Radiation Protection in LS2

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## Conclusion
Radiation Protection Rules

New Swiss Radiation Protection Ordinance will enter into force in January 2017

Major change: clearance limits for radioactive material

Council Directive 2013/59/Euratom of 5\textsuperscript{th} December 2013 laying down basic safety standards for protection against the dangers arising from exposure to ionizing radiation

\textit{and repealing Directive 89/618/Euratom, 90/641/Euratom, 96/29/Euratom, 97/43/Euratom and 2003/122/Euratom}

To be implemented by EU member States by 2018

No major impact for CERN
LHC in LS2

Dose rate increase by a factor 3 to 4
(\textit{Fluka calculations based on presently known scenarios})

D. Forkel-Wirth et al.
ATLAS/CMS in LS2:
- Increase of dose rate by a factor of 2 – 3
- Exchange of some steel components by aluminum in LS1 (in ATLAS) -> (local) decrease of dose rates
- Supervised Radiation Area for major part of cavern
- Limited Stay Area around Forward Shielding and Inner Detector

LHCb/ALICE: Supervised Radiation Area
Radiological Situation in PS complex in LS2

No major changes when compared to LS1

MTE operation should be beneficial and decrease radiation levels

Activities foreseen:
- N-TOF target change
- East Area target up-grade and consolidation
- AD target area up-grade and consolidation
- PSB modifications in injection area
- LINAC4 connection
Radiological Situation in SPS complex in LS2

Radiation levels compared to LS1
- BA2 - TT20 - TDC2/TCC2: Dose rate levels might increase by a factor of 3 (in case high intensity to North Area remains)
- BA1: no major changes expected
- BA3 and 5: new losses seen in 2015 which might lead to increased dose rate levels compared to LS1 (at the moment no details foreseeable)

Activities foreseen:
- Beam dump installation in BA5
- Removal of beam dumps in BA1
- ZS improvements
- Coating activities (test campaign)
- De-cabling campaigns
Preparation of LS2 Activities

Close involvement in the activity preparation
(like RP in Decabling Campaign Working Group, SMACC, AD stripline repair):

- RP constraints known from the beginning
- RP performs early risk assessment and contributes to problem solving
- RP requirements integrated into technical specification
- RP and equipment team - direct communication

Good and permanent communication at all levels is key:
- RP participates in all coordination meetings
  + regular meetings between RP, RSSOs and RPEs?
  + RP to go into the equipment groups and sections?
  + ...

D. Forkel-Wirth et al.
ALARA (1)

CERN’s (individual) dose objective of 3 mSv/year during LS1 was discussed with the Complex Manager and decided by the Director General!

• Dose objectives are not dose limits!
• Dose objectives are good practice in radiation protection!
• Dose objectives contribute to the protection of workers!

Cat B workers intervene in CERN’s Limited Stay and High Radiation Areas – justified as CERN takes dose objective seriously!
CERN’s objective to keep the dose to its radiation workers below 3 mSv/year was largely met*!

ALARA became an essential and natural part of CERN culture!

(*only two workers slightly exceeded the 3 mSv/year)

Safety@CERN in 2014
Dosimetry in LS1

DG’s New Year’s Speech 2015

D. Forkel-Wirth et al.
ALARA (2)

Job and dose planning to be done during Runs or early in LS

-> conservative dose estimate based on educated assumptions (dose rate, time)

-> real dose taken during interventions is in many cases lower than estimated dose

-> might cause surprise

However:

Optimizing the work is the key issue for pro-active radiation protection (and safety!)

Observation (worldwide including CERN): quality of the work improves

*Ideal*: ALARA committees during RUN - preparation during LS stressful for all parties involved
RP Training

RP training scheme will not change in LS2:
• e-learning for Supervised Radiation Areas
• face to face training for Controlled Radiation Areas

RP courses are continuously up-dated - no need for special LS2 RP courses

But:

Refresher scheme to be developed in 2016!

Number of workers arriving and influx distribution over LS2?
Insourcing of RP training for contractors?
Languages other than French and English?
Pool of CERN accredited translators?

Being studied
## Dosimetry

**LS1**: 9000 persons/y monitored

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<tr>
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</thead>
<tbody>
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<td>DIS</td>
<td>personal</td>
<td>6500</td>
<td>500</td>
<td>350 CHF</td>
</tr>
<tr>
<td>DMC</td>
<td>operational</td>
<td>1100</td>
<td>200</td>
<td>700 CHF</td>
</tr>
</tbody>
</table>

- **Number of workers arriving, influx distribution over LS2?**
- Increase pool use for operational dosimeters?
- Operational dosimeter to be connected to access and checked if switched on!
- Distribution system for operational dosimeters at the access points?
- Safe return points for both types of dosimeters spread over CERN?
- **Impact number to be selected at the access points via touch screen**
RP Operational Aspects in LS2 Activities (1)

• An RP member in the activity team!

• Activity planning:
  • balanced distribution of activities over time to avoid rush later!
  • allocate sufficient time for testing and contingency at the end of LS2!
  • finishing the LS2 jobs should have priority over cold-check out!

• Infrastructure:
  • radioactive workshop Bat 109 (Meyrin) sufficient for LS2?
  • new, mechanical radioactive workshop in Prevesin to reduce number of intersite transports (BE-BI: 600 transports during LS1!)?
  • some buffer zones are too small and more are needed (SPS/BA80)!
  • Lack of storage for radioactive material and for waste!
RP Operational Aspects in LS2 Activities (2)

RP to provide a list with SCEM code for RP related PPE and specific items like containers

- **PPE:**
  - PPE costs to be included in the activity or budget!
  - Recommended: dedicated work clothes (e.g. cotton) in radiation areas
  - Obligatory: special clothes (e.g. tyvek, gloves, overshoes) in areas with risk of contamination!
  - PPE supply for big worksites by a central GS-IS service?

- **Containers:**
  - Costs to be included into activity or project budget!
  - CADRA (EDMS 1364231) lists the types of container
RP Operational Aspects in LS2 Activities (3)

• Vacuum Cleaners (VC):

Proposal: central management of VCs for radiation activities

Dedicated RP service
Regular RP checks for contamination, dose rate, filtration efficiency, integrity & performance

- Follow-up and traceability: users, location, maintenance, verifications, etc.
- Transport
  - EN/HE or self-transport for planned activities
  - RP if urgent and not foreseen

Optimized safety, availability and costs:
- Pool allows efficient use of VCs
- Regular checks and close follow-up: less damages, less maintenance, improved reliability
- Reduced transport delay
- Reduced maintenance delay

Estimated costs: 130 - 190 kCHF/y
Radiological Control of Material

Future clearance limits will not allow the classification of potentially radioactive material as non-radioactive based on dose rate or count rate measurements only.

<table>
<thead>
<tr>
<th>Isotope</th>
<th>LS1</th>
<th>LS2</th>
</tr>
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<tbody>
<tr>
<td>22Na</td>
<td>3 Bq/g</td>
<td>0.1 Bq/g</td>
</tr>
<tr>
<td>54Mn</td>
<td>10 Bq/g</td>
<td>0.1 Bq/g</td>
</tr>
<tr>
<td>60Co</td>
<td>1 Bq/g</td>
<td>0.1 Bq/g</td>
</tr>
</tbody>
</table>

Way out:
- “Radioactivity Zoning” for all facilities - like LHC (tunnel versus galleries)
- Development of new characterization technique combining
  - dose rate measurements
  - γ-spectroscopy
  - MC simulation
Radioactivity Zoning

Samples in the area

Subdividing areas according to level of radioactivity for handling, intersite transport and waste
Intersite Transport

ADR Transport containers already in use
Thanks to EN!

Arrangements with regard to ADR rules still to be discussed within the Tripartite process (for an efficient CERN operation)

Nuclide inventory defining intersite transport class to be determined before transport
-> RP aims for an efficient scheme by identifying radiological envelop cases
Radioactive Waste in LS2 - Forecast

6500 m³ waste stored in ISR, up to 3000 m³ to be freed by LS2!

A challenge!

Regular up-dates required!

Information on influx of waste over time (scale of months) would be very helpful
Radioactive Waste in LS2

Waste management starts at the source (in the facility!) – a close collaboration*) between departments, experiments and RP is required to increase efficiency and effectiveness

(*) like for ISOLDE targets, project “Clearing of Radioactive Material Storage” [EDMS 1493919]

Proposal: Sorting and (pre-)characterization should be done at the source to optimize the elimination process**)

(**) project “Clearing of Radioactive Material Storage” is used as test case for the new approach

Implement well organized storage facilities for radioactive material and waste and link data bases (TREC, BAAN, ISRAM***)

(***) TREC will replace ISRAM at the end of 2015
Acceptance Criteria for Waste

First step towards treatment at the source
Let’s move forward together for exemplary management of radioactive material and waste - like we did for ALARA!
Conclusions (1)

• EU Directive 2013/59/Euratom and the Tripartite will have an influence on LS2 – but we have some time left to prepare

• Radiation levels in LS2:
  • LHC LSS will increase by a factor of 3 – 4,
  • LHC experiments will be compatible with Supervised Radiation Areas,
  • increase of radiation levels in SPS

• ALARA:
  • CERN’s approach to ALARA will not change,
  • CERN’s (individual) dose objective is useful – it is an objective within the context of continuous improvement and not a legal limit,
  • The optimization process is key

• Communication needs improvement
Conclusions (2)

• RP needs to be close to the activities and be integrated into the activity teams
• RP needs information about the number of workers arriving and the influx distribution over LS2 \textit{(e.g. for RP training and dosimetry)}
• The forecast for radioactive material and waste production needs to be up-dated regularly to allow the timely provision of storage space
• \textbf{Waste management starts at the source} \textit{(first exercise: “Clearing of Material Storage”)}

\textit{PS: DGS-RP as equipment group – replacement of North Area ARCON by RAMSES}