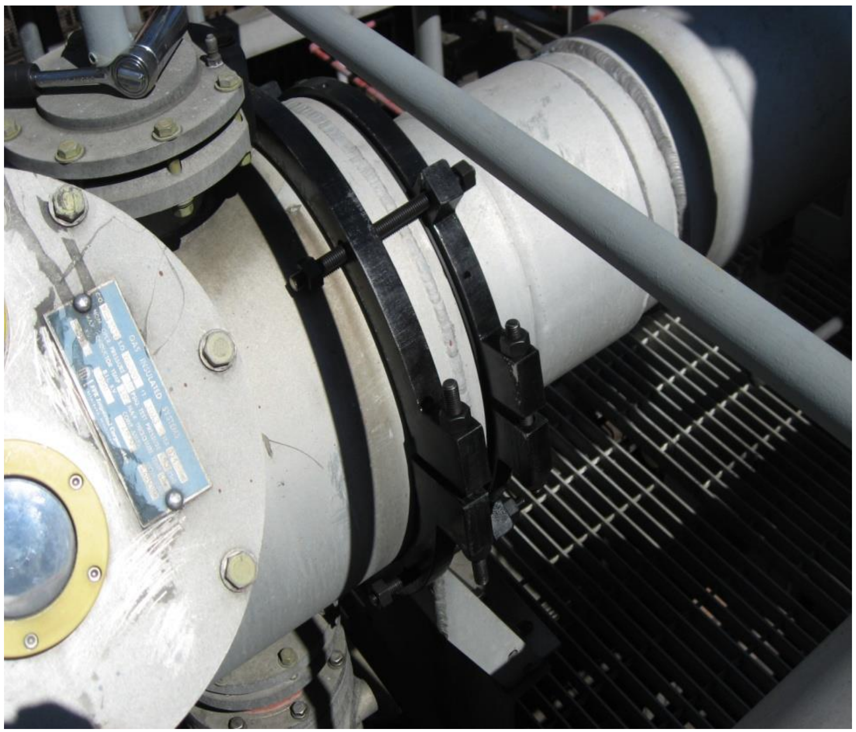
After

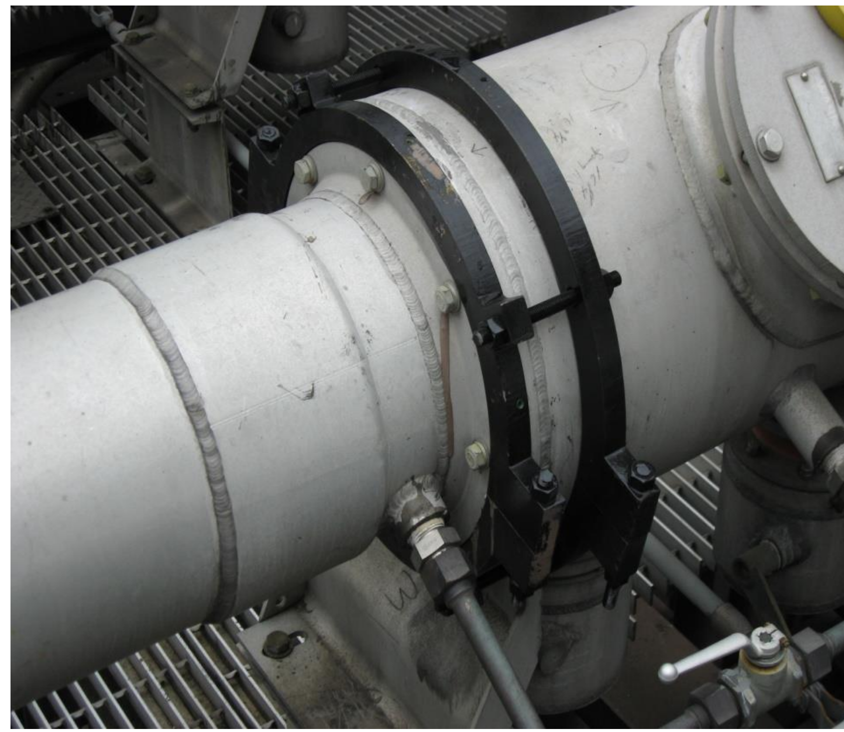
Before



After

SF6 Repair on Insulated Bus





SF6 Tubing Leak


HA-2257

Thank you

Liisa Colby
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