SF6 Gas Decomposed!
Best handling practices APC

- Billy J Lao
  General Manager
  DILO Direct,
  Odessa FL / Casa Grande AZ

- Neil Hutchins
  Senior Engineer Southern Company Services
  Substation Maintenance Support
  Support to Alabama Power Company

www.dilo.com - www.dilodirect.com
Items to be discussed

- Sulfur Dioxide SO2
  - Description
  - Safety

- SO2 – Contributing factors

- Best Practices AL Power / Southern Company

- Final Reporting practices AL Power / Southern Company
Sulfur Dioxide (SO2)

Chemical Formula
- SO2
  - Consists of 1 Sulfur and 2 Oxygen atoms (Dioxide)
  - Can be found in our atmosphere in low concentrations
  - It is a toxic gas with a pungent, irritating smell (rotten eggs)

Safety
- SO2
  - Major pollutant and in case of exposure a potential health issue
  - Inhalation can contribute to increased respiratory symptoms and disease, difficulty in breathing, and premature death
    - NOTE: Those with asthma are likely to be more sensitive to SO2 and may have stronger/heightened negative reactions
  - SO2 can be found as a powder in an area where it has formed, but may also be found in vapor space in GIE or in cylinders.
  - SO2 is a reactive substance that can have a negative impact on materials such as metals (found in GIE) as well as other materials in GIE and gas handling equipment as it is highly corrosive and acidic.
### Sulfur Dioxide (SO2) Contaminants – SF₆ Decomp Byproducts

<table>
<thead>
<tr>
<th>Chemical Name</th>
<th>Chemical Formula</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Gaseous Byproducts</strong></td>
<td></td>
</tr>
<tr>
<td>Sulfur Dioxide</td>
<td>SO₂</td>
</tr>
<tr>
<td>Thionyl Sulfide (sulfur tetrafluoride)</td>
<td>SOF₂ (SF₄)</td>
</tr>
<tr>
<td>Hydrogen Fluoride</td>
<td>HF</td>
</tr>
<tr>
<td>Disulfur Decafluoride (sulfur pentafluoride)</td>
<td>S₂F₁₀ (SF₅)</td>
</tr>
<tr>
<td>Sulfuryl Fluoride</td>
<td>SO₂F₂</td>
</tr>
<tr>
<td>Sulfur Tetrafluoride Oxide</td>
<td>SOF₄ (SF₄)</td>
</tr>
<tr>
<td><strong>Powder Byproducts</strong></td>
<td></td>
</tr>
<tr>
<td>Tungsten, aluminum, copper fluorides</td>
<td>WF₆, WO₃, AlF₃, CuF₂</td>
</tr>
</tbody>
</table>

*SF₄ is readily hydrolyzed to SOF₂.*

Sulfur Dioxide (SO2) contributing factors

Arc Byproducts

- Formed by the bonding of split atoms from SF₆, trace gases (i.e. moisture vapor) and metal oxides (erosion byproducts) after an event causing the SF₆ molecules to separate when exposed to heat > 385 F (normal operation or a fault)

- Highly corrosive
  - Can shorten maintenance intervals
  - Can cause equipment failure in high enough concentrations

- Very acidic in nature
  - Can pose a severe health risk

- Created from electric discharges
  - Partial discharges (normal conditions & abnormal conditions)
  - Switching arcs (normal operation)
  - Failure arcs (i.e. GIE dielectric failure)
  - etc.
Sulfur Dioxide (SO2) contributing factors

Primary Contaminants
U.S. EPA’s 2017 Workshop on SF6 Emission Reduction Strategies

APC SF6 Best Practices

January 24, 2017

Neil Hutchins
Southern Company Services
Support to Alabama Power Company
U.S. EPA’s 2017 Workshop on SF6 Emission Reduction Strategies

• Neil Hutchins,
  • Senior Engineer Southern Company Services Substation Maintenance Support

• Over 18 Years of experience in Transmission/Substation Maintenance
• Provide Support to Alabama Power Company on SF6 equipment,
  • Purchase SF6 Breakers, 15 kV to 500 kV
  • Manage Alabama Power Company spare SF6 breaker fleet
  • Provide support to Alabama Power Company’s Substation Maintenance groups,
    Substation support group, Substation Construction, Safety and Training
    organizations
• Advisor to Southern Company Major Equipment Committee
• IEEE Senior Member
• Member of IEEE/PES Switchgear Committee
• Member of IEEE Alternative Gases to SF6 Task Force
• Member EPRI Substation Task Force
Alabama Power Company / Southern Company SF6 Best Practices
Alabama Power Company / Southern Company SF6 Best Practices

- Plan
  - What (Event/operation)
  - Who (Personnel required)
  - When
  - Communication (Information, Location, impacts, etc)
  - Impact to employees, system, public, customers, etc.

- Training
  - Procedure and Guidelines
    - Equipment
    - SF 6 Gas
    - Hazards
    - Respirator
    - Compliance

- Practice
Alabama Power Company / Southern Company SF6 Best Practices

- Personal Protective Equipment
  - Tyvek Disposable coveralls with protective shoe covers
  - Complete Rain Suit (Switching)
  - Nitrile gloves
  - Duct Tape
  - Full-face respirator with AG/OV/P100 cartridge
  - SCBA with auxiliary, if personnel entering area/space

- Personnel and Equipment Decon
  - Defined Area for Personnel Decon
  - Distilled Water
  - Baking Soda
  - Pump up sprayer(s) with Baking soda and distilled water mix
  - HEPA Vacuum with non metallic attachments
  - SF6 Cylinder(s) empty (Under Vacuum)
  - SF6 Recovery and Testing Equipment
  - Denatured alcohol
  - Atmosphere/air monitor
Alabama Power Company / Southern Company SF6 Best Practices

• Clean-up Supplies
  • Distilled Water
  • Baking Soda
  • Pump up sprayer with Baking soda, distilled water mix and food coloring
  • Trash Bags
  • Rags
  • Paper Towels
  • HEPA Vacuum with non metallic attachments

• Wind Sock (Monitor direction of the wind)
• Weather Forecast and impacts
• Barricade tape
• Clear assignment of duties
• Disposal Plan
• First Aid Kit
• AED
• Medical Plan (Paramedics, Hospital and location, etc)
• Identify Onsite and Offsite support
• Alarms

• Relay event records analysis

• SF6 Gas Quality analysis

• Breaker Information
Crew members in PPE
Alabama Power Company / Southern Company SF6 Best Practices
View of Phase 2 Tank with Stationary Interrupter Assembly removed
Bushing connection moving side on interrupter for Phase 2
Moving Arcing Contacts for Phase 2
• QUESTIONS ?????