SF6 Leak Reduction Using On-line Leak Sealing

Presented by:

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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
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 Repair

<table>
<thead>
<tr>
<th></th>
<th>Leak Repair</th>
<th>Conventional Repair</th>
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</thead>
<tbody>
<tr>
<td><strong>Personnel</strong></td>
<td>20 hours, including switching and grounding</td>
<td>96 hours</td>
</tr>
<tr>
<td><strong>Resources</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Parts</strong></td>
<td>Repair: $2,000</td>
<td>Replacement: $5,000</td>
</tr>
<tr>
<td><strong>Other</strong></td>
<td>None</td>
<td>Oil tanker, gaskets, etc</td>
</tr>
<tr>
<td><strong>Total Cost</strong></td>
<td>$3,000 - $5,000</td>
<td>$10,000 - $12,000</td>
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</tbody>
</table>
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
On-Line Repair of Flapper Valve Flange using Drill & Tap Technique

- 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
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
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
HUB CLAMP

ASSEMBLY VIEW

STRONGBACK RING

BUSHING HUB CLAMP/SB

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MATERIAL:
PLATE: SB09 ALCAD 6061 T651
PIPE: 
EARS: 
STUDS: SA-193 B8MCLI
NUTS: SA-194 GRBM

SHEET 3 OF 3
# Design Summary/Calcs

**Design 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:** SB209 6061 T651 10900 PSI

**Plate:** SA193 BBMCL1 18600 PSI

**Bolts:** SA193 BBMCL1 18600 PSI

**Mawp:** 90 PSI @ 85 °F

Design is for internal pressure loadings only. Corrosion allowance 1.25 in. unless otherwise specified. Material stress are from ASME BPVC Sect. II Part D (2010) Formulas are from ASME BPVC Sect. VIII Div. 1 or standard engineering practices.

## Cover Thickness

\[
P = \text{Design Pressure} \\
OD = \text{Outside Diameter} \\
S = \text{Allowable Stress} \\
E = \text{Joint Efficiency} \\
CA = \text{Corrosion Allow.} \\
T(\text{turn}) = \text{Cover Thickness} \\
MT = \text{Mill Tolerance} \\
\text{T(req) = Minimum Thickness}
\]

\[
T(req) = \frac{P(OD/2-MT(T\text{turn}))+CA}{(S^*)-(E^*)} \\
= \frac{90(13.880/2-1.00(1.780)+125}{(9000*1.0)-(8*90)} \\
= 1.69 \text{ IN.}
\]

-T(req) = 1.780 IN.

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

## Working Load Per Stud

**Clamp Bolting**

\[
TL = \text{Total Load} \\
P = \text{Design Pressure} \\
A = \text{Area in Sq. In.} \\
WL = \text{Load Per Bolt} \\
N = \text{Number of Studs}
\]

\[
TL = P \times A = 90 \times 2.41 \\
A = 216.54 \text{ LBS.} \\
WL = TL = 216.54 \\
N = 2 \\
= 108.27 \text{ LBS/BOLT}
\]

## Max Allowable Load Per Stud

\[
S = \text{Max Allow. Stress/Stud} \\
A = \text{Tensile or Root Area/Stud} \\
ML = \text{Max Allow Load/Stud}
\]

\[
ML = A \times S = 126 \times 18800 \\
= 2383.16 \text{ LBS/BOLT}
\]

## Thrust on Enclosure Due to Unequal Bores

\[
P = \text{Pressure} \\
T = P \left[\left(D^2-(d)^2\right)/2\right] \times 7.854 \\
D = \text{Large Bore Dia.} \\
d = \text{Small Bore Dia.} \\
T = \text{Thrust on Enclosure}
\]

\[
P = 90 \left[\left(9.65^2-(8.09)^2\right)/2\right] \times 7.854 \\
= 1954.35 \text{ LBS}
\]

**Stud Size:** 1/2 X 13UNC BBMCL1
DESIGN CALCULATIONS

WORKING LOAD PER STRONGBACK STUD

\[ T = \text{THRUST} \quad \text{WL} = \frac{T}{N} = \frac{1954.35}{6} = 325.73 \text{ LBS/BOLT} \]

\[ N = \text{NUMBER OF BOLTS} \quad \text{WL} = \text{LOAD/BOLT} \]

MAX ALLOWABLE LOAD PER STUD

\[ S = \text{MAX ALLOW. STRESS/STUD} \quad ML = A \cdot S = 0.126 \cdot 18800 = 2363.16 \text{ LBS/BOLT} \]

\[ A = \text{TENSILE OR ROOT AREA/STUD} \quad ML = \text{MAX ALLOW LOAD/STUD} \]

STUD SIZE: 1/2 X 13 UNC B8MCI1
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
Thank you

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