Bushing Failures in MV Switchgear

Coetzee van Heerden
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Introduction

- Significant number of failures
- Major damage to buildings and plant
- Causes?
- Possible remedies
Background

- 2,396 Oil breakers installed from 1963 to 1994
- 1,472 SF6 breakers installed from 1987 to 2008
- Theoretical advantage of SF6 technology over oil
- Problem not with arc quenching medium but with resin cast bushings and shutter boxes
Failures & Observations

- Waterfront SS, Falls Breaker
Failures & Observations

- Waterfront SS, Quarry Breaker
Failures & Observations

- Santyger SS, Hardrock Breaker
Failures & Observations

- Faasen SS
Failures & Observations

- Junction SS
Failures & Observations

- Southern Sewing SS
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- Bellaire SS
Failures & Observations

- Solway SS
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- Solway SS
Failures & Observations

- Nqubulani SS
Failures & Observations

- Cape SS
Failures & Observations

- Cape SS
Partial Discharge Activity

- An electrical discharge that bridges a portion of the insulation between two conducting electrodes.
- May occur in aged, defective or poor quality insulation.
- Can lead to flashover and failure.
- Emits electromagnetic, acoustic and gaseous energy [e.g. ozone, nitric acid]
Partial Discharge: Contributing Factors

- Bushing design
- Effect of voids, pores and bubbles in mouldings
- Moisture
- Alignment of breaker or shutter box
- Introduction of foreign objects – vermin guards
PD: Contributing Factors

- Bushing design: Considerations
  - Environmental conditions
  - Suitability of materials
  - Available skills and technology
  - Quality control
  - Pollution
  - Maintenance skills and cycles
PD: Contributing Factors

- Moisture
  - Humid air
  - Water drops
  - Heaters / dehumidifiers
  - Surroundings e.g. irrigation
  - Trench dry
  - SS design - sloping trench
PD: Contributing Factors

- Breaker / shutter box alignment
  - Inconsistency of electric field
  - Decrease in air gaps
  - Damaged bushings
  - Increased PD effect in cluster contact
PD: Contributing Factors

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- Vermin seals
- Poor adhesion
- Voids
- Dirt
PD: Contributing Factors

- Vermin seals
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PD: Contributing Factors

- Cluster contact design
PD: Contributing Factors

- Cluster contact design
PD: Contributing Factors

- Cluster contact design
PD: Early Detection

- Smell / hear
- Physical inspection
- Handheld / portable instruments
- Permanently mounted instruments
Conclusion

- Design constraints
- Quality moulding and manufacturing
- Quality of installation
- Heaters / dehumidification
- Upgrade cluster contacts
- PD surveys
- Maintenance frequency
Thank you

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- Colleagues at the City of Cape Town