Documentation
Electrical design criteria for D1

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21/09/2018

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Introduction

- Electrical tests are performed to verify that the integrity of the insulations of the elements of a circuit are within the pre-defined nominal limits.
- Electrical tests are required to certify acceptance before cooling down components at cryogenic temperatures, before installation of components in the tunnel and further during commissioning and operation
- Components (magnets, bus bars, link, current leads, instrumentation, including also the warm DC distribution elements) must be designed according to voltages that they should withstand during operation. Defining test levels (according to worst conditions) is something intrinsically linked to the design of components. Defining realistic testing conditions requires the understanding of both design of components and the operational aspects
- For HL-LHC, it has been decided to apply worst case conditions including one (in some cases two) levels of failure – e.g. one or two heater circuit failing

Basis for the document

- The **values** taken as reference are given at **nominal currents**; ultimate current values are intrinsically included within the established, engineering margins

- In the same way as for ultimate current conditions, we have considered that **the conservative cases will follow the same rule, i.e. no safety margins will apply onto those extreme (realistic but with very low likelihood of happening) cases**

- No margins with respect to worst case calculated values are taken for inter-turn voltages

Structure of the document

Electrical design criteria for D1

1. Introduction (F Menendez, F Rodriguez)
2. Electrical tests strategy (F Menendez, F Rodriguez)
3. Defining the high voltage test levels (KEK, F Menendez, F Rodriguez)

Example of document: EDMS 1963398
https://edms.cern.ch/document/1963398

Defining the high voltage test levels

- **Expected behaviour at quench:**
  - Simulated quench integral
  - Hot-spot temperature
  - Peak voltage to ground
  - Peak turn to turn voltage

Example from IT

		SUPERMAGNET		ROXIE		TALES	
		I_{nom}	I_{ult}	I_{nom}	I_{ult}	I_{nom}	I_{ult}
Current	**kA**	11.85	12.80	11.85	12.80	11.85	12.80
Quench integral	**MA^2s**	15.7	16.8	15.9	16.9	15.8	16.2
Hot spot temperature	**K**	320	360	310	350	320	342
Peak voltage to ground	**V**	n.a.	n.a.	350	450	245	340
Peak turn to turn voltage	**V**	n.a.	n.a.	63	95	75	80

The values taken as reference must be given at nominal currents

- **The failure cases considered with:**
  - Simulated quench integral
  - Hot-spot temperature
  - Peak voltage to ground
  - Peak turn to turn voltage

Example from IT

		Nominal		1 circuit failure		2 circuits failure	
		I_{nom}	I_{ult}	I_{nom}	I_{ult}	I_{nom}	I_{ult}
Current	**kA**	11.85	12.80	11.85	12.80	11.85	12.80
Quench integral	**MA^2s**	15.8	16.2	16.1	16.4	16.2	16.5
Hot spot temperature	**K**	320	342	327	349	333	356
Peak voltage to ground	**V**	245	340	570	680	950	1070
Peak turn to turn voltage	**V**	75	80	80	90	90	95

Thanks for your attention