Paris Session 2022

Seismic substation design in New Zealand

SC B3 PS2 Question 1

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TRANSPOWER

Seismic substation design in New Zealand

SC B3_PS2_Q1

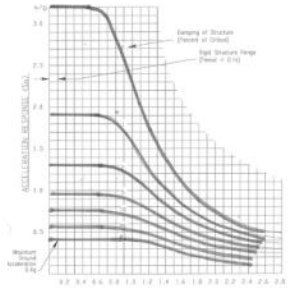
What are the management challenges to maintaining existing substations in both the short term and long term? What new ideas and concepts will provide insight on asset life extension and reduced cost while improving reliability?

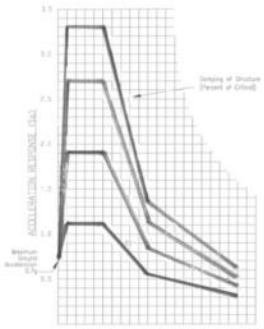
Our experience is that applying Safety by Design principles for seismic event survival is critical to achieve reliable and safe continuity of supply during and after an earthquake. This requires structurally connected systems to remain intact.

Shaker testing to seismic standards using fully built up and electrically connected equipment as it is intended to be installed has been proven to identify and correct components and connections that would have otherwise been modes of failure.

Finite Element Analysis has proven itself as a modelling methodology that increases the likelihood of system survival, provided shaker table testing outcome is measured for alignment with the deterministic FEA model's expected outcome.

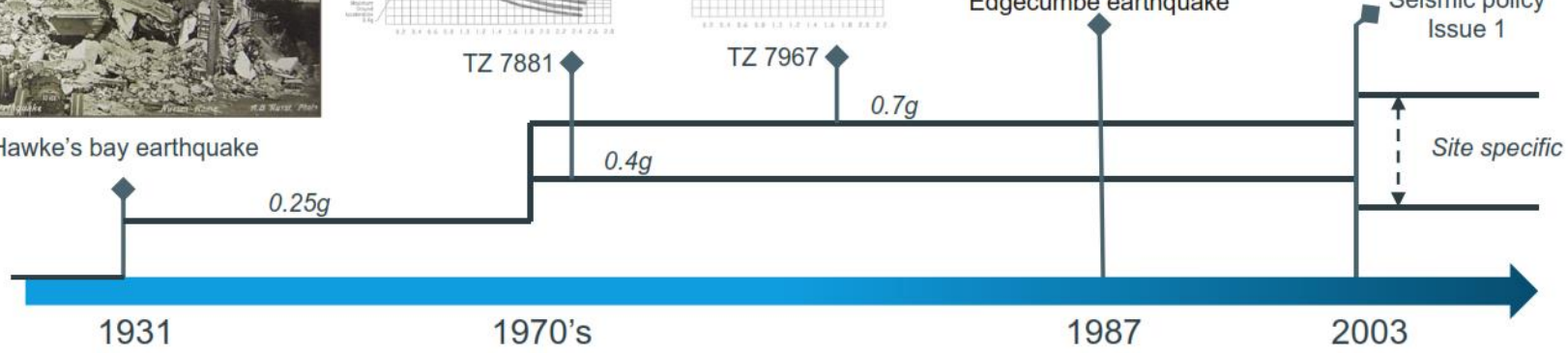
Brief history of seismic standards and practices for NZ electricity transmission assets





Edgecumbe earthquake

110KV CB AND CT (COURTESY OF ABB)



- Test at 1g peak ground acceleration, equivalent to 22 Feb 2011 Christchurch earthquake

National Grid seismic response lessons - Canterbury earthquakes

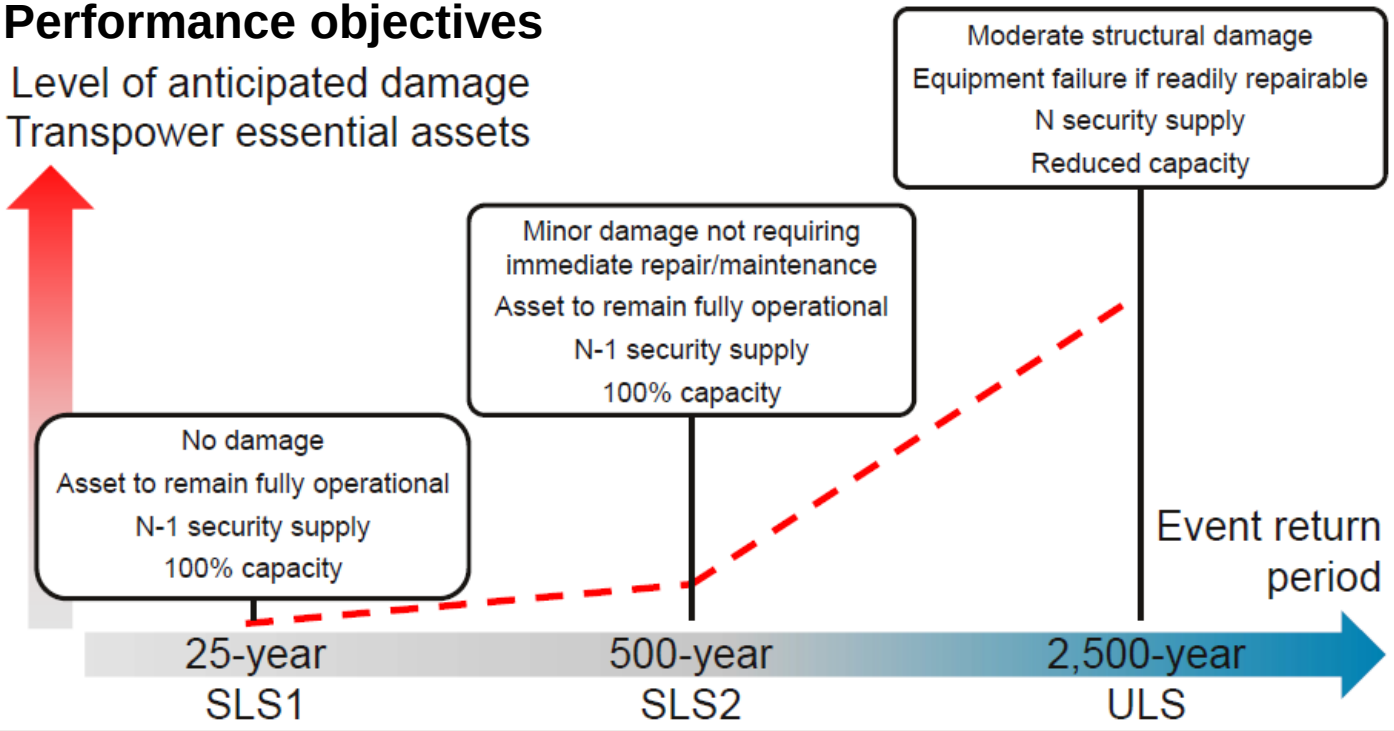
- Transmission line assets
- Existing substation buildings
- Switchyard equipment
- HV buried cables
- Switchyard flexible connections

National Grid design, test and installation out come parameters

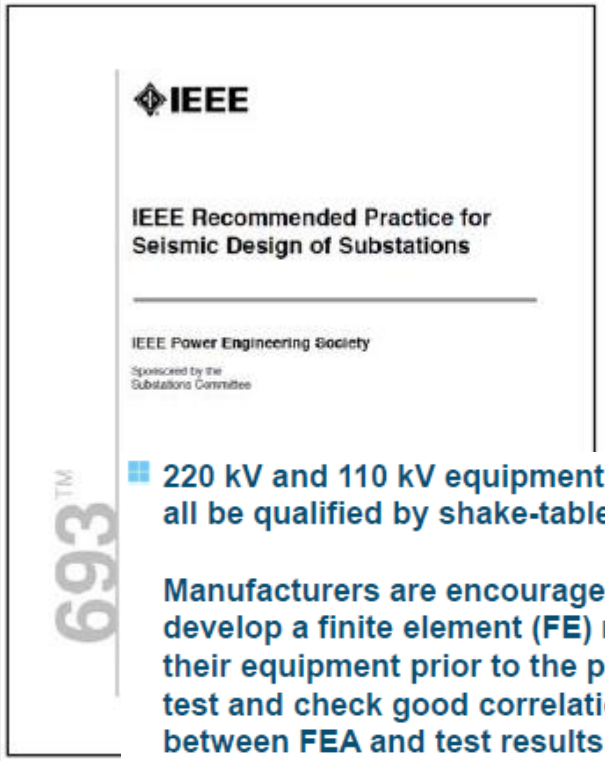
Reliability levels

SUBSTATION ASSETS	IMPORTANCE LEVEL (AS/NZS1170)	DESIGN WORKING LIFE	RETURN PERIOD (YEARS) OF DESIGN EVENT		
			SLS1	SLS2	ULS
ESSENTIAL EQUIPMENT / FACILITIES AND CIVIL STRUCTURES	4	50 YEARS	25	500	2,500

Performance objectives



National Grid seismic standards and test methods

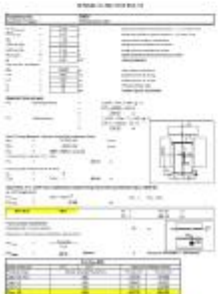


	STATIC ANALYSIS	DYNAMIC ANALYSIS	SHAKE-TABLE TEST
220kV		◆	◆
110kV		◆	◆
66kV	◆	◆	
33kV	◆		

- 220 kV and 110 kV equipment should all be qualified by shake-table tests.

  Manufacturers are encouraged to develop a finite element (FE) model of their equipment prior to the physical test and check good correlation between FEA and test results.

  They can use the FE model to qualify minor modifications to their equipment.



- Transpower's preference, when practical, is to test the complete structural system rather than its individual components as it is the performance of the system that matters.

- It is sometime not practical to shake-table test large or heavy equipment. In this case, the equipment is qualified by way of Finite Element Analysis.

Future seismic investigation for National Grid improvements