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Date of the meeting : 15 January 2020

WP6a Safety Analysis : Meeting Minutes #1

Project/Activity: HL-LHC – WP6a Safety Anaysis

Present : *P. Cruikshank, T Otto, N. Grada, V. Parma,Y. Leclerq, V. Gahier, A. Ballarino, J. Fleiter, A. Gharib*

Excused : *S. Claudet*

Agenda:

Indico event https://indico.cern.ch/event/880301/

- Introduction (P. Cruikshank)
- Failure Modes of HL-LHC cold power system (N. Grada, T. Otto)
- Proposal for safety valve & burst disc set pressures (V. Gahier)
- AOB

Introduction (P. Cruikshank)

PC recalled the motivation for starting the meeting on WP6a safety analysis with the stakeholders:

- Perform risk assessment on failure modes leading to helium release,
- Identify missing inputs (calculation, validations, mitigation, etc.) and agree planning.
- Get formal approval of risk assessment from HL-LHC and ATS management.
- Ensure design of DF, DSH, DFH fulfills the functional requirements.

Initial goals are to get agreement on:

- WP6a system design pressure,
- Burst disk & SV opening & staging,
- Ins vacuum safety valves opening & staging,
- Vac Barrier positioning,
- Instrumentation needs.

Failure Modes Document:

TO & NG introduced the document 'Failure Modes of the HL-LHC Cold Powering System (WP6a) Leading to Helium Release, Edms 2303664. The underground service areas of the HL-LHC in the UW, UR & UA remain accessible to personnel during operation of the accelerator. The failure modes are summarised in the table extracted from the document (Patricia please insert table from page 23 of edms 230664).

Discussion & comments:

- The helium inventory needs to be confirmed for all hardware.
- Based on present knowledge of the WP6a helium inventory, the possible failure scenarios and resulting discharge rates, and the volume and tunnel height of the UR galleries, TO considers that there won't be a ODH issue for personnel present in UR, but the no-stay zones and deflectors may be necessary at the DFH helium discharge locations to avoid localised ODH and cold gas hazards.
- The baseline for the system design pressure is 3.5 bara.
- The document shall reference all supporting documentation (specifications, calculations, etc,)
- The plug at the interface to the 1.9K helium enclosure of the triplet is exposed to the quench pressure of ~ 17 bar. This is similar to other LHC configurations eg the separation plugs at the DFBA interfacing to the arc magnets. TO will check how the latter is assessed and apply a coherent strategy to the DFX/DFM case. Maximum orifice in the plug due to its mechanical design to be assessed. Post meeting: VG discussion with A. Perin – the understanding is the safety devices in LHC were not designed for total plug failure.
- The pressure conditions and failure modes of the DFX heater circuit shall be included.
- The analysis of the electrical arc failure modes should be made considering the behaviour of the full cold circuit, so WP3 should be involved.

Safety valve/burst disc set pressures:

VG presented a first proposal for the safety valve and burst disc set pressures for the DFX/DFHX.

- The arrangement takes account of the normal and extended operating pressures at the DFX up to the DFHX.
- Burst disc and safety valve (SV) opening pressures are staggered to prioritise helium discharge to the LHC tunnel.
- Combining the staggering and expected tolerances on the opening pressures leaves a small margin with respect to the extended operating pressure during cooldown/warmup.
- Insulation vacuum failure of the DSH results in significant heat in-leaks (helium discharge 1000-2000 g/s peak) if the vacuum degradation is considered over its full length. In the case of a local air leak during cold operation, a more realistic model should be considered where the degraded vacuum propagation is slowed due to the cryopumping of the air components (n2,O2) on the cryogenic surfaces. Calculations could be complemented by a test on the 60 m demonstrator (after the cable performance measurements).
- Insulation vacuum failure at the DFH may lead to high initial helium discharge rates in the UR (100-200g/s) but it's expected that the L.He inventory in the DFX will be expelled over may hours due to the a low heat transfer along the link.
- Examples of the existing systems of DFB and RF cavity were recalled – helium release would be to the LHC tunnel.

- VG to check the conditions of accessibility for the replacement of burst disk (as per ISOLDE) : Post meeting: after checking with Olivier Pirotte, access is possible (with correct PPE) only if there is no liquid present and pressure is atmospheric. It should also be highlighted that DFX will be located in a "high" radiation zone (access may be delayed). In case of burst disk rupture, the event will be major and the repair may take time (replacement of the Burst disk may not be the urgency).

AOB

- AB recalled that the baseline design pressure of 3.5 bara is not acceptable for the present design of the DSH helium cryostat. Further discussion are necessary with the proposed supplier to understand the pressure limitations of the design and possible improvements to approach the 3.5 bara design pressure.
- The calculation by T. Northam are included for information.

Next Meeting: 29th January 2020, for the list of topics refer to https://indico.cern.ch/event/880865/

Prepared by: P. Cruikshank

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