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Cryogenic Risk Assessment in LHC

Helium spill risk in LHC

Pressure Tests not performed	
Temperature between 300 K and 80 K	Spill rate 1 kg s^{-1}
Powering Phase 2 (full magnetic field)	
Powering Phase 1 (standby, hardware tests)	Spill rate 320 g s^{-1}
Residual risk during Technical Stops and Shut-Downs	A spill of 100 g s^{-1} may occur, if sensitive cryogenic equipment is damaged

Helium Spill WG Recommendation

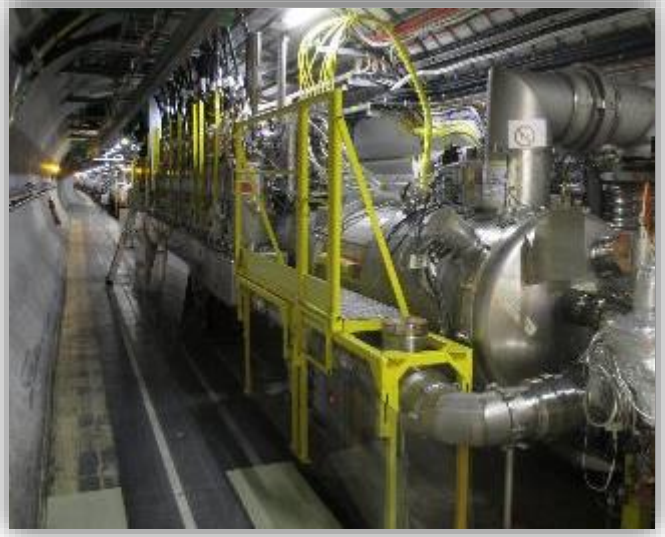
- **Once T < 80 K, access to LHC tunnel only at stable temperature and with zero current in the main magnets**
- **Remaining risk of He spill is human error on sensitive instrumentation and DFBs**

Helium pressure gauge

Memo of the Complex Manager

Since Autumn 2014:

- Activities in the vicinity of cryogenic equipment need to be authorised by the Complex Manager when T < 80 K
- For recurrent activities (piquet, “best effort”), Work Frame authorisations can be given
- Two “He-spill” Safety Officers are preparing the risk assessments



DFBA

LHC Tunnel

Exempted Activities

BE Dept.	BE-BI BPM electronics	Servicing front-end crates, electronics cards, fibres or cables of the LHC BPM system
DGS Unit	DGS-RP Survey	Assessment of radiological risks at the worksite from the transport zone of the tunnel.
	DGS-SEE Inspections	Safety inspections, tests of Level-3 alarms and accident analysis.
EN Dept	EN-HE Transport	Transport of equipment and spares in the LHC tunnel and to the RRs and REs. Transport of the Tomograph.
	EN-MEF Geometry and Alignment	Geometric measurements of the position of accelerator equipment, alignment of equipment in long straight sections.
	EN-MEF Small Works	All interventions of the Small Works team in the SI section which have been screened by the Safety Coordinators and which are not in the vicinity of sensitive cryogenic instrumentation.
GS Dept.	GS-ASE Alarms	Test and maintenance of Fire Detection and Evacuation Systems, Flammable Gas and ODH Detection Systems, Red Telephones, CERN Safety Alarm Monitoring (CSAM))
TE Dept.	TE-ABT Injection	Activities on Injection systems
	TE-ABT LBDS	Activities on LHC Beam Dump System in P6
	TE-ABT MKQ	Activities on MKQ magnets in P4
	TE-EPC Piquet	Interventions on the 60 A supplies, placed under the magnets and accessible from the transport zone and on equipment in the RRs

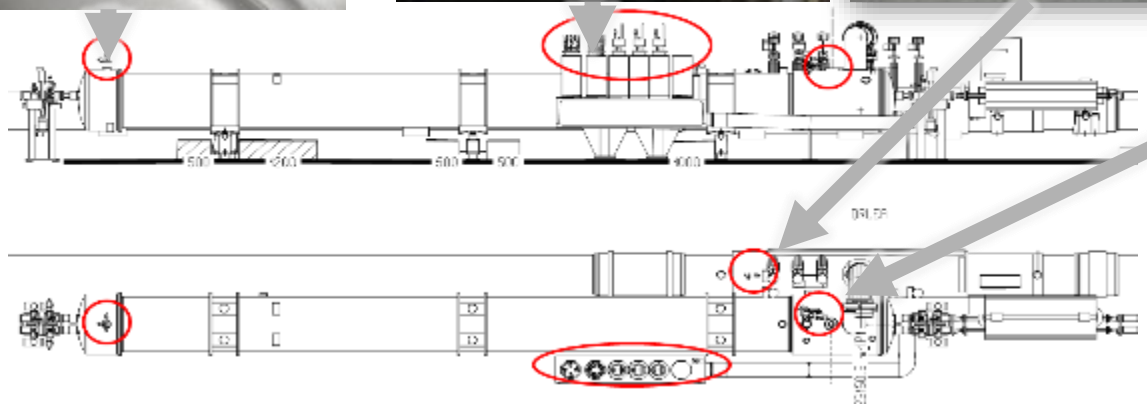
Sensitive Locations for He-spill

Multivalve port

Direct Current Feedbox (DFB)

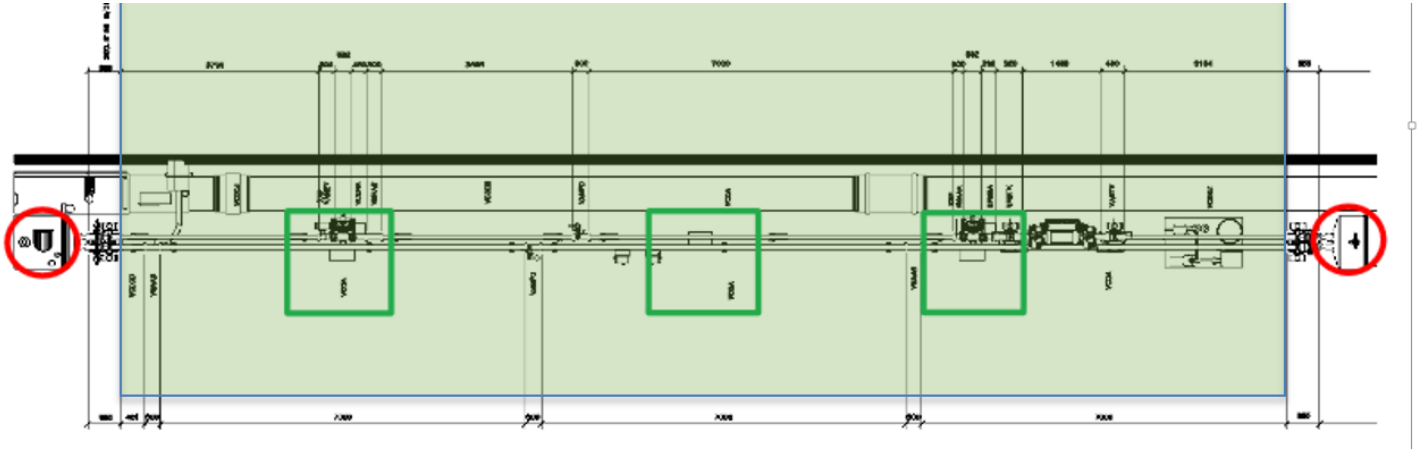
He pressure gauge

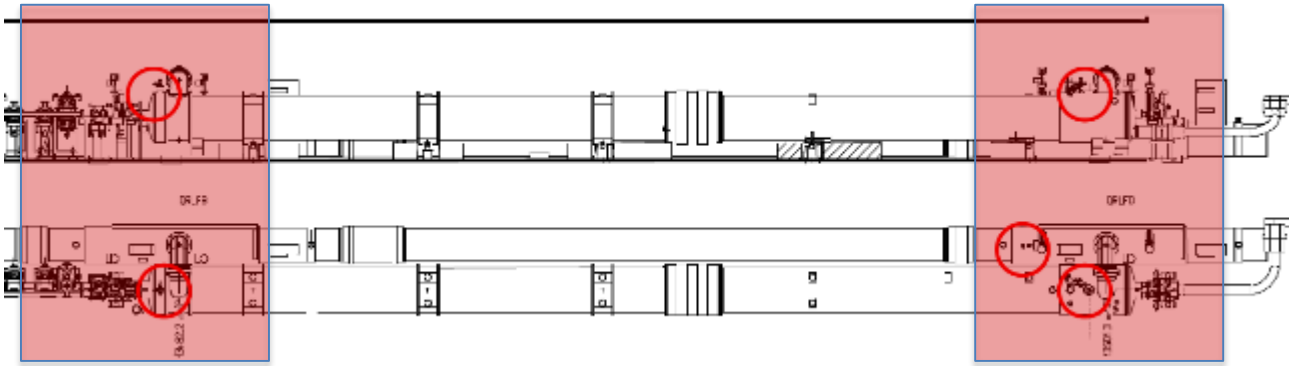
Vac instrumentation ports



Methods of Control 1

- Definition of Go / No-Go areas

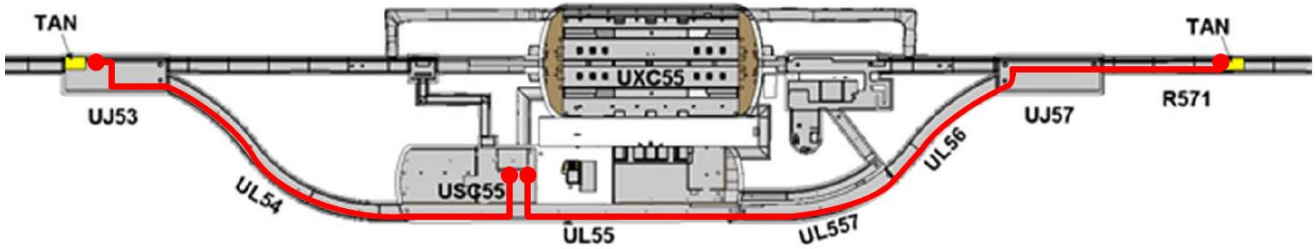


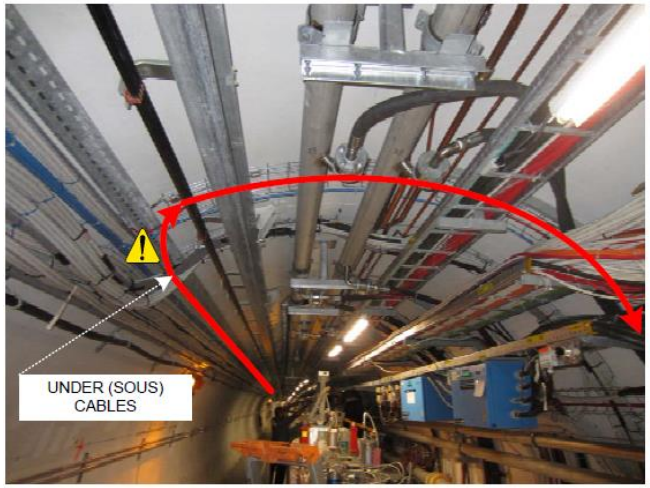


D2Q4R5, (entre R57 et UJ57) DCUM 13501

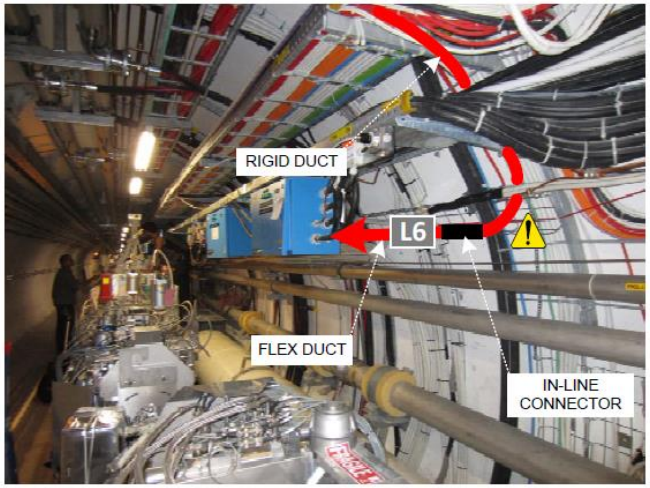
Methods of Control 2

- Detailed access instructions, avoiding sensitive equipment





P4 *Cablofil* to cross the LHC beam in R571



P5 In-line connector position in R571

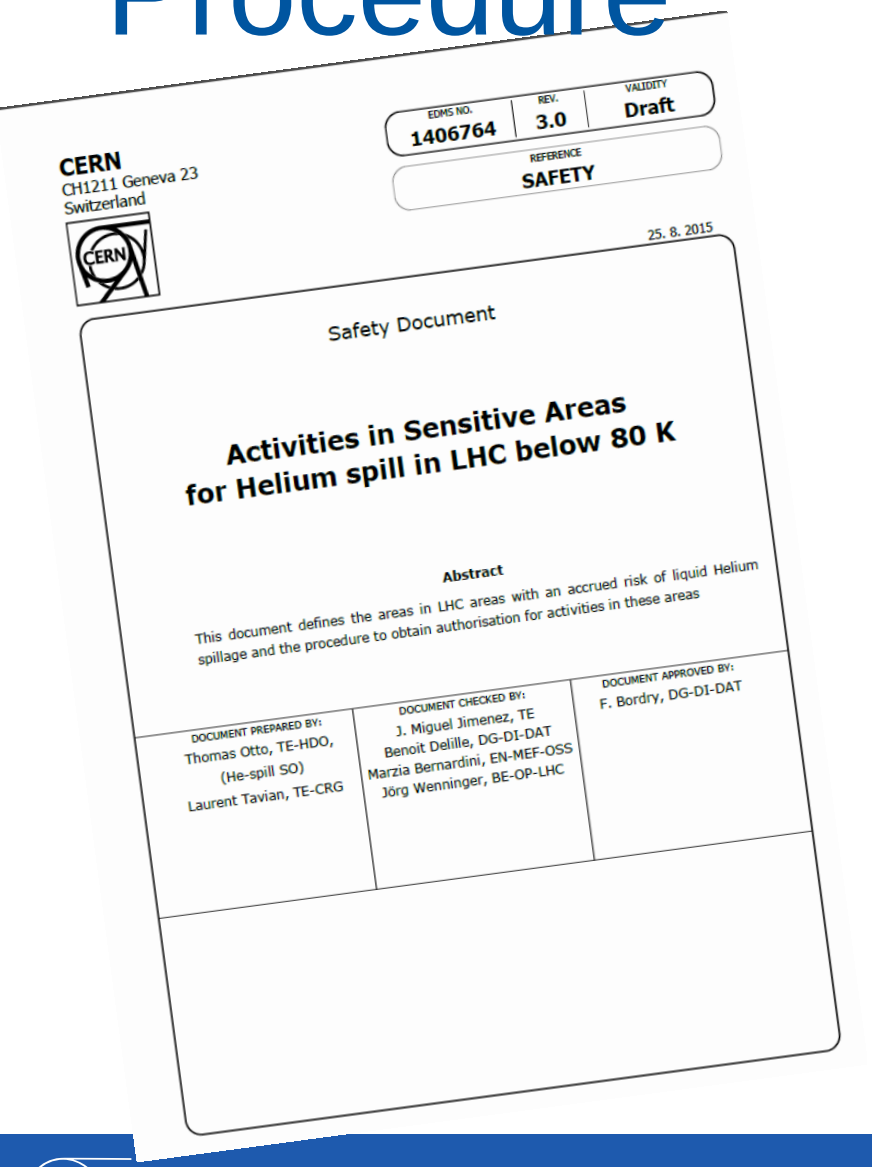
Methods of Control 3

- Information of personnel
  - Helium Spill hazards are identified during the risk assessment with the works supervisors
  - Works supervisor informs and instructs in turn personnel under his responsibility

Methods of Control 4

- Emptying sensitive equipment from lHe
  - Direct Current Feedboxes
  - RF cavities
  - … Inner Triplet Magnets (see later)

Procedure



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Safety Document

Activities in Sensitive Areas for Helium spill in LHC below 80 K

Abstract

This document defines the areas in LHC areas with an accrued risk of liquid Helium spillage and the procedure to obtain authorisation for activities in these areas

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1. Identify activities in LHC tunnel
2. Activities in transport zone alone are exempted
3. Activities around DFBs and on QRL-side of cryostat / beam line require authorisation
4. **Risk Analysis by HE-spill SO and requestor, based on documented procedures**
5. RA checked by Hierarchy
6. RA submitted to Complex Manager
7. Approval by electronic signature

Work Frame Authorisations

BE	BE-BI BGV	Installation of BGV detector
	BE-BI-BL Activities	BGI Cameras; BLM Installation and Maintenance; BWS Servicing
	BE-BI-PI Activities	BCTDC Maintenance
	BE-BI-PM Activities	BRAN Maintenance; BTV Electronics; BSRT Service
	BE-BI-QP Activities	BPM Collimator Connection; BPM Test; Tune Test; WCT Installation
	BE-CO-FE WorldFIP	Repair of connection faults in WorldFIP TAP boxes or repeaters
	BE-OP Patrol	Patrol of the access control system (*includes IT areas)
DGS	DGS-RP RAMSES	Servicing of radiation monitors
EN	EN-EL-OP	Piquet Service
	EN-MEF-MM	Radiographie Industrielle
TE	TE-ABT-FPS	Work on MKI
	TE-CRG-OA	Piquet Service
	TE-MSC-SCD	Cabling activities
	TE-VSC-IV	Interventions on insulation vacuum

Inner Triplet Area

only one direction of escape

Inner Triplet Area

- Result of the Helium-spill WG :
- Access to the triplet areas at a temperature T < 80 K is forbidden
  - In well-justified cases, exceptions from the rule can be granted by the Complex Manager, with compensatory measures
- Under which conditions are exceptions possible ?

“Well justified cases”

- Activities to take place in the cold IT areas must be related to, in order of importance
  1. Personal Safety (e.g. the BE-OP patrol)
  2. Equipment Safety (e.g. BLMs monitoring the triplet quadrupoles)
- By default, interventions should be scheduled for the next TS, where the triplets can be emptied
  1. Accelerator availability
  2. Attaining nominal performance
  3. Performance enhancement

Inner Triplet Area Access Types

- Short access
  - The duration of the access is short (t < 10 min) AND
  - the workers remain in the transport zone AND
  - no work close to the cryostats (“Hands in pocket”)
- No compensatory measures, authorisation by CM

- Long access
  - The access takes longer than 10 min OR
  - the activity involves manipulations other than in the transport zone (remote possibility to damage the cryostats / instrumentation)
- Compensatory measures and authorisation by CM

Compensatory measures

- For a long access to the IT Areas, the insulation vacuum of the triplets can be monitored with a pressure gauge attached to a visual/audible alarm.

- This is limited to max. ½ day interventions and subject to VSC manpower availability
- Another compensatory measure is to empty the triplet from liquid Helium (takes 2 times 7 hours).

Summary 1

- Helium Spill WG identified **human error** as largest risk factor for He spill once the LHC cryostats are cold and at stable T < 80 K
- Activities in sensitive areas are restricted
- **(Work Frame) Authorisations are given by the Complex Manager after Risk Analysis of work procedures**

Summary 2

- Access to IT areas remains forbidden.
- Well-justified exceptions in the interest of Safety and safe operation are possible
- Authorisation involves
  - Risk assessment
  - Compensatory measures, where required
  - The consent of the hierarchy
  - The signature of the Complex Manager
- This procedure guaranties Safety and maintains operational flexibility.


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