

## Session 4:

# Safety for Personnel Underground He evacuation

Sylvain Weisz & Daniela Macina

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- ❑ Follow-up of the recommendations on the Task Force on Safety of Personnel in LHC Underground Areas (Ralf Trant and Sylvain Weisz);
- ❑ Safety in the Experiments (Olga Beltramello and Christoph Schaefer)
- ❑ Safety organization in the LHC during shut-down work (John Pedersen and John Etheridge)
- ❑ Radiation risks during LHC operation and requirements for maintenance and repair (Doris Forkel-Wirth)
- ❑ LHC ventilation system (Mauro Nonis)

## Main messages

# Implementation status of TF recommendations

Recommendation Number	Closed issues	Open issues being addressed	Open issues
# 6			✓
# 7	✓		
# 8	✓		
# 9	✓		
# 10	✓		
# 11	✓		
# 12		✓	
# 13		✓	
# 14		✓	

The sealing of the LHC tunnel towards other underground areas to protect them from Oxygen Deficiency Hazard (ODH) and from possible overpressure.

to the safety task Force recommends the implementation of a study group to propose possible options. One such option is to use the existing ventilation ducts equipped with overpressure relief devices and reinforced to withstand the high mass-flow rates.

**All safety measures required for 2009/10 run have been completed**

Ralf Trant



# Additional recommendations by EAC – status

*[only the open issues]*

- “... The existing **risk matrices** from 1999 should be **systematically reviewed** again with regard to the latest experiences. ...”  
[Preliminary risk analysis of the LHC cryogenic system, M. Chorowski, *et al.*, *LHC-Project-Note-177*, (1998)]  
→ **open issue being addressed**
- ... a strong consideration to **formally track the progress** of each recommendation, ...  
→ **open issue being addressed**
- The **2-Phase approach** ... technical implementation of the ... control for tunnel access ... not clear whether the control will be connected to the **access interlock**.  
→ **open issue being addressed**



# Consolidation of Safety in underground areas

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The consolidation and upgrade of the He release to surface will follow a 2 steps strategy:

- 1) Fulfill RP, fire & explosion protection, and ensure the separation of UA's galleries from LHC tunnel is the first priority for the next shut-down
- 2) Study & design new He release paths to remove constraints on the access matrix. Remark from Freddy Bordry: need to validate how to seal ducts with warm cables

SW

## The LHC Experiments have implemented very high safety standards in the experimental areas in order to be ready for LHC operation

(Run period and Shutdowns activities and in case of re-occurrence of an Accidental He release in tunnel areas) :

**Sealing of CMS and access to UPS galleries at Pt5?**  
**- Not a safety issue, access is the main problem**  
**- Will be fixed during the next shut-down ...**

- ❑ The ... pressure protected and sealed.
- ❑ The Alarm 3 systems are operational and under maintenance control.
- ❑ A reinforced Safety Structure and Organization has been set up :
  - A strong activities analysis, approval and planning structure
  - And a key role : the SLIMOS
- ❑ A close collaboration with the CERN Fire Brigade has been developed
- ❑ The Radioprotection strategy has been set up and is operational

Olga Beltramello

# The SLIMOS (Shift leader in matter of safety): a Key role in the Experiments Safety Organization.

The Experiments Safety, Infrastructure and Access data converge to a central location: the SLIMOS desk.

These data are treated by the SLIMOS to which the GLIMOS delegates part of his safety duties together with the necessary authority.

The SLIMOSes are specifically trained for their safety duties, they follow regular information/instruction campaigns .

Weekly feedback and training meeting with the GLIMOS (ATLAS).

The SLIMOS coordinates the experimental cavern opening and closing process during the Beam period:

- ✓ Check the safety conditions of the cavern
- Coordinate the RPE / Safety team interventions (RP veto removal, material activation controls,...), coordinate the Patrol intervention if required,..
- Check the ventilation status and caverns overpressures (ATLAS, CMS)
- Run the access opening and closing procedures with CERN Control Center
- Strictly control the person and material going in and out during the intervention.

He coordinates actions after level 2 and level 3 alarms inside the Experimental areas:

Interaction with the Fire Brigade, the CERN Control Center and the Infrastructure and Experiment Experts.



# Ventilation

Christoph Schaefer

Critical safety functions of the ventilation system shall be guaranteed, e.g.:

- Overpressure regimes between caverns and tunnel must be established and kept stable.
- Supply a sufficient air flow rate for underground safe areas.
- Alarm level 3 actions in case of ODH, smoke, etc.
- Reliable control system and adequate instrumentation.

# Evacuation

Christoph Schaefer

The safe areas in front of the lifts are the backbone of all LHC evacuation scenarios

## Mandatory requirements:

- Work must continue to ensure that all underground Safe Areas, are safe indeed (ventilation and structure).
- Permanent availability of two independent and secured evacuation paths.



# Radiation Protection

Christoph Schaefer

- Magnetic field resistant RP measurement devices are required. Today we are practically blind. (DGS RP working on it)
- Need to evaluate if additional monitors in experimental caverns are required.
- RAMSES gate alarms must be connected to the access control system. Activated material shall not leave the site without permission.

**Remark from Doris Forkel-Wirth:  
not available on the market,  
need to develop this instrument**

# Safety Organisation Depending on Machine Mode

- ▶ Based on the nature of the two situations, or machine modes, it is proposed that
  - the EN safety organisation supervises the safety during shut down,
  - the BE safety organisation supervises the safety during operation, with or without beam.
- ▶ This proposal requires a clear definition of the interfaces and responsibilities during transfer from operation to shutdown and back.
- ▶ It also requires a clear definition of WHEN the machine can be considered in shut down mode.
- ▶ The transfer from operation to shut down – and back – will be complex.
  - It will be done sector by sector.
- ▶ How do we handle the transfer of safety supervision?
- ▶ How do we handle the safety in the machine with certain sectors in shutdown and others not? (Access, different organisation...)

# Application of Safety Rules and Procedures, 1

- The correct application of the rules will require the understanding of the rules. This implies *instruction*.
  - It is part of the responsibility of the CERN groups, and of the contractors, that their personnel follow the proper training. Time must be allotted to this.
- If properly trained elements do not respect the rules, *measures* will be taken.
- This double approach requires the support of the management.

**By-passing of Safety rules to 'gain time' is not acceptable**

**John Pedersen**

# What is the added value of the Safety Coordination ?

- We take part in joint inspections with all departments, in all areas and act as an interface with the experimental caverns, not only LHC but CERN wide.
- We get things done in a safe way in the interest of the organization.
- We manage and control difficult situations and we meet dead-lines.
- We make the most of the means and documentation available to us.
- We propose **solutions**.

John Etheridge

# When should the Safety Coordination be called upon?

- The Safety Coordination should be involved from the **conception** stage and they should be consulted if there are **major modifications** to be carried out.
- The objective is to ensure that prevention is built in where ever possible.
- This will improve the working conditions, reduce risks, improve the quality of the work and therefore save time and money.

John Etheridge

# Working Platform?



M. Arnaud, C. Bedel, J. Etheridge, E.  
Paulat

## Positive Conclusion

- ◆ Feed Back or 'Retour d'expérience'
  - ◆ The work carried out in sector 3 - 4
  - ◆ The organization for the changing of the water cooled cables
  - ◆ Consignation
  - ◆ Scaffolding
  - ◆ Coordination
  - ◆ The new practical Biocell training
- ◆ As proof of the value of the safety coordination: the number of requests for joint inspections has gone up.

**Question: Can you manage with the full Acc. & Exp. complex at CERN?**  
**Answer: there is work for a 5<sup>th</sup> Safety Coordinator ...**

# Radiation Risk During LHC Operation

Releases of radioactivity by air into the environment scale with beam energy, beam losses for machine and luminosity for experiments

Short lived isotopes:

11-C, 13-N, 14-O, 15-O, 41-Ar  
(mainly external exposure)

Doris Forkel-Wirth



Intensity	Dose to person of reference group Point 1	Dose to person of reference group Point 7
2010	~ 100 nSv/y	~1 uSv/y
Nominal	5 uSv/y	4 uSv/y (assuming modifications installed)



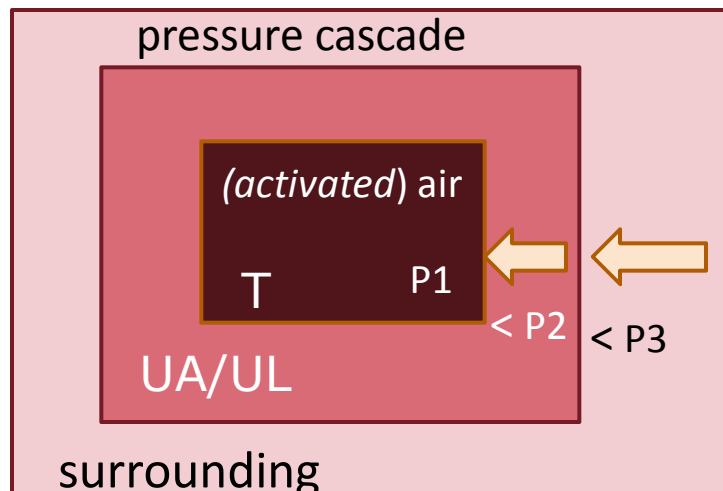
# DGS Request for LHC Tunnel Air Management

Doris Forkel-Wirth

Confinement of (*activated*) air:

- overpressure in machine areas (UA, UL, US) when compared to accelerator tunnel
- separation between UAs/ULs and the tunnel (reinstallation of ventilation doors in 2010/11 shut-down; closure of cable ducts, etc.)
- additional p-measurement stations between UAs and/or ULs and tunnel
- all released radioactivity to be monitored** – additional monitoring stations required in Point 4 and Point 6 (to be installed for 2011 run)

(+ regular sampling of water ...)



2006: First attempts (UA87/RA87)

2010/11: Consolidation

- air tightness (strict flow control UA=>RA)
- pressure and fire resistant seals

# RP Requirements for Maintenance and Repair

Maintenance and repair work (in areas like collimator regions, inner triplets, TAN, TAS, beam dump areas, etc.) will be the first to become subject to CERN's formal approach to job and dose planning (ALARA).

## CRITÈRE DE DOSE INDIVIDUELLE

Équivalent de dose prévisionnel individuel ( $H_i$ ) pour l'intervention, ou pour l'ensemble des interventions de même nature lorsque celles-ci sont répétées plusieurs fois sur une année :

100 $\mu$ Sv	1 mSv	
niveau I	niveau II	niveau III

## CRITÈRE DE DOSE COLLECTIVE

Équivalent de dose prévisionnel collective ( $H_c$ ) pour l'intervention, ou pour l'ensemble des interventions de même nature lorsque celles-ci sont répétées plusieurs fois sur une année :

500 $\mu$ Sv	10 mSv	
niveau I	niveau II	niveau III

CERN aims to optimize

- work coordination
- work procedures
- handling tools
- design
- material

to save dose to personnel

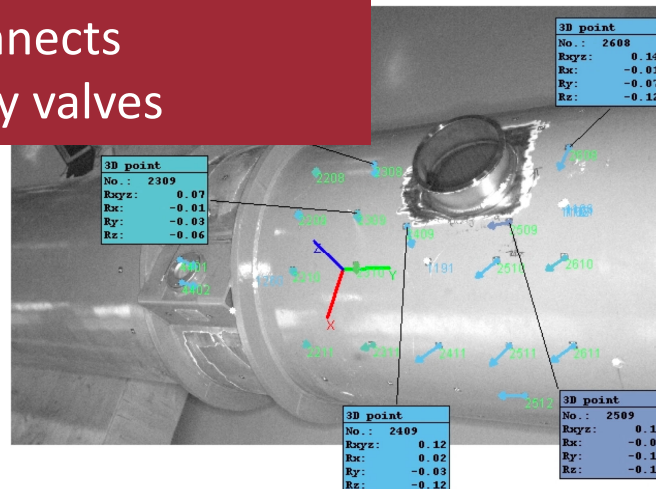
Dossier intervention au milieu radioactif (DIMR)

# RP Requirements for Maintenance and Repair

- Only radiation workers are allowed to access the LHC and/or to work on radioactive equipment
- Any destructive work (machining, cutting, drilling, etc.) on beam line components and tunnel infrastructure requires risk assessment by DGS-RP, work procedures and tooling need to be discussed with and approved by DGS-RP prior to the start of the work.

Doris Forkel-Wirth

Strong impact on maintenance jobs:  
opening of interconnects  
installation of safety valves



Grinder and similar “dirty”  
devices are not permitted  
(see Chamonix 2009)!!

# RP Requirements for Maintenance and Repair

- All material that had been in the LHC tunnel or in the operational zone of the experiments during beam operation and will leave the LHC needs to be controlled by DGS-RP
- All radioactive material needs to be maintained in appropriate workshops – but only some few workshops are available:



**More RP appropriate workshop are required  
All material leaving the tunnel must be traced**

Compensatory measures:

- sophisticated radiological risk assessment,
- temporary rad. work places to be set up,
- tight control by RP

=> very costly in man-power, time and budget for all parties involved

# Referential

Mauro Nonis

ISO 17873 (*Nuclear Facilities – Criteria for the design and operation for ventilation systems nuclear installations other than nuclear reactors*) in force since 2007, not applied as no changes to the existing LEP system foreseen by LHC Project.

- The main purpose of the ventilation system is to improve the safety of the workers, the public and the environment by keeping them free of contamination.
- Definition of functions linked to safety
  - Confinement (dynamic) to counteract any defects in the static confinement and limit the egress of contaminants,
  - Purification by conveying collected gases, dust, aerosols and volatiles towards collection points (filters, traps, etc.),
  - Monitoring of the installation, by organising air flows to allow meaningful measurements and detect spread of activated components during normal and abnormal conditions,
  - Cleaning/purging of the atmosphere by renewing the volumes of air (Industrial hygiene),
  - Conditioning of the atmosphere to obtain optimum functioning of machines.
- The HVAC system ensures the safety functions are maintained in normal O&M conditions and **may ensure some functions during abnormal or accidental situations, based upon a safety assessment of the installation.**

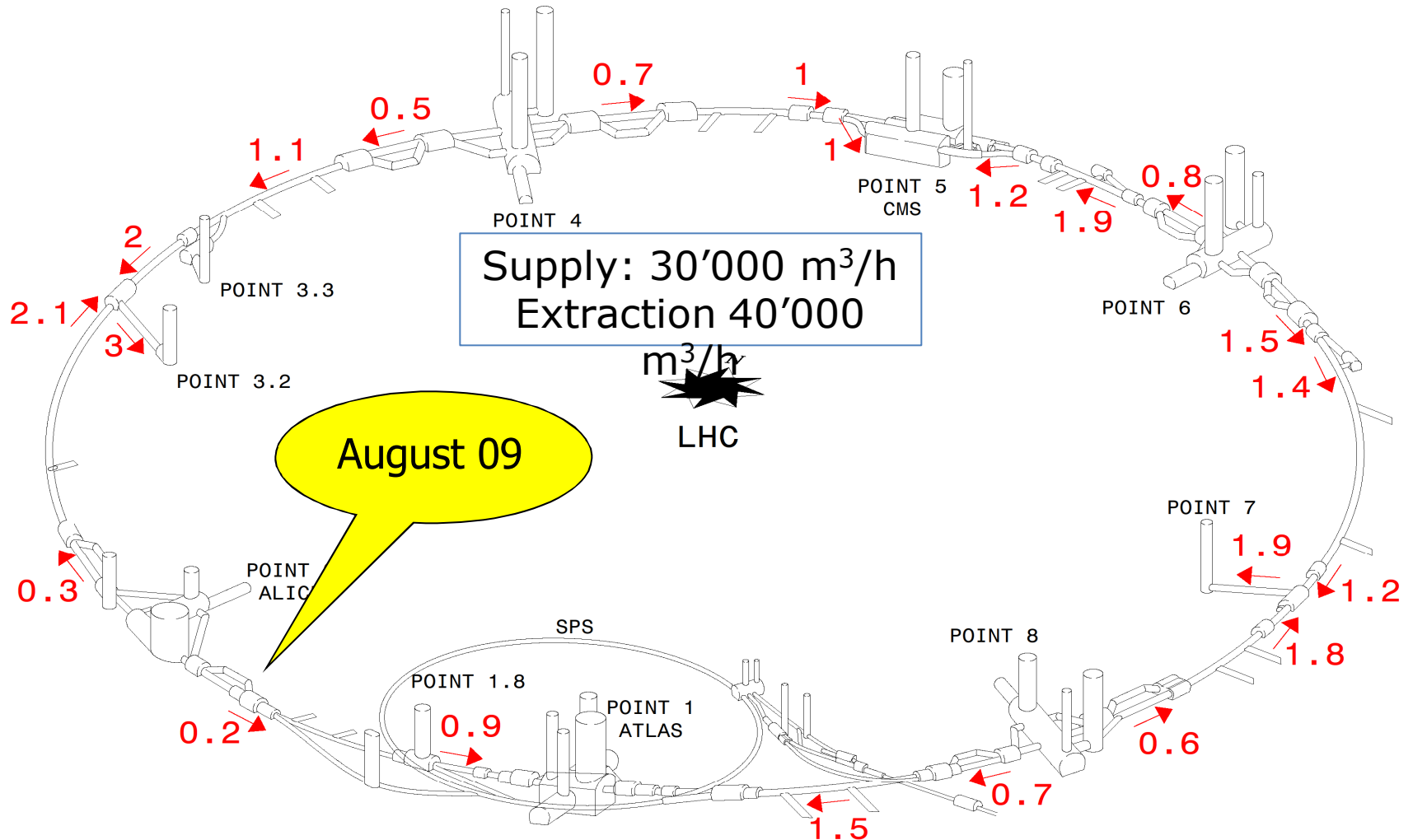
[ref. *Inigo Golfin – LHC performance workshop - Chamonix 2009*]

# ISO 17873 Guidelines

Mauro Nonis

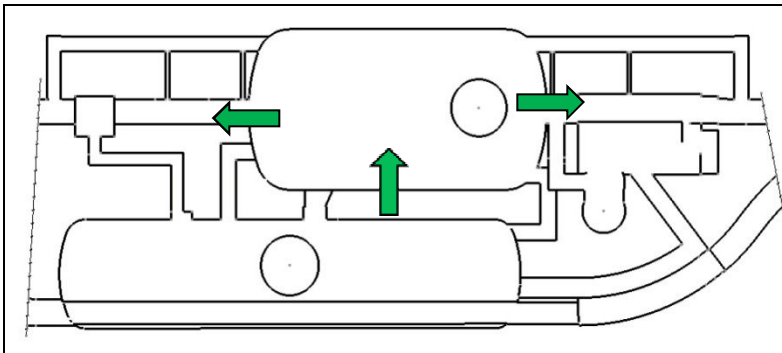
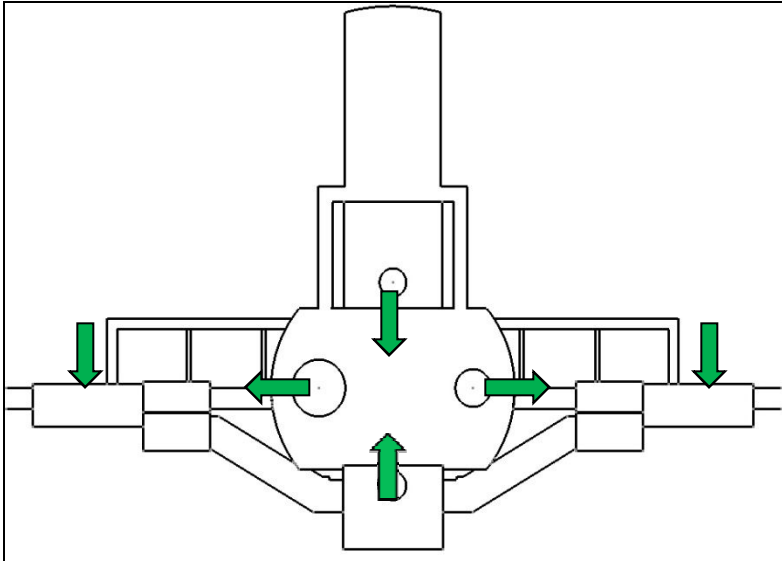
- Confinement:
  - Leaktight and static confinement recommended. **next shutdown**
  - Keep extraction networks separated: **OK**
- Purification:
  - Filter air before release (appropriate filters class) **OK**
  - Air renewal: 1 to 2 vol/hour: **(LHC: ~1) OK**
- Monitoring
  - Monitor ventilation parameters: **next shutdown**
- Reliability
  - Ensure fonctionnalités in design
  - **Situation already quite satisfactory, would be very difficult and expensive, and probably not relevant, to fully comply to ISO 17873 (Ex extraction unit on secure network)**
  - Extraction from activated areas priority; if stop supply should halt.
  - No single point of failure: **exist but experience ok**

# Operating Conditions Run 2009-2010: Air Speed

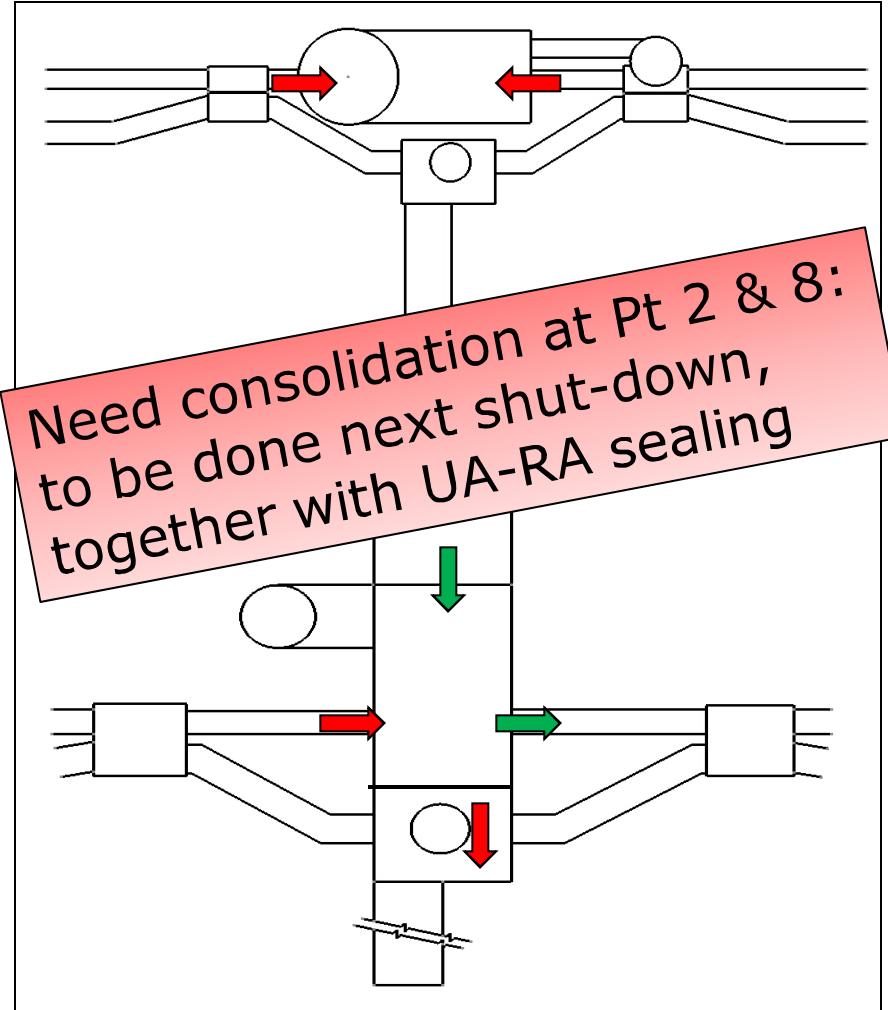


Long term: air speed between  
0.5-1.5 m/s

# Operating Conditions Run 2009-2010: Overpressures



Shaft pressurisation: ok





# Consolidation Plan

- Installations date mostly to LEP construction period.
- Although correctly performing, part of the LHC ventilation system shall need refurbishment or consolidation work in next years.
- The following issues are part of EN/CV consolidation program [ref. *Mid-term consolidation plan for the cooling and ventilation facilities, 2010-2017 – August 2009*]

	Priority	Risk score		Amount [MCHF]	Planning
		Before	After		
<i>Absolute filters (tbc by RP)</i>	(H)	6	3	0.8	2011-2012
Safety features	H	9	2	1	2010-2012
Supply air plenum	M	6	3	0.6	2012-2015
Thyristors replacement	H	6	3	0.8	2011-2013
Instrumentation replacement	M	9	3	0.5	2011-2014
Vibr. analysis AHU	M	9	3	0.8	2013-2017

N.B.: CE, EL etc. costs not included

# Main messages

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- ❑ The sealing of the LHC tunnel toward the service galleries to insure radiation, fire and ODH protection is a priority for the next shut down;
- ❑ Risk analysis and safety assessments of the cryogenic system, the ventilation , the safe areas should be systematically reviewed with regard to the latest experiences;
- ❑ The hand-over of safety responsibility between BE and EN at the beginning/end of a shut down is a new exercise, some open questions still need to be clarified;
- ❑ The Safety Coordination can and should be involved from the conception stage of new equipment;
- ❑ RP consideration will modify your working conditions: need to monitor, to organize interventions according to ALARA, to trace material coming from the LHC tunnel and to maintain/repair all equipment in dedicated workshops;
- ❑ Additional monitors to control the air speed, temperature and pressure, together with differential pressure sensors, will be installed during the next shut-down;
- ❑ A consolidation program for the cooling and ventilation facilities is on-going, how far to go in an approach to fully comply with the ISO178773 referential must be assessed.