

**Study Committee A2**  
Power Transformers and Reactors

10131\_2022

**Selection of high voltage bushings for transformers and shunt reactors  
considering local conditions – Brazilian transmission network case**Santhiago MONTENEGRO\*<sup>1</sup>Nilton VIVEIROS<sup>2</sup>Yoshio NOMI<sup>3</sup>Roberto ASANO JR<sup>4</sup><sup>1</sup>CHESF<sup>2</sup>SIEMENS-ENERGY<sup>3</sup>HITACHI-ENERGY<sup>4</sup>UFABC**Motivation**

- Bushing's reliability is a topic of interest for the Power Grid community
- Their reliability begins with a proper selection according to the requisites of use
- The market competition imposes pressure to reduce equipment's acquisition costs and consequently the requisites of bushings to the minimum requirements
- National Standard are adaption of IEC 60137 Standard
- Peculiarities of National Grid are fully reflected in Transformers/Reactors standards but the same may not be said about Bushings
- The correct match between performance required by the grid and the actual design of bushing is left entirely at responsibility of utility's specification

**Objects of investigation**

- How far from the system's necessity is an IEC homologated bushing?

**Objective of investigation**

- Support the discussions at National Committee regarding the normative requisites of transformers and reactors applied to National Grid

**Method/Approach**

- Regional Peculiarities are listed, such as regulations and grid requisites
- Specialists of manufacturers were consulted regarding some aspects presented on standards

**Results**

- Annual temperature in Brazilian territory is at least 10°C higher than the IEC requisites
- It was not possible to assert with safety that overload Brazilian condition prescribed for transformers and reactors are fully covered by clause 4.2 of IEC 60137 standard
- Type tests performed on AC 50 Hz in some cases is not entirely representative for 60 Hz requisites

**Conclusion**

- A national WG was established with the aim of give contributions to improve the reliability of transformers and reactors bushings
- Requisites is an important step to define the reliability of the component, which is influenced by market's competition on the pressure on prices
- The differences between IEC requisites and regional characteristics must be left to the asset owner to specify
- The findings of the work will be used to support the discussions on the national standard review

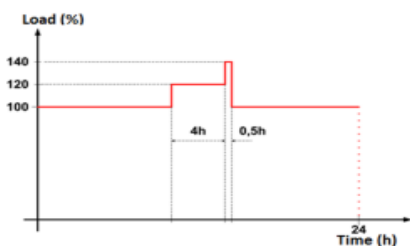
**Study Committee A2**  
**Power Transformers and Reactors**  
**10131\_2022**

**Selection of high voltage bushings for transformers and shunt reactors**  
**considering local conditions – Brazilian transmission network case**

**continued**

**Transformers Daily Load requisit**

- Top oil allowed 105°C at IEC vs 115°C at Brazilian standard load guide for transformers
- Brazilian bushings standard and IEC have the same overload requisite – 120% of maximum current rate



**Temperatures**

- Brazilian standard allows 65 K top oil elevation while IEC allows 60 K
- Annual mean temperature IEC 20 °C – Brazil at least 30 °C

**60 Hz vs 50 Hz for type tests**

- Skin effect should be considered on temperature tests
- For each 1000 A, the expected increase on 50 Hz current is an amount of 44 A
- Thermal stability also should be done considering the skin effect

**Spec practices**

- Bushings BIL one class higher than coil
- Bushing Nominal current higher than 1,2 coil current, some cases 1,5 coil current
- Request for type tests for supply or expire time limit for type test (5 years, 8 years typically)
- Some utilities forbid use of porcelain or OIP bushings to prevent fire or launch of pieces

**Sustained overvoltages in line end reactors**

- Overload permissible for line reactors

Rated Operational Voltage (kV)	Maximum sustained voltage for 1 hour (phase-to-phase) at open LT	
	kV <sub>RMS</sub>	p.u.
138	152	1,10
230	253	1,10
345	398	1,15
440	506	1,15
500	600	1,20
525	600	1,15
765	800	1,046

**Selection of high voltage bushings for transformers and shunt reactors  
considering local conditions – Brazilian transmission network case****continued****Discussions - Daily Load requisit  
at the point of view of bushings  
experts**

*“Top oil allowed 105°C at IEC vs 115°C at “The 120% “rule” in cl. 4.2 of IEC 60137 is actually only based on practical experience without need for any validation – this is indicated by the little word “considered” in the text. To further emphasize that bushings are dimensioned based on daily mean temperature the highlighted section was added to the text during the revision work preceding edition 7. ...*

*Because of the inconsistencies between IEC 60137 and IEC 60076-7 the only way for the standard to actually require verification of an overload requirement would be to agree on a load cycle between the bushing- and transformer- committees of IEC and no such discussions are in progress.*

*As already said, the 120% “rule” was a discussion item during the most recent revision work but since practical experience shows very few problems are attributed to this it was decided to just add the small clarification of which data bushings are designed from.”*

**Discussions - Daily Load requisit  
at the point of view of  
bushings experts**

*“Your scenarios are already considered by IEC60137, IEC is the standard we strictly follow to design all our bushings.*

*IEC Paragraph 4.2 mention that “bushing for transformer selected with IR not less than 120% of rated current of the transformer” so overload of 1.2X is acceptable considering air and oil temperature according to Table 4.*

*Overload 120% and oil max temperature 100°C, are scenarios accepted by IEC60137 and than by our bushing too.*

*About the below scenario (national grid transformer overload) we kindly ask to pay attention 0,5h is not enough to reach the thermal stability, on the base of the bushing type it may rise the temperature to a very high level.*

*We suggest in those cases of overload more than 120% to discuss case by case with bushing manufacturer. In this way the bushing maker will perform all the needed test and/or simulation to grant the acceptability of the condition.”*