Best practices from the ULs to UIs in underground working environment

Baltic Sea Underground Innovation Network (BSUIN)

Interreg Baltic Sea Region
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Tabel of content

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1. BSUIN project introduction

The aim of the BSUIN project is to make the underground laboratories (hereinafter ULs) in the Baltic Sea Region more accessible for innovation, business development, and science by improving the information about the underground laboratories, the operation, user experiences, and safety.

Baltic Sea Underground Innovation Network (hereinafter BSUIN) is a collaboration project between 13 partners from 8 Baltic Sea Region (hereinafter BSR) countries. Besides project partners, 17 associated partners contribute to achieving project goals.

In the project participate six (6) underground laboratories around BSR. They all will be characterized and presented to potential customers in order to attract developing innovative activities and active use of those laboratories. Six underground laboratories by name are:

1. Callio Lab, Pyhäsalmi mine, Finland
2. Äspö Hard Rock Laboratory, Oskarshamn, Sweden
3. Reiche Zeche, TU Freiberg Research and Education mine, Germany
4. Lab development by KGHM Cuprum R&D centre, Poland
5. Khlopin Radium Institute Underground Laboratory, Russia
6. Ruskeala Mining Park, Russia

The main outcome of the project is a sustainable network organization, which will disseminate the technical, marketing, operational quality, training, and other information about the BSR ULs created during the project.

The project is funded by Interreg Baltic Sea funding cooperation. Its duration is 36 months with a total budget of 3.4 M€.

2. Content of present Document

2.1 Document justification

The present document is a part of the project BSUIN work package 4.1 output, where one of the activities covers the establishment of a common standard of underground working environment among in six above mentioned UL-s.

The purpose of work package 4 is a description of the working environment and risks assessment among ULs, including also the dissemination of best practices and development guidelines.

2.2 Content description

The Uls have improved and created their own methodologies and practices on how to improve the Uls conditions and practices. These best practices are usually more than the national laws and regulations have requested. The collected practices and experiences will help to set new higher standards of the working environment for the Uls to aim at.

The best practices are based on the Ul specific questionnaire (see Appendix 1) which was carried out during August-September 2018. The Ul specific questions were based on two sources: the working environment questionnaire and the data collection tour. In the questionnaire, the Uls were asked to describe the challenge into their best practices give the solution to, the motivation to tackle the issue, and what kind of effects applying the best practice has brought up. In the next chapter the best practices are presented. Summary and conclusions are presented in the final chapter.

3. Best practices

According to Wikipedia the best practice is determined as „*A best practice is a method or technique that has been generally accepted as superior to any alternatives because it produces results that are superior to those achieved by other means or because it has* *become a standard way of doing things, e.g., a standard way of complying with legal or ethical requirements*."

Each of the Uls was sent a questionnaire with specific best practices they had developed or applied during their operation. Each questionnaire had also an open part where the Ul representatives could add their own best practice they would like to share with other Uls.

The outcome of the best practices' questionnaire has been divided into four subcategories, under which each best practice is briefly described.

3.1 Accessibility and outside visitors

Ruskeala Mining Park in Sortavala, Russia, was an old marble quarry and now has been transformed into natural tourism area. To expand the range of service also an underground part was recently opened for the public. The underground parts are partially filled with water. To enable the underground visits floating platforms have been installed. The width and the structure of the platforms enable also the disabled persons to move around in their wheelchairs.

Reiche Zeche, TU Freiberg Research and Education mine, is also used for tourism and events. The activities are carried out by a non-profit organization "Förderverein Himmelfahrt Fundgrube Freiberg e.V.". The organization was founded in 1992 to preserve the mining and industrial traditions and transfer mining/industrial history. The non-profit organization bears the costs of its surface facilities and underground gear. The tours are from short and easy up to 5h long expert tours through mining areas of the 16th to 20th century. Later meeting and festival rooms have been created to extend the range of services. There is also a route for disabled bodied visitors, called a teaching path.

3.2 Controlled parameters and observation points

Underground locations need to be monitored and the observables need to be comparable with previous and future measurements. At Reiche Zeche they are using solid measuring points indicated by wall-installed info boards where the location is identified, the previous value and the conducting engineer are mentioned. This enables to the repeatability of measurements and comparison of values over longer time periods with other Uls as well.

Closed spaces, in which the mines and Uls can be classified, can cause bad surprises in the form of building up of gases. Both lab developments by KGHM Cuprum R&D center, Poland and Callio Lab, Pyhäsalmi mine, Finland, are operating in active mines. In underground workings, the gases either from the mining-induced or the exhausts from diesel power engines can cause significant risks for the employees working underground. Common toxic gases are hydrogen sulfides, carbon dioxide, and carbon monoxide. Monitoring is conducted by infrastructural sensors and in workings by personal gas monitors.

Monitoring and determining the radioactivity of different materials, a piece of dedicated equipment and facilities are needed. One such location is located at the UL of Khlopin Radium Institute at the heart of St. Petersburg. In order to measure the gamma-ray spectrum with high precision the spectrometers need to be located underground (shielding from the cosmic rays induced background radiation) and additional shielding is required to shield from gamma rays emitting from surrounding materials. With careful selection of shielding materials, e.g. steel and lead, the background can be suppressed significantly. And by putting emphasis also on the radiopurity of detector materials the background can be reduced even more. To suppress the contribution of radon into the background the radon-laden air is displaced by using hollow, sealed liners made of lightweight and low-level material. For their manufacture was used 3D printing technology from polymeric materials, the content of radioactive impurities in which is minimal. The created unit, yielding to the best European laboratories, is by far the best in Russia. The detector system needs to run under cryostat. The scientists at Khlopin are using special liquid nitrogen regenerating dewar thus enabling the continuous operation of several years.

3.3 Personnel training and monitoring

The underground environment can be dangerous and unfriendly for the personnel. This is the reason why the training of workers, operators, and visitors on safety issues is very important. For permanent personnel and for infrequent operators like most of the UI users are, the training is extensive. These trainings include identification of risks, how to move underground, how to operate in case of an emergency. The CURPUM policy is that all non-staff operators and visitors are accompanied by a staff member. The Callio policy is that after training and gaining experience working underground one can operate without supervision. Only non-Finnish-speaking UI users must be accompanied by a Finnish-speaking UI employee. In both places all visitors take introductory training on underground safety and visitors are accompanied by guides.

In case of an emergency or getting lost in the underground tunnels locating the underground personnel is a matter of grave importance. At ÄSPÖ they are using the local area WIFI network relay stations to locate individuals through their facility VOIP phones. At CUPRUM mines they are using special signals emitted from the helmet lights to locate individuals with a receiver system.

3.4 Environmental and Economical

Wintertime with sub-zero temperatures can be a challenge for UIs due to ice formations. At Callio in the Pyhäsalmi mine, Finland, there is a constant flow of fresh air from the surface to the bottom of the mine. The airflow is at a maximum of 130m3/s. With the high flow rates, the air temperature inside the mine needs to be at least +4 degrees to prevent frost from forming. Previously the air was heated with fossil fuels or with natural gas. With the new system, the idea was to achieve cost saving by using the existing heat sources like wastewater from flue gas scrubber (water temperature up 40 C) and mine wastewater (water temperature 17C). In just three years the investment had paid back. Currently, the system uses only the mine water but is still producing annual savings. The heat recovery system saves annually 500 tons of fuel oil and reduces CO_2 emissions by 1400 tons annually compared to the old system.

Another form of adding savings is to reduce energy consumption and maintenance costs are to change from normal lighting into intelligent lighting. At ÄSPÖ the lights are dimmed or switched off when no one is at the vicinity of the light sources. For this, they used a commercial supplier who had a fully integrated product available. The change to e-lighting has created savings in energy and has also extended the interval of lamp changes.

4. Summary and conclusions

All the UIs have something unique and practical they have adapted in their operations. The best practices shown have resulted in improved safety, increased usability and accessibility of the UIs, and savings in maintaining the UI infrastructures. By sharing the best practices among the UIs within the BSUIN network the UIs organizations can learn from what others have early applied and found practical. This will in time reduce the barrier to adopt new practices as there are working examples available, and which can be developed even further.

Appendix 1: Best practices questionnaire

Dear UL representatives,

As concerning the activity 4.1. Working Environment we would like to send you some additional questions based on your answers on the questionnaire and also data collection tour findings. As one of the topics for the activity was best practices related to working environment we have chosen your facility to represent the best practices in certain fields

- In the questionnaires mentioned and identified best practice

  - What was the motivation for having / adapting solutions / practice in your UL?
  - What was the selection process which led into the selection of the solution / practice?
  - How the selected solution / practice has benefitted your UL?
  - What was the estimated investment cost for adaptation of the practice/ solution? If the cost is unknown or is non-disclosable pls. do mention it.
    - ✓ Per employee (if can be estimated)
    - ✓ Per m3 of your UL (if can be estimated) to compare the results with other facilities as well?
    - ✓ Where there any financial impact of the investment into your operations? If yes, what kind?