

## Study Committee B2

Overhead Lines

10135\_2022

### DEVELOPMENT OF METHODOLOGY FOR INSULATOR REPLACEMENT IN $\pm 800$ KVDC STRINGS USING LIVE LINE PROCEDURES

Ricardo Wesley S. GARCIA<sup>1</sup>, José Antonio A. S. CARDOSO<sup>1</sup>, Frederico T. S. SILVA<sup>1</sup>, Carlos Frederico T. MATT<sup>1</sup>, Fabiano R. FARIA<sup>2</sup>,  
Diego V. R. MACHADO<sup>2</sup>, Pedro M. BRITO<sup>2</sup>, Rodrigo A. S. COSTA<sup>2</sup>, John F. GRAHAM<sup>2</sup>, Luan O. SENNA<sup>2</sup>, Armando I. NIGRI<sup>3</sup>

<sup>1</sup>Electric Energy Research Center – CEPEL <sup>2</sup>State Grid Brazil Holding – SGBH <sup>3</sup>Consultant

#### Motivation

- Start of operation of  $\pm 800$  kVDC bipoles in Brazil



- Definition of live line procedures for replacing damaged insulators

#### Method/Approach

- Application of theoretical approach for definition of MAD and minimum number of good insulators
- Electrical and mechanical laboratory tests
- Evaluation of tool for replacing damaged insulators without removing the entire string

#### Objects of investigation



- Tool for replacing a damaged insulator locally in the string

#### Experimental setup & test results



- MAD = 6,70 m
- Minimum number of good insulators = 31 (in a string of 39 units, i.e. 8 damaged units)
- All the results obtained shown withstand voltages greater than the maximum project overvoltage (1408 kV)

#### Discussion

- Definition of procedure for moving the lineman from the tower to the insulator string

#### Conclusions

- The electrical and mechanical results confirm the withstand of all arrangements tested, indicating the safety of the lineman
- All the live line procedures were tested step-by-step and approved in the laboratory arrangement

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continued

#### Traditional methods for replacing damaged insulators

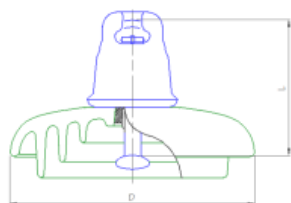
- extremely difficult or even impossible in UHV OHTLs due to length and weight of the strings
- Using trolley pole method



- Using cradle method



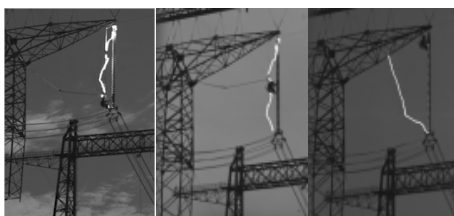
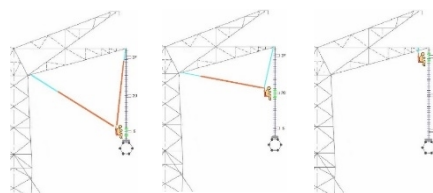
#### Glass insulators



Characteristics	320 kN	420 kN
Diameter (D)	360 mm	360 mm
Length (L)	195 mm	205 mm
Creepage distance	645 mm	635 mm
Weight (approx.)	13.5 kg	15.5 kg

#### Test arrangements

- Electrical tests



$U_w=1746$  kV

$U_w=1596$  kV

$U_w=1583$  kV

- Mechanical tests



- Tensile tests: 1.5x rated load
- set of tool + insulators
- All passed

#### Maximum number of damaged insulators

- Lineman sitting on the chair = 1.20m
- Maximum 3 damaged insulators

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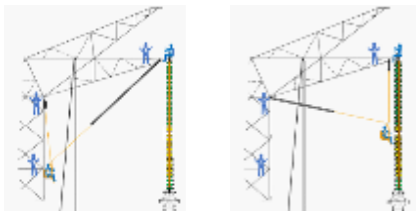
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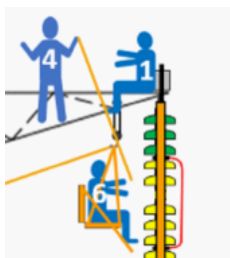
#### Displacement of lineman from the tower to the insulator string

- Using blocks, insulating chair and insulating sticks
- As perpendicular to the string plan as possible

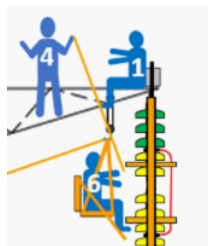


#### Step-by-step for replacing damaged insulator

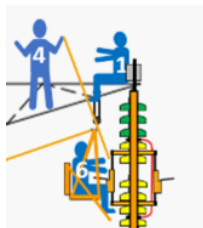
- The **lineman wearing conductive suit with face mask** is correctly positioned near the damaged insulator
- Installation of the **stick for static grounding**, placed between the second insulator above the damaged one and the fourth insulator below it



- Installation of **the upper and lower parts of the equipment** respectively on the first insulator above the damaged one and on the third insulator below the damaged one.



- **Installation of the set of tightening screw** that connects upper and lower parts to pull this section of insulator string to allow to removal the damaged insulator.



- Finally, the team on the crossarm gives the lineman a **good insulator** which is placed in the insulator string.

