Study Committee A3

Transmission and Distribution Equipment

Paper 10132_2022

Substation Equipment Overstress Management: CIGRE TB 816 Compilation

WG A3.30 **Members:**

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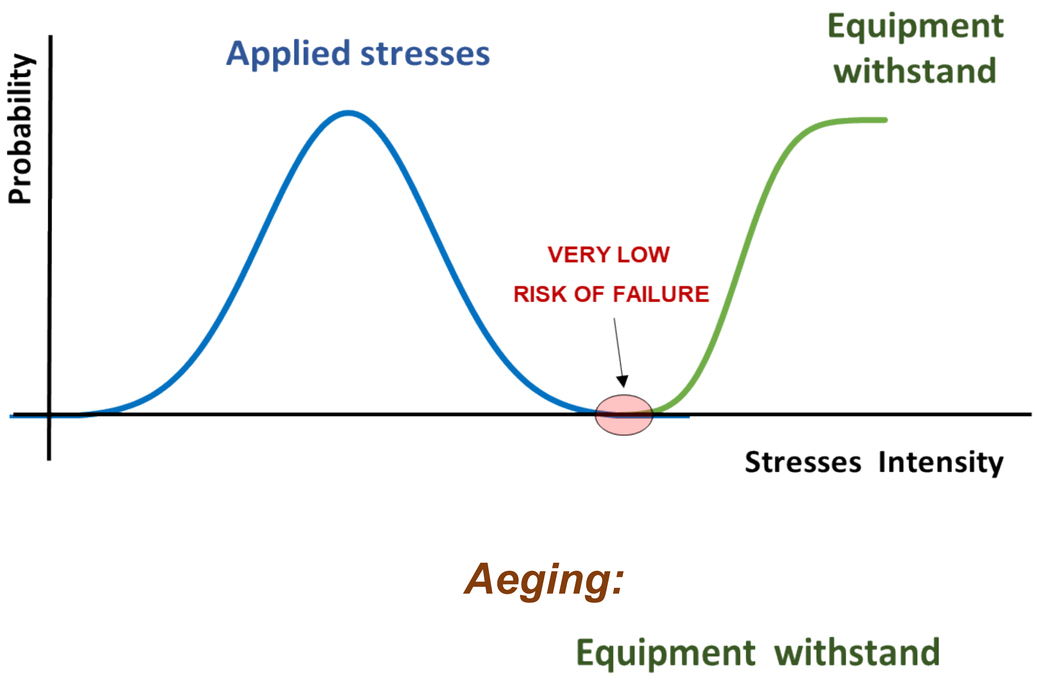
Motivation

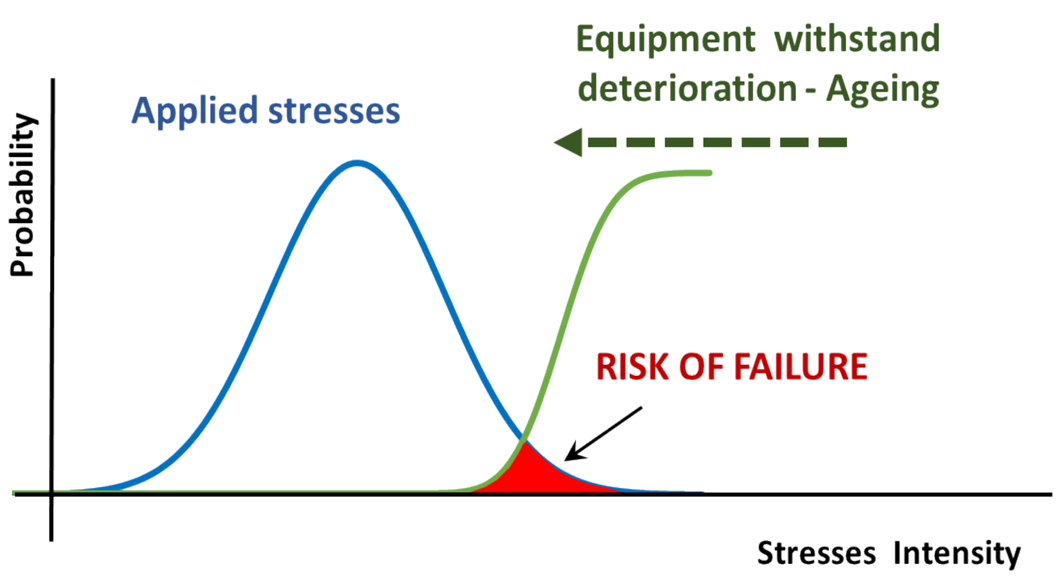
- CIGRE WG A3.30 reviewed HV substation equipment life management with respect to overstresses and overstresses management practices;
- Major motivation is the identification of possible future overstresses to avoid endangering of HV equipment performance;

Overstress Concept

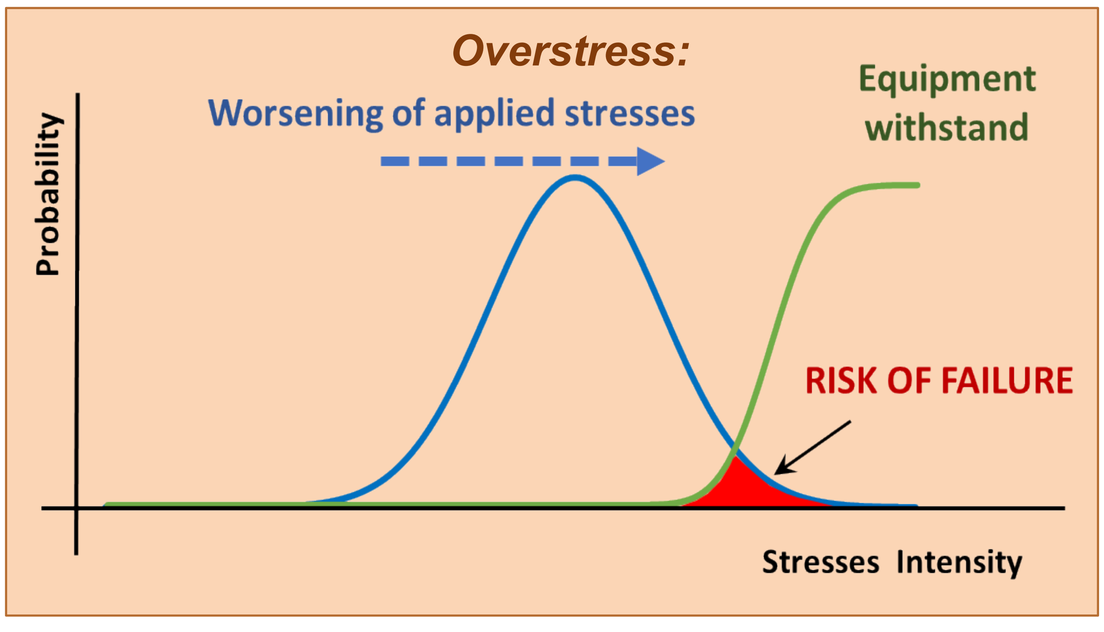
Normal operation condition:



Aeging:



Overstress:



Method/Approach

- Identification of the main kinds of overstress applied to HV equipment and the correlation with equipment performance parameters;
- Besides electrical overstresses from power system, environmental and human activities are also taken into account as possible sources of overstress;
- Prioritization of the relevant stress parameters for each kind of equipment by means of specialists knowledge (Delphi Method);
- Finally, relevant stress parameters for each equipment were identified and compiled in the Table 1:

Table 1

Equipment Impacted				CB GIS	CB AIS	Disconnector	Earthing switch	Surge arrester	Post insulator	Instrument transformer	Capacitor bank	Power Transformer	Shunt Reactor
Origin of stresses applied to HV equipment	Normal Stresses	Electric System	Continuous operation at degraded topology (N-x) leading to load current overstress	●	x	x				x		●	
			Continuous operation at degraded topology (N-x) leading to voltage overstress	●	●			●		x	x	●	●
			Temporary stress due to load current	x	x	x				x		●	
			Temporary stress due to operation voltage	x	x	x		x		x	●	●	●
			Current and voltage overstresses due to switching	●	x	x		●		x	x	●	●
		Human activities	Pollution		●	x	●	●	x	●			
			Improper erection & commissioning	x	x	●	●	●	●	●	●	●	●
			Improper maintenance	x	x	x	x	●	●	●	●	●	●
		Environment Normal events	Wind		●	●	●	●	●				
			Ice		●	●	●	●	●	●	●		
			Low & high ambient temperature		x	x	x	●			●	●	●
			Fire	●	x	x	●	●	●	●	●	●	●
			Lightning	●	x	●		x	●	●	●	●	●
			Salt fog		●	●	●	●	x	●	●		
			Heavy rains						x				
			High humidity		x	x	x	●	●	●	●	●	●
			Sand storm		●	●	●	●	●	●	●		
			Eartquake (< 8 Richter scale)		●	●	●	●	●	●	●	●	●
		Animals	Trespassing of animals			x	x		●		x	●	●
	HILF Events	Human activities	Pandemics	High impact and low frequency events impairing the whole grid. Shall be considered in the context of power systems "RESILIENCE".									
			Malicious actions										
		Environment Abmormal events	Tsunami										
			Tornado & hurricane										
			Earthquake (> 8 Richter scale)										
			Volcano activity										
			Big solar magnetic storm										
			Severe heat, severe flooding, severe rain and humidity, severe cold, snow and ice, severe wind and sand storms – above standard values										

"X": *stresses prioritized by the WG A3.30*

"●": *also relevant stresses. Utility shall decide upon its prioritization*.

- TB 816 summarizes overstresses checking routines for utilities, aiming at avoiding possible overstress in the future by taking measures to mitigate them (whenever possible), or planning equipment replacement.

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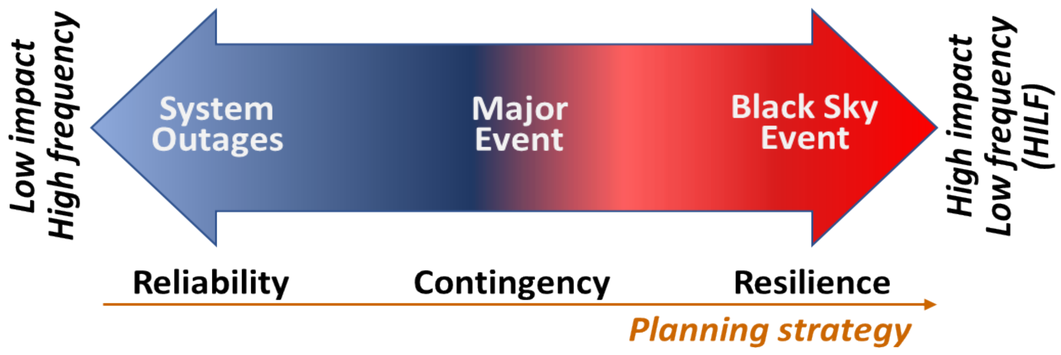
Overstress in the Context of Resilience

- After publishing TB 816, just at starting of COVID 19 pandemic, the concept of resilience of power systems gained importance;
- According to CIGRE WG C4.47, power system resilience is "the ability to limit the extent, severity, and duration of system degradation following an extreme event";
- This concept is well understood and practiced at system operation level (CIGRE SC A2 – System Operation);



- TB 816 identified several kinds of overstresses falling under HILF events (see Table 1);
- Generally, this kind of overstress can not be treated at system reliability planning level, due to the associated costs;
- **Therefore, they shall be analysed under the perspective of power system infrastructure resilience.**
- The key question is how to prepare utilities to fast recover from a HILF event.
- Focus is not reliability, but restoration of service;
- Local and Federal authorities, regulators, suppliers and customers representatives must be involved and responsibilities well defined.

Conclusion

- Overstress is quite relevant sub-process of asset management policy;
- Utilities shall assess the risk of overstresses affecting HV equipment and define applicable solutions (mitigation measures or replacement);
- TB 816 give guidance to utilities for defining equipment overstresses management process;
- Topics asking for deeper analysis:
  - **Operation voltage above ratings & Temporary overvoltage withstand ability** (JWG A3/A2/A1/B1.44 Consequence of High Voltage Equipment operating exceeding highest system voltages);
  - **Controlled switching for MV switchgear:** under discussion in Study Committee A3 the creation of a new WG;
  - **Overstress due to pandemic, abnormal environmental events and malicious acts**: falling under HILF umbrella. Shall be analysed from the perspective of infrastructure resilience.
  - Actions foreseen to the next future in the figure below.