HSE
Occupational Health & Safety
and Environmental Protection unit

# CERN Operational Radiation Protection

# CERN ALARA rule and dedicated RP computing tools

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EDMS reference

# Summary

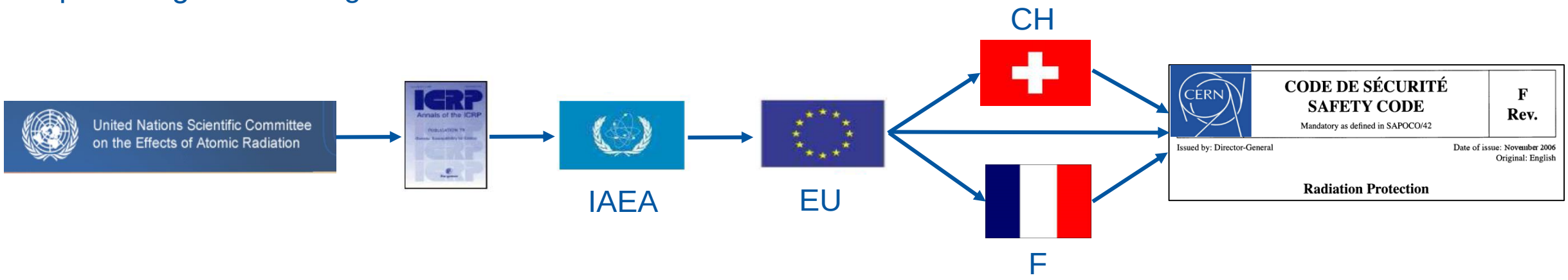
- CERN regulatory landscape in matter of Radiation Protection and Radiation Safety.
- Dosimetry data summary.
- ALARA rule applied to interventions at CERN.
- IMPACT coordination tool and dedicated RP applications.
- CERN area classification and dedicated classification database tool.
- CERN Operational dosimetry system and computing tools.

# CERN Radiation Protection Legal Framework

CERN is an intergovernmental Organization subject not to national but **international law**. Its status has been recognized by its host states where it must ensure their safety and security.

CERN has the right to establish **its own rules** as necessary for the proper functioning of the Organization, among others, **Safety Rules**.

CERN agrees to follow best practices in matters of radiation protection and radiation safety taking into account the legislation of its host states, as well European and international standards. Their implementation is discussed between the host states authorities, ASN (F) and OFSP (CH), and CERN according to a "Tripartite Agreement" signed in 2010.



# Radiation Protection – Radiation Safety

***Radiation Protection***

- Responsibility of the Radiation Protection Group (HSE-RP)
- The duties of CERN's Radiation Protection Group include operational radiation protection which comprises assessment of radiological risks, classification of work places in radiation zones, implementation of control measures, monitoring radiation levels for different radiation areas and impact of radiation on the environment, monitoring the implementation of regulations and of specific rulings, approval of ALARA plans, control and characterization of radioactive material and waste.

***Radiation Safety***

- Responsibility of every CERN Department owning radiation sources or using radiation sources put at its disposition.
- These Departments are in charge of implementing the requirements laid down in CERN's Safety rules and documents or specified by HSE-RP in order to ensure the safe operation of their existing and future installations (accelerators, beams, experiments). The Departments are also in charge of training their personnel in matters of Radiation Protection according to the rules specified by HSE-RP.

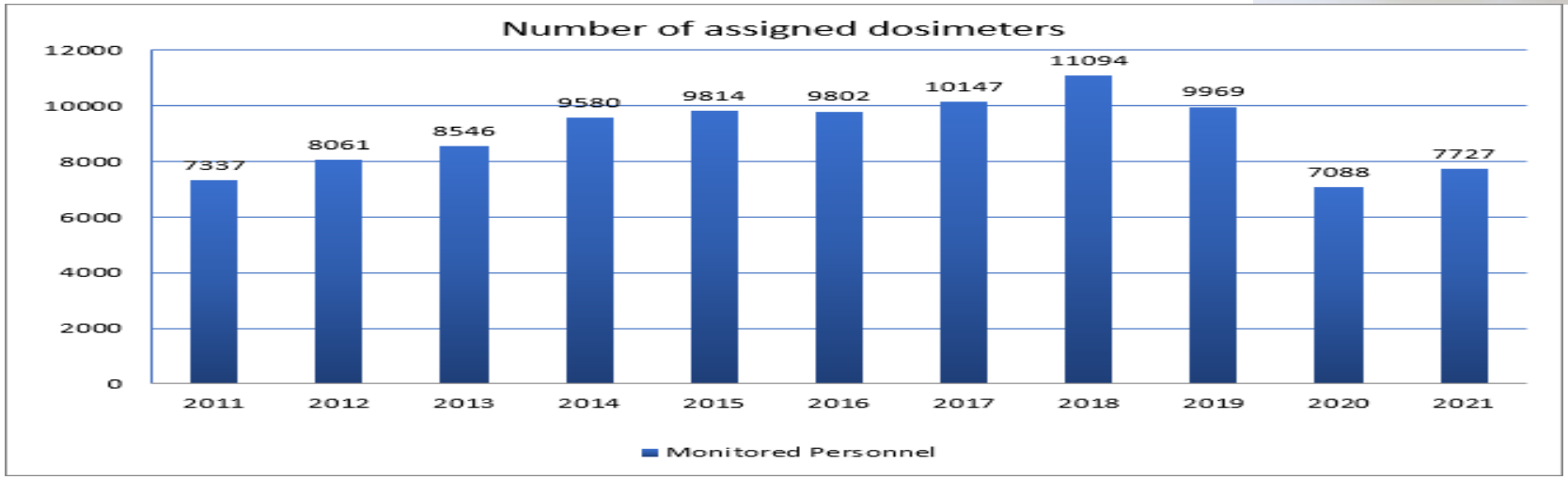
# General Principles of  Radiation Protection

1. **Justification**
   Any exposure of persons to ionizing radiation has to be justified

2. **Limitation**
   The personal doses have to be kept below the legal limits

3. **Optimization**
   The personal doses and collective doses have to be kept as low as reasonably achievable (ALARA)

# Personal Dosimetry

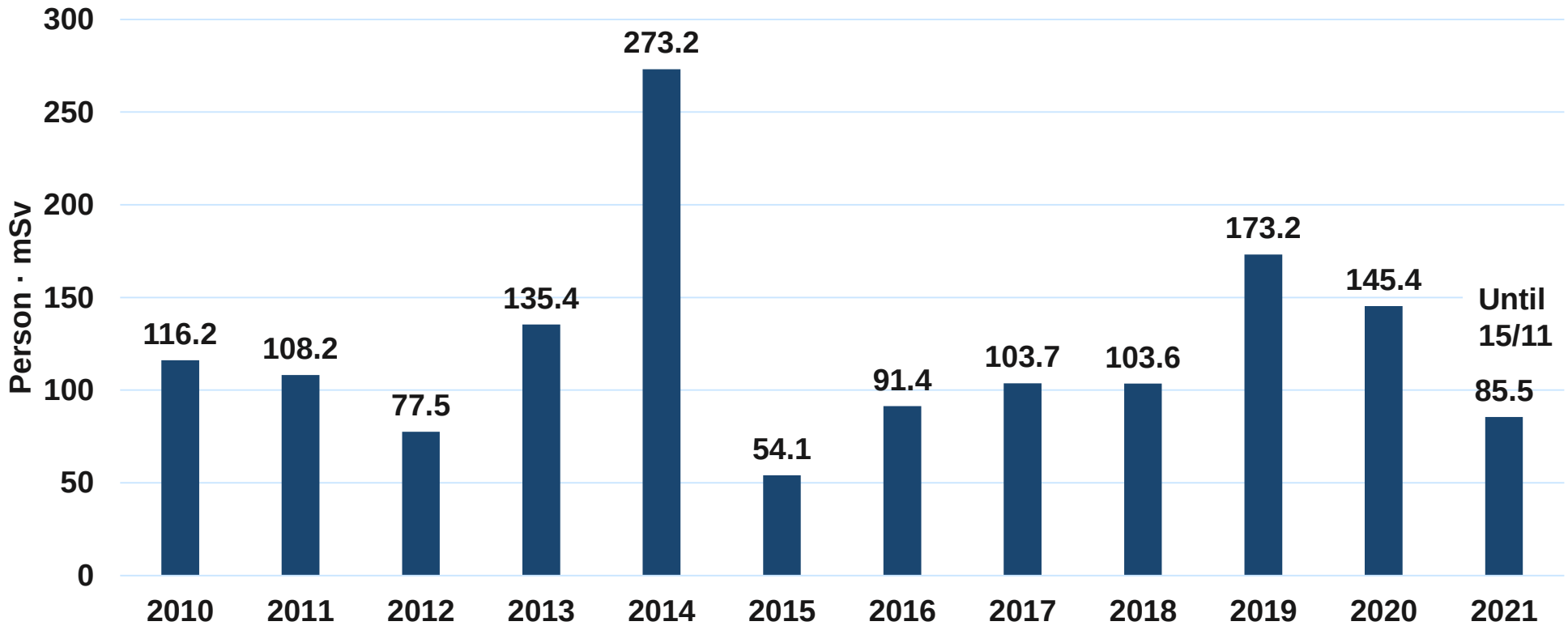




***1 mSv = 0,1 Rem***

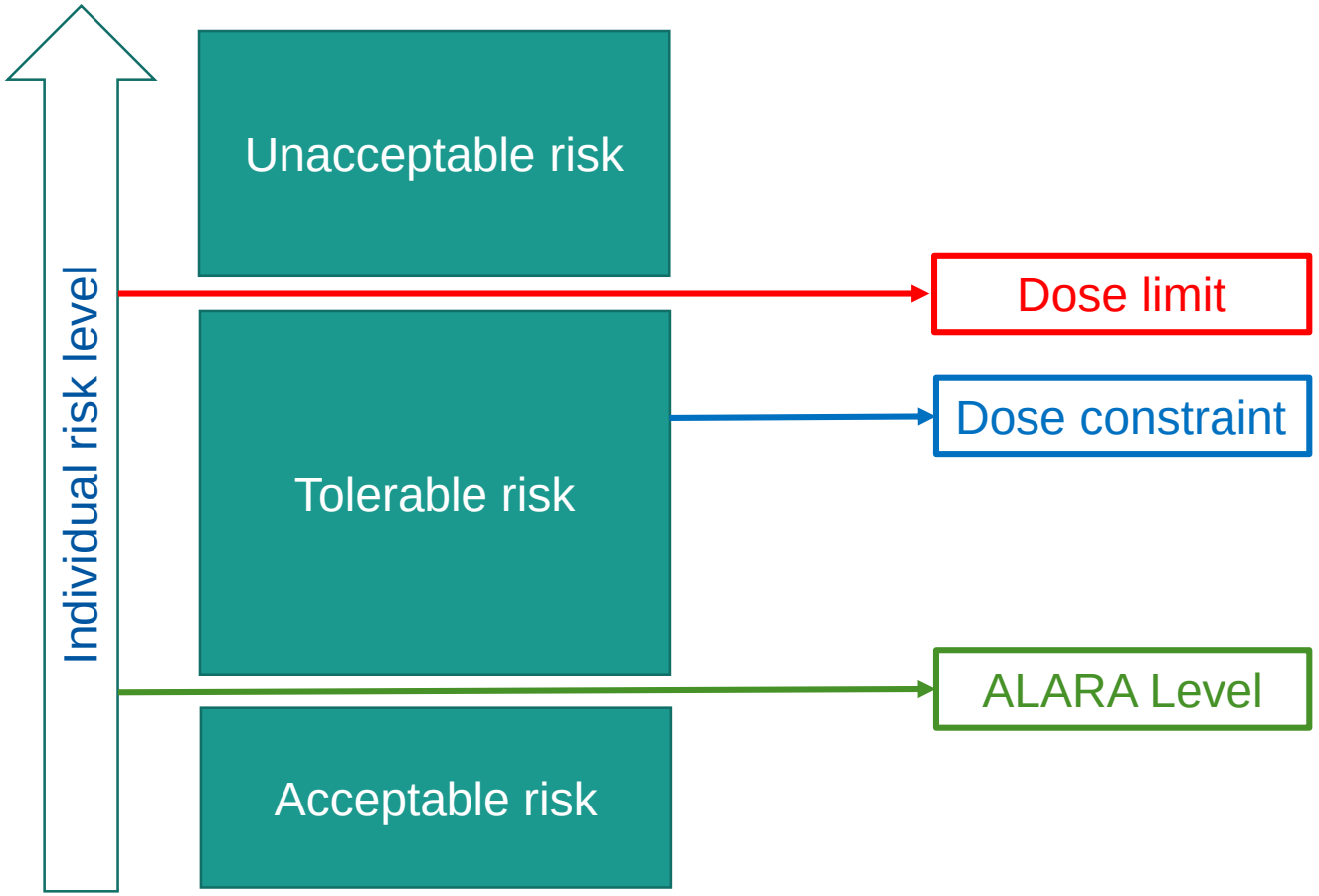
| Dose interval (mSv) | | Year 2011 | 2012 | 2013 | 2014 | 2015 | 2016 | 2017 | 2018 | 2019 | 2020 | 2021 (until 31/10.21) |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 0 | | 5315 | 6002 | 6273 | 7616 | 8704 | 8788 | 9034 | 9824 | 8462 | 6272 | 6302 |
| 0.1-0.9 | | 1984 | 2030 | 2188 | 1816 | 1108 | 1003 | 1110 | 1260 | 1494 | 799 | 695 |
| 1.0-1.9 | | 31 | 29 | 82 | 133 | 2 | 11 | 3 | 10 | 13 | 17 | 15 |
| 2.0-2.9 | | 7 | 0 | 3 | 14 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 3.0-3.9 | | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 4.0-4.9 | | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 5.0-5.9 | | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| > 6.0 | | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Collective dose (mSv) | gamma | 527 | 494 | 687 | 755 | 214 | 215 | 219 | 232 | 275 | 192 | 155 |
| | neutron | 2.6 | 4.5 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Total number of persons | | 7337 | 8061 | 8546 | 9580 | 9814 | 9802 | 10147 | 11094 | 9969 | 7088 | 7012 |

# Operational Dosimetry

## Collective operational dose



# ALARA rule applied to interventions at CERN : *Dose Optimization at CERN*




| | CERN workers | | Population |
|---|---|---|---|
| | Radiation Workers | Other Workers | |
| Dose limit | Class A: 20 mSv/yr<br>Class B: 6 mSv/yr | 1 mSv/yr | 300 µSv/yr |
| Dose constraint | 3 mSv/yr | 100 µSv/yr | 10 µSv/yr |

**Optimization process**

***1 mSv = 0,1 Rem***

# ALARA rule applied to interventions at CERN : *ALARA Criteria and Levels*

Optimization is a legal requirement if accumulated dose exceeds 100 µSv (ALARA)
Optimization includes different areas/aspects: work coordination, work procedures, handling tools, design, material choices,…

*Reference: "ALARA Rule applied to interventions at CERN", EDMS 1751123*

**Group 1 criteria** define the ALARA level

| | | | | | |
|---|---|---|---|---|---|
| Individual dose equi. | **Level I** | 100 µSv | **Level II** | 1 mSv | **Level III** |
| Collective dose equi. | | 500 µSv | | 5 mSv | |

**Group 2 criteria** are the bases of **a radiological risk assessment** (including accidents and incident scenarios) by the RSO and HSE-RP prior to the final ALARA level classification of the intervention.

| | | | | | |
|---|---|---|---|---|---|
| Ambient dose equivalent rate | **Level I** | 50 µSv/hr | **Level II** | 2 mSv/hr | **Level III** |
| Airborne activity in CA | | 5 CA | | 200 CA | |
| Surface contamination in CS | | 10 CS | | 100 CS | |

# ALARA rule applied to interventions at CERN : *DIMR Workflow*

**ALARA Committee**

| Level | | DIMR-1 | DIMR-2 | DIMR-3 |
|---|---|---|---|---|
| **Owner** | | Applicant (i.e. equipment owner, work coordinator, contract or activity responsible) | | |
| **Preparation (iterative)** | WDP template | **Optional** Applicant *(or RSSO)* | **Mandatory** Applicant *(or RSSO)* | **Mandatory** Applicant *(or RSSO, RSO)* |
| | Provides dose rates | RP | RP | RP |
| | Sets DIMR level | RP and RSSO | RP and RSSO *(or RSO)* | RP and RSO |
| | Documented work optimization process | **Optional** RSSO | **Mandatory** RP and RSSO | **Mandatory** Applicant and RSSO, RP and RSO |
| **Inform PCR (if applicable)** | | on request | Yes | Yes |
| **Approval** | | RSSO and RP | Dept. GL and RP and RSO | Complex manager (ALARA-c) |
| | Veto rights | RP Group leader | Leader of the HSE unit | Director General |
| **Follow up** | Feedback | **Optional** RSSO | **Mandatory** RP and RSSO | **Mandatory** RSO and RP and intervention supervisor |
| | Closure of WDP | **Optional**: RSSO | **Mandatory**: RP | **Mandatory**: RP |
| | Closure of intervention (DIMR) | RSSO | RSO | ALARA-committee responsible |
| **Controls** | | **Optional** RSSO | **Mandatory** RSSO | **Mandatory** RP and RSO |

### *ACRONYMS :*

***DIMR**: Dossier d'Intervention en Milieu Radioactif (English: RWP)*

***IMPACT:** Intervention Management Planning & Activity Coordination Tool*

***PCR:** Personnes compétentes en radioprotection*

***RP:** Radiation Protection*

***RPE:** Radiation Protection Expert*

***RPO**: Radiation Protection Officer*

***RSO**: Radiation Safety Officer*

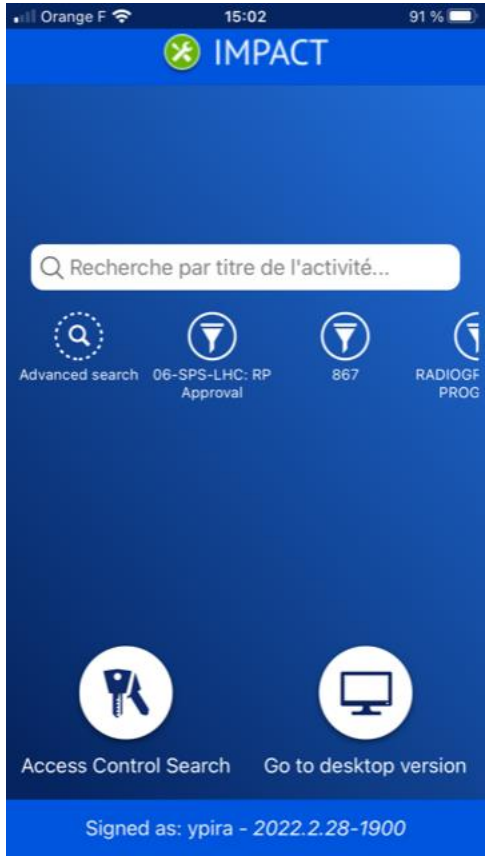
***RSSO:** Radiation Safety Support Officer*

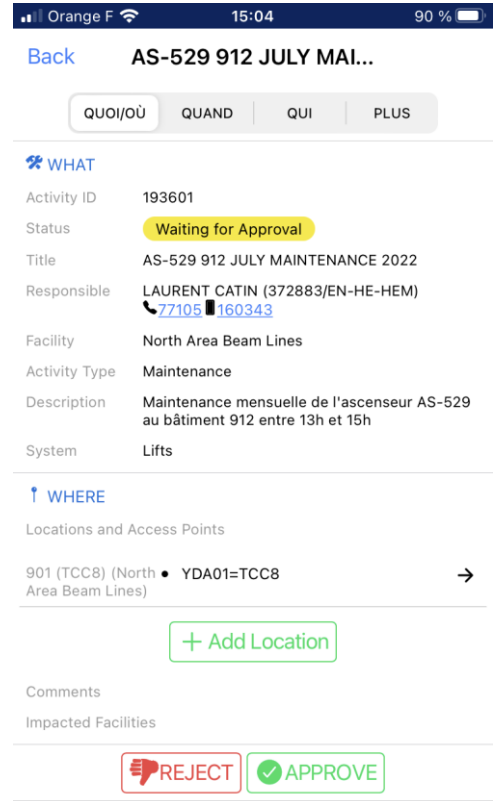
***RWP**: Radiological Work Permit (French: DIMR)*

***WDP**: Work and Dose Planning*

# The **IMPACT** tool (**I**ntervention **M**anagement **P**lanning & **A**ctivity **C**oordination **T**ool)

- IMPACT is a web-based tool:
  - That must be used to declare and approve the work activities with the concerned coordination team and officer (Building safety officer, RP officer,…)
  - That can be used to prepare works and link all the safety related aspects in it (Work procedures, modus operandi, common safety visits, Fire Permits, DIMRs, …)
  - That can be used to build the history of activities performed in a facility or building



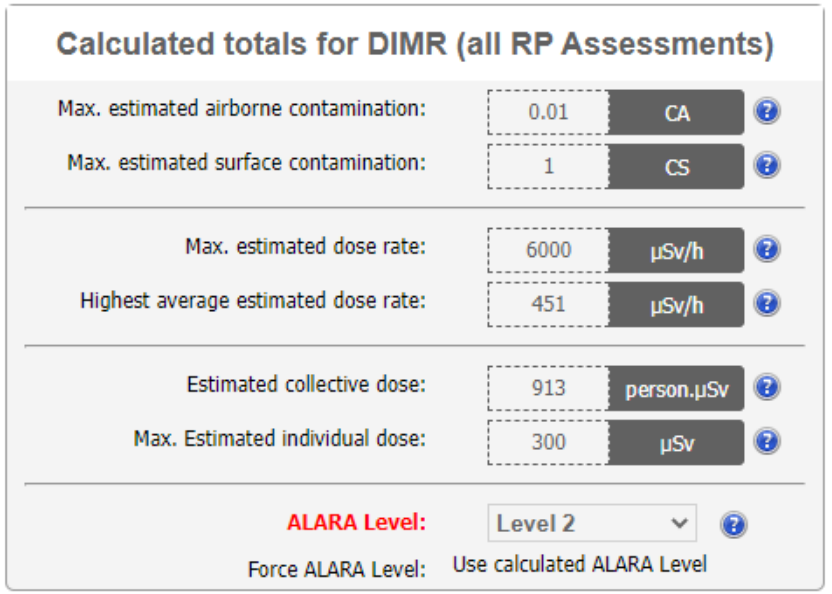




***DIMR**: Dossier d'Intervention en Milieu Radioactif (English: RWP)*

# The **IMPACT** tool (**I**ntervention **M**anagement **P**lanning & **A**ctivity **C**oordination **T**ool)

Along with the activity declaration form, two other forms related to radiation protection exists:

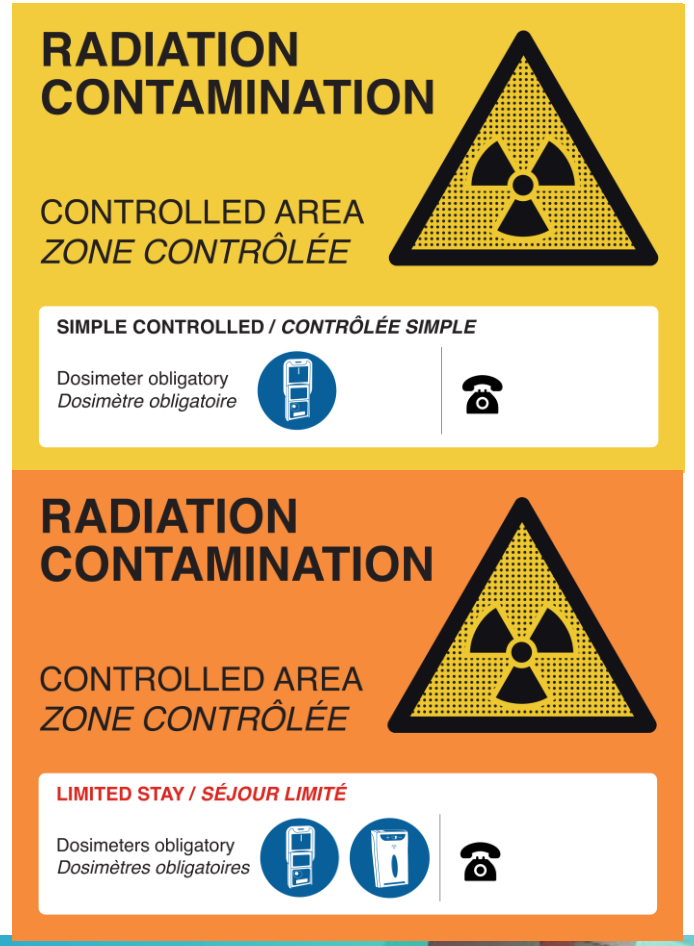
- **WDP**
  - Stands for **W**ork and **D**ose **P**lanning
  - Allows the activity responsible, with the help of other stakeholders, to carry out dosimetric estimates for one or more activities
- **DIMR**
  - Stands for **D**ossier d'**I**ntervention en **M**ilieu **R**adioactif (*English: **RWP** = **R**adiological **W**ork **P**ermit* )
  - Consists of a dosimetric evaluation (= linked with corresponding **WDP**) and other radiation risk assessment of each activity subject to an individual radiological risk analysis
  - Formalizes the final ALARA level of the concerned activity (**1**, **2**, **3**)

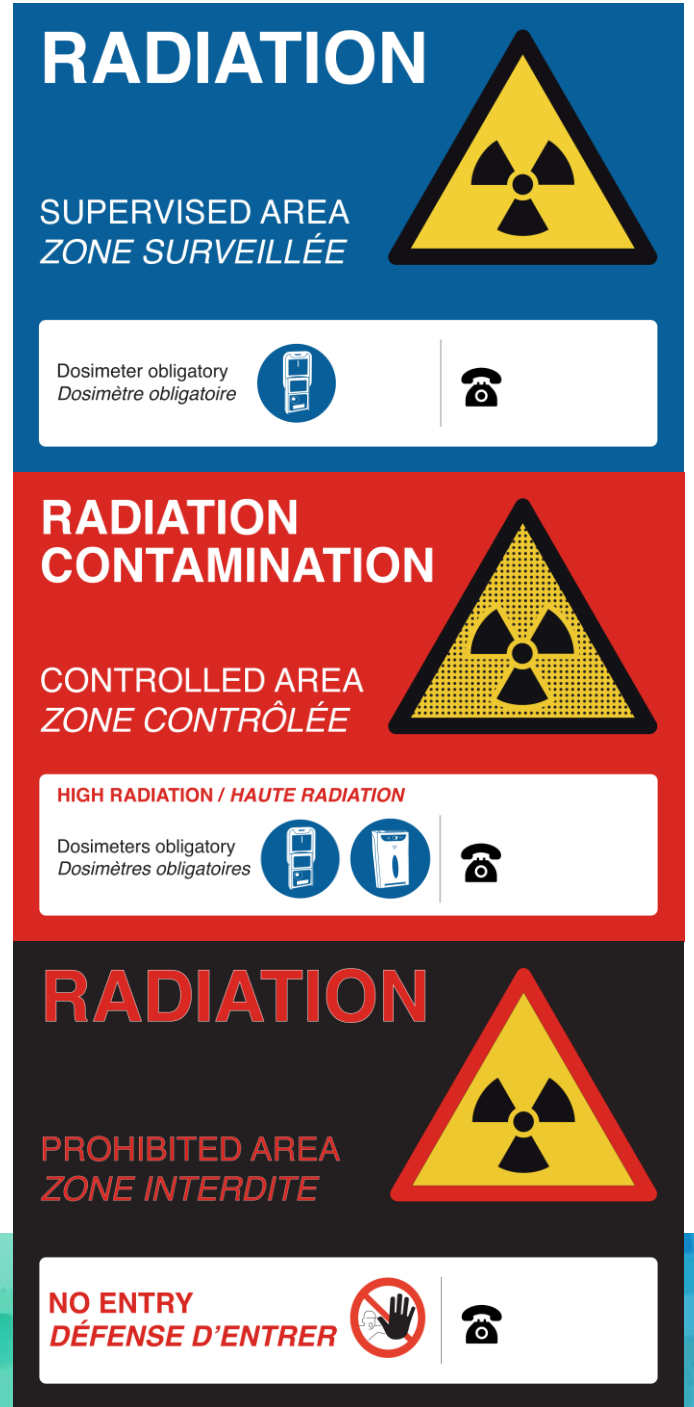


# CERN area classification

**CERN's radiation areas are divided between:**

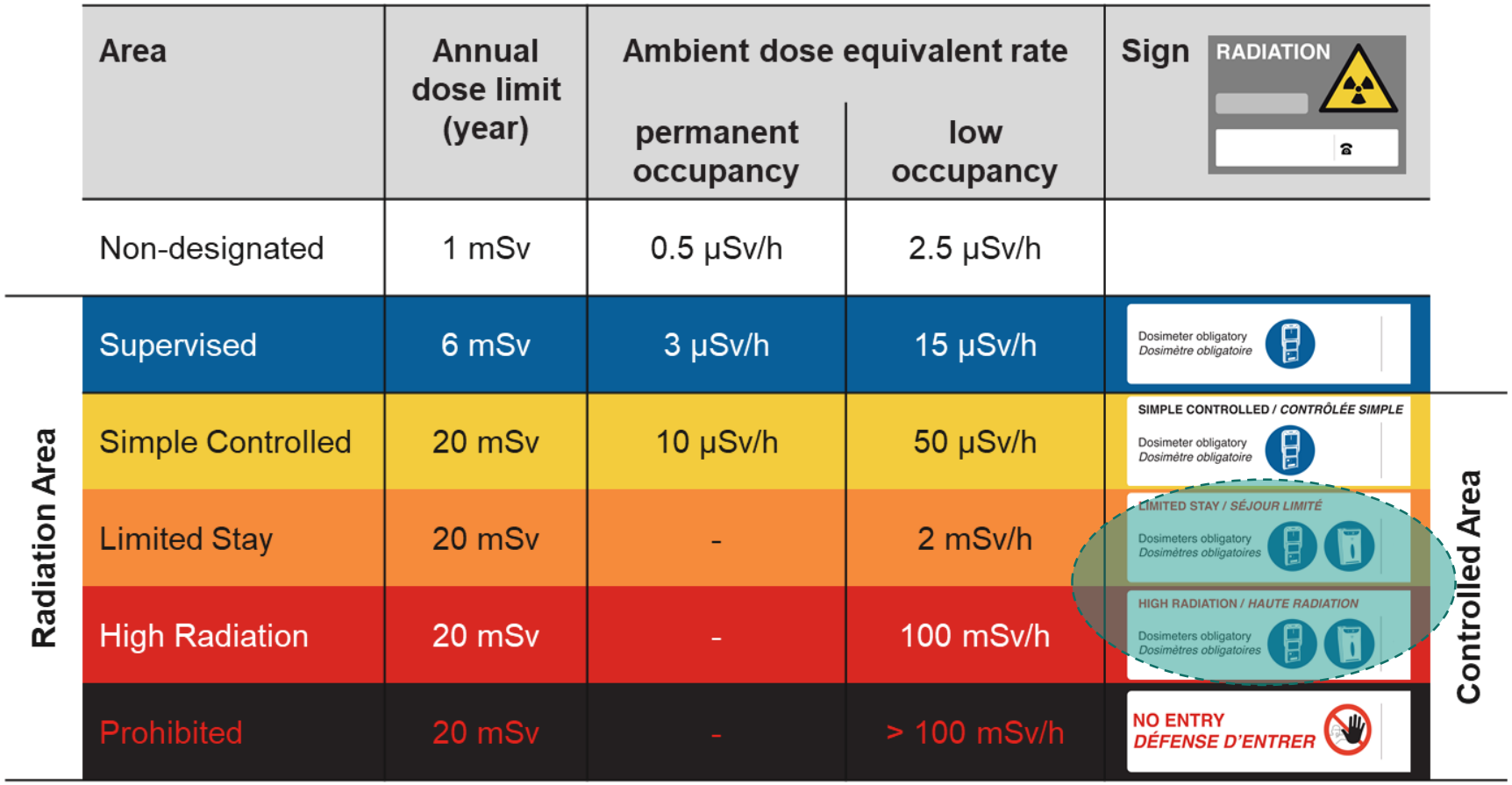
- Supervised Areas
- Controlled Areas
  - Simple
  - Limited Stay
  - High Radiation
  - Prohibited



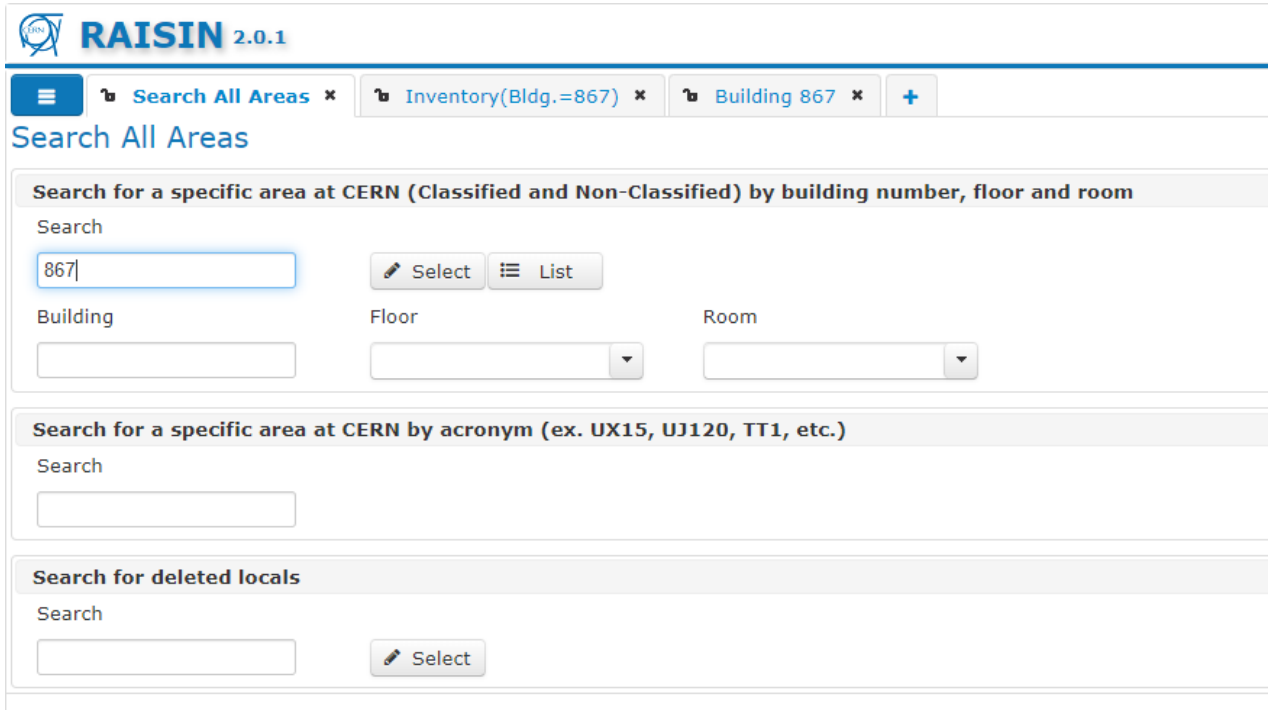
# CERN area classification

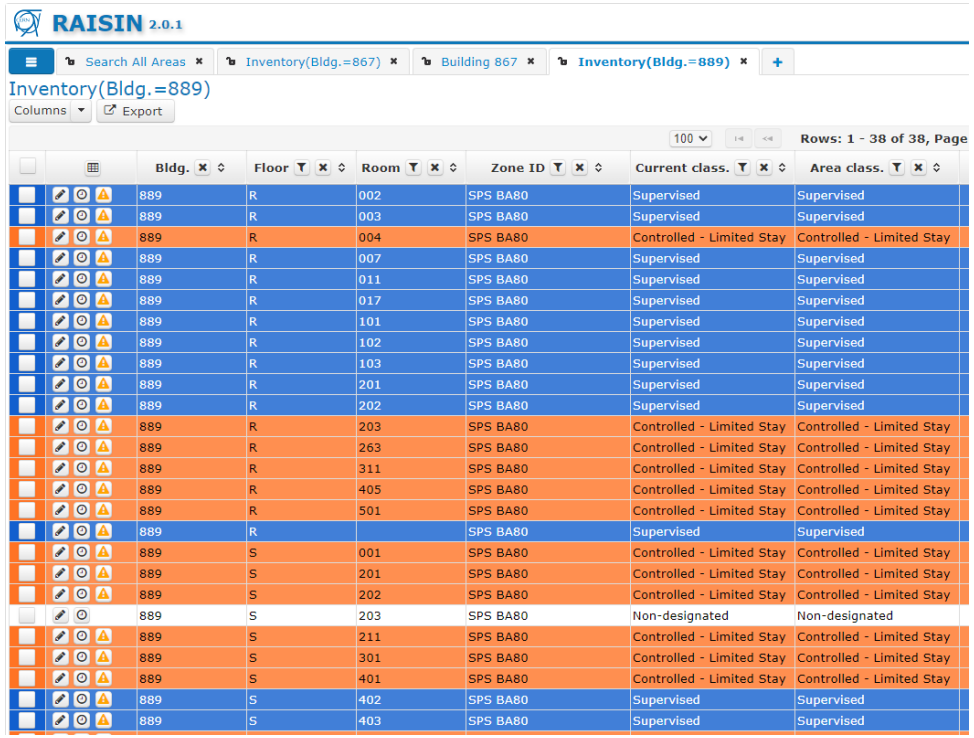
| | Area | Annual dose limit (year) | Ambient dose equivalent rate | | Sign |
|---|---|---|---|---|---|
| | | | permanent occupancy | low occupancy | |
| | Non-designated | 1 mSv | 0.5 µSv/h | 2.5 µSv/h | |
| Radiation Area | Supervised | 6 mSv | 3 µSv/h | 15 µSv/h | |
| | Simple Controlled | 20 mSv | 10 µSv/h | 50 µSv/h | |
| | Limited Stay | 20 mSv | - | 2 mSv/h | |
| | High Radiation | 20 mSv | - | 100 mSv/h | |
| | Prohibited | 20 mSv | - | > 100 mSv/h | |




**Operational Dosimetry mandatory**

# CERN area classification : *the **RAISIN** database (**RA**diological r**IS**k areas **IN**ventory)*



# CERN area classification : *How the area classification and other RP parameters drives the IMPACT workflow*

- Type of activity (e.g. radiography or guided visit in controlled areas)
- Access point linked to RP approval
- RAISIN start-of-work flag set to yes
- DIMR parameters are set such that:
  - The activity includes contaminating works
  - The total collective working time is above 500 person·h and works are located in controlled areas
  - The individual collective working time is above 100 h and works are located in controlled areas
  - Presence of short-term workers is declared and works are located in controlled areas

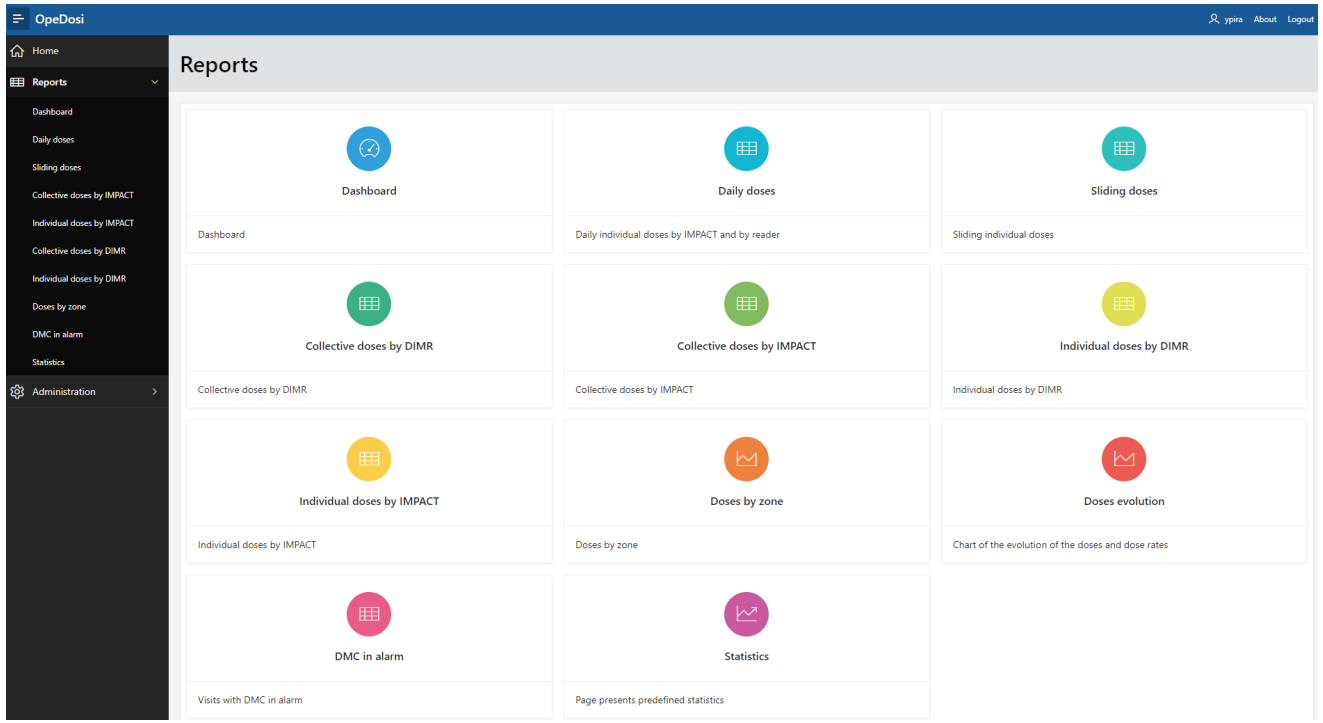
# CERN Operational dosimetry system and computing tools

Based on the system provided by Mirion Technologies

All data is kept internally, in CERN's Oracle Databases

Modified to fulfil CERN's requirements

- Dedicated website based on Oracle APEX, to perform dosimetric follow-up
- Link between Operational Dosimetry system and IMPACT web-tool




**OpeDosi website**

# Link between the operational dosimetry and IMPACT

IMPACT and the operational dosimetry system are synchronised every 6 minutes

- New workers
- New activities
- Statuses of activities

Dose estimates in IMPACT are allowing to set dose limits in dosimeters

- Allows parametrisation of dose limits and dose rate limits

When thresholds are exceeded, the worker cannot work on this activity anymore

If the worker gets to the yearly dose limit, he is not allowed to turn on operational dosimeter anymore

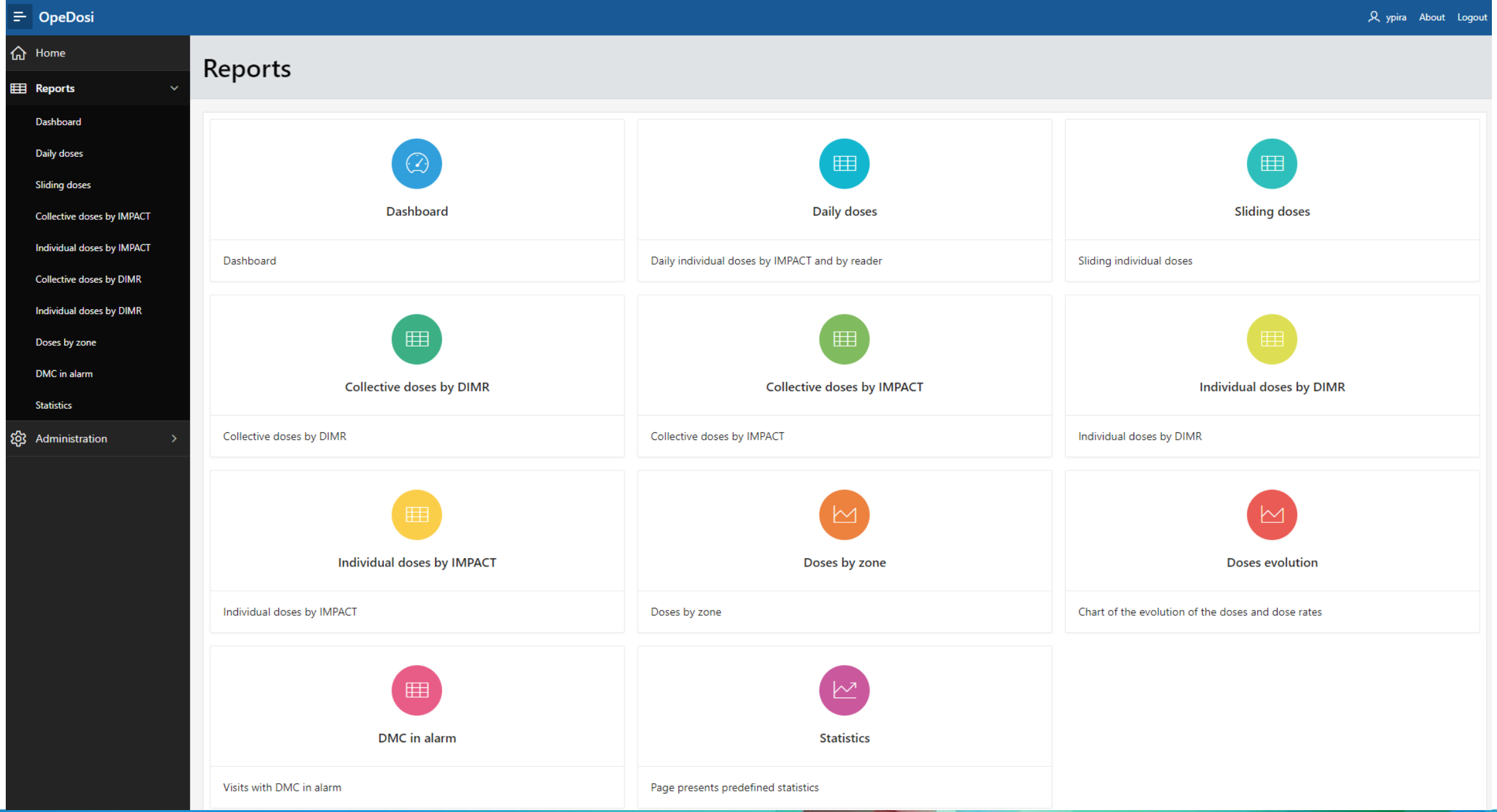
# Follow-up of interventions

Internal Radiation Protection website allow the Radiation Protection Officers to perform dosimetric follow-up of interventions

IMPACT provides a “dose reporting tool” so that stakeholders could get informed about the intervention dosimetric situation

- Dose visibility depends on users status
- Department Heads / Group Leaders / Radiation Safety Officers / Radiation Support Safety Officers / Radiation Protection Experts have dedicated visibility

Blocking mechanisms ensures that estimates are respected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Collective doses by IMPACT
Individual doses by IMPACT
Collective doses by DIMR
Individual doses by DIMR
Doses by zone
DMC in alarm
Statistics
Administration
Reports
Dashboard
Dashboard
Daily doses
Daily individual doses by IMPACT and by reader
Sliding doses
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Collective doses by DIMR
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Individual doses by DIMR
Individual doses by DIMR
Individual doses by IMPACT
Individual doses by IMPACT
Doses by zone
Doses by zone
Doses evolution
Chart of the evolution of the doses and dose rates
DMC in alarm
Visits with DMC in alarm
Statistics
Page presents predefined statistics


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