

## Study Committee A3 Transmission and Distribution Equipment

Paper 10655\_2022

# RDDS measurements for 245kV and 420 kV High Voltage Circuit Breaker

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### Motivation

- The future network, with larger contribution from renewables, will require more frequent switching. **Controlled Switching (CS)** of cap. banks or shunt reactors avoids transient overvoltage and inrush currents, provides stability and reduces maintenance
- Evaluation of **RDDS (Rate of Decrease of Dielectric Strength)** is crucial to apply CS

### Method/Approach

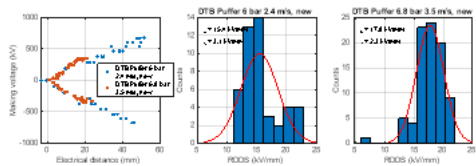
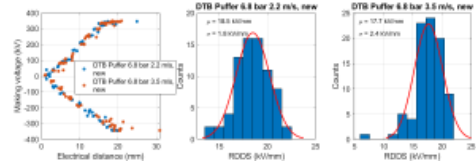
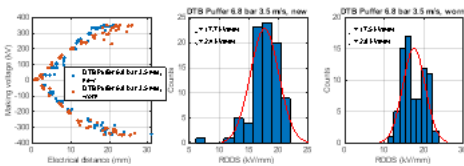
- For each shot, **"inherent" RDDS (kV/mm)** is calculated as pre-arcing(making) voltage/pre-arcing distance
- Statistical approach is applied to the RDDS test data (fit with **normal distribution**)
- For example, breakers in new and worn conditions can be compared (no influence of wear):

### Experimental setup & test results

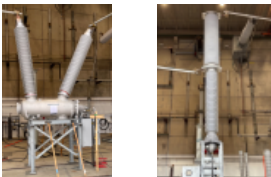
- In standard RDDS measurements, the **HV circuit breaker (HVCB)** is closed against AC rms  $U_r \times V$  (1/3)
- Dielectric breakdowns will occur when the contacts reach the **pre-arcing distance**
- The close impulse of the drive is shifted, to cover the full voltage cycle in 24 windows (by 15°)

### Discussion

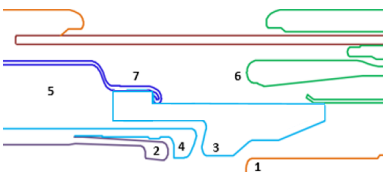
- No influence on RDDS (in kV/mm) of **closing speed**. RDDS scales linearly with **pressure** (here, DTB puffer)



### Objects of investigation

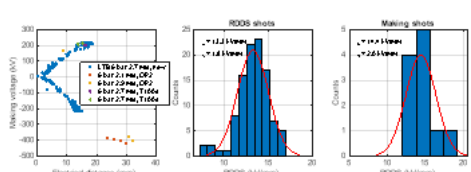


- 3 HVCB compared in this study: LTB (245 kV), DTB (245 kV) and DTB puffer (420 kV) – 6 bar SF<sub>6</sub>
- Legend: 1-plug (fixed contact), 2-tulip (moving contact), 3-insulating nozzle, 4-auxiliary nozzle, 5-compression volume (CV), 6 and 7-nominal contacts



### Conclusions

- This work has shown that nozzle/contacts wear and closing speed have no significant influence on the **inherent RDDS value (kV/mm)** of the studied breakers.
- Only the filling pressure has a clear influence on RDDS, a simple linear scaling predicts very well the behavior.
- The RDDS values derived from making operations during power tests (25% and 100% of the full short circuit currents) can be good and easy to achieve early estimates of the RDDS performance of the breaker
- Example (LTB) of RDDS evaluation from making shots



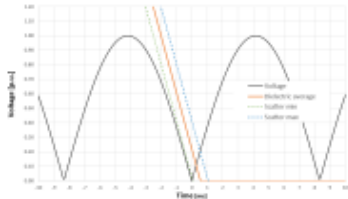
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### RDDS measurements for 245kV and 420 kV High Voltage Circuit Breaker continued

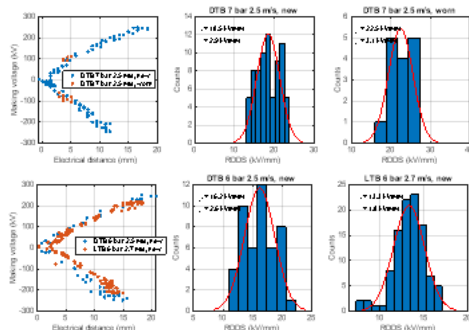
#### Controlled closing at voltage zero

- Example with of +/- 0.5 ms scatter



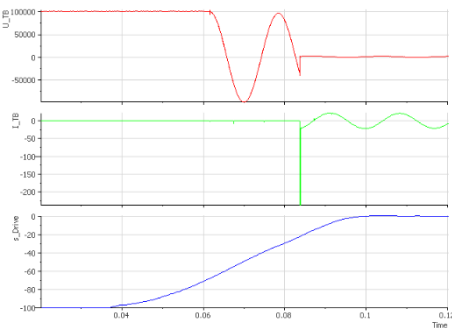
#### Additional results

- New/worn and LTB/DTB comparison



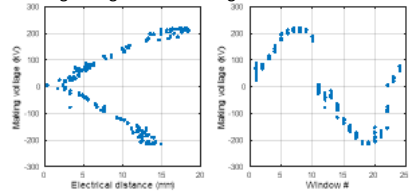
#### Experimental method

- Oscillogram example of a making operation with a breakdown occurring at around -80 kV
- Pre-arcing distance measured on the linear travel measurement



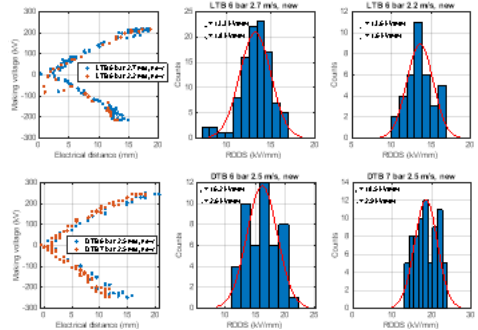
#### RDDS tests - 6.113 IEC/TR 62271-302

- The series of two to four shots performed at each making voltage is the "making window"



#### Additional results

- No closing speed effect (LTB), P linear effect (DTB)



#### RDDS evaluation from making shots

- In two type tests it is required to perform making tests at 100% and 25% of the short circuit currents
- High making current wears contacts and nozzles, but limited influence is to be expected on RDDS
- These tests can be used to evaluate the RDDS

