Workplaces in Radiation Areas

IEFC Workshop 10-12 February 2010

H. Vincke for DGS/RP

Introduction

The operation of CERN's accelerators results in the production of large quantities of radioactive material (beam line components and related material like cables, experimental detectors, material of general infrastructure like cooling and ventilation equipment, etc.). Most of these radioactive components need regular maintenance and repair.

These activities are performed at workplaces, either

- in situ, within the accelerator tunnels,
- experimental halls and experimental caverns or
- in laboratories and workshops on the surface.

Outline

- Radiation Protection rules
  - When is a material considered as radioactive?
  - Legal basis for the requirement of dedicated workshops for radioactive equipment
  - Proposal of new classification of workshops at CERN
- Radiation risk during maintenance & repair
- ALARA at CERN
- Traceability of radioactive equipment
- Examples of adequate maintenance & repair
- Present situation of workshops for radioactive equipment
- Proposal for centralized workshops (Bat.867)

When is a material radioactive?

- **Activity**
  - *Specific activity* exceeds the CERN exemption limits as given in Table 2 (column 2) of EDMS doc 942170

  AND
  - *total activity* exceeds the CERN exemption limits as given in Table 2 (column 2) of EDMS doc 942170.

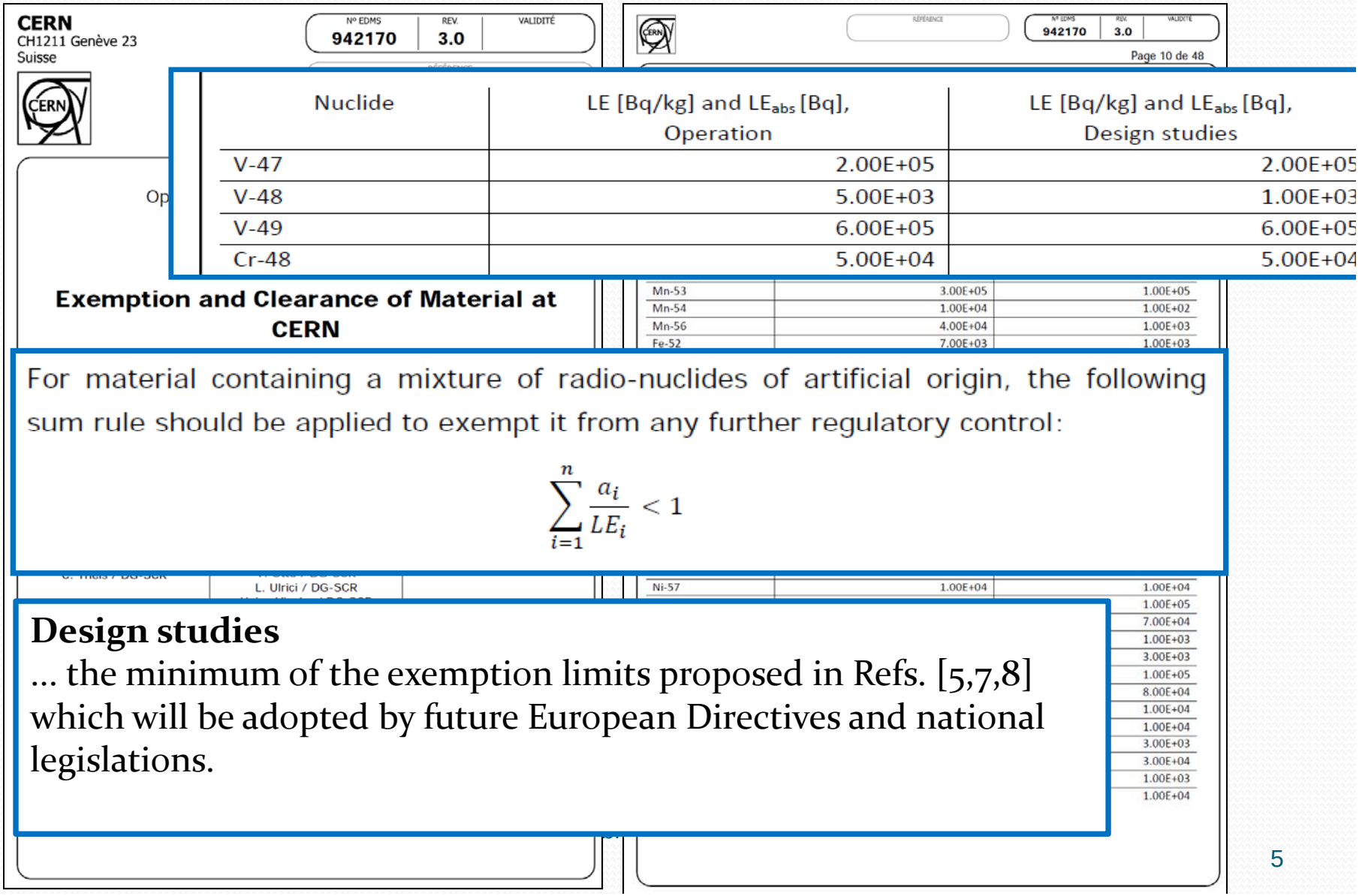
OR

- **Dose rate**
  - Ambient dose equivalent rate measured in 10 cm distance of the item exceeds 0.1 uSv/h after subtraction of the background.
    - Slightly radioactive < 10 uSv/h
    - Radioactive < 100 uSv/h
    - Highly radioactive > 100 uSv/h

OR

- **Surface contamination**
  - 1 Bq/cm² in case of unidentified beta- and gamma emitters and 0.1 Bq/cm² in case of unidentified alpha emitters. Once a radio-nuclide has been identified then the *CS*-values given in Table 4 of EDMS doc 942170 can be used.

When is a material radioactive?



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Nº EDMS	REV.	VALIDITÉ
942170	3.0	

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Nuclide	LE [Bq/kg] and LE_{abs} [Bq], Operation	LE [Bq/kg] and LE_{abs} [Bq], Design studies
V-47	2.00E+05	2.00E+05
V-48	5.00E+03	1.00E+03
V-49	6.00E+05	6.00E+05
Cr-48	5.00E+04	5.00E+04

Exemption and Clearance of Material at CERN

Mn-53	3.00E+05	1.00E+05
Mn-54	1.00E+04	1.00E+02
Mn-56	4.00E+04	1.00E+03
Fe-52	7.00E+03	1.00E+03

For material containing a mixture of radio-nuclides of artificial origin, the following sum rule should be applied to exempt it from any further regulatory control:

$$\sum_{i=1}^{n} \frac{a_i}{LE_i} < 1$$

L. Ulrici / DG-SCR

Ni-57	1.00E+04	1.00E+04
		1.00E+05
		7.00E+04
		1.00E+03
		3.00E+03
		1.00E+05
		8.00E+04
		1.00E+04
		1.00E+04
		3.00E+03
		3.00E+04
		1.00E+03
		1.00E+04

Design studies

… the minimum of the exemption limits proposed in Refs. [5,7,8] which will be adopted by future European Directives and national legislations.

Legal basis for the requirement of dedicated workplaces for radioactive equipment

Safety Code F (1996)

Chapter III, 1.4, 3.2

Machining, chemical treatment, dust producing work
→ Min. class C area for all type of radioactive materials

Chapter IV, 3.3

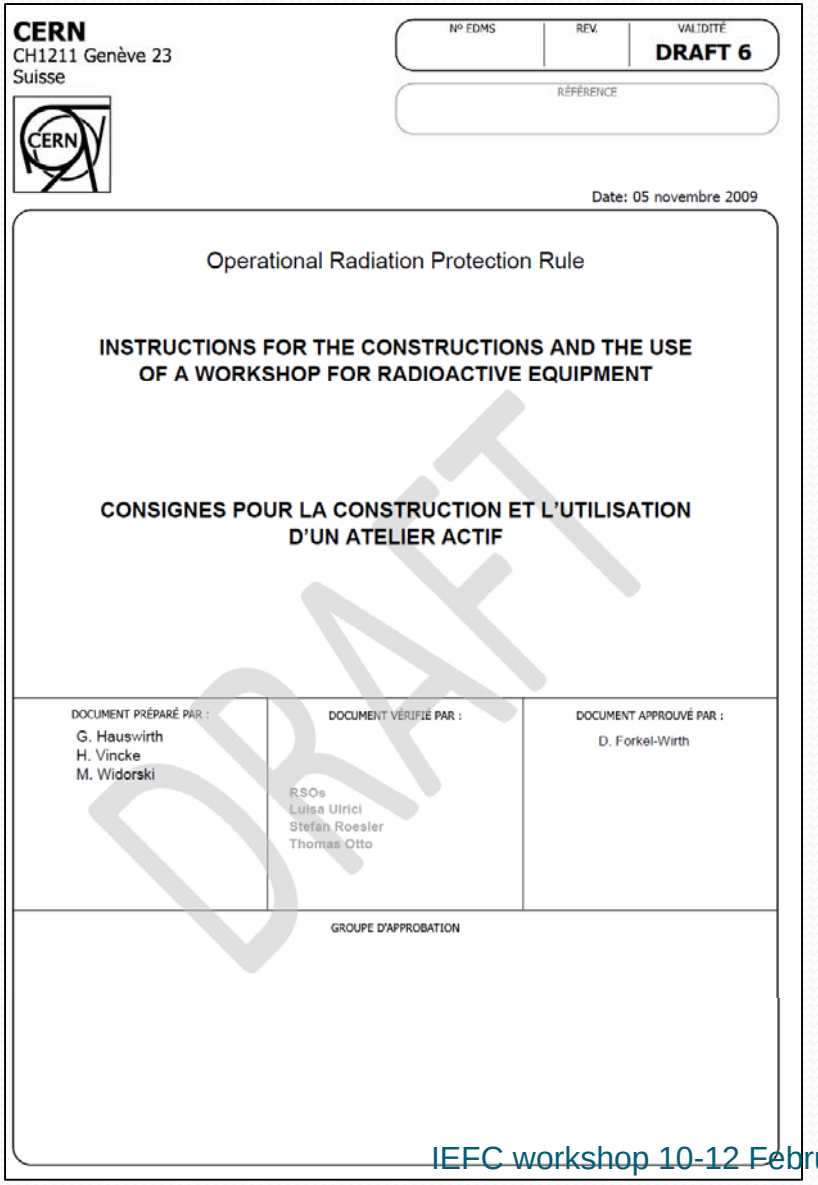
Radioactive material must be handled exclusively in controlled areas

Safety Code F (2006)

3.6.6 "Radioactive materials must be only handled in Supervised or Controlled Radiation Areas."

3.6.7 "(…) machining work (..) only in specially appointed workplaces as defined in the relevant Safety Instruction."

CERN: workshops «ateliers actifs» (AA)



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RÉFÉRENCE

Date: 05 novembre 2009

Operational Radiation Protection Rule

INSTRUCTIONS FOR THE CONSTRUCTIONS AND THE USE OF A WORKSHOP FOR RADIOACTIVE EQUIPMENT

CONSIGNES POUR LA CONSTRUCTION ET L'UTILISATION D'UN ATELIER ACTIF

DOCUMENT PRÉPARÉ PAR :	DOCUMENT VÉRIFIÉ PAR :	DOCUMENT APPROUVÉ PAR :
G. Hauswirth H. Vincke M. Widorski	RSOs Luisa Ulrici Stefan Roesler Thomas Otto	D. Forkel-Wirth

GROUPE D'APPROBATION

DRAFT

Approval process will start soon!!

In the document one can find the
- classifications of workshops,
- the radiation limits ,
- the requirements,
- responsibilities,
- etc.

Classification of workshops

«ateliers actifs» (AA)

Two different categories of workshops for radioactive equipment:

- Workshops for non-destructive work are subdivided according the ambient dose equivalent rate into:

AAND0 .... Supervised Radiation Area

AAND1 .... Simple Controlled Radiation Area

AAND2 .... Limited Stay Area

- Workshops for destructive work are subdivided according the ambient dose equivalent rate and the risk of contamination into:

AAD0 .... Simple Controlled Radiation Area

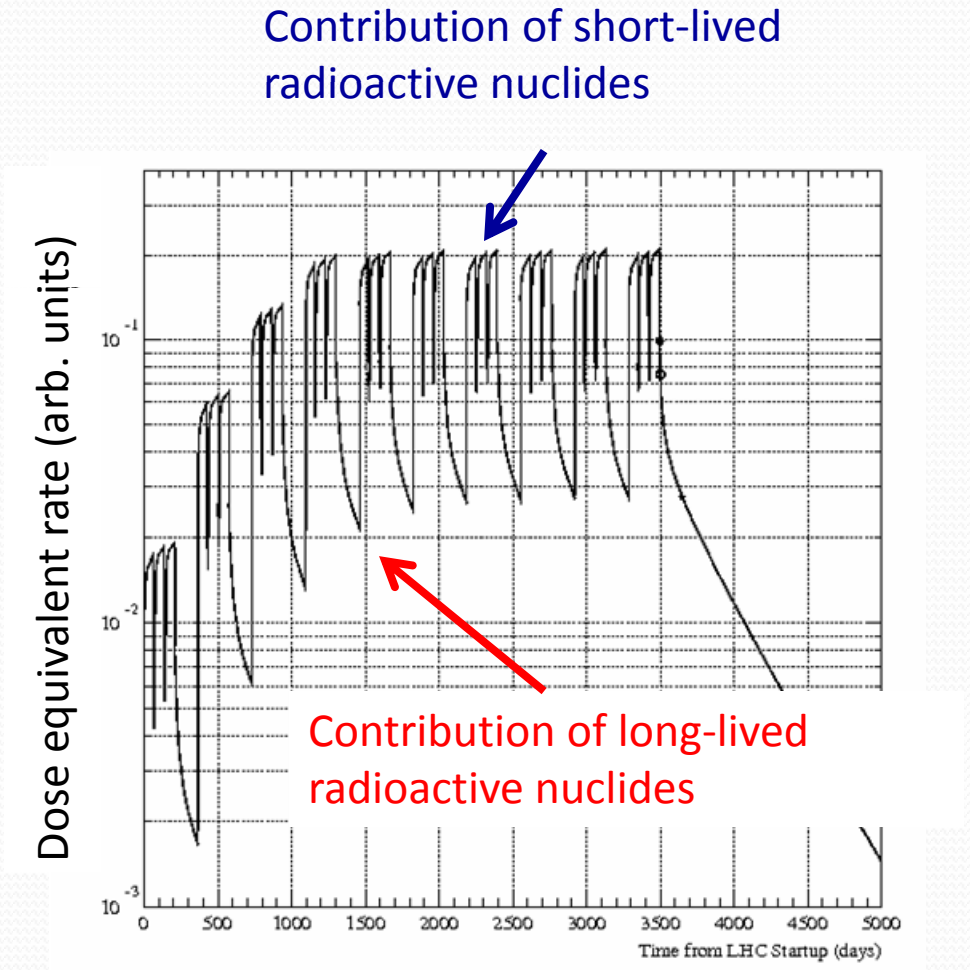
AAD1 .... Limited Stay Area

The concept and the approval of a workshop will to be done together by the RSO and DGS/RP

Radiation Risk During Maintenance &Repair

Risk of
- external exposure (all work)
- internal exposure (destructive work *or* work on contaminated objects)

Radioactivity of material is function of
- chemical composition
- impurities
- radiation fields
- beam energy
- beam losses (machine)
- luminosity (experiments)



M. Huhtinen, RPC/2003/XXXVIII/138

Contamination

Radioactive contamination at CERN can arise from:

- the use of unsealed radioactive sources;
- activation of air and dust around the accelerators;
- activation of oils or cooling fluids;
- the machining or treatment of radioactive components;
- normal or accidental emissions from targets whilst they are irradiated or after irradiation.

Two factors will be considered by the RP Group in defining precautions for the control of unsealed radioactivity:

- the risk of personal contamination and
- the prevention of the contamination of equipment.

Implementation of ALARA at CERN

Already since December 2006:

- systematic, formalized approach
- Presently applied to the PS, ISOLDE, SPS and CNGS and LHC – to be extended to all work in radiation areas
- "close collaboration" between RP and the maintenance team and the RSO

All work in radiation areas has to be optimised

- Supervised Radiation Area: general optimisation by shielding, optimised installation of workplaces…
- Controlled Radiation Areas: All work must be planned and optimised including an estimate of the collective dose and of the individual effective doses to the workers participating in the completion of the task (Dossier D'Intervention en Milieu Radioactif - DIMR).

most of the ALARA elements were already used all over CERN in the past.

ALARA at CERN – 3 levels

CRITÈRE DE DÉBIT DE DOSE

Débit d'équivalent de dose prévisionnel ($\dot{H}$) dans la zone d'intervention :

50 µSv·h^{-1}	2 mSv·h^{-1}	
niveau I	niveau II	niveau III

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 µSv	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 µSv	10 mSv	
niveau I	niveau II	niveau III

CRITÈRE DE CONTAMINATION ATMOSPHÉRIQUE

Activité aérienne spécifique CA :

5 CA	200 CA	
niveau I	niveau II	niveau III

CRITÈRE DE CONTAMINATION SURFACIQUE

Activité surfacique spécifique CA :

10 CS	100 CS	
niveau I	niveau II	niveau III

ALARA procedures – 3 levels:

- If the rad. risk is **low**
  <> very light procedure
- If it is **medium**
  <> an optimization effort is required
- If it is **high**
  <> an optimization effort is required, the procedure will be submitted to the ALARA committee

CERN aims to optimize

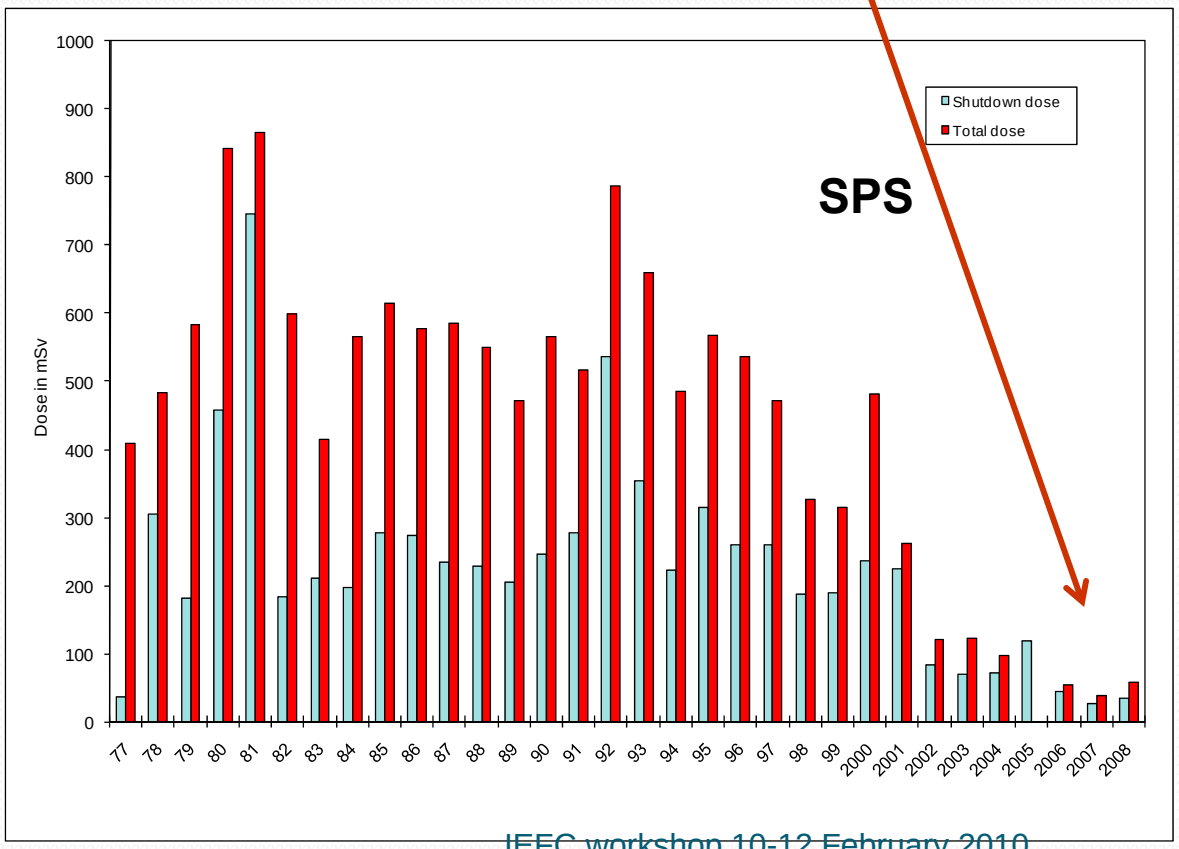
- work coordination
- work procedures
- handling tools
- design
- material

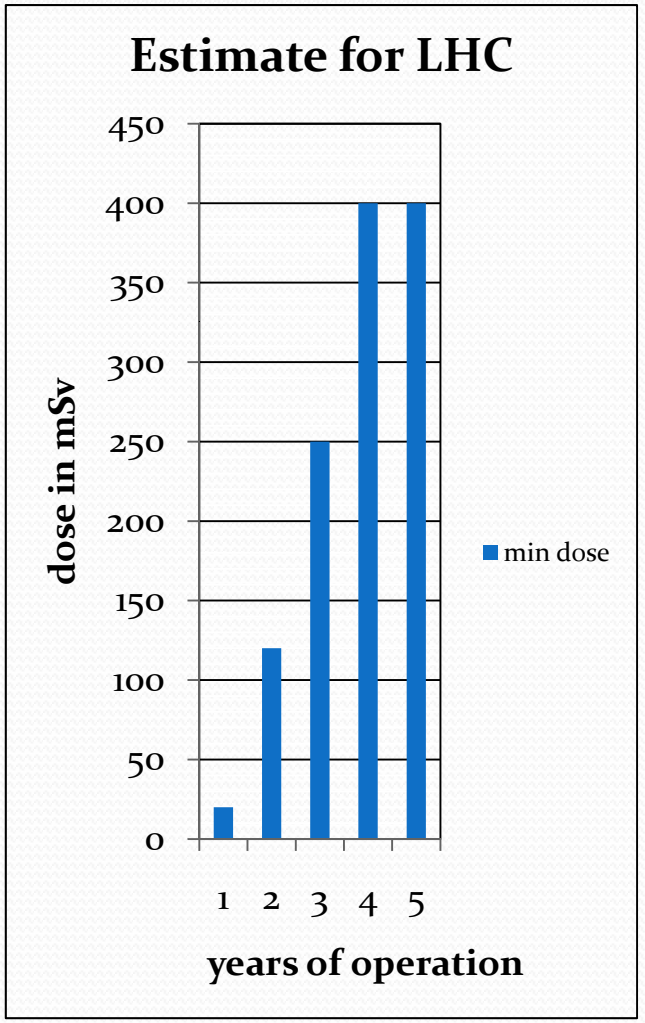
to reduce dose to personnel

For details see EDMS No: 810176

Collective Doses

CERN's approach to ALARA





Traceability of radioactive material

Traceability of radioactive material is required:

- Risk of mixing radioactive and non-radioactive components (due to lack of appropriate infrastructure)
  - in workshops
  - in storage areas
- Increase of efficiency for any radiological risk assessment in context of
  - maintenance
  - shipping
  - disposal
- Status:
  - LHC experiments use a modern traceability system (e.g. ATLAS)
  - machine: functional specification released (L. Bruno, EDMS 1012291)

Traceability requirement for CERN accelerators

..... should be similar to the one of the LHC experiments:

- Equipment owner removes and labels material (barcode!)
- Equipment owner enters origin, owner, etc… into the database
- RP controls and enters the result in the database
- All material receives an entry in the database (non-radioactive, radioactive)
- All material is marked according to its radiological risk (non-radioactive, radioactive)
- Non-radioactive material needs no further tracing – the label(s) are sufficient
- All movements of radioactive material need to be traced via the database

Today (ZO, ZDC, Non-activated)

Equipment Id : **3 23 4567 8901 2345 6789**
Owner : **CMS, Tracker**
Origin : **UXC55** *Check Time :* **2009 NOV 12 (12:45)**
Operational Zone: **YES** *Radioactive Waste Zone :* **NO**
Background Value : **60** *count/s* *Above Background :* **NO**

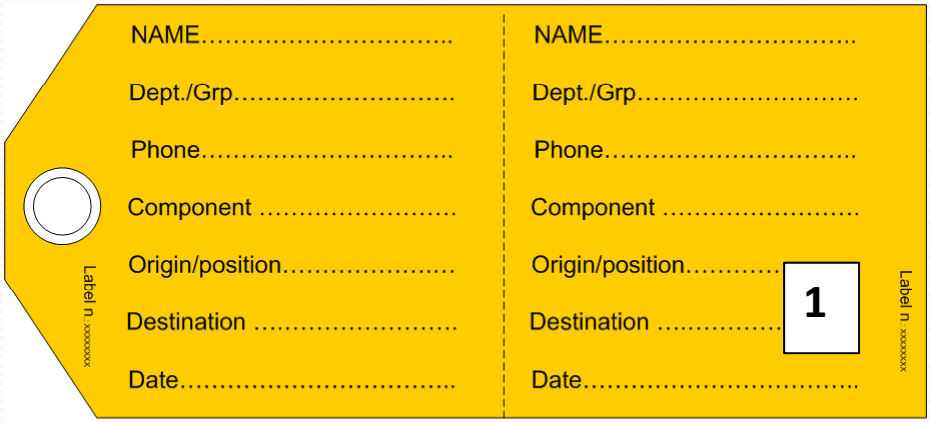
Possible Inside Detector (ZO, ZDR, Non-activated)

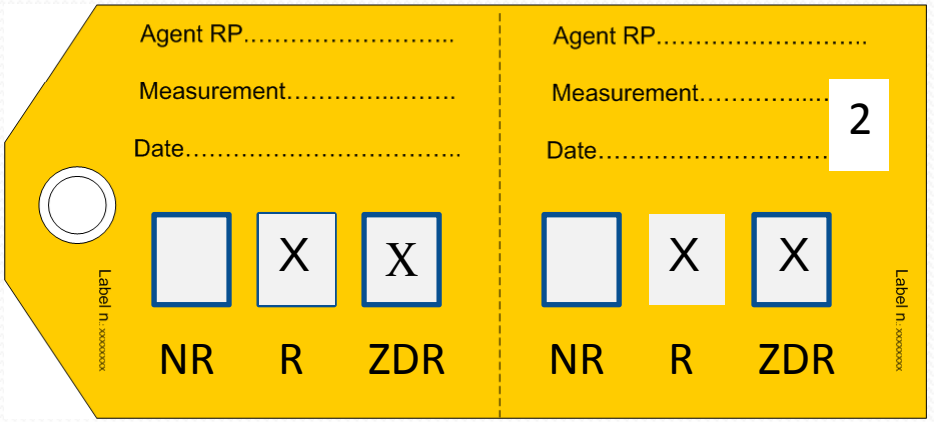
Equipment Id : **3 23 4567 8901 2345 6789**
Owner : **CMS, Tracker**
Origin : **UXC55** *Check Time :* **2009 NOV 12 (12:45)**
Operational Zone : **YES** *Radioactive Waste Zone :* **YES**
Background Value : **60** *count/s* *Above Background :* **NO**

Measured as Radioactive

Equipment Id : **3 23 4567 8901 2345 6789**
Owner : **CMS, Tracker**
Origin : **UXC55** *Check Time :* **2009 NOV 12 (12:45)**
Operational Zone: **YES** *Radioactive Waste Zone :* **YES**
Background Value : **60** *count/s* *Above Background :* **140** *count/s*

…a temporary solution for the accelerators





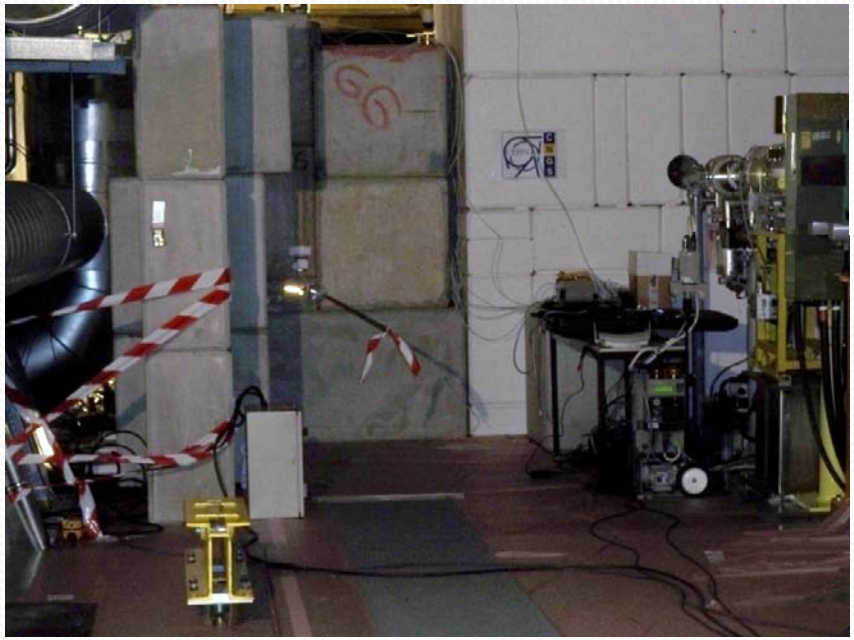
- Equipment owner fills in side 1 before leaving the component in the buffer zone
- RP technician fills in side 2 and ticks the appropriate box
- Radioactive material : RP attaches a trefoil «radioactive « to the material
- One part of the label is kept by RP, the other remains attached to the component
- The labels are progressively numbered, allowing to trace back the components

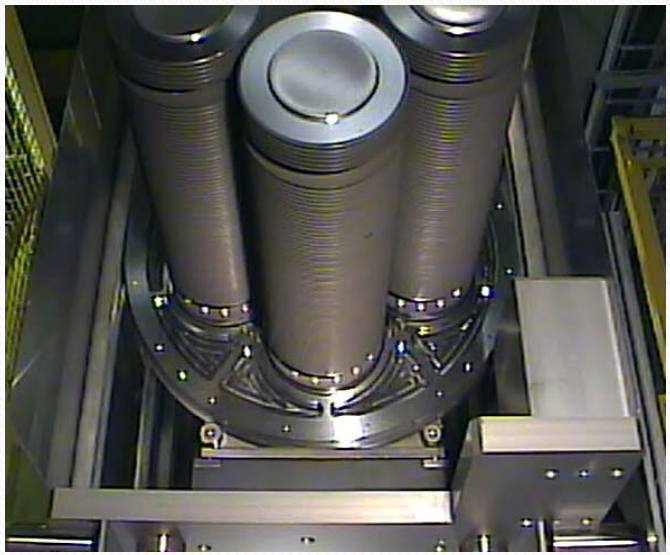
Examples of adequate maintenance & repair

Examples – inspection of the CNGS target

- Dry runs in 867 on spare target
- Installation (in TCC4) of
  - temporary concrete shielding + thick lead glass + plastic cover on the floor
  - remote controlled cameras
  - Motor to rotate the target
- Remote controlled transport of the target
- Inspection done with an endoscope

  → total integrated dose: 287 uSv
  (17 persons, dose max 48 uSv)





Examples – Dismantling of TCX blocks in TCC6 (BA7)

- Modification of a forklift (EN/MEF)
  - Installation of a lead shield and lead glass
  - Design of a new 'fork' (EN/HE)

- If ordering new shielding blocks consider that this forklift can be used for transport.
- Think about modification of existing blocks

For details and a movie see **S. Evrard's** presentation on Thursday afternoon at 17:00

WORKSHOPS

Present Situation of workshops for radioactive equipment

- CERN has only ONE common mechanical workshop appropriate for destructive work on radioactive material:

  Bat 109 in Meyrin – limited in size (objects < 1 m) and tooling
  - work was done in other workshops (not fully compliant with RP regulations **or** with additional protective measures after granted exemption)

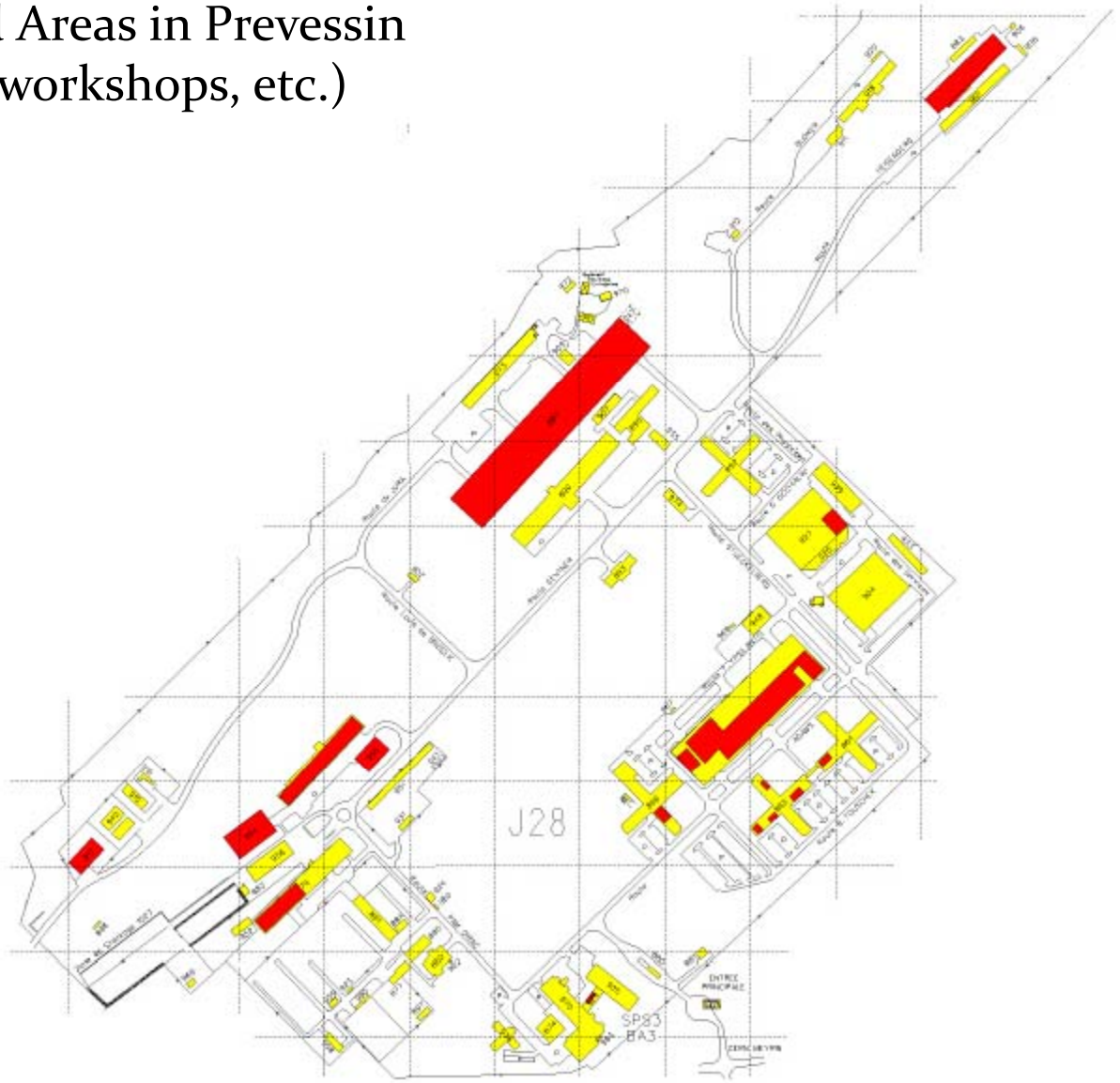
- Besides some few, large radioactive laboratories (e.g. magnet repair and assembly in Bat. 867, 181), CERN has many little "radioactive" workshops and laboratories spread all across the Meyrin and the Prevessin site.

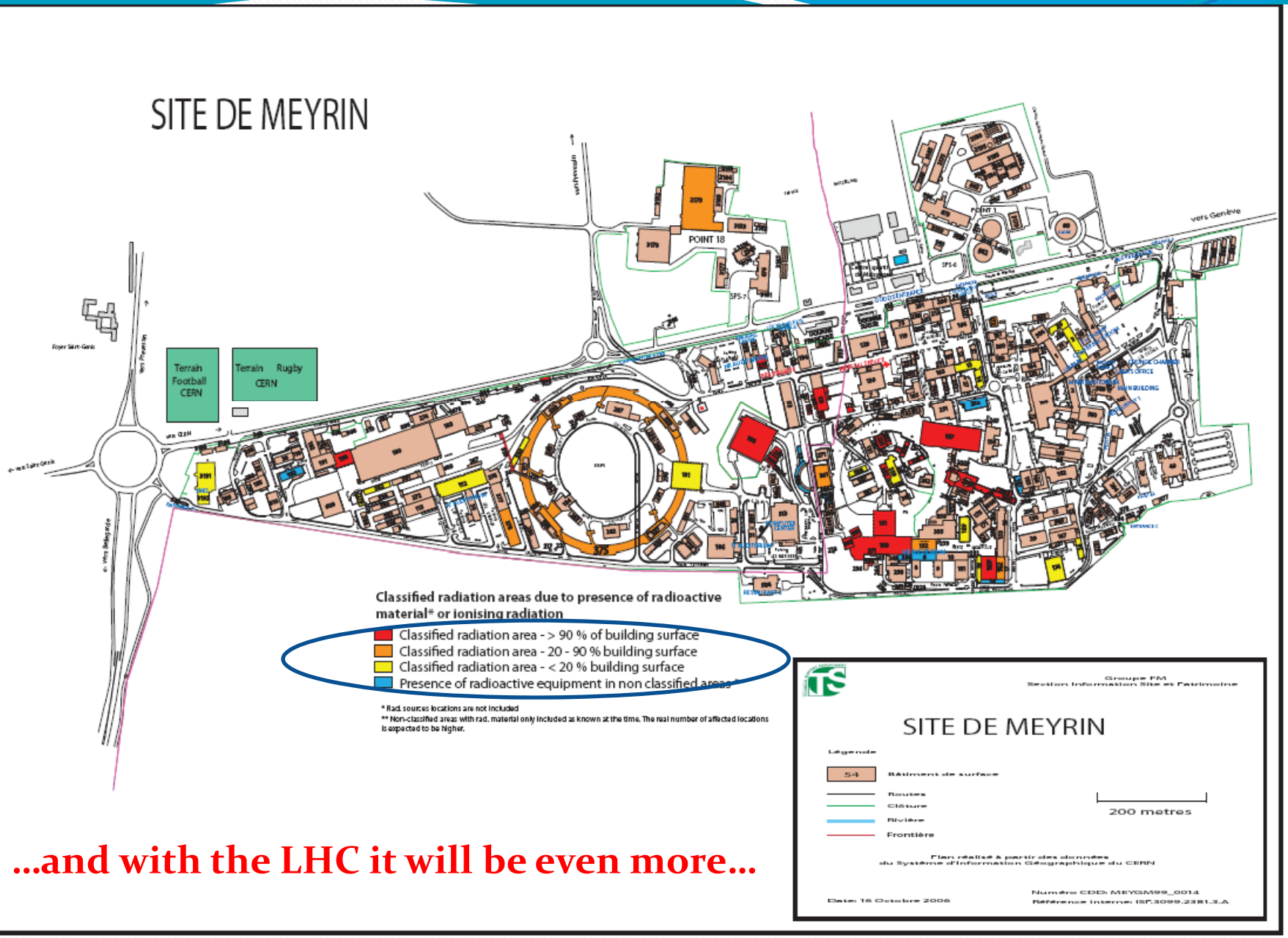
Compensatory measures:

- maintenance and repair jobs to be limited to the minimum,
- 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

Designated Areas in Prevessin (including workshops, etc.)





...and with the LHC it will be even more...

Consequences

- Dispersion of radioactive activities, mixture of radioactive and non-radioactive activities.

- Dispersion of radioactive material

  (at least once per week radioactive items are detected in "non-radioactive" waste bins)

1.3µSv/h

- Too resource intensive with respect to installation, maintenance and RP control of the laboratories.

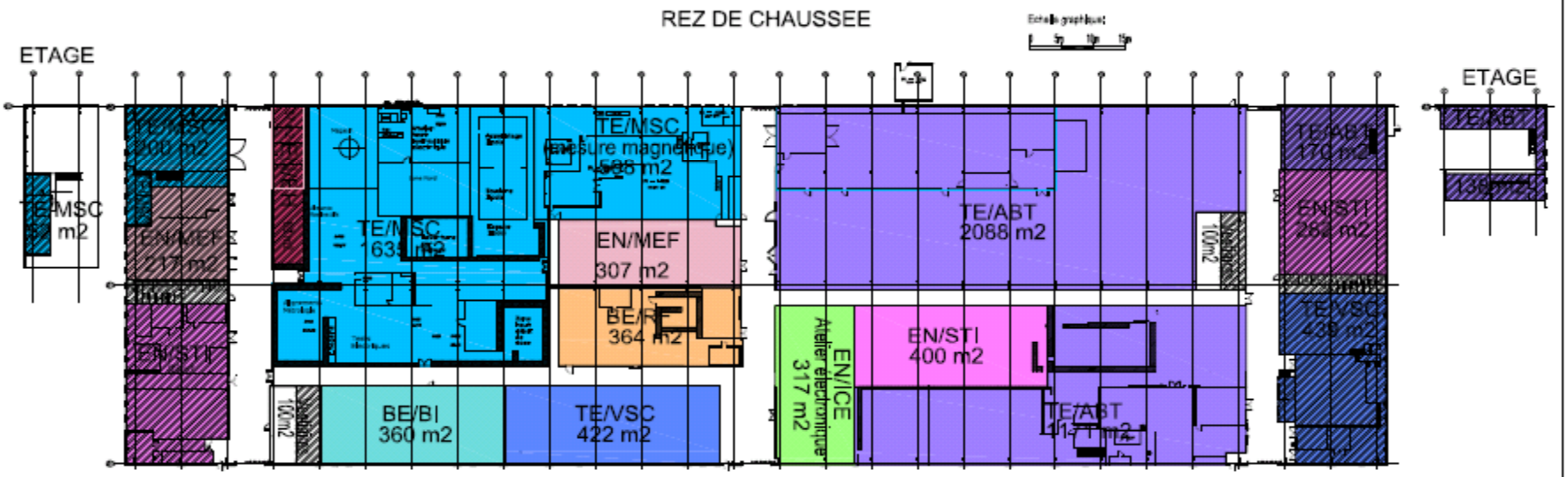
RP request

- Maintenance and repair activities should be grouped in some few areas, comprising:
  - Mechanical workshops
  - Assembly areas
  - Electronic workshops
  - Equipment specific workshops (e.g. magnet workshop)

- Advantage:
  - state of the art infrastructure
  - savings with respect to infrastructure, maintenance of the areas (*gerant du site*) and control

- Proposal:
  - Bat. 867 for Prevessin -> study group
  - South Hall (Bat 150, 152)– or areas close by *or the* ISR ring

Proposal for 867



LEGENDE:

Espaces radioactifs : 7685m2

- TE/MSC : 1635+598=2233m2
- TE/ABT : 2088+1171=3259m2
- TE/VSC : 422m2
- BE/RF : 364m2
- EN/STI : 400m2
- BE/BI : 360m2
- EN/MEF : 307m2
- EN/ICE :Atelier électronique : 317m2

Espaces non radioactifs : 2375m2

- TE/MSC : 200+34+52=286m2
- TE/ABT :170+138= 308m2
- TE/VSC : 439m2
- EN/HE : 127m2
- EN/STI : 406+282=688m2
- EN/MEF:217m2
- Sanitaires et Vestiaires :50+60+100

Some radiation protection constraints:

- combustible material limited to a absolute minimum (fire risk)
- access control and a changing room at the entrance to the 'radioactive' workshops
- radiation monitoring is required
- in areas of destructive activities:
  - -continuous and impermeable floor coating, no rough surface, plinths welded or sealed to the floor
  - - separate ventilation system
- clear responsibilities
- daily cleaning
- well defined and approved work procedures
- maximum dose rate without shielding 10 µSv/h (40 cm)
- material with a dose rate between 10 µSv/h at 2 mSv/h must be properly shielded
- work or storage of equipment exceeding 2 mSv/h is prohibited.
- general services outside the radioactive zone (wherever possible)

Conclusions

- Accelerator components are or will become radioactive. Thus, job and dose planning (DIMR) is required for any maintenance and repair work – prepare work procedures now! Work procedures need to be approved by RP.
- Systematic, formalized ALARA approach needs to be extended to all work in radiation areas
- Traceability is required for radioactive material
- Optimised (remote) handling needs to be used
- Appropriate workshops are required for maintenance and repair of radioactive equipment -> Bat 867 and some more (e.g. TE-EPC, cold magnets) to be adapted for this purpose. Similar approach for Meyrin site.

I know that I am running out of time but I would just like to mention that:
- Access control for all experimental areas would be required
- 'Recreation' room outside the experimental halls (in an attached building) should be envisaged – no drinking, eating in radiation areas!!