



NERC Lessons Learned

Donnie Bielak
Manager, Reliability Engineering



Cold Weather Operation of SF₆ Circuit Breaker



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November 12, 2020

- January 29-30, 2019 upper Midwest US
- SF₆ circuit breakers hit critical low pressure from cold temperatures
- Operating philosophies:
 - Circuit breakers auto-trip
 - Rely on breaker failure scheme and remote clearing
 - Contingency modeling will need to change
- Tank heaters may be overwhelmed by cold weather and high wind

- Mixed-gas CB's developed for use at temperatures as low as -50°C (-58°F)
- These breakers utilize a gas mixture to prevent condensation of the SF_6 gas
 - SF_6 & CF_4
 - SF_6 & N_2
- Costly
- Require more equipment
- No heaters
- Reliable for extreme cold temperatures
- Used predominantly in far northern locations

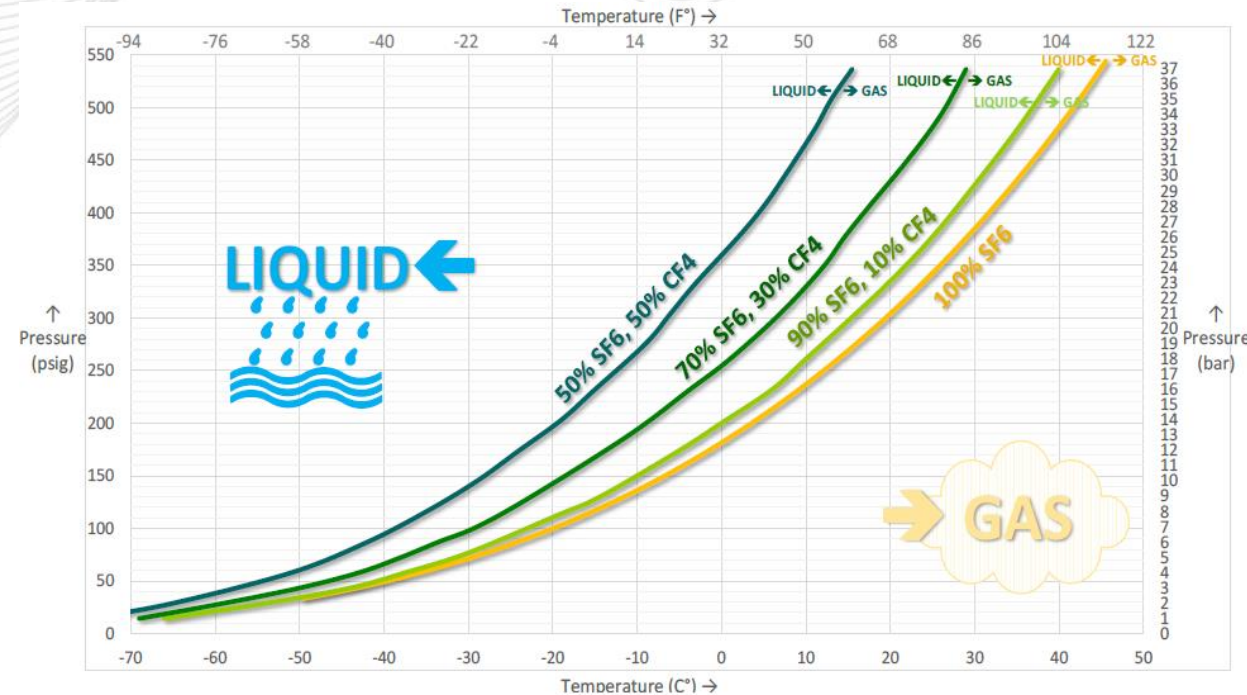


Figure 1: SF_6 and SF_6 - CF_4 Mixed Gas Phase Change Diagram [1]

- Regional Data Query for CB operations due to critical low pressure provided
- Prior to winter, there should be maintenance and inspection of SF₆ CB tank heaters
- Alarming for a tank heater failure can alert in advance that a CB may hit critical low
- TOs/TOPs should assure that the contingency model involving that CB is updated and shared with all impacted TOPs and RCs



Loss of State Estimator due to
Contradicting Information from Dual
ICCP Clusters



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- Primary ICCP points were suspect
- Failed over to backup ICCP
 - Hundreds of external devices switched status from indexing error
 - Two isolated topology areas were formed due to external devices switching status
 - State Estimator (SE) became non-convergent
- SE returned to using primary values when backup points suspect
- Entity able to override SCADA statuses closed
- Backup was corrected by rebooting ICCP cluster (reason for corruption unknown)

- Entities should develop and practice plans for disabling one or more external company data feeds
- Servers should be rebooted before any changes are implemented under the vendor's recommendations
- A dashboard should be developed to quickly show values from all SCADA sources and the SE for each piece of incoming data
- Call out procedures should be reviewed to determine if support staff are notified within an appropriate time frame
- Collaboration tools should be reviewed and tested to determine if modifications are needed while staff may be working in disparate locations

[1] Cold Weather Operation of SF6 Circuit Breakers

https://www.nerc.com/pa/rrm/ea/Lessons%20Learned%20Document%20Library/LL20201101_SF6_CB_Operation_during_Cold_Weather.pdf

[2] Loss of State Estimator due to Contradicting Information from Dual ICCP Clusters

https://www.nerc.com/pa/rrm/ea/Lessons%20Learned%20Document%20Library/LL20201102_Loss_of_SE_due_to_Contradicting_Information_from_Dual_ICCP_Clusters.pdf

Presenter:
Donnie Bielak, donnie.bielak@pjm.com

SME:
Donnie Bielak, donnie.bielak@pjm.com

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Member Hotline

(610) 666 – 8980

(866) 400 – 8980

custsvc@pjm.com