Summer Student Project Report

IMPROVE THE SUPERVISION AND THE MONITORING OF THE OPERATIONAL DOSIMETRY DURING WORK ACTIVITIES WITH A NEW REAL-TIME MONITORING SYSTEM

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Abstract

Given the paramount importance of radiation protection, particularly in optimizing safety measures, the task of monitoring workers during interventions involving radiation exposure is a formidable challenge. This project centers on mitigating these challenges by introducing a new solution—a Bluetooth-enabled dosimeter tailored for up to three workers stationed in high radiation zones or in general working under radiation exposition. The primary objective is to identify prevailing issues encountered by radiation protection (RP) supervisors and present a novel solution that seamlessly integrate a new software « ConnectStudio » to monitor and track workers' radiation dose and dose rates in real-time. By harnessing this technology, the project aims to enhance RP practices, facilitate adherence to safety protocols, and proactively address potential issues, thus promoting a safer working environment.

Acknowledgements

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Introduction

Operational dosimetry, also known as operational radiation protection dosimetry, is the process of monitoring and measuring the radiation exposure received by individuals working with or around sources of ionizing radiation. The primary purpose of operational dosimetry is to ensure the safety of radiation workers by using the personal dosimeters to track the cumulative radiation dose received by workers. The data collected helps ensure their safety, comply with regulatory limits, and maintain radiation protection standards in various industries.

The aim of this project is to enhance the supervision and the monitoring in real-time during work by adapting a new tool.

1. Radiation protection Principles

Passive dosimeters are suitable for longer monitoring periods and are often used for routine or periodic monitoring, as well as for personnel working in areas with relatively stable radiation levels.

- **Justification**: Any exposure of persons to ionizing radiation must be justified
- **Limitation**: The personal doses must be kept below the legal limits
- **Optimization**: The personal and collective doses must be kept as low as reasonably achievable (ALARA).

- ALARA Principles

Optimisation is about maintaining doses as low as reasonably achievable, which is known as the ALARA principle. Different protection measures can be taken to reduce exposure to radiation, such as:

- Reduce the exposure time.
- Increase the distance.
- Increases the shielding.

2. Interventions in radiological zones

We are focused on the planned interventions; these interventions are part of the scheduled work activities during a long shutdown or during technical stops.

2.1- The tools used:

To survey these interventions, the RP team uses the following tools:

→**The impact tool (I**ntervention **M**anagement **P**lanning & **A**ctivity **C**oordination **T**ool**):** is a web-based tool that can be used to:

- Build the history of activities performed in a facility or building.
- Prepare works and link all the safety related aspects in it.
- Declare and approve the work activities with the concerned coordination team and officer.

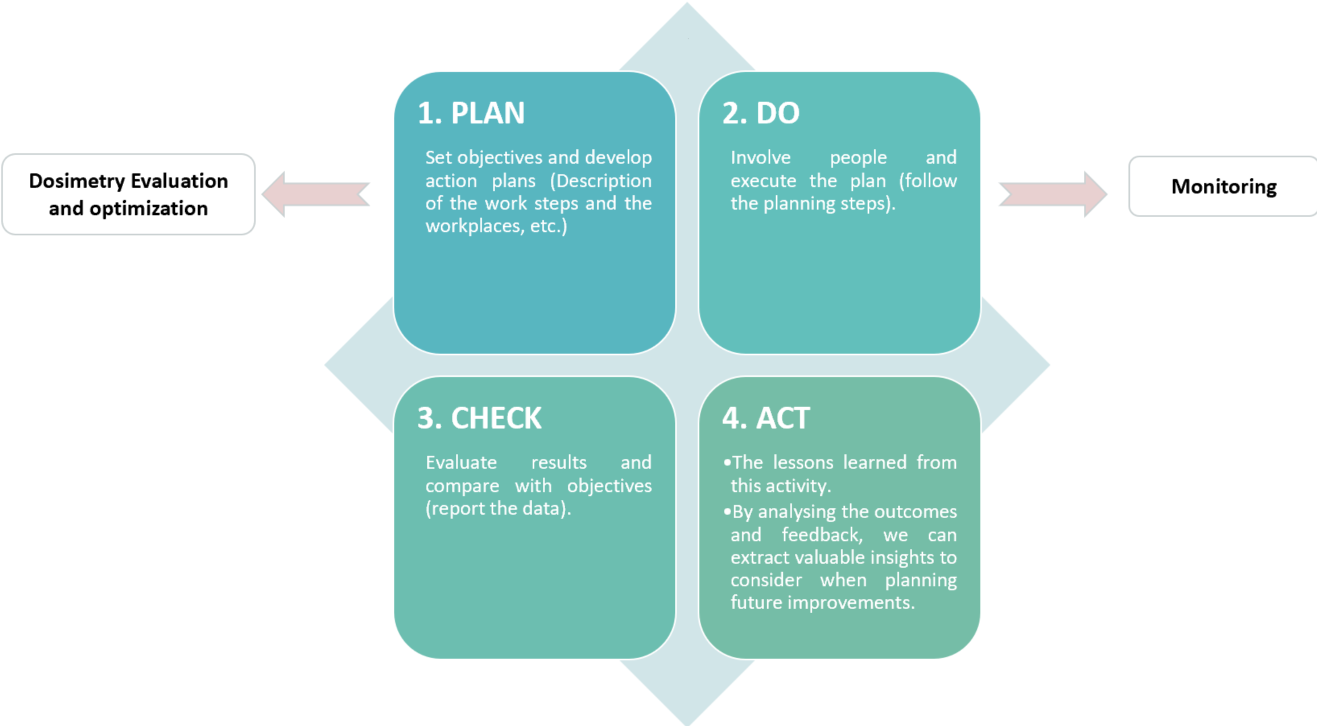
→**WDP (W**ork and **D**ose **P**lanning**):** Allows the activity responsible, with the help of other stakeholders, to carry out dosimetry estimates for one or more activities.

→**DIMR / RWP (D**ossier d'**I**ntervention en **M**ilieu **R**adioactif / **R**adiological **W**ork **P**ermit**):** Consists of a dosimetry evaluation (linked with a 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)
- For each intervention leading to individual or collective doses exceeding 50% of the ALARA Level 1 criteria (i.e., 50 µSv or 250 person-µSv, respectively) a DIMR is established.

2.2- The global ALARA process

PDCA is an acronym that stands for Plan-Do-Check-Act, also known as the Deming Cycle. It is a continuous improvement framework widely used in various industries to enhance processes, products, and services, as well as CERN industry. The PDCA cycle consists of four sequential steps, each serving a specific purpose in the improvement process:



2.3- The material used:

- **DMC 2000S:**

The DMC 2000S dosimeter has a :

- Flat response curve for X and gamma radiation for energies from 50 keV up to 6 MeV.
- A linear dose rate response for natural background noise up to 10 Sv/h.
- The DMC 2000S can display the dose, the dose rate and have programmable alarms.

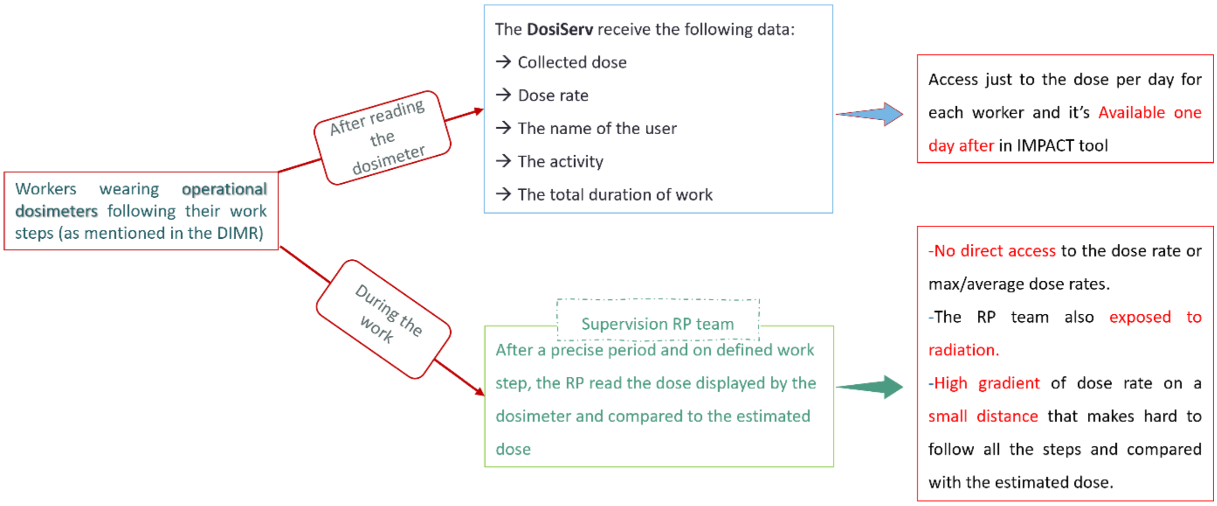
- **DMS 3000**

The characteristics of the DMC 3000:

- Loud audible alarm, vibrator and ultra-bright LEDs
- Clearly visible backlit display
- Additional modules (telemetry…)
- Easy navigation with only 2 buttons.

3. Challenges

In general, we have a worker performing their job and, as part of their work, they are exposed to radiation. In this scenario, there are two approaches for collecting the worker's radiation dose: **manual** (During the work) and **automatic** (After reading the dosimeter) methods.



Based on a comparison of two cases, one with a short duration and small number of participants, and the other with a long duration and large number of participants we have reached to the following results:

Case 1 installation/removal of new Totem T2 detector

- ✓ The steps are well identified and precise, as it is a short duration task.
- ✓ The worker may encounter high-exposure areas at different times, further complicating the task of defining an average dose and meticulously tracking each step.
- ✓ With constant supervision, there is a dedicated availability of resources for oversight and support, and it's more likely that all steps and procedures are consistently followed.
- ✓ Supervision is guaranteed at 100% throughout the entire period.

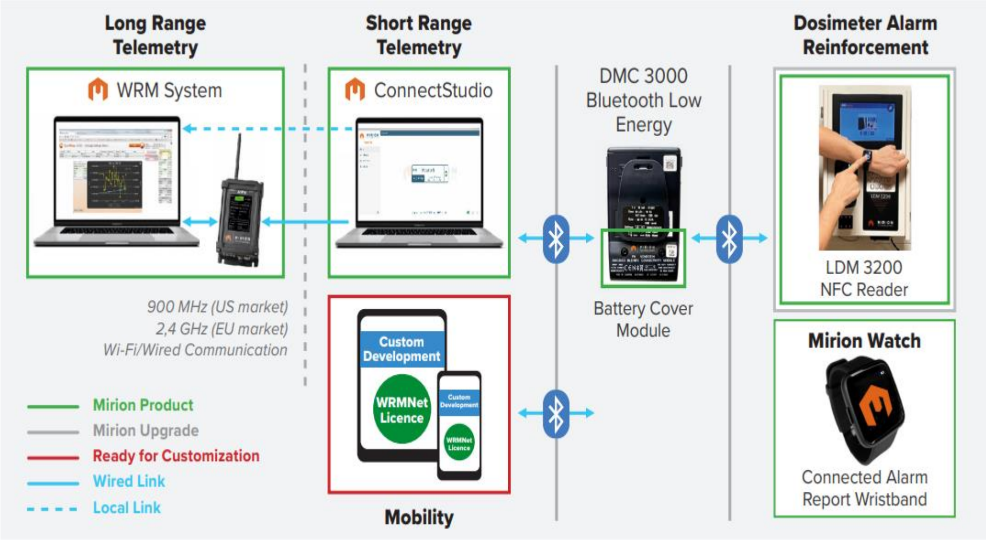
Case 2 Removal, maintenance, and Re-installation of Pixel detector in Long Shutdown 2

- ✓ **Lack of details:** Difficulty in identifying levels before inspection, making it hard to determine all the sub-steps involved in each one.

- ✓ **Various positions:** meaning a worker can move through different locations, creating a wide range of scenarios.
- ✓ It's challenging to ensure supervision throughout the entire period and for all personnel due to a lack of available resources (co-activities).
- ✓ Coordination with different group members becomes difficult due to the large number of participants.

4. Suggestion

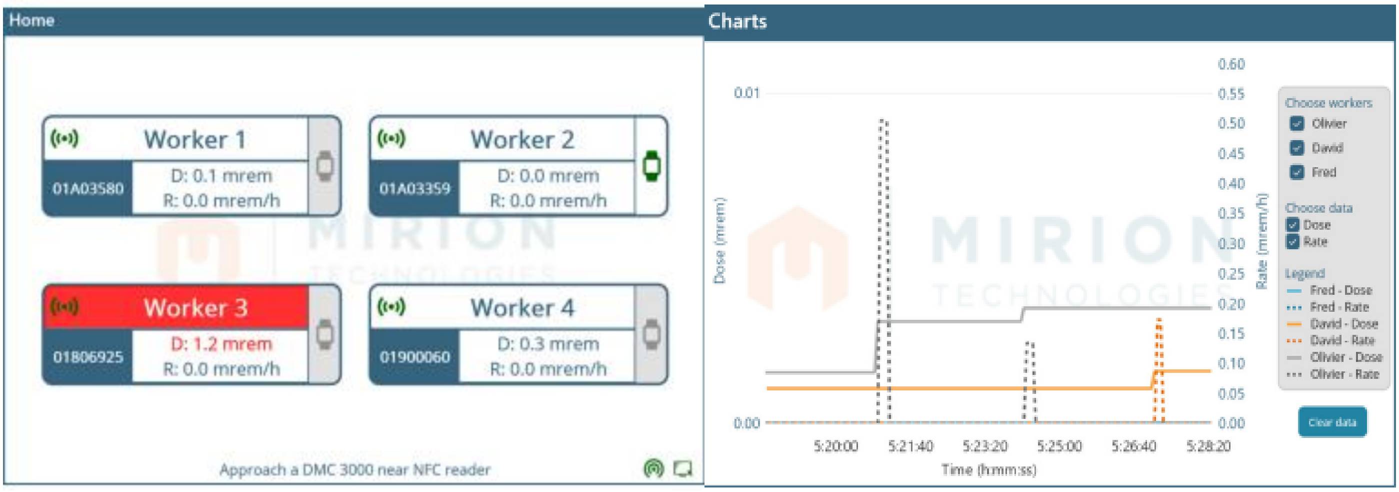
By implementing a new technical solution,



we envision the deployment of a select group of workers equipped with the latest **dosimeters**.

- **Frequencies:** 2.4 GHz
- **Transmission interval:** Adjustable 1 or 4 seconds
- **Transmission range:** (20-25 m) line of sight

This team will operate near the radiation source, with their real-time dose and dose rate monitored remotely by the RP team via tablets situated approximately 20 to 25 meters away. The strategic advantages of this approach are manifold. For workers, it ensures vigilant supervision and consequently minimizes workflow interruptions, fostering heightened concentration on tasks at hand. Simultaneously, supervisors' benefit from an effective oversight mechanism, enabled by instantaneous access to critical data such as individual dose, dose rate, and exposure periods, facilitated by the integrated software.



5. Conclusion & Future work

In conclusion, this project encompassed several pivotal stages aimed at enhancing worker safety and efficiency within the context of radiation exposure. Initially, a comprehensive understanding of the tools and processes for interventions and tasks was acquired, forming the bedrock for subsequent advancements. Identifying existing issues paved the way for the proposal of an innovative solution: the integration of new dosimeters.

In summary, the project not only addresses challenges but aims to redefine radiation safety norms. By integrating technology, vigilant monitoring, and continuous feedback loops, the objective is to establish new benchmarks, prioritizing worker well-being and operational excellence.

Moving forward, the project's trajectory encompasses essential elements. To ensure its viability, a meticulous budget analysis is essential, followed by a precise estimation of associated costs. As a vital step, practical implementation will entail executing trials during future interventions while systematically collecting valuable user feedback. Furthermore, acknowledging the paramount role of knowledge dissemination, plans for the training of supervisors and the RP teams remain integral to sustained success.