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ENhancinG stAkeholder participation ENGAGE in the GovernancE of radiological risks

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* Development of radiological protection culture to support the governance of radiological risk

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Abstract

The ENGAGE project, funded under the H2020 CONCERT, aims at *ENhancinG stAkeholder participation in the GovernancE of radiological risks.* This two-year project started on November 20th 2017, seeks to identify and address key challenges and opportunities for stakeholder engagement in relation to medical use of ionising radiation; post-accident exposures; and exposure to indoor radon. In all these situations, stakeholder engagement is a key issue for improving the governance of radiological risks and the radiological protection of the exposed individuals.

Within this project a specific Work Package (WP3) is dedicated to analyse the processes and tools to disseminate radiological protection culture. The objectives of this WP are the following:

i) to investigate the **role and the potential benefit of building and enhancing radiological protection culture for supporting effective stakeholder engagement and informed decision-making** in relation to radiological protection at the individual and collective level;

ii) to identify **processes to build and transmit radiological protection culture**, adapted to the specificities of different exposure situations; and

iii) to **elaborate guidelines/recommendations for building radiological protection culture** in view of supporting stakeholder engagement in the governance of radiological risk.

These objectives are studied in each of the three fields of exposure situations investigated in the ENGAGE Project: medical use of ionising radiations, exposure to indoor radon, emergency preparedness and response.

The work of WP3 is based on case studies performed in these three fields. In each field, ENGAGE partners have identified some processes aiming at disseminating radiological protection culture that could be studied to answer the question raised in the WP: role and benefits of enhancing radiation protection culture; elements contributing to the building of radiation protection culture; lessons learned from the stakeholder engagement processes implemented in the studied exposure situations.

This preliminary report content the full case studies as well a synthesis of the findings in each exposure situation, regarding the main topics addressed in the analysis grid:

- Target stakeholders / aim of RP culture
- Characterisation of RP culture
- Tools, methods and processes to build RP culture
- Evaluation of RP culture

The case studies and synthesis have been discussed during a workshop held in Athens from 13 to 15 February, 2019. These discussions have provided elements to further elaborate the synthesis and lessons learned. These will be included in the final WP3 report (D9.87) to be issued in June 2019

<End of abstract>

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1 ENGAGE project overview

The ENGAGE project, funded under the H2020 CONCERT, aims at *ENhancinG stAkeholder participation in the GovernancE of radiological risks.* This two-year project started on November 20th 2017, seeks to identify and address key challenges and opportunities for stakeholder engagement in relation to medical use of ionising radiation; post-accident exposures; and exposure to indoor radon. In all these situations, stakeholder engagement is a key issue for improving the governance of radiological risks and the radiological protection of the exposed individuals.

The project aims are:

a. to assess why, when and how stakeholders engage in radiological protection;
b. to develop novel approaches to analysing stakeholder interaction and engagement, and provide guidance to meet the challenges and opportunities identified in response to (a);
c. to investigate the processes for enhancing radiological protection culture and their role in facilitating stakeholder engagement, and develop guidelines for building radiological protection culture; and
d. to build a joint knowledge base for stakeholder engagement in radiological protection.

Through its research and innovation activities, ENGAGE will inform stakeholder engagement approaches to radiological protection in ways that all relevant stakeholders find meaningful and legitimate. It will contribute to improving radiological risk governance and radiological protection itself. Its beneficiaries are radiological protection researchers, policy makers, civil society stakeholders and wider publics.

The Project is organised in four main Work-Packages (WP), coordinated by a management WP, which interact to achieve the objectives as presented on Figure 1.

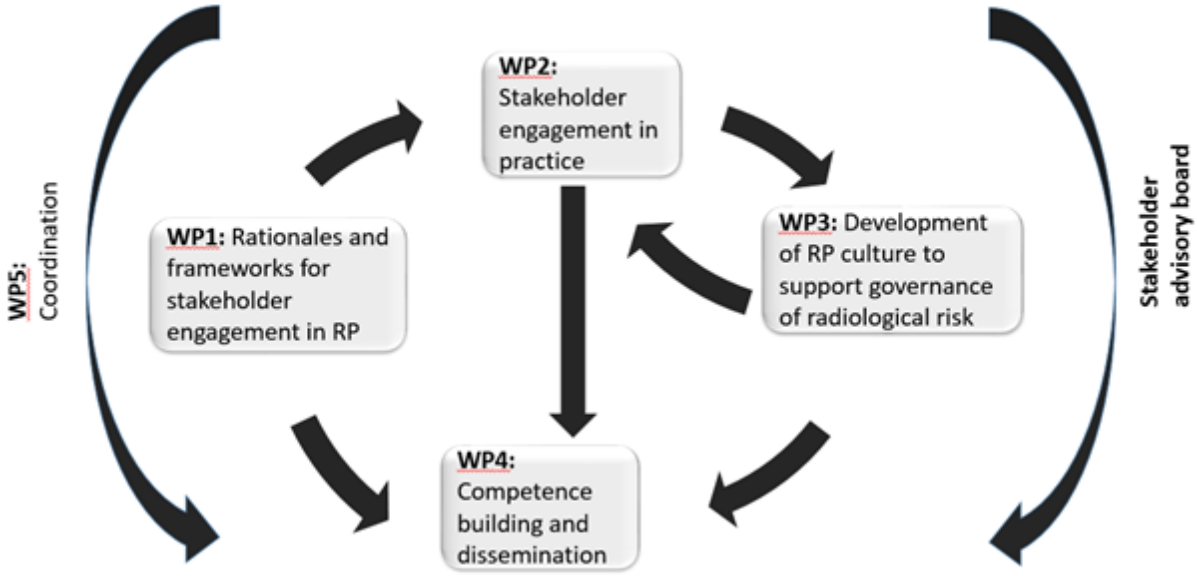

Fig. 1 Interaction between ENGAGE work packages

ENGAGE is part of CONCERT. This project has received funding from the EURATOM research and training programme 2014-2018 under grant agreement No 662287.

2 Overview of WP3 - Development of radiological protection culture to support the governance of radiological risk

2.1 Radiological protection culture and objectives of WP3

Radiological protection (RP) culture is a concept of a composite nature, characterized at the same time by an assembly of knowledge, know-how, skills, experience, practices related to radiological protection; a set of perceptions, values, attitudes, believes, expectations, related to radiation risk; a dynamic building process based on multi-stakeholders' interactions.
From a general point of view, the aims of RP culture are to favour the understanding of radiological protection norms and standards, to enable individuals, where relevant, to reflect on their own protection and/or that of other individuals, to consider consciously radiological protection aspects in their activities or decisions and/or to participate to the decision-making process related to the management of radiological exposure situations.

The objectives of ENGAGE WP3 are the following:

i) to investigate the **role and the potential benefit of building and enhancing radiological protection culture for supporting effective stakeholder engagement and informed decision-making** in relation to radiological protection at the individual and collective level;

ii) to identify **processes to build and transmit radiological protection culture**, adapted to the specificities of different exposure situations; and

iii) to **elaborate guidelines/recommendations for building radiological protection culture** in view of supporting stakeholder engagement in the governance of radiological risk.

These objectives are studied in each of the three fields of exposure situations investigated in the ENGAGE Project: medical use of ionising radiations, exposure to indoor radon, emergency preparedness and response.

2.2 Working Methodology

The work of WP3 is based on case studies performed in the three fields investigated in the ENGAGE Project. In each field, ENGAGE partners have identified some processes aiming at disseminating radiological protection culture that could be studied to answer the question raised in the WP: role and benefits of enhancing radiation protection culture; elements contributing to the building of radiation protection culture; and lessons learned from the stakeholder engagement processes implemented in the studied exposure situations. The following case studies have been selected:

In the medical field:

- In France: elaboration of a radiological protection training course to be included in the 3rd year of studies of a nurse school.
- In Greece: specific actions undertaken to build and enhance radiological protection culture among hospital staff involved in fluoroscopy guided medical procedures.
- In Italy: actions undertaken to mitigate the risk of accidental exposures in the field of radiotherapy.

In the field of radon exposure management:

- In France: actions developed within the "Franche-Comté Radon pluralist project" since 2011 to develop awareness on radon risk and to contribute to the information and the support of different actors who deal with the management of radon.
- In Greece: actions implemented by the Greek Atomic Energy Commission (EEAE) in the framework of the Radon National Action Plan.
- In Switzerland: actions implemented by the Federal Office of Public Health (FOPH) in the framework of the Radon National Action Plan since 2012.

In the field of Emergency Preparedness and Response:

- In France: Actions undertaken in the framework of the Steering Committee for the Management of the Post-Accident Phase of a Nuclear Accident (CODIRPA) created by the French Safety Authority (ASN) to elaborate "Policy elements for post-accident management of nuclear accident".
- In Italy: Actions undertaken for the preparedness to nuclear emergency management at the level of hospitals.
- In Slovak Republic: Actions undertaken to improve and strengthen the emergency and post-accident preparedness and recovery management at all levels: national, regional and local.
- In Belarus: Overview of radiological protection knowledge and culture in education (primary and secondary schools, universities) and in Public Information / mass media, after the Chernobyl accident.

A common analysis grid to be used for the preparation of each case study has been elaborated. It is structured around the following topics (the full grid is presented in Appendix 1).

- **Characterisation of case study including type of actions, processes:** This part is dedicated to a description of the actions/processes that are studied and analysed from the point of view of RP culture dissemination processes. It also identifies who are the main target stakeholders for the dissemination of RP culture
- **Characterization of RP culture (elements / definition):** The objectives are to reflect upon the "definition" of RP culture and its characterization according to the exposure situation. The objective is also to identify aspects that can influence RP culture such as organisational, societal, ethical or economic aspects.
- **Development of tools, methods & processes to build, enhance and transmit RP culture:** This part is dedicated to the description and analysis of the RP culture dissemination processes. Its objective is to identify the elements of RP culture, the dissemination process, and its specificities according to the target stakeholders. It also examines the efficiency of the processes of dissemination of RP culture and how it may have influenced the practices, understandings, behaviours... of the target stakeholders regarding RP. Finally, the question of the sustainability or dynamics of the process is investigated.
- **Evaluation of the level of RP culture:** This question is directly linked to the evaluation of the efficiency of RP culture dissemination processes, but it can also be addressed separately in a broader view not linked with a specific process
- **Highlighting the role of RP culture:** This is one key question for WP3, in the search to demonstrate the role and the potential benefit of building and enhancing radiological protection cultures for supporting effective stakeholder engagement and informed decision-making in relation to radiological protection at the individual and collective level.

Case studies in each field have been analysed by the Project partners following this grid, based on their feed-back from their practical experience in the actions / processes described. Interviews of some key actors of the actions have sometimes been used to complete the analysis.

2.3 Content and structure of this report

This preliminary report presents in section 3 the synthesis of the findings from the case studies, in each exposure situation, regarding the main topics addressed in the analysis grid:

- Target stakeholders / aim of RP culture
- Characterisation of RP culture
- Tools, methods and processes to build RP culture
- Evaluation of RP culture

The full case studies are presented in Appendix 2.

3 RP Culture in the medical field

3.1 Case studies

The following case studies have been analysed (see details in Appendix 2):

- In France, elaboration of a radiological protection training course to be included in the 3rd year of studies of a nurse school
    - Local action implemented at the initiative of the local urban public authority of Montbéliard (Pays de Montbéliard Agglomération - PMA) in the framework of the global radiological protection project (radon management, radiological risks and medical field) with the collaboration of the French Institute for Radiological Protection and Nuclear Safety (IRSN) and the University of Bourgogne - Franche-Comté.
    - Involvement of the pedagogic staff of the nurse school.
    - Involvement of the Radiological protection Expert of the local hospital.
- In Greece, specific actions undertaken to build and enhance radiological protection culture among hospital staff involved in fluoroscopy guided medical procedures
    - Actions implemented by the Greek Atomic Energy Commission (EEAE).
    - Involvement of related medical professional societies.
- In Italy, actions undertaken to mitigate the risk of accidental exposures in the field of radiotherapy
    - Actions undertaken at the initiative of the Italian Association of Medical Physics.

3.2 Target Stakeholders – Aim of RP Culture

In the three cases, the target stakeholders are medical professionals directly or indirectly involved in medical procedures using ionising radiations. According to their specialty, they have different roles to play regarding the radiological protection of patients and staff, and the aim of developing a RP Culture varies accordingly.

- **Student nurses (& indirectly school pedagogic staff)**: the aim of RP Culture is to raise awareness on RP exposure situations they may encounter on their workplace in order to implement self-protection actions, to understand and apply the relevant radiological protection protocols for the patients, as well as disseminate RP Culture elements to their colleagues. As these professionals are in direct contact with the patients, the aim is also to give them elements to be able to provide advice and explanations to the patients who might have concerns regarding radiological protection issues.
- **Medical professionals participating in fluoroscopy guided medical procedures (Interventional radiologist, interventional cardiologist, orthopaedist, urologist, gastroenterologist, etc.)**: These procedures may lead to high exposure of the patients and also of the participating staff (the specialist and the surrounding staff). The aim of RP Culture for these professionals is to improve their practice by integrating the radiological risk as an additional criterion in their decision-making process, as well as to understand and implement processes to optimise the radiological protection of the patients and the whole staff. RP culture is also needed to improve their communication and work with the RP Qualified Experts on RP issues related to interventional procedures.
- **Medical professionals involved in radiotherapy (RT) procedures:** The aim of RP Culture in that case is to raise awareness of the various staff involved in RT procedures on the potentiality of incidents/accidents that can give rise to very high exposure of the patients, and thus to develop a structured approach in the different steps of the RT process to identify and analyse adverse events, occurrence rating and potential severity to prevent critical situations. The target stakeholders include medical physicists, radiotherapist, and other staff that may be involved on RT procedures.

3.3 Characterization of RP culture

These case studies allow to analyse three types of actions covering different aspects of RP Culture:

- *Raising risk awareness for student nurse:* Case of an initial education for medical professionals who will not be directly involved in medical procedures giving rise to patient and/or staff exposure, but who may be potentially exposed and/or in charge of some protective actions and/or in contact with patients.
- *Integrating RP as a part of the professional skill of medical professionals participating in fluoroscopy guided medical procedures:* Case of a continuous education for medical professionals who are directly involved in medical procedures giving rise to patient and/or staff exposure.
- *Raising awareness on the potentiality of incidents/accidents for medical professionals involved in radiotherapy (RT) procedures:* Case of medical professionals involved in high dose procedures, for which the intention is to reinforce the quality control and quality assurance processes to prevent incidents/accidents.

Raising risk awareness for student nurses:

- As an initial training for those type of students, the elements of RP culture combine knowledge on radiations and associated health effects, overview of the use of ionizing radiations in the medical field, associated exposure levels, means of protection.
    - Definition and identification of radiation sources and health effects (units, radiation sources, radiation health effects), exposure levels associated with different exposure situations
    - Medical practices using ionising radiation (radiology, interventional radiology, nuclear medicine, radiotherapy)
    - Exposure levels for patients and staff related to these practices, other RP aspects (eg radioactive waste management)
    - Means of protection (for patients and staff)
    - Means of exposure evaluation and follow-up
    - RP regulation and RP management at the level of a hospital
- A key element also for this type of training is to provide the possibility to have access to further information (i.e. links to websites, identification of RP Qualified Expert in a hospital, …).

Integrating RP as a part of the professional skill of medical professionals participating in fluoroscopy guided medical procedures

- In that case, the objective is that these professionals perceive the risk associated with the use of ionising radiation in a more realistic way and that they integrate radiological protection issues when appropriate in the medical procedures.
- It can be noticed that these professionals have usually received an initial training on radiological protection, usually during their first year of study, as well as some element during their undergraduate/post graduate studies for their specialty, the information provided usually covers only theoretical aspects of RP and not practical ones. Furthermore, this training has been provided for most professionals since many years, and the techniques are evolving quite quickly.
- Continuous education should include theory and practice. The main topics are listed below. However, they should be adapted to the specialty as well as to the initial knowledge.
    - Physics of ionizing radiations
    - Biological effects of ionising radiations, according to the level of exposure
    - RP regulation, RP principles, specificities of the medical field (risk-benefit)
    - Typical levels of patient/staff exposure associated to the different medical procedures

- How practices can influence these levels of exposures
- Individual and collective means of protection according to medical procedures
- RP management at the hospital, role of RP qualified expert
- Tools facilitating the follow-up of exposures, the measure of performances (notably how to use the Diagnostic Reference Levels or Trigger Levels).

Raising awareness on the potentiality of incidents/accidents for medical professionals involved in radiotherapy (RT) procedures

- To raise this awareness, and improve attitudes and behaviours at individual and collective level for the management of RT procedures, the main elements includes:
  - Roles and responsibilities of each actor in the treatment processes
  - Aspects of decisions-making processes that can be at the origin of an incident/accident
  - Complexity of the considered treatment techniques and potentiality for unexpected high doses
  - Quality control processes.
- As some staff involved in a RT procedure might not have the same level of knowledge in radiological protection as the radiotherapist or the medical physicist, the organisational and management aspects should be completed with basic knowledge regarding the radiation risks associated with RT treatments.

3.4 Tools, methods and process to build RP culture

Initial training of nurses

The case study highlighted the deficit of initial training of nurses in radiological protection. The processes implemented, initiated by local actors (municipality, university, nurse school, local hospital) started with a work with the pedagogic staff of the school to identify the needs and elaborate a programme based on two aspects:

- An initial personal work by the students, integrating specific questions related to radiological protection into a research project linked with the more global topic of cancer treatment: this allows to initiate an individual research and reflection regarding these issues
- Complement with a 2 hours lecture given by a RP Qualified Expert of the hospital.

The time slot allocated to the lecture (2 h) is quite short. It reinforces the need to provide other sources of information (websites, handbooks, contact persons,..)

Besides training at school, the dissemination of RP culture for the students can also be provided during the time spent 'on the field' at the hospital for example. In that respect, the RP Qualified Expert has a key role to play to relay information and sensitize the students during their practical internships.

The dissemination of such initiatives at the national level would be needed to develop awareness among the whole profession. The role of national/local associations of nurses in that process should be studied as actors involved in spreading dedicated information to the professionals.

Integrating RP as a part of the professional skill of medical professionals participating in fluoroscopy guided medical procedures

The actions initiated by the authority can be grouped in two main categories:

- Raising awareness through continuous education and training

  - Organization and/or participation to seminars covering all the aspects of radiological protection (theoretical & practical) in fluoroscopically guided interventional procedures
  - Elaboration of training materials covering theoretical and practical aspects of radiological protection. To be available on line on the Authority website, including e-learning part.
  - Approval of RP training programme to be provided by the RP Qualified experts for continuous education of interventionists.
- Use of inspections to foster the awareness of medical professionals on the importance of radiological protection
  - Define appropriate indexes for the evaluation of the RP culture
  - Monitor and evaluate in a systematic way the radiological protection culture among interventionists during the on-site inspections.

Actions from professional associations are also essential in the process of continuous education. It takes the form organization of specific seminars. Their involvement in the elaboration of the training materials by authorities should be also considered.

Some aspects of work management, or work organization, can also be identified as key elements to integrated RP issues on a day-to day basis in the medical procedures. For example:

- The internal evaluation of RP practices by the RP Qualified expert. These evaluations, to be performed in close cooperation with the medical professionals, favour the creation of meeting places where dialogue can take place and RP issues can be addressed.
- The implementation of Quality Assurance programmes are key organisational elements to integrate in a formal way the procedures to be applied for the provision of training, information dissemination and the evaluation of practices.

Raising awareness on the potentiality of incidents/accidents for medical professionals involved in radiotherapy (RT) procedures

Here again, the role of professional association is central. In that case it is the Italian Association of Medical Physics which initiated different actions:

- Highlighting the issue of potential events: elaboration of a report explaining the events and causes of such events. Presentation of the results of the report in various places at the national levels, including national / regional conferences
- Proposal for specific organisations integrating a pro-active approach in elaboration of RT procedures.

3.5 Evaluation of the level of RP Culture

For the evaluation of RP practices in hospitals, different tools can be used:

- In a hospital: internal evaluation at the level of the relevant Departments. This is usually the role of the RP Qualified expert.
  - Quantitative indicators include: Evolution of patient / staff exposures associated with specific procedures, follow-up of Diagnostic Reference Levels, follow-up of the number of RP events or unexpected exposures.
  - RP Qualified experts have a generic overview of the department's operational procedures and can identify gaps or weaknesses related to the development and implementation of an RP culture among the personnel.

- External evaluation by the Authorities during inspections:
    - Check compliance with regulations regarding the mandatory continuous RP training (number of persons trained, content of training, …)
    - Observation of the practices in the field.

4 RP Culture in the field of radon management

4.1 Case studies

- In France, actions developed within the "Franche-Comté Radon pluralist project" since 2011 to create awareness on radon risk and to contribute to the information and the support of different actors who deal with the management of radon. Actions are also developed in a general perspective of Indoor Air Quality (IAQ) and energy efficiency.
    - Local actions, undertaken at the initiative of the local urban public authorities (PMA – Pays de Montbéliard Agglomération), the French Institute of Radiological protection and Nuclear Safety (IRSN, Technical Support Organisation), the Center on Evaluation of Protection in the Nuclear Field (CEPN, Research and Expertise Center), the Regional Agency for Air Quality Monitoring (ATMO BFC), the Health Regional Agency (ARS).
    - Involvement of university experts (University of Bourgogne - Franche-Comté), national and local authorities (Nuclear Safety Authority, the regional environment directorate), national and regional experts on radiological protection and Indoor Air Quality (Federal Office of Public Health of Switzerland, Centre of Scientific Culture, Centre For Studies and Expertise on Risks, Environment, Mobility, and Urban and Country planning, French Environment and Energy Management Agency, Medical University) and representatives of building professionals (French Building Trades Federation, consultants, artisans).
- In Greece, actions implemented in the framework of the Radon National Action Plan. Radon measurements performed in the country are accompanied by actions to increase public awareness and to inform local decision makers.
    - Implementation of the Action Plan is coordinated by the Greek Atomic Energy Commission (EEAE), which performs radon measurements countrywide and carries out communication actions.
    - Involvement of Ministries (Environment, Interior, Health), Local Authorities, Building engineering organisations.
- In Switzerland, actions implemented in the framework of the Radon National Action Plan since 2012.
    - Actions implemented by the Federal Office of Public Health (FOPH)
    - Collaboration with the Society of Engineers and Architects, universities of applied sciences and building professional schools .

4.2 Target Stakeholders – Aim of RP Culture

These case studies reveal the wide range of target stakeholders for the dissemination of RP culture related to radon exposures in dwellings and public buildings (the case of radon at work was not addressed): inhabitants living in radon prone areas, building professionals, local/national authorities, local elected representatives, or local communities.

The aim of RP culture for these stakeholders presents some common aspects (eg: raising awareness about the health risk associated with radon exposure), as well as specificities related to the role of these stakeholders in the protection against radon exposure:

- **General Public**: the aims of RP culture are to raise their awareness about radon risk in dwellings, to acquire knowledge on ways to measure and to remediate, to increase their willingness to implement measurements in their home and remediation / protective actions.
- **Local elected representatives/local communities (mayors, group of municipalities,…)**: the aims of RP culture are to raise their awareness about radon risk in their local area, to acquire knowledge on their responsibilities regarding this risk, to implement measurement campaigns in their municipalities (public buildings, but not only), to implement or support remediation / protective actions, to engage action plans on radon as part of their duty to address public health issues in their territories.
- **Building professionals (organizations, groups and workers in the field of building construction and maintenance)**: for these professionals, the aims of RP culture are to raise their awareness about radon risk in buildings (dwellings, public buildings,..), to acquire knowledge on the possible remediation actions, to integrate radon risk at the design stage of new buildings (preventive actions), to integrate the radon issue in a global approach of public health in buildings (in connection with indoor air quality, energy efficiency,…).
- **National/local authorities (in charge of RP, Health, Environment, Air Quality,..)**: the aims of RP Culture are to raise their awareness about radon risk, to be involved in (support) the implementation of actions such as measurement campaigns, remediation / preventive actions.

It can be noticed that, in the case studies analysed, the role and importance of those stakeholders may vary, due to the type of actions undertaken in the radon management processes.

4.3 Characterization of RP culture

The case studies show that radon is unknown for most of the stakeholders: general public, building professionals, local actors, national/local authorities. Thus, the efficiency of the implementation of radon action plans (at local or national level) relies on the dissemination of RP Culture among the various types of stakeholders, to fulfil the aims presented above.

Raising risk awareness (for all the target stakeholders): What is radon, where does it come from, health risk related to radon, who is concerned (radon map areas)

Whoever the stakeholders, the first element to raise awareness about radon risk is the knowledge about health risks associated with radon exposure, together with the necessary elements needed to understand the origin and source of radon exposures.

In most cases, it appears that the health risk is expressed with reference to the risk of lung cancer in a general way, for example “radon is the second cause of lung cancer”. In some cases, the estimated number of lung cancers due to radon in the country (or in the local area) is also provided.

The link between the level of radon concentration and the probability of lung cancer is usually not a question raised at first by the general public or other stakeholders. It might be an information given later for those who wish to know more about mechanisms of health effects.

The regulatory reference concentration level (in Bq/m^3) is the key element used to weight the level of risk. It is used after measurement campaigns to commensurate the remediation actions.

Together with the origin of radon, it is also important to inform the stakeholders on the main areas where radon can be an issue. This is usually done using the radon map areas published by the national authorities.

Protective measures (for all the target stakeholders): main types of remediation and prevention actions

The description of the main remediation/prevention measures has to be given together with the information about the risk (eg. sealing the ground, improving ventilation system, treating the basement).

The degree of detail in the presentation of these measures will of course vary with the type of stakeholders (see below). The objective is to avoid to raise concern about a risk without providing also the means to deal with it. *"There is a health risk, these are the protection measures"*.

Beyond the 'basic' knowledge about the health risk associated with radon, and the main protective measures, other elements need to be disseminated to fulfil the aim of RP culture for the different stakeholders, related to the type of actions and/or to role of these stakeholders.

General Public: focus on assessment of radon levels and remediation/prevention actions

- how to measure radon in homes,
- who can provide measurement devices,
- what should be done according to the result of the measurement (providing a scale of actions between the two reference levels),
- what are the remediation/preventive actions,
- who are the building professionals that can help to implement those actions,
- where to find more information.

Local elected representatives/local communities (mayors, group of municipalities,…): focus on the identification of radon areas, as well as the role and responsibilities of local communities

- what are the regulation and responsibilities of local elected representatives regarding radon in dwellings and in public buildings,
- who are the national authorities, experts, building professionals that can provide more information or support,
- how to implement measurement campaigns in public buildings,
- how to develop radon risk awareness for inhabitants,
- what are the remediation/preventive actions,
- who can help to implement those actions
- how to support remediation and/or preventive actions for inhabitants at the local level.

Building professionals: focus on the identification of radon areas, the integration of radon risk management as part of their professionalism

- detailed technical knowledge on remediation technics in existing building and preventive measures in new buildings,
- integrating radon issues when addressing building energy efficiency,
- integrating radon issues when addressing indoor air quality.

National/local authorities (in charge of RP, Health, Environment, Air Quality, ...): focus on their role and responsibilities regarding radon action plan implementation

- actions that can be implemented at the national/local level to increase radon risk awareness,
- actions to be implemented at the national level to increase the radon expertise among building professionals,
- integrating radon issues in the building energy efficiency politics,
- integrating radon issues as part of indoor air quality management programs.

Some other considerations are also worth mentioning regarding the characterization of RP culture in the case of radon:

An individual and collective knowledge

Actions to remediate radon form part of multi-stakeholder, multi-disciplinary processes. Individuals will not be in a position to implement measurement and/or/protective actions if radon in not an issue handled at the collective level.

Radon risk in the context of Indoor Air Quality issues

In France and Switzerland, one can notice the integration of the radon risk within a more global perspective of indoor air quality issue, radon being a "pollutant" like other indoor pollutants giving rise to potential health effects.

4.4 Tools, methods and process to build RP culture

The dissemination of RP culture elements among the various stakeholders relies on the use of multiple tools and processes (leaflets, training sessions, dedicated meetings, …), to be adapted to the needs and integrated into radon action plans (at the local or national levels, even European level with Euratom BSS). The existence of a radon management regulatory framework to refer to is essential to support the processes elaborated to disseminate RP Culture, as it provides legitimacy to their initiators and structures to build upon action plans.

A key lesson learned from the case studies is the importance of involving multidisciplinary teams in the elaboration of the tools and involving also representatives of the target stakeholders in the elaboration of the communication media.

It is also necessary to involve acknowledged experts in their fields to disseminate the knowledge, not only RP experts, but also experts from the target stakeholder groups (eg . Involvement of Scientific and Technical Center for Building in France, Building Engineers and Architect Schools in Switzerland).

Some specificities of the tools and processes according to the target stakeholders emerge from the case studies:

General Public: information, communication, involvement

- A first generic information to raise awareness is in most cases disseminated through the use of information leaflets.
- However, it is also essential to create meeting opportunities between population, experts, authorities, local elected representatives, to discuss and share the information initially provided in leaflets.
- These meetings are also essential after measurement campaigns to explain the results of measurements and provide advice for remediation/prevention.
- The elaboration of guidelines for radon management will benefit from the involvement of stakeholders (eg. In Switzerland where guidelines have been elaborated at the initiative of authorities with the involvement of representatives from owners/renters associations and local authorities).
- Information dissemination can also benefit from the help of (local) actors in charge of scientific culture dissemination or linked to public health issues (like Cancer League).
- In all cases, whatever the channel of communication about radon risk, one has to keep in mind the need to provide at the same time means/possibilities of measurements and means/possibilities of implementing remediation/prevention actions.
- The identification at local or regional level of "radon consultants" (eg. in Switzerland) is one interesting way of ensuring relays at the local level for the dissemination of the technical information towards the population.
- Dedicated websites are also elaborated to inform about radon. Such a website gives access to complementary information when people are already aware of a radon issue.

Building professionals: training, practice, networking

- First issue is to identify the various types of building professions that can potentially be involved in diagnostic, remediation or prevention actions, and the adapted education and

training programme needed. It includes notably craftsmen form various fields, engineers, architects.

- Initial training: the integration of radon issues in the professional schools is the basis to initiate awareness and to ensure an integration of these issues in the long term.
- Continuous education: this is necessary not only for those who didn't beneficiate from an initial training, but also to regularly update the knowledge and techniques integrating feed-back experience and new developments. One issue with continuous education is that it is usually not mandatory for these types of professionals, and it is found difficult to motivate the professionals to attend training course besides their working time for a subject in which they are not sure that it will be useful to develop their activities.
- Enhancing professional competences: this is essential to foster the willingness of the professionals to be trained and to work in the field of radon diagnostic, remediation or preventive actions. The creation of a specific "radon label" recognised at a national level, or to provide a recognized certification should thus be part of the processes set up to disseminate and enhance the RP culture among professionals.
- E-learning tools can be developed to facilitate the access to training (eg. Switzerland) but needs to be completed with practical work on the field.
- Building professionals associations, or unions, have a specific role in raising awareness about radon issues. It can take various forms: integrating radon issues in seminars or congresses of the professions, favouring the integration of radon topic in the initial training programmes related to their professions, ory creating a network of professionals that can exchange information about their practice and collect feed-back experience.

Finally, as radon is still unknown for a major part of the identified target stakeholders, it is essential to consider the processes to disseminate RP culture on radon on a long-term perspective. It takes time to involve the relevant stakeholders which can initiate or support the various types of dissemination actions. These actions also have to be renewed regularly to maintain momentum toward the radon action plans.

4.5 Evaluation of the level of RP Culture

The existence of a RP culture in terms of radon means that the consideration of a potential radon problem is part of the normal process of activities wherever the level of radon can be influenced.

For the general public, the "success" of a measurement campaign launched at a local level can be an indicator of radon awareness level in the population: for example, estimates of the number of homes where dosemeters have been provided, rate of return of the dosemeters, participation to the meeting organized to share the results, participation to specific activities organized to explain remediation/preventive actions.

The willingness of various actors, not coming from the RP field, (eg national/local health or environmental authorities, local elected representatives, building professional associations,..) to be involved in the radon action plan is also an indicator of the progressive spreading of radon risk awareness.

The introduction of radon issues in building professional school programmes is also an example of the consideration of these issues by the profession. In the same way, one can notice for example, the anchoring of radon in some building codes by the Swiss Society of Engineers and Architects.

5 RP Culture in the field of Emergency Preparedness and Response

5.1 Case studies

The following case studies have been analysed:

- In France: Actions undertaken in the framework of the Steering Committee for the Management of the Post-Accident Phase of a Nuclear Accident (CODIRPA) created by the French Safety Authority (ASN) to elaborate "Policy elements for post-accident management of nuclear accident".
    - Actions initiated by the national safety authority
    - Creation of several working groups involving various types of stakeholders to work on the preparation of post-accident situations.
- In Italy: Actions undertaken for the preparedness to nuclear emergency management at the level of hospitals.
    - Actions undertaken by different hospitals in the framework of CBNR emergencies planning.
- In Slovak Republic: Actions undertaken to improve and strengthen the emergency and post-accident preparedness and recovery management at all levels: national, regional and local.
    - Actions undertaken in the framework of European and national projects enhancing emergency and post-accident preparedness, response and recovery management.
- In Belarus: Overview of radiological protection knowledge and culture in education (primary and secondary schools, universities) and in Public Information / mass media, after the Chernobyl accident
    - Actions undertaken by professionals from the educational system.

5.2 Target Stakeholders – Aim of RP Culture

Through these case studies, it appears that a distinction can be made between the stakeholders involved in the preparedness phase of emergency/post-accident situations, and those who might be concerned during/after a radiological emergency.

In the preparedness phase of emergency and post-accident management

Stakeholders involved in the various processes (elaboration of guidelines or handbooks, exercises, workshops, …):

- **Professionals that would be involved in the emergency phase:** public authorities, civil security, experts, firemen, health professionals, …
- **Professionals that would be involved in post-accident management, due to their function and responsibilities**: public authorities (national and local level), experts, health professionals, teachers, economic actors, …
- **Representatives of populations**

Aim of RP culture for these stakeholders:

- To allow these stakeholders to reflect on what is at stake in case of a nuclear accident from the radiological point of view, but also concerningthe daily life of affected populations.
- To have them identify which role they may have to play during emergency and/or post-accident situations and what would be the consequences of their actions/decisions from the RP point of view.
- To build capacities to participate and to interact in the process of elaboration of EP&R plans and exercises, and to identify which policy framework, tools, guidelines,…, could be developed.

In the emergency or post-accident phase

For the local communities, general population affected by an accident, the aims of RP culture are:

- To understand what is at stake in their environment (characterization of the radiological situation, interpretation of measurements) and to get a grasp on the health effects of exposures
- To be able to act (individually or with the support of local authorities or professionals) in their day-to-day life or fields of activities for their own protection.
- To take informed decisions on RP, and participate to decision-making processes were also other aspects than only radiological protection issue might be addressed (well-being, economic issues, future of the territory, etc.);
- To help to better discern what belongs to the consequences of radiation exposures as such, and what belongs to other consequences, other disturbances in their daily life related to the accident.

For the professionals that are involved in the emergency or post-accident management, due to their function and responsibilities, the aims of RP culture are:

- To identify which role they have to play in the management of the situation.
- To consider the consequences of their actions/decisions from the RP point of view.
- To act as relay in disseminating RP culture elements to the population or other actors in order to favour the involvement/empowerment of affected population in the decision-making processes.

5.3 Characterization of RP culture

For the stakeholders involved in the preparedness phase of emergency and post-accident management

Understanding the complexity of a nuclear accident

- Based on practical feedback from past accidents, or simulation of accidents, ...
- Distinction between what originated from RP consequences and from other consequences (economic, social, psychological, disruption of living conditions, …).

Understanding the characterization of a radiological exposure situation

- Contamination maps, individual exposures, food contamination, among others.

Identifying protective actions (collectives and individuals), their effectiveness and consequences

- Food restrictions, limitation of access to different areas, decontamination strategies ,…
- Addressing the time evolution and lifting of protective actions.

Identifying what would be the concerns/questions raised by the population

- Concerns about health effects (thyroid cancers, long term effects, genetic effects, general health status,…), and health surveillance programmes.
- Concerns about everyday life (food, water, travels, animals, …).

Capability to provide elements of answers

- Based on scientific knowledge (knowledge about dose-effect relationship, addressing uncertainties, …).
- Based on practical feedback from past-accident situations.

For the local communities, general population affected by an accident, and the professionals involved in the management of the situations

Understanding environmental contamination: where can radioactivity be found, how much,..:

- External dose rate and maps of the environment (inside and outside buildings, recreational areas, working areas…), soil contamination, food contamination
- Levels of contamination to be compared with other situations (providing scales).

Identifying sources of individual exposure in contaminated areas

- Use of individual devices (e.g. D Shuttle after the Fukushima accident), analysis of daily activities and impacts on individual dose, discussion on extrapolation for annual dose, comparison of individual exposures within the local community, putting into perspective with other locations and other exposures to ionizing radiation.

Ability to evaluate / understand the efficiency of collective decisions on protective actions

- Food restrictions, evolution of agricultural production, limitation of access to different areas, decontamination strategies.

Ability to implement self-help actions

- Selection of food products, selection of activities depending on the environmental contamination, follow-up of individual exposures, Implementation of decontamination actions.

Capability to empower stakeholders in the joint assessment and management of the situation

5.4 Tools methods and process to build RP culture

For the stakeholders involved in the preparedness phase of emergency and post-accident management

As described in 1.2, there is a multiplicity of actors who can be involved in the preparedness phase of emergency and post-accident situations, from local, national or international level: public authorities, elected representatives, civil security, firemen, health professionals, teachers, economic actors, representatives of the population, students, … The tools and processed to involve them and to disseminate the RP culture elements take various forms: working groups, seminars, training sessions, nuclear emergency exercises, among others. - Some key elements from these processes can be highlighted:

- Favour approaches addressing practical issues rather than theoretical knowledge.
- Practical experimentation or real situation-based exercises help to understand the meaning of the RP culture components: testimonies, feedback from past accident situations, use of models and simulation tools, or case studies using scenarios are key elements favouring the understanding of emergencies and post-accident situations.
- These practical experimentations should also help the participants to put the radiological risk into perspective and to compare with current situations, where other RP criteria are applied.
- The European projects dedicated to radiological protection in EP&R (EVATECH, EURANOS, NERIS-TP, PREPARE, CONFIDENCE, TERRITORIES, SHAMISEN, SHAMISEN SINGS …), play an important role as they permit to involve a wide range of national and international stakeholders in the development of guidelines, the collection of feedback from past-accident situations, the participation to training sessions, the sharing of experience, …
- Also a key role played by INEX in the organization of national and international exercises, as well as actions from WPNEM (Working Party on Nuclear Emergency Management) from OECD/NEA

- In some cases, the use of existing networks is useful to identify stakeholders to be involved in the processes (eg: ANCCLI – National Association of Local Commission of Information in France, GMF – Group of European Municipalities with Nuclear Facilities, NTW – Nuclear Transparency Watch).

For the local communities, general population affected by an accident, and the professionals involved in the management of the situations

The methods and tools to develop RP culture after an accident have not been fully addressed in the case studies, except through the elaboration of guidelines for the population, to be used by different types of professionals in post-accident situation to answer the questions and concerns of the population, and through the Belarus case study which refers to the training and education.

In the post-accident phase, there is a need to train experts (eg in radiological protection, radioecology, health surveillance, radiation monitoring system, …) that would be in charge of answering questions from the various stakeholders concerned by the accident (professionals, population, mass media, …).

These experts might be mobilised in processes of co-operation with local stakeholders aiming at sharing local knowledge and scientific expertise for the purpose of assessing together the radiological situation and developing actions to protect the people and the environment and improve living conditions. Such co-expertise process contributes to the empowerment of the local population and are part of the development of the radiological protection culture among all the involved stakeholders.

5.5 Evaluation of the level of RP Culture

The evaluation of the level of RP culture for the stakeholders involved in the preparedness phase can be done for example during the nuclear emergency exercises or within working groups, where people are sharing the evaluation and characterisation of the situations. It has been noticed that a real competence building developed in terms of understanding of RP issues in the context of accident / post-accident situations from the various types of stakeholders involved in national / international working groups of exercises.

Social networks based on sharing information can also play a key role in the self-assessment of the understanding and level of RP culture (eg. Safecast, Open Radiation).

6 Conclusion

The case studies analysed within this WP have shown the specificities of the processes to build and transmit RP culture according to the exposure situations and the target stakeholders. It is thus essential to contextualize any action undertaken to disseminate RP culture, to adapt messages, tools and processes to the specificities of the exposure situation. The identification of the target stakeholders and the aim pursued with the dissemination of RP culture is thus an important step in any process.

The case studies and synthesis have been discussed during a workshop held in Athens from 13 to 15 February, 2019[1]. These discussions provided elements to further elaborate the synthesis and lessons learned.

These will be included in the final WP3 report (D9.87, to be issued in June 2019) that will present guidelines/recommendations for building radiological protection culture in view of supporting stakeholder engagement in the governance of radiological risk.

[1] See ENGAGE Deliverable D9.84.

Appendix 1. Analysis Grid

The following set of questions has been identified in order to guide the analysis of the case studies and to facilitate the cross comparisons of results between case studies and countries.

It is not an exhaustive list of questions that should be answered, but a first guide for the reflexion and the construction of the analysis. Many other questions will certainly emerge in the course of the analysis and will be shared among the WP3 team;

Reminder: the objectives of WP3:

*iv) to investigate the **role and the potential benefit of building and enhancing radiological protection culture for supporting effective stakeholder engagement and informed decision-making** in relation to radiological protection at the individual and collective level;*
*v) to identify **processes to build and transmit radiological protection culture**, adapted to the specificities of different exposure situations; and*
*vi) to **elaborate guidelines/recommendations for building radiological protection culture** in view of supporting stakeholder engagement in the governance of radiological risk.*

Characterisation of case study including type of actions, processes

This part is dedicated to a description of the actions/processes that will be studied and analysed from the point of view of RP culture dissemination processes.

- Description of the context of case study
- Who are the 'target' stakeholders - what are the aims of RP culture for them?
- Which stakeholders initiated the implementation of the actions / processes?
- Was there any evolution of the actions with time - for which reason (eg lack of success for some actions, …)?

Characterization of RP culture (elements / definition)

These questions will be answered in the course of the analysis. The objectives are to try to elaborate around the "definition" of RP culture and its characterization according to the exposure situation. It should help also to identify aspects that can influence RP culture such as organisational, societal, ethical or economical aspects.

- Is RP culture based on an individual knowledge?
- Is it a collective knowledge?
- How is the individual knowledge shared with the 'community' around the individual, with others?
- Which knowledge: radiation effects, risks, actions to manage radiation risk situations, emergency situation actions, radiation hygiene…?
- Is it possible to make the distinction between scientific, practical and behavioural knowledges?

- What is the role of historico-societal culture and differences in individual behaviour (prudency, consciousness, impulsivity, etc.) linked to radiological protection and radiation hygiene?
- What are the specificities of RP culture within a broader health protection culture?

Development of tools, methods & processes to build, enhance and transmit RP culture

This part is dedicated to the description and analysis of the RP culture dissemination process.

It should help to identify the elements of RP culture, the dissemination process, its specificities according to the target stakeholders.

It should also examine the efficiency of the processes as dissemination of RP culture and how it may have influence the practices, understandings, behaviours... of the target stakeholders regarding RP.

Finally, the question of the sustainability or dynamic of the process should also be investigated.

- By which way(s) are "information", or "elements of RP culture" disseminated to the target stakeholders? (leaflets, training course, awareness session, workshops, discussions,…)
- Which types of information was disseminated, which content?
- How was this "information" elaborated?
- Who participated to the elaboration?
- How were identified the needs and concerns of the target stakeholders?
- How are RP key questions addressed such as the risk associated with low doses, the management of uncertainties, ….

- Exploration of the ethical framework underlying RP culture dissemination processes (in connection with the ethical foundations of RP system – pub 138 of ICRP)

- Was there any specific role for "experts" in this process? If yes, what was this role?
- Has specific 'training' be performed to support the experts in the development of RP culture?

- In which context are the RP issues addressed?
- Are RP issues addressed together with other risks, or other elements of the situations?
- Is the process giving the possibility to have access to more knowledge if necessary or asked by the stakeholders?

- Was there any evaluation of the efficiency performed in the course of the process?
- How was this efficiency evaluated? (see also evaluation of the level of RP culture below)
- Did this evaluation modify the process or some actions, … why and in which way?
- Is it possible to draw lessons on the reasons of efficiency (vs inefficiency) of some actions / tools / methods?

- Dealing with sustainability of the RP culture disseminations process, according to the situation, or the context, is a 'one shot' action sufficient or not? If not, what as (should be) implanted to provide a dynamic in the process?
- How to ensure the transmission of RP culture over time?
- How can the target stakeholders be actors of the dissemination around them, for other stakeholders?

Evaluation of the level of RP culture

This question is directly linked to the evaluation of the efficiency of RP culture dissemination process, but it can also be addressed separately in a broader view not linked with a specific process

- Is the level of RP culture evaluated in the process studied, how, by whom?
- Is the evaluation of RP culture used to evaluate the efficiency of the dissemination process, and maybe to change the process?

- According to exposure situations, how can be evaluated the level of RP culture?
- Is it the capability of target stakeholders to interact with RP professionals (or other actors)?
- Is it the capability to implement RP actions to protect themselves or others?
- Is it a willingness as well as a capability to be involved in RP decision making processes or to implement RP actions?
- Is it the capability to share common knowledge, to share common view?
- What can be the role of quantitative or qualitative evaluation?
- Is there any tools or methods which have been elaborated or could be elaborated to evaluate the level of RP culture according to the different situations or the different types of stakeholders?
- Is there any tools or methods which have been elaborated to present some major evaluation results/conclusions?

Highlighting the role of RP culture

This is one key question for WP3, in the search to demonstrate the role and the potential benefit of building and enhancing radiological protection culture for supporting effective stakeholder engagement and informed decision-making in relation to radiological protection at the individual and collective level.

- How has RP culture contributed to the improvement of the situation for which the dissemination process has been implemented (decision-making process, stakeholder engagement process, radiation risk management situation, health and well-being of the population, …)
- In particular, are any stakeholder engagement situations which have been improved by the dissemination of RP culture within the various stakeholders?

- What has been achieved when developing / building RP culture? (impacts on the level of exposures, the protection actions, the decision making-processes,…),…
- Are there also examples which can show that the lack of RP culture could be seen as an obstacle for the success of a stakeholder engagement process, a radiation risk management process or a decision-making process? For which reasons?

Connection with the European RP research programme

ENGAGE Project takes place in the context of the European RP research programmes. It is thus essential to create links with the RP research platforms as well as the RP research roadmaps

- How can the scientific programmes developed in various fields of RP research favour the building and dissemination of RP culture?
- Does these programme answer to some concerns identified by the stakeholders?
- Are there any recommendations to be given to the RP research platform?

Appendix 2. Case studies

Table of content

1 Case studies in the field of medical exposures management

The objectives of radiation protection culture dissemination in the medical field are mainly:

- to facilitate the dialogue between practitioners and patients regarding radiation risk in the framework of the informed consent processes
- to foster the implementation of the principles of justification and optimisation of radiation protection for patient exposures.

1.1 France – Elaboration of a RP training course to be included in the 3rd year of studies of a nurse school

Characterization of case study including type of actions and processes

The action has been implemented by the public authority of Montbéliard in the framework of the global RP project (radon management, radiological risks and medical field) with the collaboration of IRSN and the University of Franche-Comté. The aim of the medical part of this project is to develop RP culture for different student nurses and school pedagogic staff. Indeed, we notice that there is a lack of information about RP in the training of nurses and in their official pedagogic program. That's why we proposed in a first step, a conference about RP with practical cases in different situations and domains (nuclear medicine, diagnostic radiology, etc…).

It was to demonstrate to the nurses and the pedagogic staff the importance of RP for both informing the patient and for setting up RP self-protection actions.

The first conference was realized by a RP expert of the hospital. It was open for volunteer students without exam but with a survey to evaluate their RP knowledge, the content of the training course and their practical needs. This qualitative evaluation showed that nurses were confronted to RP issues without knowing and they were interested in learning RP information. After this conference, pedagogic staff has understood the interest to integrate RP in a course which belongs to the official program. As a follow-up, we organised meetings with pedagogic staff to build the content and the form of the second training course. Now, the RP conference is integrated in a course unit of the program (tumour processes and therapeutics).

Characterization of RP culture (elements / definition)

RP culture is essential to understand why to set up protection action and give information to patient.

The elements below are dealt in the course of 2 hours:

- Definition and identification of radiation sources (units, radiation sources, radiation effects and value scale: annual exposure and distribution of the different exposure situations, dose related to thorax CT-scan or radiography, etc.)
- RP regulation (actors of RP, exposure limits, dosimetry, measurement)
- Exposure situations (radiology, interventional radiology, nuclear medicine, radiotherapy)
- Information available into patient file (procedures and information between staff and team)
- Means of protection (dosimetry, personal RP, dissemination of RP information to patients…)

Development of tools, methods & processes to build, enhance and transmit RP culture

In order to transmit RP culture to nurses' students a conference of 2 hours was given by an RP expert who works in the hospital, and thus had legitimacy versus nurses. The first conference was open for volunteer students because it was not included in a course unit of the program.

To improve the process, the format and contents of the second conference were developed in collaboration with the pedagogic staff and taking into account the qualitative assessment of the first conference by the nurses.

The second conference contains two parts:

- The first one is before the conference: in tutorials dedicated to digestive cancer we include RP questions in order to identify the level of RP knowledge in different phases (diagnostic and therapy: for example, the distinction between MRI, CT-scan, scintigraphy …). The last question concerns a description of a RP professional experience during an internship. The answers elaborated by a group of four students are given in a report 15 days before the conference.
- The second one is the conference of 2h for all nurse students which contains:
    - Generalities on radioactivity (units, natural and artificial exposition, health effects)
    - Generalities on RP (context, regulation, units)
    - RP for workers and/or patients related to different exposure situations (nuclear medicine, mobile radiography, …)

To build the conference the first step was to demonstrate that RP culture is important in the professional activity of nurses. To explain the role of RP in their professional activity it is necessary to give concrete examples in order to illustrate what is RP. Indeed, the concept of RP is unknown by the nurses (definition, terminology …) and they don't understand at the beginning the interest of RP information and protection actions.

As the duration of the course is limited, we give additional resources to the students and the pedagogic staff:

- Internet links to scientific society
- Examples of protocols used in hospital
- Course complement.

Evaluation of the level of RP culture

To date, radiological protection is not included and dealt with into the training programme of nurses. The conference organised in January 2018 was the first. An evaluation through a feedback questionnaire was put in place at the end of the conference to see what the students had memorized, what their needs were and whether it would change their work behaviour (for example wearing Individual Protection Equipment). We can only evaluate the contents of the conference but to evaluate the RP behaviour during their professional activity it is the role of the national RP authority. However, the authority can only evaluate the collective knowledge of RP. In hospital, the RP action works only if all the staff is implicated in RP. It is thus necessary to have a collective RP culture (the individual action is often not sufficient).

To improve the conference, it is necessary to realize Interviews and/or questionnaires to nurses working in hospital and liberal nurses. But it was complicated, because the context of RP is unknown for this professional and moreover they don't have time during their activity.

Highlighting the role of RP culture

- RP culture contributes to improve students and future nurses engagement process for self-protection actions, advices and explanations to patients.
- RP culture allows to give keys to apply protocols and to disseminate RP culture to colleagues.

Lessons and recommendations

- Conference seems to answer to the needs and concerns of students
- Evaluation of the conference highlights that elements of RP culture transmitted during the conference gave keys to students to protect themselves, disseminate RP culture to their colleagues and also to patients.

- Necessary to integrate RP culture in the official pedagogic program. But the difficulty is the limited time to tackle RP in a program already very full.

- This case study is a local experience. To disseminate this experience to regional or national level, it is necessary to have the help of the national RP authority, professional association and government (Ministry of Health).

- Role of Competent Person in RP in hospital is known only for monitoring dosimetry personal. Nevertheless, to develop culture RP it will be necessary that all health professional know his role.

1.2 Greece - Building and enhancement of a radiation protection culture among medical specialties participating to fluoroscopically guided medical procedures

Characterization of case study including type of actions and processes

EEAE, as the national competent authority for radiological and nuclear safety, has the responsibility to proceed to all the required actions for the development and enhancement of the radiation protection culture in the country.

Taking into account information from the national radiation protection database, the results from the on-site inspections, as well as related references in the literature, EEAE considers that fluoroscopically guided interventional procedures is an area which requires further attention regarding radiation protection.

Medical specialties which make use of fluoroscopically guided medical procedures include: Interventional radiology, interventional cardiology, orthopedics, urology, gastroenterology, among others.

Due to their complexity, the above procedures may lead to high exposures of the patients, but also of the participating staff. Therefore, the personnel involved should have not only the required education and training on radiation protection, but also the necessary RP culture.

Moreover, the European Directive 2013/59/Euratom introduces specific requirements for the continuous education & training on radiation protection of the personnel involved in practices with ionizing radiation including medical exposures.

In the light of the above, EEAE in cooperation with the related professional societies initiated the organization of training courses covering both theoretical and practical aspects of radiation protection and emphasizing on the respective culture.

Characterization of RP Culture

The training of interventionists on radiation protection is usually carried out during the first years of their undergraduate studies in the medical school. The main topics which are covered include, among others:

- Physics of ionizing radiation;
- Biological effects of ionizing radiation – risk;
- Dosimetric quantities and units;
- Theoretical and practical aspects of radiation protection in diagnostic and therapeutic applications;

Although elements of RP culture are given to the interventionists during their undergraduate studies or/and postgraduate training for their specialty, the information provided usually covers only theoretical and not practical aspects of RP. Furthermore, interventionists mostly relate safety culture with the general clinical practice they apply and therefore it is difficult to emphasize the radiation protection aspects of it.

Development of tools, methods & processes to build, enhance and transmit RP culture

EEAE will proceed to specific actions to facilitate the building and enhancement of a radiation protection culture among medical specialties participating in medical exposures. More specifically, EEAE will:

1. Define appropriate indexes for the evaluation of the RP culture of the physicians involved in fluoroscopically guided interventional procedures. These indexes could also be applicable for personnel participating in other types of medical exposures.
2. Organize and participate to seminars covering all the aspects of radiation protection (theoretical & practical) in fluoroscopically guided interventional procedures. By participating to these seminars, the physicians (radiologists, cardiologists, urologists, etc.) will have the opportunity to cover possible gaps and improve their practice in terms of radiation protection.
3. Monitor and evaluate in a systematic way the radiation protection culture among interventionists during the on-site inspections it performs for authorization purposes. Special attention will be given to the proper implementation of the DRLs as well as of trigger levels in interventional procedures.
4. Prepare appropriate educational material for interventionists, which will cover theoretical and practical aspects of radiation protection. This material will be available on line via the EEAE web site. E-learning capabilities will also be used.

In 2018, EEAE organized a two-day seminar on radiation protection for angiosurgeons and last April participated with presentations to two conferences:

- The first organized by the scientific association of cardiac radiology;
- The second organized by the scientific associations of gastroenterologists and medical physicists.

The role of “experts” in this procedure of development and continuous improvement of the RP culture has also to be pointed out. The medical physicists who play the role of Qualified Experts (QE) in hospitals and large clinics are responsible, according to the national radiation protection regulations, to provide appropriate and continuous training on RP to the interventionists. The syllabi of this training should be approved by EEAE.

Additionally, the medical physicists have to evaluate the RP of the applied practices and when needed to suggest specific measures for their improvement. This procedure requires an effective cooperation with the interventionists which can be established only within the framework of a well-developed RP culture.

Finally, the implementation of Quality Assurance programmes to the departments where fluoroscopically guided procedures for diagnostic or/and therapeutic purposes are carried out is considered crucial for the standardization of the procedures applied for the provision of training, information dissemination and the evaluation of practices.

Evaluation of the level of RP culture

The RP culture of the interventionists participating to fluoroscopically guided procedures is evaluated at two levels:

The first level of evaluation is performed within their departments by the QEs who are responsible to check regularly the applied procedures and practices in terms of RP. Possible gaps should be identified, analysed and discussed with the involved physicians.

Qualitative indexes which are used for this evaluation include among others:

- Patient typical doses
- Occupational exposures
- Number of accidents and inadvertent exposures.

Additionally, QEs have a generic overview of the department's operational procedures and can identify gaps or weaknesses related to the development and implementation of an RP culture among the personnel.

The second level of evaluation is carried out during the inspections performed by EEAE for the verification of compliance with the safety requirements in the national legislation. EEAE inspectors check, among others:

- the files of personnel training in order to verify that the provided training on RP is in accordance to the predefined syllabus and organization's plan, and
- the applied practices in terms of RP.

Moreover, the role and contribution of the personnel in the optimization of the applied procedures regarding RP are also qualitatively evaluated.

Highlighting the role RP culture

The effect of providing additional training to interventionists participating to fluoroscopically guided procedures is encouraging. As some of them stated, after the completion of the courses they started to perceive the risk associated with ionizing radiation in a more realistic way and to use regularly this risk as an additional criterion in their decision making. They realized that simple, practical measures during their clinical routine could improve their RP performance and benefit the patients, themselves and the rest of the participating personnel.

For some interventionists the content and use of the Diagnostic Reference Levels (DRLs) and Trigger Levels was not so well understood. Therefore, the provision of this additional training was an excellent opportunity to get more familiar with these optimisation tools and to understand their significance for the fluoroscopically guided interventional procedures.

Moreover, the training has also a positive effect on their communication with the QEs, thus facilitating the exchange of information on issues related to the optimization of the interventional procedures. The communication channels created improved the level of cooperation for addressing practical issues related to medical or occupational exposures, therefore resulting in many cases in the reduction of the respective doses.

Lessons and recommendations

The provision of E&T to medical specialties participating in fluoroscopically guided procedures is crucial for building and enhancing an RP culture. Therefore, it is of great importance the:

- Continuation of the provision of training on RP to these specialties through the organization of appropriate seminars.
- Support to the establishment of sustainable mechanisms for the provision of re-training on RP within the institutes.
- Evaluation on a regular basis of the training and retraining needs of the personnel participating in these procedures.

1.3 Italy - Actions undertaken to mitigate the risk of accidental exposures in the field of radiotherapy

Characterization of case study and places of RP culture

The object of this case study is in relation to the idea to "foster the implementation of the principle of optimisation of radiation protection for patient exposures" that is an important point in the RPC. The concept of optimisation is the basic principle of radiation protection which establishes that the dose should be ALARA. When this principle is applied to radiotherapy of patients (as in the case here introduced) it is best described as management of the radiation dose to the patient to be commensurate with the medical purpose.

This study relates to the proactive approach and its use towards the risk of accidental exposure in Radiation Therapy (RT), in contrast to the view of using only the reactive approach.

Description of the case: To prevent accidents in RT, which may give higher or lower doses with respect to the best expected in the plan, good practice is needed but might not be sufficient.

RT should be performed with a clear knowledge of the process, awareness in all the aspects of RP together with a clear sense of accountability.

Basic points in the Italian experience:

- To introduce and promote a proactive approach in the most advanced forms of planning and dose deliveries RT.
- To be proactive and not just reactive is part of an adequate RPC.
- Think not only to react properly if something happens, but also start to develop a structured approach to identify and analyse adverse events, occurrence rating and potential severity, where it could be relevant in the different steps of the RT process (since in RT high doses are involvement).
- Our work started not under the pressure of specific or local emergency situation in action.
- The work was not motivated by a particular negative real experience, but by a full awareness on the RP implication within the intrinsic complexity of new RT technologies.

In RT when using a proactive approach, the ICRP Publ. 112 recommends that "Hospital administrators and heads of radiation therapy departments should provide a work environment that encourages 'working with awareness', facilitates concentration, and avoids distraction. They should monitor compliance with procedures of the quality control programme, not only for the initial treatment plan but also for treatment modifications."

Characterization of RP Culture

RP Culture, in the presented case study, is based on the knowledge about the radiation use with particular attention in radiation therapy and the awareness about the high level of exposure managed in radiation therapy and the related questions. It is important, as part of RP Culture, to create 'a work environment that encourages working with awareness', thus to facilitate concentration and avoid possible distractions. This is an attitude important in all the work fields, but particularly in this case of high dose management.

Appropriate training has to be ensured for the staff on the basis of the complexity of the considered treatment techniques, the potential for accidental exposure, and includes also in vivo-dose measurements and physical aspects of quality control. Basic needed knowledge: radiological quantities, radiation detection, biological effects of radiation, risk of stochastic and deterministic effects, quantity control and quality assurance, national regulation and international standards.

Development of tools, methods & processes to build, enhance and transmit RP culture

A Task Group (TG) was created in 2010, under the Italian Association of Medical Physics, on the aspects of a proactive approach with reference to risk in RT. A number of events were organised by the TG, at national level, with attention to risks of over-exposure in RT and to introduce a proactive approach, in 2011 and 2013.

Moreover, national accredited courses (e.g. Feb. 2012 and Oct. 2014) were organised in conjunction for both the professional figures of medical physics, radiation therapists and for technical and scientific involved experts, e.g. by starting with four groups working on process and analysis of risk and evaluation of consequences, for different radiotherapy approaches (IMRT, SBRT, Brachitherapy, IORT).

Moreover lecturers were given in national conferences and in events of inter-regional groups (e.g. Veneto, Trentino Alto Adige, Friuli Venezia Giulia), to disseminate this approach and create a related interest.

In the events and courses the attention to our case study launched the need to continue to increase the quality for medical performances with attention to health of workers and patients, in particular in new technologies using ionising radiation. Radiation Protection Culture is a key for the improvement in individual and group values, attitudes and expectations in relation to the management of radiation risk, and to consider consciously the radiation protection aspects in all the relevant applications of medical technologies.

To be proactive is part of RPC attitudes in relation awareness of what is radiological risks and the sense and meaning of the levels of this risk. In RT a good practice is necessary but may not be completely sufficient, the contribution of RPC through a full understanding of the process involved in irradiating the patients, with awareness of all the aspects of RP, embedded in mindfulness and a clear sense of accountability, can help to reduce the case of accidents in modern RT (higher complexity) in terms of frequency and severity.

In the events and in the report produced by the Task Group it was explicitly pointed out that radiation risk management is a culture fact combined with science and that all the involved professionals must be sensitized towards this level of culture. The introduction of the proactive approach, as in the final report of the TG of the Italian Association of Medical Physics, considered for example: decision making approaches under uncertainties, the challenges that in this case are common for the different professional experts, and how to apply proactive approaches.

Evaluation of the level of RP culture

The Task Group launched in 2012 a survey for the professionals in medical physics, in the different medical structures of the country regions, with regards to if and how attention is dedicated to risk management in RT and which is the level of involvement in activities able to increase awareness on this risk, such as dedicated training introducing technical and behavioural approaches in reducing risk of accidental exposure in RT. Not so highly diffused culture of risk management and in particular for the proactive approach resulted from that survey. Subsequently the work was dedicated to the proactive approach in RT addressing, also in the practice, the implementation of the most recent tools of the complex modern RT (SBRT, Cyberknife, IORT, proton RT), from 2012 to 2016, with groups of the involved professionals to evaluate the criticalities and advantages of the proactive approach. In the last two years there was the intention to repeat the survey to check changes, but this action has been delayed.

Highlighting the role of RP culture

RP Culture contributes to an effective and active involvement of the professionals that, as in this case study, are part of the staff in the RT application, thus supporting the reduction of accidental risk.

RP Culture has intrinsic value with respects to judgments and to help in identifying adequate/optimal behaviours (for different professionals in the relevant cases). In this sense the proactive approach is seen as an instrument of RPC in the practice to evaluate potential failures and their effects in the area of RT.

RPC can also help to consider the aspects of distribution of resources in the specific medical area, on the basis of RP implications and experience.

Lessons and recommendations

The performed round tables with professionals and patient representatives evidenced the values of a radiation protection culture with attention to the need to consider and apply in the practice the proactive approach with an increased awareness of benefit and risk in medical exposures.

Nobody can do all the work (as in RT) alone, it is a matter of a multidisciplinary team (different professional figures are involved in RT) and sharing experiences and judgements is important even in case of bad experiences, like in case of errors.

2 Case studies in the field of radon exposures management

The case studies will look at the actions undertaken in the framework of radon exposure management in territories to increase awareness of radon risk among stakeholders such as the local population, the local elected persons and the building professionals.

2.1 France - Management of radon exposure in the Franche-Comté area in France

Characterization of case study including type of actions and processes

The French Institute of Radiation Protection and Nuclear Safety (IRSN), the Montbéliard urban public authorities (located in the Doubs department within the Franche-Comté Region), the CEPN, the regional agency for air quality monitoring and the health regional agency have initiated the Franche-Comté Radon pluralist project in September 2011. This project aims to develop awareness on radon risk and to contribute to the information and the support of different actors who deal with the management of radon (general public, doctors, local councillors, building professionals). Furthermore, actions are developed to improve the management of radon risk within a general perspective of Indoor Air Quality (IAQ) and energy efficiency.

After one year, many partners have joined this project in order to develop actions of training and raising awareness among different actors, for example: university scientists (University of Franche-Comté), national and local authorities (Nuclear Safety Authority, the regional environment directorate), national and regional experts on radiation protection and IAQ (Federal Office of Public Health of Switzerland, Centre of Scientific Culture, Centre For Studies and Expertise on Risks, Environment, Mobility, and Urban and Country planning, French Environment and Energy Management Agency, University Hospital) and representatives of building professionals (French Building Trades Federation, consultants, artisans).

This action has allowed to develop a collaboration with Switzerland which has led to the Jurad-Bat Interreg V project aiming at an exchange of experience on radon risk management in the Jura arc area.

Characterization of RP culture (elements / definition)

The first approach concerns the health risk (lung cancer prevention). The used indicator is the number of cancers linked to lung cancer. The residual risk is not addressed, because we have not the knowledge and this subject is complex to explain for a public who is not expert in RP.

The RP elements are given about the threshold (regulation) and the exposure context. Information is common for all the public (population, building professionals and public authorities). After this general presentation, we develop the specificity of the problematic for each public:

- For population: the importance of measurements
- For public authorities: the information about regulation and their role to develop awareness campaign for population and to set up measurements in public buildings
- For building professional: information about remediation technics in old buildings and preventive measures in new buildings taking into account the energetic efficiency.

Development of tools, methods & processes to build, enhance and transmit RP culture

Different working groups develop tools with a validation in plenary session. Each group has a common core of RP experts, local councillors, public authorities (regulation and health), university, and expert in scientific vulgarisation. Added to the common group, representatives of each target public are associated (for example: public authorities, building professionals...)

Several tools were developed (leaflets, training course, awareness session, workshop, discussion, website) in conversation with specialists of the target public:

- For population, it was the "center for scientific and technical culture" who builds information and messages in order to ensure they are understandable and non-alarmist,
- For public authorities and building professionals, we organize meetings with elected representatives and building professionals in order to identify their needs.

To promote identification, we developed a "mascot" adapted to each public and we used a key sentence in leaflets:

- For population, it is a family with the sentence "take care of your health and that of your family"
- For public authorities, it is a mayor with the sentence "Radon, a public health issue: elected representative, what is your role?"
- For professional, the mascot wears tools and construction clothes with the sentence ""Radon, a public health issue: construction, renovation, which solutions?"

RP experts also participate to the working group, to the elaboration of leaflet contents and training. They help and advise the public authorities or other organisation to organize the measurement campaigns.

This multi-stakeholder approach works for several reasons:

- We used feedback of the public authorities who organize since many years measurement campaigns, so it is easier to identify the priority actions (information and training of the building professionals).
- The motivation of the project participants who are actors in the decision making process. Authorities are partners just as all the participants of the project. They are not alone decision makers.
- This approach allows setting up a pluralistic group who works together with a common soundness.

Nevertheless, this approach has also some limits:

- It is difficult to develop RP culture on the radon issue because is unknown for public and professionals. It is easier to explain radon risk through indoor air quality topic (as radon is a pollutant of indoor air quality).
- A multi-stakeholder approach needs time. It is a long process to build stakeholder engagement.
- For each organisation, only one or two people work on the project, so we have sometime a lack of human resources to develop some actions notably the diagnostic of building after measurements to identify mitigation solutions.
- The approach is not enough applied by some institutions. There is a lack of recognition.
- There is a difficulty to engage some stakeholders to attend the training course or information session notably the elected representatives and building professionals.

Finally, actions have to be developed on long time to adapt them in function of the needs and the expectations of the target public. Only one action is insufficient because the radon risk is unknown to the public:

- For the public the dynamic of the project is linked to the measurement campaigns,
- For the public authorities and professionals, the dynamic is linked with the repetition of the actions and the opening to other building professional category (artisan, project manager, architect,…).

Evaluation of the level of RP culture

For initial training: Multiple Choice Questionnaires and case studies allow to evaluate the level of understanding and knowledge at the end of the training session but it is a punctual analysis and not an evaluation on the long time.

For population, it is difficult to have a feedback between the measurements and the remediation action. Indeed, some people don't continue the process after the measurements for different reasons:

- The cost of remediation action
- The lack of building professional trained
- The weak perception of the radon risk because little information are given by the different media unlike for example the road accidents which lead to the same number of death by year (~3000)

For the other public: there is a difficulty to evaluate. The possible solution will be to implement a label, or agreement or certification for the building professionals. But this approach is limited because the agreement is based on the preventive and remediation technics and not on the RP culture.

Moreover, the difficulty is also the evaluation of mitigation action which is not controlled by a new measurement.

Highlighting the role of RP culture

RP culture allows to different actors to understand the risk associated to radon and the issues of managing this risk: measurements to know the risk in dwellings or public buildings and mitigation actions to reduce radon concentration.

RP culture also allows to place radon among all the risk in order to increase the perception of risk.

Lessons and recommendations:

- Approach needs to be initiated by the territorial actors (not imposed by the authorities)
- Need for multidisciplinary message conception. Need of transmission by experts who are recognized by each public (CSTB for building professionals, ARS & ASN for the elected representatives...)
- Need to have a regulatory framework to support and justify the actions, to motivate some public, notably building professionals
- Management of radon risk requires:
    - to develop adaptive structure and expert group,
    - to make territorial action step by step in order to test action, and allow to optimise the process. It is a long term process because the information and training take time and repetition.

    - to set up a scientific monitoring and a regulatory surveillance to have an improvement process.
- It is very important to be close to the public to:
    - Answer their questions
    - Explain the risk
    - Give advice on measurements and mitigation actions
    - Organize awareness and measurement campaigns regularly in order to maintain the dynamic and the culture of RP.

2.2 Greece – Development of radiation protection culture for different categories of stakeholders at local level

Characterization of case study including type of actions and processes

EEAE as the competent authority on radiological safety coordinates the implementation of the Radon National Action Plan (RNAP) at national level. In this framework, it performs indoor radon measurements countrywide in order to:

- estimate the distribution of indoor radon concentrations in dwellings,
- complete the national radon map and
- identify areas with increased levels of radon concentration in indoor air.

Moreover, EEAE takes communication actions in order to increase public awareness on the radon issue and inform local decision makers. Additionally, information leaflets are distributed to the members of the public and especially to those who participate in the radon survey.

Stakeholders involved, such as the ministry of environment, the ministry of interior, the ministry of health, local authorities and building engineering organizations have been invited by EEAE to consultations during the previous years. The aim of these consultations was to present in detail the radon issue and to initiate a series of appropriate actions following a common and efficient approach. EEAE's intention is to engage them more intensively during the preparation of the RNAP.

The preliminary results of the indoor radon measurements performed by EEAE showed elevated concentrations of radon in dwellings at the municipality of Xanthi. The municipality of Xanthi is located at the northeast Greece with an area of 1793 sq.km and a bedrock rich in granites. Therefore, EEAE initiated a survey based on large scale measurements in the region together with further actions aiming to make the local stakeholders (authorities and owners of dwellings) aware of the radon issue.

Characterization of RP culture

The main source of information to the public on the radon issue is the informative material provided by EEAE, either in the form of leaflets or on its website. Additionally, EEAE scientists give related presentations in the framework of conferences or seminars on radiation protection or during special events organized by local authorities where the radon issue is addressed.

The information provided by EEAE covers a wide range of topics such as the nature of ionizing radiation, its biological effects, the associated risks, the particularities in the case of radon as well as the measures that could be applied in order to reduce its hazardous effects.

However, it is considered necessary for the information provided to be reviewed regularly and revised appropriately in accordance to the needs of each target group of stakeholders (local authorities, members of building engineering organizations, dwelling owners, etc.)

Development of tools, methods & processes to build, enhance and transmit RP culture

EEAE in collaboration with the local authorities performed large scale measurements across the region of Xanthi. The measurements are currently analysed and the results as well as the related conclusions are expected in the near future.

During the period of measurements EEAE was in contact with the Department of Regional Planning and Urban Development (Ministry of Environment and Energy) and with the local authorities in order to provide information on the progress of the measurements and coordinate the required actions.

Additional actions are planned by EEAE for increasing the awareness of local stakeholders in the region of Xanthi in order to be engaged more intensively in the efforts to limit the exposures due to radon. These actions will include, among others:

- the organization of meetings with the local authorities to present in detail the survey results followed by an analytical discussion on the associated radiation protection issues,
- the organization of events aiming to increase public awareness on the radon issue. Similar events are also expected to be organized for professional societies involved in the construction of dwellings and public buildings.
- the dissemination of informative material to schools (in collaboration with the Ministry of Education) and hospitals (in collaboration with the Ministry of Health).

The above actions are expected to:

- increase the awareness of the local authorities and the public on the radon issue and support the development of the necessary radiation protection culture;
- establish an effective and sustainable communication channel with the local authorities and other involved stakeholders in order to facilitate further cooperation;
- enhance common efforts for the reduction average radon concentration and the improvement of air quality in the dwellings of the region;
- establish a model case to be used as an example in similar situations.

At this point, it is of great importance to underline the role of the professionals involved in the construction of the dwellings and public buildings who could contribute effectively in the implementation of appropriate RP measures in the case of radon. It is considered necessary that professionals such as architects, engineers are provided with appropriate education and training on RP issues through related courses, conferences or seminars. In this respect EEAE encourages the participation of professionals to meetings organized by the IAEA which address the radon issue.

Evaluation of the level of RP culture

It has to be pointed out that in the case of radon there is not a formalized process to evaluate the RP culture of the stakeholders. An initial effort to evaluate qualitatively the level of RP culture of the people in the region of Xanthi showed that there was a strong need to provide them with basic information regarding ionizing radiation, its biological effects and the associated risks before starting any further discussion on the issue of radon.

The information was given by the personnel of EEAE during their visits to perform the required measurements. These introductory “lectures” facilitated not only the communication with the stakeholders (owners of the dwellings) but also the survey performed. Similar discussions were carried out with the local authorities in order to present in detail the extent of the radon problem and to ensure their cooperation in the related future actions.

However, the development of a RP culture is an on-going and demanding procedure. Therefore, the initial evaluation of the stakeholders' RP culture requires a follow-up in order to confirm the effectiveness of the related EEAE actions.

Taking also in to account the experience from similar EEAE activities in other regions, it is easily concluded that continuous efforts are needed in order to increase awareness regarding radon. In these efforts the role of the competent and the local authorities as well as the scientific societies is crucial.

Finally, the greatest difficulty in this building RP culture efforts is not the provision of appropriate information, but to change beliefs and perceptions of the involved stakeholders and to ensure their participation in the required corrective actions.

Lessons and recommendations:

- Further actions are necessary to increase the awareness of the public on radon and to change its beliefs and perception regarding the exposure to radiation, such as:
  - the organization of events where the radon issue will be addressed properly;
  - the dissemination of informative material to schools (in collaboration with the Ministry of Education) and hospitals (in collaboration with the Ministry of Health).
- The cooperation of the competent authorities with the local authorities and the professional and scientific societies is necessary. This requires the creation of appropriate communication channels among authorities and societies.
- Professionals involved in the construction of the dwellings and public buildings should be provided with appropriate education and training on RP issues through relative courses, conferences or seminars.

2.3 Switzerland – Actions undertaken in the framework of the implementation of the radon national action plan

In Switzerland, FOPH is developing and implementing since 2012 a radon national action plan as a large part of the country is concerned with this issue. Several actions are implemented, such as promotion of protective measures against radon in buildings, planning efficiency strategy for remediation, including radon in the training of construction experts, improving public awareness to health problems caused by radon. An external evaluation of the goals achieved by the current implementation of the national action plan will be launched end 2018 to define the best strategy guiding the future FOPH actions in this field.

Characterization of case study including type of actions and processes

The national radon action plan 2012-2020, approved by the Federal Council on May 25, 2011, was largely motivated by the upward revision of the radon risk level by international bodies (ICRP, WHO). The plan has seven axes of development which are listed below.

1. Revision of legal provisions. This approach governs the commitment of the action plan.

   In the new ordinance on radiation protection, the limit value of the average radon concentration in premises where people can reside regularly of 1000 Bq / m^3 and its guideline value of 400 Bq / m^3 have been replaced by a reference level of 300 Bq / m^3. This new provision completely changes the radon risk landscape in Switzerland. Whereas previously only a few regions (Southern Alps, Jura) had been declared at risk, now all of Switzerland is concerned.

2. Improved knowledge of radon exposure in homes

   The new national situation implies an increase in the coverage of measurement of radon on the territory. The strategy put in place consists concentrating the effort on the new constructions; thus, the radon problem is being addressed mainly through the renewal of the building stock. Efforts have been made, however, in a few particular areas, including schools and kindergartens.

3. Promotion of Radon Protection Actions in Construction

   A collaboration with the Society of Engineers and Architects led to a revision of Standard 180 (Thermal Protection, Protection against Moisture and Indoor Climate in Buildings) that better reflects radon construction requirements. The integration of radon into indoor air quality standards is an effective way to constrain the consideration of radon. In the framework of a collaboration with the cantonal services of the construction, information on the radon problem and on the requirements put to the building owner will be introduced in the procedure of authorization of construction. It is envisaged to establish guidelines for the application of the new Ordinance for the owners.

4. Developing an effective strategy for remediation

   An updated "Radon Handbook", presenting the remediation methods, has been published. Three competence centers for construction consultancy have been set up, one per language region. A directive is being prepared on the deadlines for remediation. In addition, a database dedicated to remediation is under study.

5. Integrating radon into the training of construction specialists

Training days for teachers in construction trades training schools were organized. The goal is for all building specialists to be trained in this issue. In this context, didactic material is in preparation (e-learning, virtual radon house, etc.).

6. Improved public awareness of the health problem posed by radon

Passive forms of information are put in place on the FOPH's website. A major awareness-raising effort is planned to accompany the implementation of the new radiation protection ordinance.

7. Development of tools and methods

A new approval for radon measurement services has been established in the new Radiation Protection Ordinance and a revision of the measurement protocols has been launched in collaboration with the Federal Office of Metrology. Bi-annual intercomparisons are organized to guarantee the quality of radon measurements.

Characterization of RP culture (elements / definition)

The situation of radon is very special and requires public collaboration

- initially, no public demand
- no instrument from the authority (no authorization scheme)
- the state has a role of requestor towards the public
    - need for knowledge for effective public collaboration
    - setting up relays to introduce the radiation protection culture

Development of tools, methods & processes to build, enhance and transmit RP culture

Following tools have been developed in the context of RP culture

- creation of the legal basis for delegating responsibilities
- creation of relays (cantons, competence center, measurement services, radon consultants)
- creation of information for construction specialists (protective & corrective procedures)
- training of construction specialists
- annual radon day to encourage the participation of the cantons
- transfer of powers to the cantons by legislation
- involvement of the Swiss league against cancer
- public information (press, website)

To help the Cantons and the interested associations (Owners and Renters) in implementing the new reference level (300 Bq/m^3) applying to all regularly occupied indoor space (dwellings, schools and workplaces), it was decided to elaborate following guidelines involving stakeholders such as cantons and owner association:

- prioritization of radon measurements
- radon remediation:
    - assessment of the urgency of a renovation
    - order of remediation by the canton
- radon protection for new buildings and renovation

In parallel, the regulatory authorities (FOPH, ENSI, and Suva) in charge of the surveillance of occupational exposure informed the enterprises, which workplaces are classified at risk, on the process

to be engaged since the new threshold value (1000 Bq/m^3) is exceeded. The associated dose calculation is described in the dosimetry ordinance.

Other tools developed in the framework of the radon action plan:

- specific measurement protocols for dwellings, schools and workplaces ;
- new radon database and requirements for measurement services ;
- predictive radon mapping for the general population ;
- building codes including radon and education plans of building professions ;
- new radon guide and training requirements for radon consultants in the FOPH list.

Evaluation of the level of RP culture

- participation in the drafting of legislation (explanatory report, consultation, information on the evolution of knowledge, change of the reference level);
- dialogue with local authorities (transfer of powers by legislation to cantons and building owners);
- delegation to the centers of competence (training, development of tools, animation of workshops);
- introduction of radon in building trades (state of the situation).

Highlighting the role of RP culture

- necessity if we want to mobilize the population on a problem affecting the private sphere ;
- need for a good supervision of the process (creation of relays, information and training of relays);
- difficulty to raise the interest of the general public without frightening it. Find the good balance!

Lessons and recommendations:

The following two areas, which can be considered poor parents of the radon action plan, have not yet received all the desirable attention:

- awareness of the general public; the process is difficult and the reluctance on the part of the authorities must be overcome; a reflection on the method to be initiated is in progress;
- development of approaches to the factors influencing the measurement of radon; it would be advisable, in view of the use of the new ICRP dose coefficients, to be able to measure equilibrium factors and aerosol characteristics in the field; reflection is still in its infancy.
- development of a protocol of short term measurement to indicate the probability of exceeding the reference value especially in case of real estate transaction
- promote synergies with IAQ management; creation of an indoor air quality observatory in the French spoken part. Radon should be perceived as an additional pollutant of indoor air quality.

The following two elements illustrate the relevance of the promotion of the radiation protection culture in Switzerland through the involvement of stakeholders outside the field of radiation protection (building and health professionals), but whose action is essential to solve the problem represented by radon in the context of the general health protection in built environments.

- For a small country like Switzerland, the setting up of a radon delegate per language region within the education centres specialized in construction trades constitutes a major relay for the integration of the radiation protection culture into the professional sectors of building, energy saving program and indoor air quality. In this context it should be emphasized that the major

difficulty lies in the recognition and taking into account of the radon problem by the responsible authority for energy mitigation.

- The Swiss particularity of integrating radiation protection into the ministry of public health represents an asset that makes it possible to treat the radon problem in a health protection perspective extending to all indoor air pollutants. In this context radon anchoring in the following Swiss Society of engineers and architects (SIA) building codes constitutes a definite advancement:

  SIA 180: Thermal protection, protection against moisture and climate in indoor buildings

  SIA 272: Waterproofing and drainage of buildings under terrain and underground construction

  SIA 2023: Home ventilation

An effort remains to be made to ensure the public's awareness of the radon risk, e.g. with the requirement for information on the radon concentration in the rent lease, notwithstanding the risk of the concern/worry that such information could induce.

3 Case studies in the field of emergency preparedness

The objectives of the case studies in this field are to analyse the actions undertaken in the framework of accident preparedness programme to foster the dissemination of practical radiation protection culture within the civil society and to elaborate tools and guidance, taking notably into account lessons learned from the Chernobyl and Fukushima accidents.

3.1 France - Actions undertaken in the framework of the Steering Committee for the Management of the Post-Accident Phase of a Nuclear Accident (CODIRPA) created by the French Safety Authority (ASN)

Characterization of case study including type of actions and processes

In 2005, the National directorate for nuclear safety and radiation protection (DGSNR) which has since become the Nuclear safety authority (ASN), established a Steering committee for the management of the post-accident phase of a nuclear accident or a radiological emergency (CODIRPA), at the request of the Government.

When the CODIRPA started its work, lessons learned from the Chernobyl accident were already available, showing notably the great complexity of a post-accident situation going far beyond the radioactivity issue, with profound disturbances affecting every aspects of the populations' lives, including the economy of the territories.

Three objectives were given for the elaboration of the post-accident policy for the three post-accident phases (exit of early phase, transition period, long term period):

- Protect the population form the danger of ionising radiations
- Provide support to the population victim to the consequences of the accident
- Reconquer the affected territories, from the economic and social standpoint.

The process implemented by the CODIRPA involved a large number of stakeholders affected by post-accident management: the public authorities, operators, NGO's, experts, etc.

- 18 topical Working Groups (most of them steered by French administrations, authorities or TSOs), with a membership of non-institutional representatives (NGOs, local elected people, professional unions, independent experts and consultants…) and dealing with various issues (waste management, economic issues, RP culture, health considerations, …)
- 2 pluralistic Committees in charge of the elaboration of the policy for the post-emergency (transition) phase and long-term (late) phase (the latter lead by NGOs)
- Large participation of local and national stakeholders (around 300 participants from 2005 to 2019)

The first step of CODIRPA work has been conducted in three phases:

- 1st Phase (2005-2007): Progressive involvement of non-institutional experts
  - Co-construction at the national level of the first elements of the policy with a pluralistic participation
- 2nd Phase (2008-2010): Consultation at the local level
  - Local administrations, decentralized State services (Prefectures) and representatives of the civil society (municipalities, NGOs)
- 3rd Phase (2010-2011) Co-construction at the national and local levels

- Local Emergency Response Plans
- Drills and exercises (including a post-accident dimension)
- Elaboration of guidelines for the so-called transition and late phases
- Publication of the "Policy elements for post-accident management of nuclear accident"[2]

The work of CODIRPA has been based on concrete feedback from Chernobyl situation. Some members participated also to European projects dedicated to these aspects (ETHOS, CORE, SAGE, PREPARE) allowing notably to share testimonies from affected populations and to visit Belarus.

After the publication of the Policy, a second step was initiated in 2012 (CODIRPA 2) in order to accompany its implementation in the territories at the local level as well as to update its content. It can be noticed that ASN obtained in October 2014 another mandate from the Prime Minister for a period of 3 to 5 years to continue its work. The work includes:

- Involvement of territories in the preparation to post-accident management situations
- Update of the policy, taking notably into account more severe accidents, feed-back from Fukushima
- Complementary works: Water resource management, Waste management, Q&A to Local Health professionals, Guidance for population living in a contaminated territory

Regarding RP culture developments, the case study will focus on;

- The Working Group on RP Culture (2010-2011)
- The Working Group on 'Questions and Answers to Health Professionals' (since 2016)
- The Working Group on Guidance for Population (since 2016)

Working Group on RP Culture

This WG was created during the 3rd phase of CODIRPA (2010). It included 14 participants: School teachers, NGOs, health professionals and RP experts. The main issues addressed by the WG were the following[3]:

- How to develop RP Culture of population in 'normal situation' and 'post-accident situation'?
- Which partnership could be established with professionals for developing RP Culture within the population, and in particular students and patients, and according to which modalities?

The target stakeholders of the WG were the students, the teachers and health professionals.

Working Group on 'Questions and Answers to Health Professionals'

The objective of the WG is to enable health professionals to be able to respond in a relevant and documented way to the health issues of the population in post-accident situations, whether in the reception and public information centers or during their daily practice (cabinet, hospital)[4].

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2 Autorité de Sureté Nucléaire (ASN), "Policy elements for post-accident management of nuclear accident", Final Version, October 2012, http://www.french-nuclear-safety.fr/Information/News-releases/National-doctrine-for-nuclear-post-accident-management

3 CODIRPA, Rapport du groupe de travail « Culture pratique de radioprotection en situation post-accidentelle », décembre 2011. https://www.asn.fr/Prevenir-et-comprendre-l-accident/Gestion-post-accidentelle/Les-travaux-du-CODIRPA/Synthese-et-rapport-de-chaque-groupe-de-travail.

4 CODIRPA, Groupe de travail « professionnels de santé » : rapport de phase 1, 2016.

For this purpose, a pluralistic sub-group of health professional, chaired by a Health Regional Agency representative has been set up. It is composed of 13 persons, from the local area of Civaux (city closed to a nuclear power plant), from various health professions (emergency medicine, pediatrics, family doctor, nuclear medicine, occupational health, pharmacist, …). The missions of this group are:

- To identify and express the needs of health professionals in terms of knowledge (health issues, but also in other fields if necessary);
- To request the hearing and debate with the experts according to the needs expressed;
- To receive the answers to the questions and answers table and give an opinion on their relevance, comprehension, readability;
- To formulate training and training format requirements, before the crisis and during a crisis

Another sub-group of around 15 experts has also been set up. This group includes scientific experts (epidemiology, medicine, radiation protection, sociology) and persons familiar with the context of post-accident management and existing reference documents on which the expert group can base its response to the question raised by the health professionals. This group of experts has two very distinct missions:

- at first: write the answers to the questions asked;
- in a second step: reflect on the rise in competence of health professionals.

Working Group on Guidance for Population

The origin of the creation of this WG within CODIRPA 2 relies in the work performed in the European Project SAGE (2002 – 2005) which elaborated "Guidance on Practical Radiation Protection for People Living in Long-Term Contaminated Territories"[5]. This handbook was produced with stakeholder groups from civil society from 4 different countries (Germany, France, UK, Belarus) with the support of experts having experience of the Post-Chernobyl accident management and good knowledge for the concerns and worries of the population living in contaminated territories.

The objective of the WG "Guidance for population" is, based on the SAGE handbook and considering the feed-back experience from the post-Fukushima accident, to elaborate a handbook of good radiation protection practices to be used by the population affected by a nuclear accident.

The Group is composed of 17 members from civil society (farmer, cheese producer, teacher), NGOs (Consumer protection, environment protection, promotion of decent living conditions), experts in radiation protection (IRSN, ASN, CEPN, Health Regional Agencies), Local Commission of Information around NPPs. All those members have skills and competences in the management of radiation protection and/or post-accident situations, having been involved in previous European Projects (ETHOS, CORE, SAGE, PREPARE) or in the first step of CODIRPA.

Characterization of RP culture (aim of RP culture / elements of RP culture)

Within this case study, a distinction can be made between the different target stakeholders for the dissemination of RP culture:

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5 "Guidance on Practical Radiation Protection for People Living in Long-Term Contaminated Territories", Project deliverable of the EC SAGE Project, "Strategies and Guidance for establishing a practical radiation protection culture in Europe in case of long-term radioactive contamination after a nuclear accident". http://www.ec-sage.net/members/WP4_Handbook.pdf

- The stakeholders involved in the various WGs of CODIRPA,
- The high school students
- The general population and/or specific professionals that would be involved in the management of a post-accident situation
- The health professionals

For the stakeholders involved in the various WGs of CODIRPA:

It is necessary to raise their awareness about the various and complex issues of a post-accidental situation and to have them identify how the development of a practical RP culture can help to cope with these issues. This understanding of the complexity of a nuclear accident should be based on lessons learned from practical feedback from past accident, or simulation of accident, aiming notably at identifying the distinction between issues originated from the RP consequences of the accident and that due to other consequences of the accident (economic, social psychological, disruption of living conditions, …).

The objective of RP culture dissemination for those stakeholders is also to acquire the knowledge about their possible role in the event of a nuclear accident.

Finally, acquiring a RP culture is also necessary for those stakeholders to be in a position to interact and participate to the process of elaboration of EP&R plans.

For the High School Students

The objective of the actions undertaken to disseminate RP culture are to contribute to promote scientific and technical culture and to initiate a civic approach for these students, as part of an appropriation of scientific, ethical and societal dimensions related to ionizing radiations. The sharing of experience with students from Japan and Belarus, for whom radioactivity is a daily issue, is a key element to acquire the understanding of the post-accident situation.

For the general population and/or specific professionals that would be involved in the management of a post-accident situation

It is necessary to build a practical RP Culture to understand what is at stake in their environment and be able to act in their day-to-day life or fields of activities in emergency or late phase of an accident for their own protection.

RP culture, shared with their community, allow individuals to implement their own protective actions, with the support of local authorities and professionals. It also provides the necessary knowledge to take informed decision, to participate to decision-making processes where other aspects than the only radiation protection issue might be addressed (well-being, economic issues, future of the territory, etc.). Finally, it helps to better discern what belongs to the consequences of exposures as such and what belongs to other consequences, other disturbances of the « well-being » related to the accident.

For health professionals

The aim of disseminating RP culture in a preparedness phase to the health professionals is to raise their awareness about radiological risk as well as to give them the necessary elements to be able to answer to the concerns of the population and try to limit its anxiety.

Elements of RP culture related to EP&R

Lessons learned from the work of the various CODIRPA WGs show that the main elements contributing to a practical RP culture for stakeholders that are involved, in the preparedness phase or in the direct management of post-accident situations, include the following topics:

- Understanding the characterization of a radiological situation and the environmental contamination
  - External dose rate and maps of the environment (inside and outside buildings, recreational areas, working areas…), soil contamination, food contamination
- Identifying source of individual exposure in contaminated areas
  - Use of individual devices (D Shuttle…), analysis of daily activities and impacts on individual dose, discussion on extrapolation for annual dose, comparison within the local community, putting into perspective with other locations and other exposures to ionizing radiation
- Identifying protective actions (collective and individuals), evaluate / understand their effectiveness and consequences
  - collective decisions on protective actions: Food restrictions, evolution of agricultural production, limitation of access to different areas, decontamination strategies,…
  - Individual actions: Selection of food products, selection of activities depending on the environmental contamination, follow-up of individual exposures, implementation of decontamination actions, …
- Identifying and answering to the concerns of the population
  - Concerns about health effect (thyroid cancers, long term effects, hereditary effects, general health status, …) and health surveillance programmes
  - Concerns about everyday life (food, water, travels, animals, …)
  - Capability to provide answers based on scientific knowledge (dosed-effect relationships, uncertainties, …), or on practical feedback from past-accident situations

Development of tools, methods & processes to build, enhance and transmit RP culture

The processes studied in this case to develop and transmit RP culture are related to the three working groups presented above (RP Culture, Questions and answers to health professionals, Guidance for Population).

Working Group on RP Culture

The work of this Group was performed in interaction with actions implemented to develop RP culture for high school students ("Les ateliers de la radioprotection"[6],) undertaken since 2007 by CEPN, in cooperation with IRSN, ASN, INSTN-CEA, Pavillon des Sciences and SFRP. These actions undertaken each year have involved since the beginning more than 1,000 students and 30 different high schools from France, as well as some other countries (Belarus, Japan, Ukraine, Germany, Moldavia)

[6] http://lesateliersdelaradioprotection.com/

The actions are based on the voluntary commitment of professors and students with the support of organisations involved in radiological protection. Each high school initiate workshops with the student on various aspects of radiation protection (Scientific and technical foundations of radiological protection, management of radon exposure in homes, radiological protection of workers and patients in hospital, monitoring radioactivity in the environment, …). An annual meeting of the all the students who participated to workshops in their school (around 150 students per year) is organised to share their work, experience and to improve their knowledge.

One important aspect of the workshop organized in the high school is that they are favoring approaches to address practical issues rather than theoretical knowledge. The work is based on visit of facilities as well as practical experimentations made by the students. The RP experts are supporting the actions by helping to build the projects of each school and by providing analysis and interpretation of results of the experimentations.

It can be noticed that such workshops are not included in the existing school programs. However, it is possible usually to elaborate multi-disciplinary projects where students can participate on a voluntary basis.

The annual meeting is an important event as it provides a place to share experience between the students. The feedback from Japanese and Belarus students and professors plays notably a key role to favor the understanding by all students of the complexity of a post-accident situation.

Working Group on "Questions and answers to health professionals"

Health professionals (medical doctors and other health professionals) are important stakeholders to be involved in the management of post-accident situations as they are largely considered by local population for providing answers to their concerns. These stakeholders usually have a limited knowledge coming from their professional background on radiological protection or on environmental health issues, it is thus important to find ways of rising their competence in this fields in the preparation phase of post-accident management.

In this case study, the Working Group on "Questions and answers to health professionals" was created with the aim of preparing material / information that could be used by health professionals in case of post-accident situation. The first step was to identify the key questions raised by the population. This was done by the members of the group from their own experience and also using their network of colleagues. One important rule was that all questions were relevant (no "silly question") and had to be answered.

Around 200 questions that could be asked by patients have been identified. This corpus was initiated by the collection of questions asked during nuclear exercises or during the Fukushima accident, supplemented by data from the literature concerning mainly the Fukushima accident. Nevertheless, besides the fact that some questions remain universal, the working group could usefully supplement the initial data by its own questioning or by that of the patients bordering the Civaux nuclear power plant who had expressed their concerns following the accident of Fukushima.

The questions have been phased over time (emergency, transition, long-term phases) and groups by topics:

- Worries and concerns about children and pregnancy
- Generic pathologies
- Iodine and thyroid
- Food-stuff management
- Social relationships
- Animals

- Occupational risks
- Actions to be taken
- …

The sub-group of experts will now provide answers to all questions, answers to be discussed and validated by the sub-group of health professionals. In a second step, the Group will identify the needs in terms of education and information of health professionals regarding nuclear accident and post-accident situations.

Working Group on "Guidance for population"

As described above, the WG is composed of representatives of various group of population that will have a role to play in the management of a post-accident situation: local information committees around nuclear power plants, consumer groups, farmers, NGOs, teachers, and also experts in radiological protection. To elaborate a relevant handbook for the population, it is necessary to largely rely feedback experience from Chernobyl and Fukushima. For this reason, the members of the group are persons already involved in the past in other activities related to follow-up of RP issues in post-accident situations

In order to elaborate the handbook, the Group collected around 100 questions that are raised by the population (in synergy with the questions collected by the working group "Questions and Answers to Health Professionals"). The identification of the questions relied largely on feedback from Chernobyl and Fukushima. Some members of the Group participated to visits to Belarus or Japan, and collected testimonies from the local population living in contaminated territories.

The handbook will take the form of structured information sheets where each topic will be addressed providing answers to the questions. The main topics, addressing day-to-day life after an accident, are the following:

- General aspects (who is doing what? who can be contacted?...)
- Measurements (Tools, By who? For which reasons? radiation quantities, ...)
- Health (health effects, health surveillance, individual protections…)
- Water (drinkable water, other use of water, …)
- Food (vegetable garden, local markets, picking, hunting, fishing, food control, feeding of livestock and domestic animals, …)
- Every day (wood and ashes, clothes, garden, household waste, pets, ...)
- Travels (personal and professional travels, sports and leisure, means of transport, ...)
- Citizenship and mutual help

The target stakeholders of the handbook to be produced by the group is the local population who might be impacted by a nuclear accident, including elected people, NGOs, economic actors or teachers.

It can be noticed that while all group members expressed their interest for the production of such guidance, they encountered difficulties in finding times to be spent in writing it. The process is clearly interesting, but is quite time consuming and a technical support from experts is necessary to elaborate the answers.

The next challenge will be to identify a process to establish a regular update of the handbook, as well as to disseminate it (around 150 per year) in the population.

Evaluation of the level of RP culture

Relying on the willingness of different stakeholders to be involved in the working groups to contribute to preparedness for emergency and recovery issues, no formalized evaluation process has been established. It is expected that stakeholders participating to the working groups and those who may receive information delivered by these working groups will understand the post-accidental situation as a whole and its complexity. Although no formal evaluation is performed, the issues addressed within the working groups show the increasing capability of the participants to catch what is at stake.

It should be noted that people better understand the role of the radiological protection culture which does not provide individual solution without support behind (notably the support of experts to help interpreting the situation). It is also emphasized by the participants of the working groups that RP culture does not aim at justifying any exposure to ionizing radiation but contribute to take informed-decision.

In the context of post-accidental situation, It is also clearly emphasized that RP Culture is part of a process of global understanding of the complexity of the situation addressing the different dimensions (health, environmental, social, economic, ethical…) affected by the situation. The level of RP culture could be appreciated by the capacity for the stakeholders to contribute to a collective process of optimisation of the situation, with the support of authorities and experts.

One sensitive issue related to the RP culture concerns the difficulties for stakeholders to put the results into perspective and to catch their meaning. This has been clearly observed in the dialogue with local stakeholders after the Chernobyl and Fukushima accidents. In order to overcome this difficulty, it is important to promote practical experimentation to understand the meaning of the RP culture components.

Following the Fukushima accident, the social network plaid a key role for assessing the level of RP culture of stakeholders. The constructive exchange and self-verification of the understanding (e.g. Safecast) set up a process contributing to the assessment of RP culture.

Lessons learned

The development of RP culture in the preparedness process for post-accidental situations largely relies on the capability to be connected to concrete experience to better catch the complexity of post-accident (PA) situations. This process has to involve experts, but also other stakeholders such as national and local authorities, health professionals, local population, local elected people, specific professionals, etc.

Due to the sensitive issue of post-accident situation, it is important to emphasize that RP Culture is a key process contributing to informed-decision to be made by the stakeholders. This is not a process to transfer the responsibility to local population for managing alone their situation. In this perspective, the development of co-expertise to address the situation is crucial and RP culture is essential to allow all stakeholders to be involved. Notably, it should be noted that RP Culture is disseminated at the individual level but is part of collective actions.

There is no predetermined model for developing RP Culture in a PA situation. RP Culture should be adapted to the specificities of the territory and the local needs. It is essential to cope with the complexity of the situation and to rely as much as possible on practical approach in order to help people to make their mind on the way RP culture could be expressed and help them.
ethical considerations have to be addressed carefully. Among the issues to be considered, it should be noticed the respect of autonomy of local stakeholders, the respect of dignity of affected people, the

actions taken to maintain and promote long term vigilance, the acknowledgement of the responsibility of the experts and authorities.

3.2 Italy - Preparedness to nuclear emergencies management at the level of hospitals

Characterization of case study including type of actions and processes

The case study here reported is related to the Fukushima accident - an event that has attracted much attention, and helps to better implement an approach to the nuclear emergency response for what was already relevant to the Italian reality: the direct and primary involvement of hospitals in nuclear/radiological emergency or even in case of terrorist attack.

The management of radiological and nuclear emergencies is configured in Italy as a current problem with many facets. Although in our country, since many years, nuclear power plants are inactive, there remains a risk of accidents involving the presence of radioactive substances in relation to their use in industry and medicine, and the corresponding activities of transport, detention, use of radioactive sources. To be added to this, there are the potential dangers arising from the management of radioactive waste, from the decommissioning of nuclear plants, from the possibility that accidents to nuclear plants across borders have repercussions on the national territory, from possible accidents to nuclear-powered submarines or satellites with radioactive sources, from illicit traffic of radioactive substances and finally, from other activities that could be linked to the discovery of orphan radioactive sources.

As we know, in hospital one should go in case of need for health care, but if people arrive from an area of possible nuclear emergency, the hospital has to be prepared for some measurement/estimation of risk. In any case it is recognised that the access to the hospital must be limited only to cases of need, and the selection of cases must be made on the basis of risk estimates. On March 11, 2011 an emergency situation in Japan was reported, on March 12, 2011 an environmental release of I-131 and Cs-137 was released, and consequently the communication has been given, in the different national regions, by the Regional Environmental Protection Agency, e.g. ARPA of the Piedmont Region[7] with the results of the first local monitoring and information about the successive updates. Starting from 14 Mach, 2011, different hospitals prepared documents per specific procedures to assist subjects coming from the Japanese area and potentially exposed to ionising radiation, and information on the path for suspected contamination was given the interested subjects, as e.g. the Niguarda Ca' Granda Hospital in Milan[8]. The Italian Ministry of Health issued a note to harmonize the procedures for the assistance to people coming from Japan[9].

The Italian people returning from Japan after the accident, independently on the area they were in Japan, decided to go directly to the hospitals, considered the main centres for public in the event of an emergency.

Italian people from Japan turn to hospitals, as workers or public after their visit in Japan. Moreover, a number of people just worrying about environmental contamination, not in Japan but directly in Italy, came up to hospitals, perceived as centers for any needs, to express their concern or to simply ask information.

Hospitals are seen as a place of great trust and characterized by high sensitivity towards the public.

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7 http://www.arpa.piemonte.it/comunicati-stampa/2011/radioattivita-in-piemonte-14-marzo-2011/at_download/file

8 https://www.aimcnet.it/data/allegati/2011_niguarda_giappone.pdf.

9 http://www.trovanorme.salute.gov.it/norme/renderNormsanPdf?anno=0&codLeg=37625&parte=1%20&serie=

A note released by the Italian Ministry of Health regarding the first controls on Italians who returned home from Japan, has shown the great advantage of the cooperation between the regional administrations and the Ministry: a number of 23 hospital centers were activated in 10 regions[10] .

A case of very large mediatic attention refers to the musicians of the *Maggio Musicale Fiorentino*, who were in tournée in Japan just during the tsunami and the risk of radiation risk exposure. The group counted a large number of members, including choir, orchestra, technicians and employees, and when they returned more than 200 persons were examined in the laboratories of the Careggi Hospital (the main hospital in Florence). Medical physicists and nuclear physicians explained to people, authorities and to journalists, that results of the urine analysis, indicating I-131, were not of great concern.

From that moment on, an alarmism started in the public in general, and at the same time questions emerged at the journalism level, and public and experts were also involved.

Characterization of RP culture (elements / definition)

Indeed, at national level, before the accident in Fukushima, the management of radiological emergencies was seldom an interest for medical physicists (unless very qualified) , and this field was limited to few experiences in some principal large hospitals and in relation to very special circumstances. After the case of Fukushima, emerged the values that medical physicists may represent in the management of nuclear emergencies, for the assessment of irradiation and contamination of the involved subjects, and for an adequate risk communication to the community. The medical physicists of the different hospital centers, as in the case of the Careggi hospital, on the basis of the radiometric instrumentation available in their structure, proceed with a proper calibration, their analyses, their estimate of the results and their evaluation of the level of radiation exposure[11]. Moreover, it emerged how, before the Fukushima event, CBRN emergencies were somehow perceived as a niche sector, as rare events, but, as explained by the Careggi's Medical Physics in an interview, it is precisely their low frequency that involves, in practice, specific elements of criticality in their management. Given that hospitals are among the first to be used in the event of a health emergency, an effective hospital response becomes crucial in the management of CBRN emergencies

In Tuscany, during the Fukushima initial period, the Careggi Hospital structure enhanced the project to establish a CBRN emergency hospital management program towards an optimization of the human, instrumental and structural resources present in the hospital. At the same time the process started also in various other Italian hospitals, in particular with great attention at the Niguarda hospital in Milan (Lombardy). It is well known that embedding RP at cultural level helps to be more effective in delivering the best performance. RP is already present in hospitals, as we know, before any nuclear accident, but this case study evidenced the importance of RPC in hospitals, encompassing not only the RPC in medicine, but that could face radiological and nuclear emergency, in case there is some need.

Medical Physicists are the professional health figures who have the necessary scientific and technological skills for the management of irradiated and/or contaminated subjects, for the radioprotection aspects of the personnel and for the determination of contamination levels and the relevant dosimetry quantities.

In Italy their training, in addition to a master's degree in physics, includes a post graduate specialization school for the achievement of a four-year diploma in medical physics, with apprenticeship at the accredited facilities of the National Health Service.

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10 http://www.salute.gov.it/portale/news/p3_2_4_1_1_stampa.jsp?id=3243

11 http://aifm2013.to.infn.it/topic/7fisicamedica.pdf

With reference to nuclear/radiological emergency situations in practice, because of the reduced frequency of occurrence, it is possible to configure various critical issues such as the lack of familiarity of the health and rescue personnel in the management of such events, the need for their adequate information and training, the availability of suitable and ready to be used instruments for measurements.

In planning health related activities, one of the essential points, which is also part of the RPC, is the optimization of available resources which, for the case study, entails necessarily a radiological triage path in order to establish a priority in the treatment of victims and in the implementation of the necessary measures for the protection of collective health on short, medium and long-term effects. This is true even for local hospitals: in fact, if on the one hand we are taught that the priority of transport and the destination of the involved subjects towards the hospitals should be through the filter of the rescuers, experience teaches that in emergency situations many people turn spontaneously at the hospital or because they have escaped from the first aid network or, even if not directly involved/injured, because they are worried about the consequences on their health of a possible contamination.

The case study evidenced that:

- when people have concern for any possible health problems, they go to the Emergency room of an hospital,
- in the event of a confirmed emergency (i.e. intervention on the scene of CBRN and Civil Protection groups), people prefer to arrive independently at the hospital to have more information and reassurances,
- health care centres have to be ready for receiving people in emergency, even for the nuclear/ terroristic emergency.

RPC supported the response of hospitals in that circumstances, in terms of proper behaviour and technical point of view (i.e. radionuclides different from those used in hospital in radiopharmaceuticals and quite different level of radioactivity at the moment of measurements) in cooperation with CBRN and universities.

In this case, RPC was helping decision making, as a combination of knowledge and awareness of the situation (that is not a routine situation for hospitals) to more organisational and individual behaviours towards a higher degree, and with attention to establishing a level of communication, adequate for the case, among the involved practitioners, with a sense of the social dimensions of the communication. In the situation of emergency, regardless of the severity level, it clearly emerges how the interaction, as a whole system, of professionals with different fields of expertise, but same interest in doing the best in emergency, e.g. as in CBRN approach, contributes to create synergies which are not inherently present in the single parts (see for example: "*The experience needed to build a holistic approach is being drawn from various sectors of activity*". T. Lazo, B. Kauher, A global approach to risk management: Lesson from the nuclear industry . Facts and opinions, NEA News 2003 –No.21.1). This aspect is also part of the RPC.

Development of tools, methods & processes to build, enhance and transmit RP culture

Italy does not have active NPP, and is not expected to have possible local events of emergency such as in nuclear countries. This case study is dedicated to possible radiological / nuclear events from local or international level, where the help of hospitals might be requested in view of their intrinsic ability to face aspects of health care, health emergency and also radiation risk. In this sense and in relation to the Fukushima accident, we have to note that a number of 23 hospital centres in ten Italian regions were officially engaged. Professionals from the hospitals were engaged in dosimetric evaluation of members of the public, in communicating dose to the interested people, and they committed also themselves to give information on the meaning of the levels of the dose found; which may represent

situations that are very different from those typical of medical exposure. For the professionals, this need to react in practice on the technical and communication aspects, have enhanced RPC:

- on how to approach people coming to hospital for a measurement and evaluation of exposure, and how to proceed with an adequate level on communication,
- on dedication to more awareness and ethical values in the judgement,

The attention in learning from events, incidents and near misses, as an important part of culture development, was already present before Fukushima. For example, the attention of the Careggi hospital in Tuscany and of the Niguarda hospital in Lombardy to cases of emergency situations with cooperation with CBRN were already well oriented in 2005, even if not specifically addresses to nuclear emergency, but more on radiological emergencies.

It was recognised, already from 2005, the importance to maintain the active role of the radiation protection culture to set up the general organizational structure procedures, workflow and communication of the final results and their significance. The 2005 Regional Decree reporting the Guideline for the management, in hospital departments, of person's exposure and/or contaminated in the event of radiological emergency, considers also the case of terroristic actions using radioactive materials[12].

The regional hospitals deemed able of handling irradiated victims irradiated and/or contaminated are those endowed with a department of emergency and acceptance, Health Physics Operating Unit, and protected hospitalization for patients with radioactivity in the area of radiometabolic therapy and / or interstitial brachytherapy. The most involved professional figures are: the General Managers and the Health Directors, the competent doctors and the managers of the Prevention and Protection Services. Moreover, important role is given to the professional with a high level of radiation protection culture, as the specialist in radiotherapy, nuclear medicine and health physics. Specific attention is given to a necessary basic preparation for the personnel of emergency department, who do not have their own specific curricula in radiation protection, in order to be able to correctly manage priorities in the triage of irradiated people, with their support. The need for written procedures is indicated in order to guarantee training, create and increase the radiation protection culture in all personnel involved in the management of this type of emergency, and, moreover, exercises are indicated with annual frequency.

The hospital response also depends on the presence of suitable facilities and resources and adequate operating procedures. With regard to the structural aspects, it seems not considered justified that ad hoc structures are set up, but rather that existing structures having some indispensable requisites and adapting them, where necessary and possible with limited-scale interventions, are exploited and optimized for their use, in order to be used also in cases of radiological emergency, at the level that can be hypothesized. In any case resources have to be considered for training in relation to radiation protection in emergency response, including also the aspects of exchanging information among the professionals and communication activities.

In the organisation of emergency response in case of nuclear/radiological accident or terrorist attack, attention is given to the management of the individual potentially contaminated. A significant work, published in 2008[13], was based on the collaboration of the hospital of Alessandria in the Piedmont Italian Region, the Agency for the Environmental Protection and Prevention of Piedmont (ARPA), with the Military Geographic Institute of the Italian Army General Staff, the Radiobiology laboratory of the

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12 http://www.google.it/url?sa=t&rct=j&q=&esrc=s&source=web&cd=1&ved=2ahUKEwiQj9LTh_PfAhXRyqQKHXw0CI4QFjAAegQIBhAB&url=http%3A%2F%2Fnormativasan.servizirl.it%2Fport%2FGetNormativaFile%3FfileName%3D615_DDG2005_11514.pdf&usg=AOvVaw3GwjxD-dPGaZ3saqtcQds

13 http://www.ecj.it/ Emergency Care Journal, Vol 4, N. 1, pp. 30-37, 2008

Clinical Department of the University in Florence and the Direction of the Master in CBRN of the same University. In the intra-hospital phase, it is advisable to set up an assistance path that takes into account the multidisciplinary professional resources and the technological and structural resources capable of affecting the complexity of the problem. In this study the bases of the training course for health personnel and aspects are described. The training for health care professional in emergency, includes the part of nuclear/radiation emergency by introducing the main related knowledge and protection actions and legislation aspects. The idea is to give to the professionals, at different level of involvement, the tools to act towards a radiation protection of quality and to improve the effectiveness on how to deal in facing radiation emergency in practice, where relevant.

The planning phase in the hospital includes to finalize the drafting of the PEIMAF -Internal Emergency Plan for Massif Influx of Injuries- and the PEIVAC -Internal Emergency Plan for Evacuation of the hospital- as well introduced in regional and local documents, (e.g. 2008, Technical Management in Macro Emergency[14].

The drafting of all these plans involves the staff of each qualification and each operating unit and, being dynamic plans, linked to the continuous reorganizations involving a hospital or the territory, will be subject to periodic reviews and updates.

As already introduced in the first part dedicate to 'Characterization of case study' the Fukushima event enhanced the evidence of the importance for preparedness, increased the attention of the community for crises events and the radiation protection community towards the response of the hospital structures and consequently to the dissemination of radiation protection culture.

The aspects of response to the event, together with the real life faced by the hospital staff in internal communication and harmonization of their views, were presented at the national conference of AIFM, the Italian Medical Physics Association, already at the 7th National Congress on September 2011. The presentation was followed by comprehensive discussion by the participants as most of them were involved in the aspects on how to proceed effectively in facing the situation of Fukushima emergency.

As already mentioned, after the Italian newspaper 'La Repubblica' reported on March 2011, the results of the urine analysis indicating the presence of I-131, in the article 'The contaminants are 44. - Renzi: "No Alarmism". Slight traces have been found of exposure to radioactivity.' - La Repubblica 20.03.2011, an alarmism in the public started. At the same time questions emerged, like:

- Is it correct to scare some tourists or workers (such as Maggio Musicale Fiorentino) who were in Japan and at the same time discuss less of the dead and missing Japanese persons in the Fukushima event?
- Do we have to be contaminated to justify our fear?

An answer was that minimizing is as absurd as dramatizing, but in the communication to the public clear issues emerged in those days on the level of radiation doses and their significance

These points were then evidenced at national level in the 2013 Congress of the Italian Society of Medical Physics[15] and an open discussion started, with more calm with respect to that introduced in 2011, on the role of medical physicists, together with technicians and other components of the hospital staff, in facing nuclear and radiological emergency, taking in mind the advantage of radiation protection culture and the possible results in an holistic vies together with other involved professional (not directly related to the medical care).

14 https://www.118er.it/gecav/upload/attivita/Gestione_maxiemergenze1.pdf

15 http://aifm2013.to.infn.it/topic/7fisicamedica.pdf

In the presentation by Dr. Gori, the responsible of Medical Physics at the Careggi Hospital '*An effective health response is an essential component in the global management of nuclear and nuclear and radiological emergencies and to be validly implemented requires careful planning and organization, which takes into account all the possible consequences in the various hypothetical accident scenarios*.' Indeed, in general, the effective health response poses challenging challenges for the institutions due to the inherent complexity of situations, which require highly specialized skills as well as very specific organizational tools and structures (*IAEA, Generic procedures for medical response during a nuclear or radiological emergency, EPR-MEDICAL, 2005*). In the debates later after Fukushima, and also underway in 2013 at international level (*ICMP, Nuclear Emergencies Workshop, Medical Physics International Journal, vol.1, No.2, 2013*) it started to be clear the value the physicists can bring in the nuclear/radiological emergency management in term of evaluation of contamination and correct and impartial communication of risk to the community.

A number of local and national events were organized to disseminate this view and encompassing a basis of science with ethical and social values. In 2013 an event with main object the role hospital in CBRN emergency towards a Regional guideline (December 2013 - The hospital in CBRN emergencies. Towards a regional guideline[16].

Health Care Structures, mainly those of a university nature, in the organization of training courses in radioprotection, normally insert a specific attention to nuclear emergencies, together with parts such as radiation protection in nuclear medicine and the attention to the environment, as for example the Radiological Protection course at the Federico II University Hospital, 2015 organised by the Italian Association of Medical Radioprotection[17].

The attention in the management of emergency, including nuclear/radiological emergency with the involvement of health care structures is present also in the successive years. In 2016 the Annual Congress of the Italian Association of Radiation Protection was dedicated to 'Scenarios in radiological emergencies and accidents' with a part dedicated to the experience of the health care structures in radiological emergency[18].

The first presentation gave a view of the evolution, and state of art, of national network in surveillance of environmental radioactivity at 5 years from Fukushima accident. A specific presentation was given on the basis of the experiences of the Niguarda Ca' Granda Hospital in Milan, one of the hospital identified as reference in the management of radiological emerge Figure 6. On-line seminar on radiation protection in Belarus

ency. The procedures adopted by the hospital in case of management of a nuclear emergency event are described, considering both large-scale events and specific events related to a series of persons who presented themselves directly to the hospital.

The attention to the important role of Health Care Institutions in emergency response continues, as for example with the Course organised, on December 2018, by the Hospital Structure of Salerno together with the Local Agency of Health, the Italian Association of Medical Physics, the National

16 https://www.ilgiornaledellaprotezionecivile.it/istituzioni/emergenze-nbcr-la-toscana-lt-br-gt-si-dota-di-un-piano-operativo

17 http://www.ecm.unina.it/programmi%202015/Corso%20in%20RADIOPROTEZIONE%20(la%20nuova%20prevenzione%20radiologica%20e%20tutela%20della%20salute).pdf

18 http://www.airp-asso.it/?convegni=emergenze-e-incidenti-radiologici-scenari-ambientali-sanitari-e-industriali

Association of Qualified Experts, the Italian Association of Radiation Protection, with the partecipation also of ENEA[19].

This Course is addressed to professionals and technicians involved in the management of radiological/nuclear emergencies and to all those who have an interest in these topics, and it is aimed to deal with the adequate information of operators, that is one of the needed tools for reducing the damage potentially deriving from similar events. Attention has been dedicated to the aspects of evaluation of dose for external and internal exposures and transparency and efficacy in the communication during radiological/nuclear emergencies.

Professional and technicians related to health care centers are indicated in the accreditation for this course, for example, Physicians in Nuclear Medicine, Radiology, Neuroradiology, Emergency Medicine, Internal Medicine, Occupational Medicine, Radiotherapy and other professionals as Medical Physicist, Head of Prevention and Protection Service, Medical Radiology Technician, Professional Nurse.

Evaluation of the level of RP culture

Within the case study here discussed with attention on the role of hospitals in case of emergency, the main stakeholders are:

- the members of the public (as told before they refer to the hospital for any problem and moreover we do not have institution, known by the public, available for such measurement on the persons);
- workers in particular the hospital staff taking care of possible contaminated people, consider for example the list of professionals indicated in the reported course on December 2018;
- who take decision on the role of the hospitals (and on which hospital is ready for this action) in the specific emergency;
- the experts of national institutions with expertise in the field (e.g. professionals from Health Physics Laboratories of National agencies, like ENEA, working in RP);
- the official communication and indications by Ministry Offices, in the information to the public given by diffusion of indication by Ministry
- more in general the journalist (as result of interview of RP experts and of members of the public and workers), i.e. the head of the Medical Physics of the Careggi Hospital had a number of interviews by the journalist, to have info on the results of the analysis and a view about the contaminated cases), also discussion on the risk more in general and not on single cases.

Regarding the capability of target stakeholders to interact with RP professionals, we can consider that in this case study the target stakeholders can interact with the main professionals (Consider for example the members of the public who go to the hospital if they worry about a possible contamination; they are taken into consideration, after a sort of interview related to their fear, before the triage. Consider also the large exchange of info and on the procedure among the different professionals)

Regarding the capability to be involved in RP decision making processes or to implement RP actions, we can consider that the attention, in the present case study, is given to the hospital structures and to a strict cooperation with CBRN, where relevant. Moreover, the health care structures are in direct contact with local or regional institutions, since it is recognised very important the planning of

[19] https://www.fisicamedica.it/sites/default/files/corsi_presentazioni/brochure.pdf

response to emergency also at local level. Document on the approach for response planning is related to the region since local specificities have to be taken into account for the evaluation of the scenarios.

Highlighting the role of RP culture

The attention to the RPC through the dissemination of essential points of interest regarding emergency situations has led to the involvement of a large number of professional figures of health environment, including among them some professionals initially not directly related to the RP, and mostly has led to a general greater awareness on this theme of radiological emergencies.

We can notice that, over time and more often, events, congresses and courses that refer to the use of radiation in medicine tend to include also presentations and references to the role of hospitals in nuclear emergencies, and similarly at the same time, events, congresses and courses that refer to nuclear emergency and terrorist attacks, always introduce more attention to the role of the Health Care Institutions for their contribution in the response.

RPC, through the awareness of the main point of protection, contributes for a more comprehensive communication among workers in the hospitals and for more an adequate application of the procedure foreseen in case of emergency. It also can contribute for an improvement in the communication with the members of the public, patients, and other professionals of the same or other structures.

Another point with attention to communication is that RPC can contribute in helping the information and communication with journalists, thus to improve the transmission and articulation of the data evaluated and their meaning in the view of radiological protection.

In general, a dialogue started among the parties and it was evident the role of RPC in any aspects of communication and dialogue. In the frame of different views of the parties, even opposite points of view about what they consider the best for the people involved, RPC would give a support for a common basis of discussion.

Lessons and recommendations

To be able to activate the values that medical physicists of the hospitals may represent in the management of nuclear/radiological emergency situations, and to allow that this chance become a concrete resource, it is necessary that the competences, proper of the medical physicists operating in the hospitals, are translated into easy-to-use procedures and specific training programs to be prepared.

For example, the study aimed at defining an internal operating protocol for use in emergency conditions of the radiometric instrumentation, which are normally present in the hospital, for the purpose of quantify the levels of external and internal contamination of victims as quickly and appropriately, was finalised at the Careggi Hospital and other of the hospital centers indicated through the cooperation between the regional administration and the Ministry of Health.

RPC is a basis for any attention/involvement in emergency, and the need to better introduce RPC and continue to maintain it active and present is clear.

Embedding RP at a cultural level helps to be more effectively in delivering the best performance. RP is already present in hospitals, as we know, before any nuclear accident, but this case study evidenced the importance of RPC for hospitals, that encompassing not only the RPC in medicine, but that could face the situations of radiological and nuclear emergency.

A correct response of the hospital structures implies to have the availability of some minimum structural requirements, such as the definition of an appropriate area for triage in order to guarantee the containment of any contamination, and the availability of an area for monitoring those who

present themselves spontaneously. Moreover, the availability of specific material and instrumentation, such as decontamination material, specific pharmaceuticals, whole body counter, is needed together with the availability of rotating staff, the definition of specific procedures, and the organisation of specific training activities for the personnel of D.E.A., Department of Emergency and Acceptance.

When considering an emergency involving a large number of people on the territory, specific procedures should be foreseen for in the PEMAF (Plan for massive influx of injured persons); specific therapeutic procedures and protocols have to be set up in order to treat victims, by considering the most common hypothetical scenarios.

These procedures and protocols must be adequately trained. The training should be continuous and specific depending on the roles in the response. The training path considers different level: - fundamental information on the management of radiological emergencies; - fundamental information on how to defend against ionizing radiation; - training on radiological emergency management procedures; - exercises.

3.3 Slovak Republic – Actions undertaken to improve and strengthen the emergency and post-accident preparedness and recovery management at all levels: national, regional and local

In Slovak Republic, within the framework of the international and national projects enhancing emergency and post-accident preparedness, response and recovery management in Slovakia, specific actions are undertaken to develop and apply methods and models of stakeholder engagement and participation to allow and support dialogue and to foster the dissemination of a practical radiation protection culture within the civil society and to elaborate the necessary tools. The RP culture building process will be studied particularly through the analysis of some actions: workshop with stakeholder panel on decision analysis of clean-up action in inhabited areas, training courses on decision making in emergency management, seminars and workshops to elaborate handbooks to assist in the management of the recovery phase, technical visits to Belarus, national and international (INEX) exercises.

Characterisation of case study including type of actions, processes

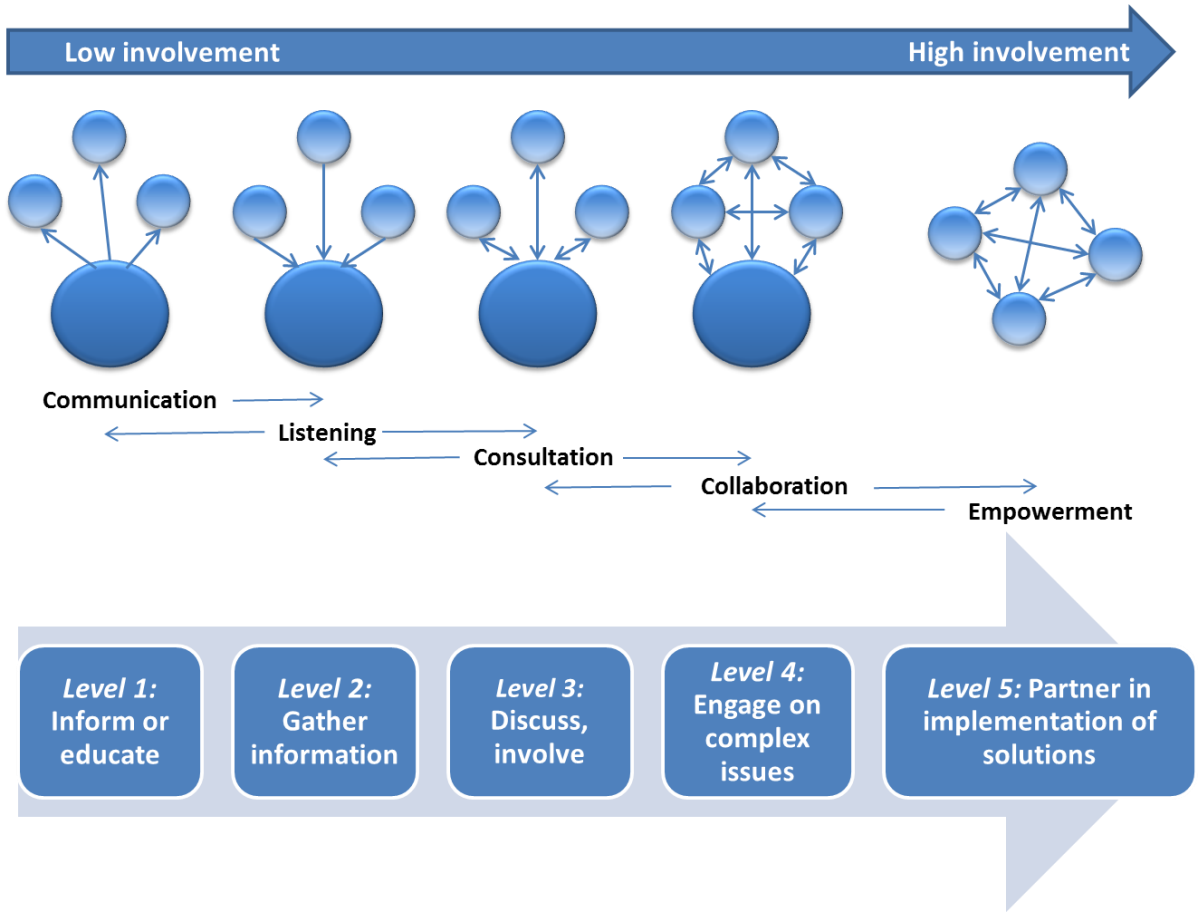
The complexity of the emergency preparedness and post-accident management has been recognized and was analysed deeply in the Slovak Republic what influenced also the process of the radiation protection culture development and improvement.

Context of the Slovak Republic process:

- The main goal:
  - to improve and strengthen the emergency and post-accident preparedness and recovery management at all levels: national, regional and local
- The main interest and motivation:
  - to share experience about different initiatives on emergency and rehabilitation preparedness and management throughout Europe
- How to fulfil:
  - to develop and apply methods and models of stakeholder engagement and participation to allow and support dialogue.

Relations among different stakeholders, their roles and tasks within the emergency response and post-accident preparedness process has been recognized and studied deeply with focus on the radiation protection culture development.

It could be illustrated by the following picture:



EVATECH	EURANOS	NERIS-TP, INEX 4	PREPARE, INEX 5, CONCERT, CONFIDENCE, ENGAGE
Emergency plans	Recovery Handbooks development	Case studies	Exercises
RP strategies – post accident	Case studies - RP focus	Exercises	Emergency plans - review
RODOS DSS Web-HIPRE	Demonstration projects	Belarus - exchange visit	Facilitated workshops, Training
Facilitated workshop, training	RODOS DSS scenario use	Facilitated workshops Training	Education
	Seminars, facilitated workshops	Education	
	Training		
	RP culture building		

Figure 1: Process of interaction with target stakeholders[20]

The process has been started with EVATECH project with objective to improve the decision support methods, models and processes in ways that take into account the expectations and needs of different

[20] Adapted based on The Health Canada Policy Toolkit for Public Involvement in Decision Making, 2000, https://www.canada.ca/content/dam/hc-sc/migration/hc-sc/ahc-asc/alt_formats/pacrb-dgapcr/pdf/public-consult/2000decision-eng.pdf

stakeholders participating in decision making to protect members of the public and workers in a nuclear emergency situation. The emergency plans has been deeply studied and compared among four European countries (Germany, Belgium, United Kingdom and Slovakia). The process modelling made the identification of the target group of stakeholders easier. As a result the core of target group of stakeholders was identified as well. The first facilitated workshop related to the complex issues of radiation protection strategies focused on decision analysis of clean-up actions in inhabited areas took place in November 2003 when different strategies has been discussed and compared using the RODOS decision support tool (DSS) and multi-criterial decision analyses (MCDA) tool Web-HIPRE. Follow-up training course on decision making in emergency management brought not only new knowledge and understanding of radiation effects but also provide possibility to build up additional skills and capabilities for participants to interact with radiation protection professionals and capability to share common knowledge.

Participation in the EURANOS project offered complex solution in the development of the Recovery Handbooks, their customisation, demonstration and training in their use for the radiation protection issues in the area of the management of contaminated inhabited areas, food production systems and drinking water supplies. Wide range of stakeholders has been involved in different activities within EURANOS Recovery Handbooks development including non-institutional experts and local stakeholders. Gathering information, listening to the needs of different stakeholders within the open discussions contributed to the radiation protection culture further development and improvement. Willingness to be involved in radiation protection decision making process or to implement radiation protection actions was recognized and expressed by stakeholders involved in process.

The continuation of the radiation protection culture development came to other phase of development within the NERIS-TP project and establishment of the NERIS Platform on preparedness for nuclear and radiological emergency response and recovery in 2011. The active involvement, engagement in complex issues and active participation in different activities contributed to the collaboration of wide range of stakeholders and followed by preparation and conducting of the first national exercise based on the INEX 4 scenario in 2010-2011, just before the Fukushima accident. Radiation protection culture came into play strongly and radiation protection of first responders has been improved significantly as a consequence of the INEX 4 exercise and lessons learned.

The last phase of studied process is related to post Fukushima period when NERIS-TP project provided possibility for local stakeholders wider involvement, realisation of exchange visits with Belarussian experts and stakeholders living and working in the area deeply affected by the Chernobyl accident and conducting of wide range of training courses and exercises - national and international (INEX 5). These activities contributed to build-up capability of target stakeholders to interact with radiation protection professionals or other actors. The follow-up process of the review of National emergency preparedness and response plan has shown the level and quality of the radiation protection culture build-up in last 15 years in Slovakia, the role of RP culture and lessons learned. The radiation protection culture came into play for the purpose of making the plans and their implementation efficient, based on building of trust.

Target stakeholders participated in the Slovak Republic process are following:

- The Nuclear Regulatory Authority of SR
- The Public Health Authority of SR
- Crisis Management and State Safety Office, SR Government Office
- The Ministries and national administrations concerned by post-accident issues (civil protection and security, agriculture, health, etc.)
- Public and private expert institutes and Universities in the field of nuclear safety and radiation protection (VUJE Inc., SZU in Bratislava, Academy of the Police Force)
- Regional Civil Protection and Crisis Management Offices

- Mayors of villages and representatives of Municipality Crisis Staff – members of GMF – Group of European Municipalities with Nuclear Facilities and national Association of Municipalities and local/regional Civic Information Commissions (Dolny Lopašov, Madunice, Kalna ad Hronom and other)
- Representatives of population
- Regional Public Health Authorities
- Regional Veterinary and Food Administration
- Slovak Head Office of Radiation Monitoring Network (SURMS)
- Slovak Hydrometeorological Institute (SHMU)
- Slovak Army, RCHBO
- Slovak NPPs, Emergency planning and preparedness units and Headquarters
- Police,
- Fire and Rescue brigade.

The first actions were originally initiated by VUJE, technical support organisation of the Nuclear Regulatory Authority within the EVATECH project with support and active participation of the Nuclear Regulatory Authority of the Slovak Republic (NRA SR) as a subcontractor within that project.

The whole process was initiated by the active participation of stakeholders in the project activities and was funded by the NRA SR. There was no one and unique leading organization or authority that time. The Slovak emergency management model had a Local level that coordinates and implements the countermeasure decisions made at the National level, providing feedback to the National level. On the Local level there were the Civil Protection Crisis Staff of the County, the District and the Municipality (CSC, CSD and CSM). On the National level there was the Central Crisis Staff of the Slovak Republic (CCS) and the National Emergency Commission for Radiation Accidents (NECRA) working together. NECRA included a group called the technical operations management group (ORS) who were sent to a support centre, the Emergency Response Centre (ERC) of the Nuclear Regulator (NRA SR). In the Slovak process model there was also a level referred to as 'Technical support and advice'. The technical support and advice was provided by the ERC of NRA SR, the Slovak Radiation Monitoring Network (SORAMON) and Information Services.

After the experiences from EVATECH project NRA SR took the leadership in the national activities and created conditions in a form of the complex national projects supporting the international one under the EC FP5, FP6, FP7 and Horizon 2020 with VUJE in a position of project manager and main coordinator and implementer of different project's tasks. The established network of stakeholders mentioned above contributed significantly to the initiating and implementation of follow-up actions related to the radiation protection culture dissemination.

There was evolution of the actions as new projects brought new dimensions and process could go dipper in details. The success of the actions was the main motivating factor for the wider range of stakeholders and willingness to actively participate was evolving with time. Nowadays the emergency and post-accident recovery management processes are improving and some are changing conceptually what influence also the preparedness process to potential radiological events.

More details on particular actions could be found in the reports and articles in the references given to the Slovak Republic case study.

Characterization of RP culture (elements / definition)

Radiation protection culture is essential in the process of the improvement and strengthening the emergency and post-accident preparedness and recovery management at all levels: national, regional and local. It is important to understand the complexity of situation, why to set up protection actions

and give information to stakeholders at different levels, to develop radiation protection strategy and ensure its implementation after the nuclear accident.

The main elements contributing to a RP Culture for stakeholders that would be involved in the management of post-accident situations include the following topics:

- Understanding environmental contamination
    - External dose rate and maps of the environment (inside and outside buildings, recreational areas, working areas…)
    - Soil contamination
    - Food contamination
- How to assess individual exposure in contaminated areas
    - Use of individual devices
    - Analysis of daily activities and impacts on individual dose
- Protective actions that can be implemented: collective and self-help
    - Ability to evaluate / understand the efficiency of collective decisions on protective actions
        - Food restrictions
        - Evolution of agricultural production
        - Limitation of access to different areas
        - Decontamination strategies
    - Ability to evaluate different strategies and make decisions taking into account different factors influencing the process of decision making
    - Ability to implement self-help actions
        - Selection of food products
        - Selection of activities depending on the environmental contamination
        - Follow-up of individual exposures
        - Implementation of decontamination actions
- Addressing health effects
    - Concern on thyroid cancers
    - Concern on long term effects
    - Concern on general health status
- Addressing well-being of population.

The models for stakeholder engagement, participation and dissemination of radiation protection culture have been following:

- testing, customization and use of models and tools;
- case studies using scenarios developed;
- building network and trust between partners within the Slovak Republic and within Europe through EC projects;
- facilitated workshops, exercises, seminars, training courses;
- establishing the Slovak panel and EURANOS Handbooks Users Group;
- participation in the network involved in development of the EURANOS Handbooks for assisting in the management of contaminated inhabited areas, food production systems and drinking water.

The individual knowledge is shared with the 'community' around the individual via:

- education seminars,
- facilitated workshops and table-top exercises,
- topical workshops,

- training courses,
- development of scenarios (INEX 4 and INEX 5 exercises, facilitated workshops),
- inclusion in national and international exercises (NPP emergency response organisation + municipalities, INEX 4 Exercise on consequence management and the transition to recovery, INEX 5 Exercise on Notification, Communication and Interfaces Related to Catastrophic Events Involving Radiation or Radiological Materials),
- inclusion of mayors and municipality members in the activities of the GMF - Group of European Municipalities with Nuclear Facilities.

The knowledge shared is:

- actions to manage radiation risk situations,
- emergency situation actions,
- radiation effects,
- Environmental contamination
    - External dose rate and maps of the environment (inside and outside buildings, recreational areas, working areas…)
    - Soil contamination
    - Food contamination
- Management of contaminated inhabited areas,
- Management of contaminated food production systems
- Management of drinking water supply,
- Withdrawal of emergency countermeasures,
- Rehabilitation of living conditions in the contaminated areas
- Organisation of public authorities
- Stakeholder involvement
- Communication
- Post-accident policy
- Evaluation tools and methods for supporting the management team.

It is possible to make the distinction between scientific/theoretical, practical and behavioural knowledge. Scientific knowledge has been presented at the training courses, seminars and workshops. At follow-up facilitated workshops and exercises based on exercise scenario more practical aspects and practical knowledge have been studied and shared. Both theoretical and practical knowledge are presented during the excursions to the edutainment centre ENERGOLAND and follow-up visit to the site of the operating nuclear power plant Mochovce. Behavioural knowledge was visible and has been noticed within the facilitated workshops, technical exchange visits to Belarus and during the national and international exercises.

The role of historical-societal culture and differences in individual behaviour (prudency, consciousness, impulsivity, etc.) linked to radiation protection and radiation hygiene could be seen from the different phase such as: before Chernobyl, after Chernobyl, before changes in political regime ("velvet revolution") in Slovakia, after "velvet" revolution - democracy processes influence, Fukushima accident influence.

Development of tools, methods & processes to build, enhance and transmit RP culture

The information and elements of RP culture have been elaborated within the above mentioned international projects (EVATECH, EURANOS, NERIS-TP, PREPARE) and national projects supported by NRA SR „Nuclear Safety – Research&Development decision support at performance of supervision beyond nuclear safety", (I. and II. Level), WP 01 - „Enhancement of the emergency preparedness quality and its harmonisation in a case of accident on nuclear installation in the Slovak Republic and

utilization of the tools for prognosis of accident evolution on nuclear installation outside of SR territory, too“ (2003-2011). They have been disseminated to the target stakeholders via: education seminars, facilitated workshops and table-top exercises, topical workshops, training courses (training trainers) and follow-up lectures at Academy of the Police Force in Bratislava (first responders), inclusion in national and international exercises, development of scenarios, exchange visits – Slovak Republic-Belarus and Fukushima Mission 2013 on the FAIRDO and ISAP 2013 mission in 2015.

The information was related to the following areas with focus on radiation protection as a key issue:

- Management of contaminated inhabited areas,
- Management of contaminated food production systems
- Management of drinking water supply,
- Withdrawal of emergency countermeasures,
- Rehabilitation of living conditions in the contaminated areas,
- Organisation of public authorities,
- Stakeholder involvement,
- Communication,
- Post-accident policy,
- Evaluation tools and methods for supporting the management team.

Representatives of wide range of stakeholders mentioned above have been participating in the process of information development and dissemination via different activities mentioned above. Their needs and concerns have been identified via the dialogue during the different activities and were based on the results of facilitated workshops based on scenario developed and the results and lessons learned of the practical exercises.

The method for stakeholder involvement in exercises and emergency planning was developed and successfully applied in the Slovak Republic within the EVATECH project (Information Requirements and Countermeasure Evaluation Techniques in Nuclear Emergency Management, 2001 – 2005). The essential goal was to start the process, develop and implement methodologies to conduct scenario-focused decision making workshops with participation of relevant stakeholders and training on using available computer-aided techniques (RODOS, Web-HIPRE) in decision analysis and conducting facilitated decision-making panels/workshops.

First facilitated workshop: “Decision analysis of clean-up actions in inhabited areas in the Slovak Republic after an accidental release of radionuclides” took place in November 19-20, 2003 with 25 participants. Two facilitators (one from VUJE - research organisation and one from the Nuclear Regulatory Authority) among other participants were introduced to decision analysis and facilitated workshop skills, and were trained to conduct this kind of workshops, where representatives from different organisations and different stakeholder groups gather around the same table to find the most practicable solutions to a problem, in this case countermeasures in an inhabited area following an nuclear emergency situation.

The management of uncertainties was addressed using the Web-HIPRE (HIerarchical PREference analysis in the World Wide Web) software for structuring decision analytic problems using multi-criteria evaluation and prioritisation with integrated module allowing the import of ESY-files (“RODOS output files”), which contain a selection of appropriate alternatives and attributes and tools for sensitivity analyses. Many of participants appreciated the future possibility to use the Web-HIPRE software as a tool integrated or connected directly to the RODOS system.

Democratic and open attitude to participants and their contributions was new element for many of them. Open and successful cooperation caused and resulted in the process when each participant gladly cooperated on further work and meetings. This workshop defined further direction of stakeholder works. Many of participants expressed the need of similar workshops for training purpose

with invitation of other specialists from different resorts and focus not only on advisors but also on leaders who are the members of the emergency commissions at different levels and on residents who will (it is expected) execute some of the countermeasures.

All participants agreed that the countermeasures in inhabited areas have to be discussed again in more details and thoroughly during some special workshop.

Follow-up training courses supported the development and dissemination of the radiation protection culture in wider community of stakeholders. Two training courses has been coordinated by NRA SR and conducted by VUJE:

- Training Course Decision Making in Emergency Management within the Project Strengthening of the Nuclear Emergency Preparedness – Sharing of New International Experience (NSP/03-S2), February 14-16, 2005, NEA SR Bratislava, 21 participants, 8 lecturers
- Training course: „Evaluation tools and methods for supporting the emergency management team“ developed and conducted by VUJE under the EURANOS Project (7FP) and national R&D project in VUJE facility Modra-Harmonia, 25.-27.5.2009, 19 participants, 2 lecturers.

Content of the training courses was focusing on:

- major issues, which require decision making for mitigation of consequences in case of nuclear accident,
- assessment if affected area is liveable,
- radiation doses (workers and public),
- emergency situation, intervention criteria and application of intervention levels and countermeasures.

The courses prepared wider community of stakeholders in Slovakia for work in stakeholder panels in the field of emergency preparedness. The content of the training course covered the major issues, which require decision making for mitigation of consequences in case of severe nuclear accidents, including assessment of habitability of areas affected by nuclear accident, controlling radiation doses to workers and the public, intervention situation, intervention criteria and application of intervention levels and countermeasures.

Stakeholders agreed on evolving decision-framing process within and between stakeholders that is inclusive and participatory, with open and two-way discussions, leading to relationships where issues can be identified, discussed and resolved, resulting in sustainable decisions. This was main motivation and goal of common activities.

It was essential for that period that representatives from municipalities and local community (Civil protection crisis staff of county, district and municipalities and mayor of the village Dolny Lopasov) have participated. Their personal experience and knowledge were disseminated then widely through their active involvement in the National Association of Municipalities and local/regional Civic Information Commissions.

The EURANOS training course mentioned above was developed in such a way that target stakeholders appropriate the information given in such a way that it influenced their practices, understanding and behaviour regarding radiation protection.

EURANOS project and wide stakeholders involvement in different activities was key in the process of radiation protection culture development. Stakeholders have been directly involved in the development of the Generic Handbooks for Assisting in the Management of Contaminated Inhabited Areas, Food Production Systems and Drinking Water and Recovery Phase.

The stakeholder panel was set up and convened in Slovakia to determine the suitability of such a handbook with regard to its scope, format and content and further their customisation to the Slovak

Republic conditions. The findings from the second round of stakeholder panels when they were reconvene to provide feedback on the overall applicability of the handbook including the annexes for customising handbook for different regions of EU were taken into account during finalizing of the first versions of the handbooks.

The seminars and scenario-based facilitated workshops within the Handbooks development and demonstrating process took place in the time period May 2005-May 2011. All together 10 seminars and workshops have been developed and conducted attended in average by 16 representatives of different groups of stakeholders in each. All Handbooks have been adapted to Slovak conditions and were made available for free to all institutions participated in the project from Slovakia. The conclusion of participating stakeholders was that handbooks should be given the status of official national documents as a basis for their use by wider community of specialists and organizations related to emergency preparedness. The relation should be established so, that the use of handbooks will go up to the local authorities and self-government in suitable and appropriate form. NRA SR provided them officially to Ministry of Interior and County offices for direct use and to all other institutions involved in the emergency preparedness and recovery management who expressed an interest. Unfortunately these documents did not reach the official status at the level of legislation in the form of official guidance even it was required by stakeholders.

Within that work presentation of rehabilitation project results in Belarus after Chernobyl accident (ETHOS project) have been studied, analysed and discussed within the stakeholders' activities.

All this experience were used in preparation and conducting of lectures by NRA SR representatives at the Academy of Police Force in Bratislava preparing first responders together with other risks to be managed, acknowledging that radiation protection is not the only concern in a specific situation or for the target stakeholders.

Among other activities there were following activities conducted by NRA SR related to presentation of Handbooks to:

- the Mayors during the periodical training – Trnava District , Malacky District, presented by the NRA SR, supervision of the Ministry of Interior
- the lecturers of the Educational and Technical Institution of the Ministry of Interior in Nitra and Spisska Nova Ves.

To support development of high level initiative on emergency preparedness and rehabilitation and radiation protection culture it was agreed to inform about results of stakeholders panels more intensively also at the governmental level, what should have an effect on future development and effectiveness of the process. The information should be not only published via media and publications in journals and conferences, but should be prepared as information for the government council and referred by the Nuclear Regulatory Authority Chairman.

Slovak stakeholder panel has shown that they are able to work together, to communicate problems, to absorb new comers to the working groups.

Working in the form of facilitated workshops with scenario developed using customized operational tools (RODOS, RTARC, Web-HIPRE) makes work more efficient, focus on possible real problem and finding real solutions.

There is a common understanding in necessity of continuation of joint meetings of stakeholders and willingness to have organized annually workshops for sharing experiences, identifying gaps and improving preparedness.

The need in training and exercising the recovery and rehabilitation issues at national, regional and local level was expressed within the stakeholder panel.

INEX 4 Exercise was developed and conducted in January 26-27, 2011 at ÚJD SR with participation of 76 stakeholders from 36 organisations on the basis of specifications and details developed by WPNEM working group (OECD/NEA), focused on Consequence Management and the Transition to Recovery in response to malicious acts involving the release of radioactive materials in an urban setting. The expertise and consultations during exercise preparation lead by VUJE took place, scenario was developed in co-operation with all crisis management representatives involved in the exercise, VUJE representative worked as facilitator within the discussions during the exercise. It was the first of such kind of exercise prepared, organized and conducted in the Slovak Republic. The exercise outputs encouraged dipper analysis of the situation in the Slovak Republic in the area of emergency planning and preparedness and subsequent Fukushima disaster and response to the situation accelerated the process of design and development of the Concept of the organisation and development of Civil Protection and Concept of organisation, operation and development of the Integrated Rescue System in the Slovak Republic.

This exercise has shown the efficiency of the process. It was expressed by stakeholder the clear message, that without all activities, development and improvement of radiation protection culture it will not happen. Lessons learned have been recognized and reported to the OECD/NEA WPNEM working group as well as at the governmental level of Slovak Republic.

Follow up Seminar "Recovery Management following a Radiological Incident" conducted in May 16-18, 2011 with 34 participants provided floor for deeper discussion of following topics:

- INEX 4 exercise conclusions, relevant issues: Nuclear Regulatory Authority of the Slovak Republic (UJD SR);
- Response to the Fukushima accident: UJD SR, Health Protection Agency, Ministry of Interior – Section of Crisis Management and Civil Protection;
- Monitoring system: relevant issues and conception related to INEX 4 outcomes and Fukushima accident;
- Emergency planning in Slovakia – analyses of the system in relation to the measures undertaken after the Fukushima accident;
- Assisting in the management of emergency and existing exposure situations – tools and international cooperation; and
- Generic Handbooks for Assisting in the Management of Contaminated Inhabited Areas, Drinking Water Supplies and in the Withdrawal of Emergency Countermeasures in Europe Following a Radiological Emergency and their implementation to the local, regional and national conditions of Slovakia – block of presentations with complex information.

The capability of experts to listen and understand the concerns of the stakeholders was significantly improved after the Technical visit of stakeholders group (11 experts) from Slovakia to Belarus within the WP3 activities in the framework of the NERIS-TP Project of the Euratom FP7 (GA 269718) which took place from June 1 to June 7, 2013.

The two topics were blended together during the visit:

1) Improvement of national-local cooperation in Slovakia and Belarus, and

2) Radiation control and dissemination of radiological culture as the roles of the centres for practical radiological culture implemented and coordinated by RIR.

The main goal was to share the experience on the process, methodology and tools used for the improvement of the practical radiological culture of population living at the long term contaminated area. This activity have been undertaken within the continued work of the local-national forums where national, regional and local actors from Slovakia and Belarus draw the most essential lessons learned in relation to post-accident management and rehabilitation with the main goal of improvement both national and local plans for preparedness and recovery.

The Slovak stakeholder group was formed by representatives from different professional organisations, authorities, experts, and the local government and population.

The exchange visit proved essential for the engagement of mayors from Madunice and Kalna nad Hronom Municipalities in Slovakia, which are members of the Group of European Municipalities with Nuclear Facilities (GMF). Beyond simply acquiring information, the visit has created a common understanding, relationships forged in the hardships of shared experience, commitments to new approaches and friendships as a foundation for future networking. I was suggested that initiatives to involve local stakeholders in post-accident management and emergency preparedness are most effective when they are part of global initiatives, and international programmes or projects, such as NERIS-TP.

The experience from Belarus has shown the way how to ensure the transmission of radiation protection culture over time what is the case in Belarus after the Chernobyl accident. Education at school and involvement of children, young generation engagement and collaboration with parents via building local practical radiological centres is the way.

Within the Slovak Republic process the radiation protection issues have been addressed in the context of:

- municipality, region and Slovakia as a whole country,
- favouring approaches to address practical issues rather than theoretical knowledge,
- difficulties to fit with the existing program but existence of multidisciplinary international projects,
- key role of exchange of experiences with stakeholders and professors from Belarus,
- sharing experience about different initiatives on emergency and rehabilitation preparedness and management throughout Europe.

The RP issues are addressed together with other risks or other elements of the situations during the emergency exercises.

The process gave the possibility to have access to more knowledge when it was necessary or asked by the stakeholders. Involvement in the international projects and NERIS Platform gave the opportunity for sharing the knowledge and experiences from other countries. Internally within the Slovak Republic exchange of practical knowledge, results, methodologies and active involvement in multidisciplinary projects provided this possibility.

National and international exercises provided the floor for thorough discussions and evaluation of the efficiency performed in the course of the process comparing the goals of the exercises with the results and discussion of lessons learned.

Evaluation of the level of RP culture

There is no particular evaluation process focusing on efficiency itself. There is no any formalized evaluation process with focus on radiation protection culture.

The exercises - national and international at all levels are the main instrument for the evaluation.

Underestimated evaluation of the INEX 4 exercise at national level has become visible just after the Fukushima nuclear accident which confirmed the INEX 4 exercise conclusions and recommendations. The practical improvement of situation and real actions at governmental level came several years later after INEX 5 exercise which was conducted in November 2015. Essential role finally was in the developed radiation protection culture at the level of advisors - national authorities, regional and local decision makers and their persistent effort and their tireless and relentless work.

Such kind of evaluation modified the process and some actions such as the involvement of wide range of stakeholders took place. The evaluation of exercises becomes the issue for the government and following and review of recommendations activated the process and made it not “sleeping”. The national exercises become to be more important in the process and process of establishing of working groups and commissions in different areas have been started.

The capability of target stakeholders to interact with radiation protection professionals improved with active participation in the range of different projects.

The capability to implement radiation protection actions to protect themselves or others increased after technical visit to Belarus to the area affected by Chernobyl and also after the Fukushima accident. The first responders such as police forces have been equipped with personal dosimeters after INEX4 exercise and follow-up in time Fukushima accident.

Willingness to be involved in radiation protection decision making process or to implement radiation protection actions grown-up in line with more information received during seminar and working in topical groups during facilitated workshops and training courses.

Sharing of common knowledge and common view become reality among the stakeholders. Requirement to have prepared and conducted annually workshops or seminars also practical exercises was expressed at each common activity and was the key recommendation to make the process sustainable.

Highlighting the role of RP culture

Radiation protection culture improved decision making process by elaborating the local and regional emergency plans taking into account new development and results of the international and national projects.

Stakeholder engagement process was growing with growing the radiation protection culture and vice-versa.

Radiation protection culture development made it possible to run national exercises and wide range of stakeholders’ involvement and so review of the national emergency and recovery management plans.’

The Handbooks even not been given an official status have been used for the local and regional emergency plans development and improvement.

The systematic and sustainable stakeholders’ education and involvement and radiation protection culture development at local and regional level has been promoted.

The importance of practical experimentation to understand the meaning of the radiation protection culture components has been stressed.

Lessons and recommendations

Need to have governmental priorities and support in the form of personal and financial resources availability at place.

Need to have radiation protection culture developed at the governmental level so bottom-up approach goes to be reality and is not disappeared just in front of the last level of decision makers.

Need to have a regulatory framework to support and justify the actions, to motivate some public as building professionals.

Need multidisciplinary in the message conception and radiation protection culture disseminated in wider range of community in general, not only close to the NPP or nuclear facility site.

Need of transmission by experts who are recognized by each public.

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3.4 Belarus case study (a & b) – Radiation protection knowledge and culture in a) Education (higher, primary and secondary schools) and in b) Public Information (mass media) – overview in Belarus after the Chernobyl accident

Characterization of case study, including type of actions and processes

The educational system and mass media are the main sources of information available to the general population for the development of radiation protection(RP) knowledge and culture. In this case study, we conducted a brief review of both sources, and how they evolved with time, in Belarus, the country most contaminated by fallout from the Chernobyl accident.

a) After the Chernobyl accident, it became obvious that there was an urgent need to incorporate information about radiation and RP within the **state educational system (**Kuchinskaya, 2014; *ISEI*, 2017; *ISEI-BSU* history, 2019). At the higher educational system level, RP education was included in the training of professionals who had to work on mitigation of the consequences of the accident as well as other workers involved in radiation issues in environment, health and industry.
Stakeholders involved: Professionals involved in educational programs and in training future professionals in fields requiring RP knowledge, who in turn can disseminate their knowledge and practical experience at their future workplaces and to general populations (Fig.1).
The introduction of changes and topics related to RP at the primary and secondary schools level were found to be important for the acquisition of RP knowledge and culture on early phase after the accident, especially when it concerns affected populations who can implement this knowledge in their daily life.

b) **Mass media** is one of the most powerful tools of dissemination of information to the general public. A content analysis of information provided by the mass media in Belarus after the Chernobyl accident reflects the role of different stakeholders groups involved in issues of RP knowledge and culture.
Stakeholders involved: Radiation Protection and Health professionals in radiation protection as well as the general public (bilateral process). It is noted that at the time of the accident, social media did not yet exist and hence mass media includes printed press, radio and television, media that could be influenced by historico-cultural (political) issues, through censuring and controlling of the information disseminated.

Characterization of RP culture (elements / definition)

Both approaches, (a – education and b – mass media) addressed core questions and knowledge related to radiation effects, risks, radiation hygiene and actions to manage emergency and radiation risk situations.

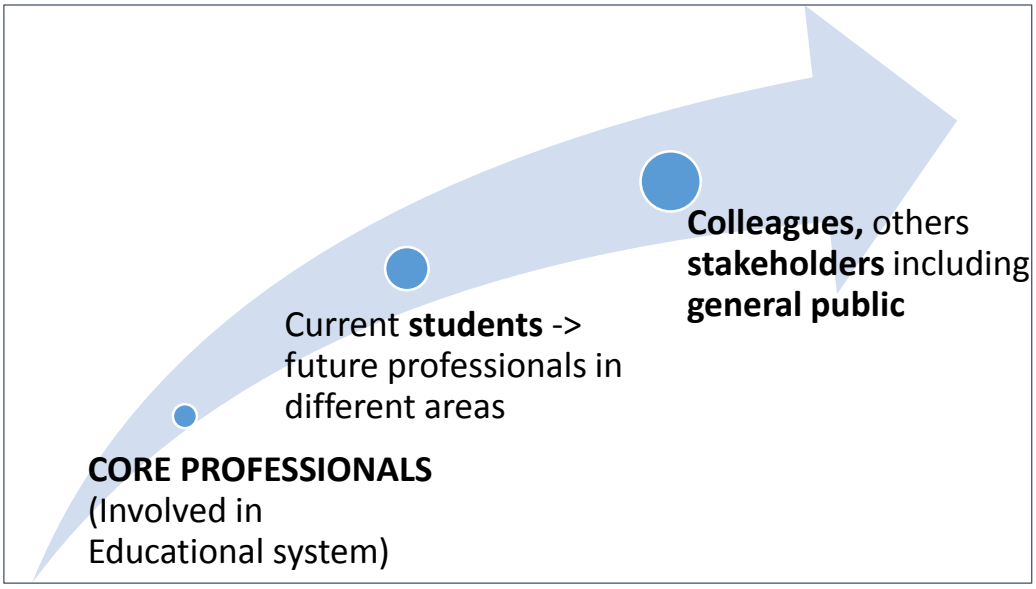

Figure 1. RP knowledge and culture dissemination process

In both cases (a & b) the stream or flow of dissemination was generally unilateral, from professionals to other stakeholders (students and general public). However, in some cases printed media (not major newspapers but popular journals) was used as a means to transmit questions from the general public to professionals for reply.

In Educational settings, the information provided was mainly scientific content, with the exception of practical sessions where theoretical knowledge on RP standards and radiation hygiene was applied, in particular for dose measurements and other field works (gathering biological samples from forests and camps).

In the mass media, the main newspapers published information concerning the accident and mitigation progress in brief and technical format, thus not providing to the readers information they might understand and need for the organisation of their daily lives. In some instances, "heroic stories" of clean-up workers or other individuals were also published to raise "the spirit" of the public. The publications in popular journals used a more of bottom-up approach, related to questions from, or doubts of the general public in relation mainly to radiation protection in day-to-day life activities.

Historico-societal (both political and cultural) changes in the years after the Chernobyl accident (including the break-up of the USSR and Glasnost) were important motors of changes in RP communication, both in the educational system and mass media: with time information that was new, or classified as "restricted" or even "secrete", became more open and accessible for everyone.

Development of tools, methods & processes to build, enhance and transmit RP culture

The creation of the International Sakharov Institute of Radioecology (ISIR) in 1992 (Minsk) to train professionals of different areas (scientific workers and professoriate, medical workers, radioecologists, engineers, politicians, etc...) to mitigate the consequences of the Chernobyl accident was one of the initial and major steps to develop tools, methods and processes to build, enhance and transmit the RP culture in Belarus.

Brief history of the International Sakharov Institute:

The issue of environmental education was not perceived as so crucial several decades ago, not only in Belarus, but in the world as a whole. However, the Chernobyl disaster in 1986 significantly changed

the lives and consciousness of a major part of population in Belarus and other countries (*ISEI-BSU history*, 2019). The tragedy in Belarus was aggravated by the fact that the scale of the disaster could only be assessed by professionals able to work in a multidisciplinary context, including physics, chemistry, biology and medicine. The country lacked such specialists due to concentration of "best brains" in Moscow (as The cultural and intellectual centre during the USSR period) or even abroad (Wilson, 2011).

In May 1991, within the framework of the United Nations International cooperation on Chernobyl issues, A. M. Lutsko, Associate Professor of the Chair of Nuclear Physics in the Belarusian State University introduced the project of the International Sakharov College of Radioecology. The project was supported by the Government of the Republic of Belarus and the Congress in memory of Andrei Sakharov (1991, Moscow). As a result, the International Sakharov College of Radioecology (ISIR), within the Belarusian State University (BSU), was established on January 20, 1992, according to the Decree of the Council of Ministers. On October 21, 1994 the College was transformed into the International Sakharov Institute of Radioecology, and in 1999 it passed the state accreditation and gained the status of University (ISEI, 2017).

Since 2005, according to the decision of the Heads of Government of the Commonwealth of Independent States, the International Sakharov Environment University (ISEU) received the status of one of the core organization on environmental education of states-members of the CIS.

In 2011 the University was accredited by the State Committee for Science and Technology and the National Academy of Sciences as a research organization. In 2012 the University opened a branch in Armenia (Yerevan). In September 2015, in accordance with the Resolution of the Council of Ministers the University was returned to the BSU structure as an institution of higher education "International Sakharov Environmental Institute" of Belarusian State University (ISEI-BSU) as an independent legal entity. The first Rector of the University was Alexander Lutsko (*ISEU-BSI history*, 2019; *ISEU*, 2017).

The creation of this type of institution provoked a lot of attention throughout the world reflected by announcements on radio and in press on international level and supported by scientists from European and USA universities forming a part of Advisory Board, including Richard Wilson (from Harvard) among others (*ISEU Advisory Board*, N/A). It was at that time unique in that it used a multidisciplinary approach to education with the goal of improving knowledge on radiation in various areas of application. It helped to train professionals, providing them with a core knowledge about radiation, radiation protection and radiation effects on health and environment, thus contributing to a more efficient recovery and mitigation of the consequences of the Chernobyl accident that has lasted till today (Kuchinskaya, 2014).

Today, the International Sakharov Environmental Institute covers a wider range of environmental problems, not only related to radiation.

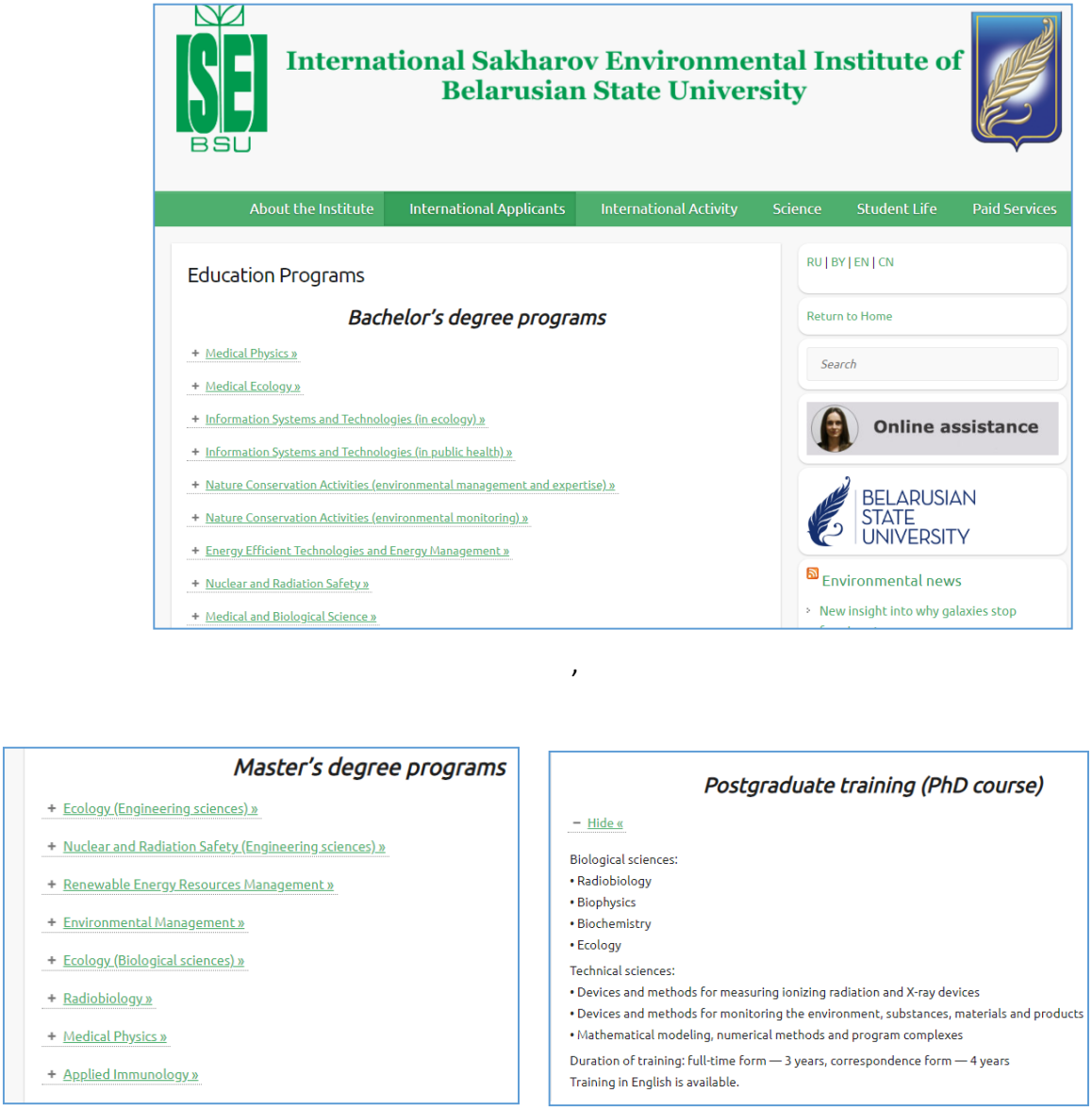

Figure 2. List of Bachelor's and Master's degree programs and postgraduate training PhD courses (from the institutional web-page: http://en.iseu.by/).

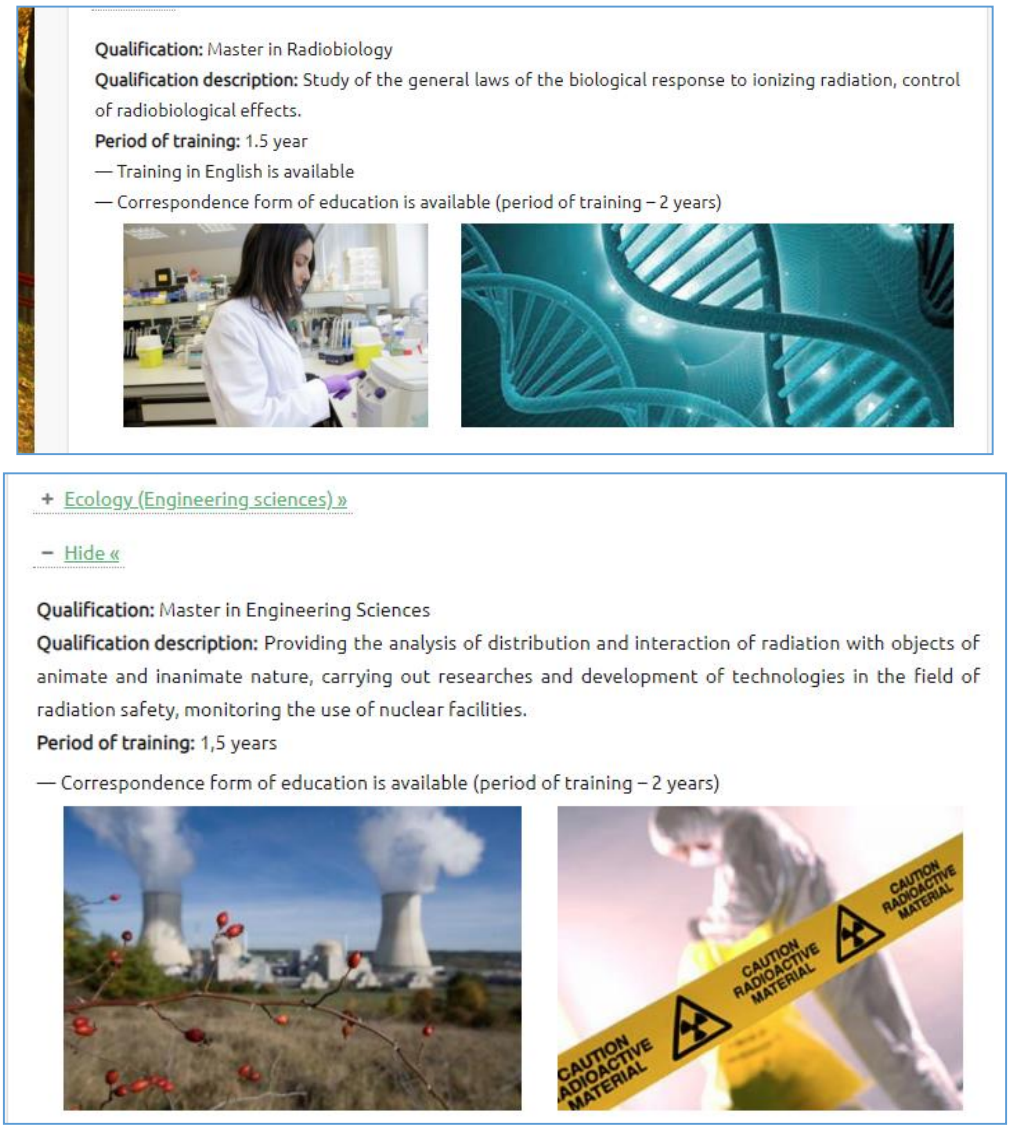

Figure 3. Examples of Masters in Radiobiology and in Engineering Science (http://en.iseu.by/).

As can be seen above, the ISEI-BSU continues to train highly qualified specialists in radioecology, radiobiology, and radiation safety (Department on Liquidation of the consequences of the Chernobyl accident, 2017). Since 2001, it also provides continued education (up-dating knowledge and increasing qualification) in the framework of the IAEA Regional Courses on Radiation Protection and Safety of Ionizing Radiation Sources. These courses teach young Russian speaking professionals from the CIS (State Independent Countries), Baltic and Eastern European countries. By 2016, 153 specialists were trained, 13 of them from the Republic of Belarus. International cooperation in the field of radioecological education has developed among the CIS countries. Established under the Council of Education of the CIS countries by the Standing Committee on Radioecological Education, ISEU was named leading organization in this area (Department on Liquidation of the consequences of the Chernobyl accident, 2017).

Other activities contributing to RP culture by professors and students of ISEU

The students during their studies realized obligatory practical or field work in the contaminated areas of Belarus (Gomel and Mogilev regions). This involved contact with residents of these territories, for

example, the course of dose measurement practices and work in villages. This was an opportunity to provide information to residents about levels of doses in their place of residence and to answer the questions they had.

Moreover, as part of the curriculum in the ISEU, the topic "Teaching methods about radiation and radiation protection", (both theoretical and practical) was included among obligatory subjects; thus, facilitating and preparing students to take part in the dissemination of information on RP and the construction of a RP culture in other educational institutions, including primary and secondary schools.

For example, the first rector of ISEU, A.M. Lutsko, and his collaborators created the first manuals on RP and RP hygiene with a Comics version in Belarusian and English aimed at different age groups. The Belarusian version was included in the primary and secondary schools programs (1st & 2nd grades in Russian and Belarusian; 5-6 grades and 10-11 grades in Belarusian) by Ministry of Education[21].

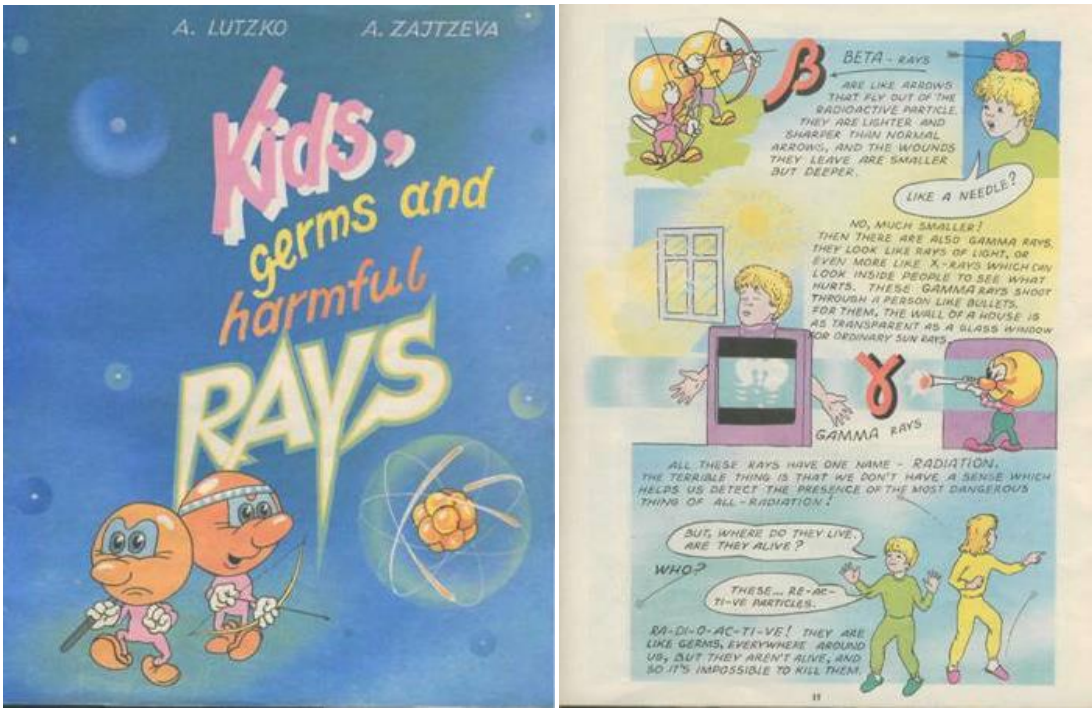

Figure 4. The manual for 1st grade pupils (accredited by Ministry of Education in Belarus). In Russian, Belarussian and English.

[21] The originals can be downloaded from the virtual museum dedicated to A.M. Liutsko, section "books/manuals" [In Russian]: http://lutsko.brsmok.by/?tag=%D1%83%D1%87%D0%B5%D0%B1%D0%BD%D0%B8%D0%BA%D0%B8

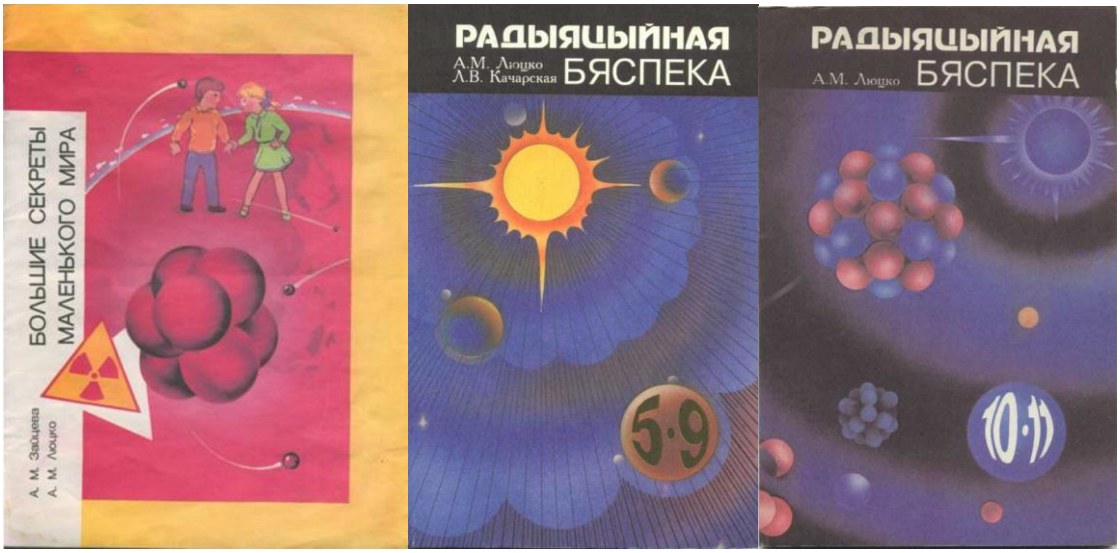

Figure 5. "Big secrets of a small world" for pupils of the 2nd grade, primary school [In Russian] (on the left) and "Radiation Safety" for pupils of 5-9 and 10-11 Grades [In Belarussian] (accredited by Ministry of Education in Belarus).

Other examples of growing Radiation Protection and Radiation Protection Culture education

- *RP in official programs of other Belarussian universities (medical, ecological, etc.)*

Medical and Environmental Medicine universities in Belarus include Radiation Medicine in their programs for the medical and pediatric departments. The content of the program consists of basic knowledge on radiation, sources of radiation, effects of radiation on health, as well as practical points of calculation of doses of populations living in contaminated areas and preparation of programs to reduce intake of radionuclides (specific nutrition programs, etc.) and other preventive measures (Zimatkina, 2011).

- *Optional classes on radiation protection at schools*

Optional courses on "Radiation Safety" were also in late 90s proved by Ministry of Education of Belarus in 2 blocks: for primary school pupils (1-4 Grades) and for obligatory secondary school level (5-9th Grades).

The program of for the **first cycle (children 7-10 years old)** is of more basic and includes:

- Providing knowledge about radiation, effects of ionizing radiation on humans, as well as ways to protect against radioactive emissions;
- Mastering the knowledge and practical skills for improving safety of living conditions in the territory contaminated with radio nuclides;
- Providing the foundations of radioecological culture and values in the field of preserving and strengthening their health.

A distinctive feature of the curriculum is the inclusion of a wide range of issues for a healthy lifestyle, since it is at this age that kids need to form an idea of the close relationship between lifestyle and safety measures when living in conditions of radiation risk. The curriculum includes practical (laboratory) work as well as excursions, subject to the availability of facilities and conditions (*Bases of Radiation Safety*, 1-4th grades, 2011).

The program for the **2nd cycle (children 11-15 years old**) includes:

- to form and consolidate knowledge about different sources of radiation: cosmic, solar radiation and solar activity, radionuclides in the earth's crust; natural (natural) vs artificial sources of ionizing radiation; external and internal exposure of the human body; main types of radiation.

- to acquaint pupils with the concept of radiation, the role of solar radiation in maintaining life on Earth; sources of non-ionizing radiation used in everyday life, IR protection; human-made sources of ionizing radiation and how they serve people; nuclear energy prospects; modern radioecological problems;

- to expand students' knowledge of the biological effects of radiation on the human body; about doses of radiation, methods of controlling the degree of irradiation of the organism; principles of radiation safety; ways to reduce dose loads on the human body, preserve and strengthen their own health when living in conditions of high radiation risk;

- to master the rules of the organization of safer living in conditions of high radiation risk.

Classes on the fundamentals of radiation safety in grades 5-9 are include 8 hours of training hours in each grade (*Bases of Radiation Safety*, 5-9th grades, 2011).

- *Internet courses or seminars on radiation protection*

The use of new technologies allows to organise also on-line courses successfully. For example, an on-line seminar "Modern technologies in the field of developing a culture of life safety of the population, within the framework of a system of remote consulting and informing the population of the contaminated territories of Russia and Belarus" (Figure 6) was performed in Belarus. Representatives from the Belarusian and Russian branches of the Russian- Belarusian Information Center on the problems of the consequences of the Chernobyl nuclear power plant, Bryansk State University named after academician IG Petrovsky, Institute of Radiology, and Svenskaya secondary school in Slavgorod district.

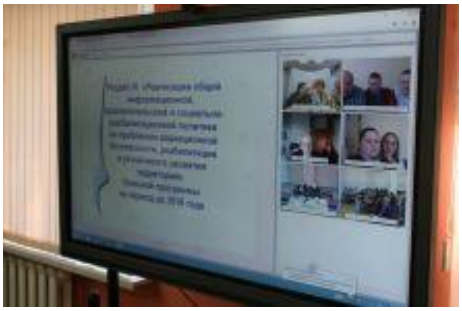

Figure 6. On-line seminar on radiation protection in Belarus

(*Source:* web http://www.liceymes.by/2016-11-02-09-55-08/702-2015-10-16-13-32-01.html).

Brief overview of importance of information provided by mass media and mass media as a tool of RPC development

Mass media, especially in our digital era play an important role in transferring information.

Briefly speaking, owing to historico-social and cultural aspects of transmitting of events of the Chernobyl accident and post-accidental period in soviet time, the censuring of information and its scarcity can be mentioned with aspects of what occurred and possible consequences of disaster (Liutsko, Ohba, Cardis, Schneider, & Oughton, 2018). Newspapers that time mainly reflected the accident itself and efforts of stopping the fire and prevention of further, more grave catastrophe.

The questions related to radiation safety, especially relevant to those affected populations that resided in the contaminated areas, started to appear in mass media (mainly in informal journals) as questions

to professionals (mainly medical workers) about day-to-day life. These questions were still asked even 30 years later (reviewed by Liutsko, L., unpublished; Liutsko et al., 2018).

Pupils' and mass-media ideas about radioactivity

The importance of mass media role in information and support of radiation protection culture can be represented by the following example:

"The Chernobyl accident has been used as an opportunity to study pupils' ideas about radioactivity, in relation to the information presented in the mass-media. Our study produced a detailed picture of pupils' ideas about the accident, the spreading of radioactive materials that resulted from it, the danger arising from the materials and about what to expect from possible safety measures. The correspondence between pupils' ideas and mass-media information appears to be striking. It is argued that information derived from the mass-media is particularly important as a starting point for science education topics that relate to the life-world domain." (Lijnse, P. L., et al., 1990).

In a sum, mass media create a kind of virtual knowledge that reflect the reality they «had been shown» (not always corresponds to a reality) and general public, especially if they do not have professional knowledge to judge the information provided, will believe in what they have read.

Evaluation of the level of RP culture

The subjective evaluation – an increase in level of RP culture among general population (especially those who were affected by the Chernobyl accident) owing to changes occurred in Education system after the Chernobyl due to a necessity of practical implication of it while mitigating the consequences and people living on the contaminated territories that are previewed to be reduced (Cs137) to a 30km zone only by the year 2050.

However, on except of students who take courses and realises practices (field trips in the contaminated and exclusion zones) from the university study; the general impact of RPC is not assessed (% of general population or professionals that acquired it or improve).

> *"The training of specialists in radioecology, radiation safety and radiation medicine, and the upgrading of the skills of radiation monitoring system workers are extremely important for the Republic of Belarus. Before the Chernobyl disaster, such work was not conducted in the country*.
>
> *Systematic work on the organization of radioecological education began in 1989, when a decision of the Ministry of Education and Science introduced separate courses on radiation safety for all contingents trained at all levels (secondary school, secondary special and higher educational institutions). In 1996, the "Concept of Radioecological Education in the Republic of Belarus" was developed, approved by the National Commission on Radiation Protection and the Ministry of Education.*
>
> *Purposeful training of necessary specialists with higher education is conducted today by the International State Ecological Institute (ISEU) named after Sakharov, and for the needs of agriculture - the Belarusian State Agricultural Academy (BSGA). In some universities (Belarusian National Technical University, Belarusian State Agrarian Technical University, etc.), the departments of relevant profiles have been created.*
>
> *Systematic training of personnel of the highest scientific qualification for work on Chernobyl-related subjects is conducted in the postgraduate course of the Institute of Radiology, the postgraduate study of the Institute of Radiobiology of the National Academy of Sciences of Belarus, as well as through a degree.*

The Department of Radiation Medicine has been established and successfully operates at the Minsk State Medical University. In other higher medical institutions of education and advanced training and retraining of personnel of the Ministry of Health, typical work plans and programs provide training in radiation medicine and human ecology, radiology and radiation safety.

In the Belarusian Medical Academy of Postgraduate Education, advanced training and retraining of personnel in the field of radiology and radiation safety are carried out in the framework of two-week courses at the departments of hygiene and medical ecology, radiology, oncology, emergency medical care and disaster medicine.

In the Republic of Belarus, an order has been established according to which employees of radiation monitoring units are required to undergo further training every 5 years. The following educational institutions provide advanced training and retraining of specialists in the republic:

- *The Institute for Advanced Studies and Retraining of the Agro-Industrial Complex in the Belarusian State Agrarian Technical University. Radiologists have been trained here since 1990, and over 350 radiation monitoring specialists are trained annually. During the period 1990–2015, 11,600 radiologists were trained.*
- *Institute for Advanced Studies and Retraining of the Gomel State University. F. Skaryna (GGU) - annually about 200 specialists of the Ministry of Forestry, Ministry of Housing and Communal Services and other ministries and departments. Over the period 2011–2015, 974 specialists have been trained."*

(translated from the web of the *Department for Liquidation of the consequences of the Chernobyl accident in Belarus*, 2017)

Highlighting the role of RP culture

The increasing role of RP culture was a crucial issue due to the faced reality in the aftermath of the Chernobyl accident. With help of professionals who started to work on it and those who contributed later (also with a foreign help via international projects as CORE, ETHOS and *d*-shuttle) Belarusian population had opportunities to acquire it both theoretically, and, what it is most important, on a practice in their daily life.

The Chernobyl disaster ... It will have to be considered both by the present and future generations. Therefore, ***radiation culture should become an integral part of human culture.*** *This can be achieved only when people learn the skills of living in a polluted area, the rules of nutrition, behavior.*

(translated from the book of "Chernobyl: A chance to survive" from Russian; Lutsko et al., 1996).

Lessons and recommendations

In case of Belarus (similar to Ukraine, Russia, Japan), the reality of the occurrence of nuclear accident pushed and speeded up the development of Radiation Protection, radiation safety first at university level, later also at primary and secondary schools and for general public. The experience of these countries has been shared and even more can be done also in the direction of education.

Questions:

- Would be such educational programs and courses (obligatory and/or facultative) proposed by somebody in the countries that were not affected ever by a nuclear accident?
- Will they have competent professionals to create such programmes, manuals, books or at least translated from other languages?
- Is the current Ministry of Education or Ministry of Health in those countries are motivated, support and competent to check, prove and adapt to a local country level Radiation Safety programs?
- Who should support such type of activities (Radiation protection associations?)

The experience that other countries have passed because of nuclear accidents and a huge amount of work that was done already, should be studied and transferred with adaptation to other countries in order not to create something form zero.

Education is an important channel together with mass media information to disseminate the radiation protection culture among people. Mass media representative should also have at least basic specific formation in order to represent information more real and should be free of any political and economic state or others interests.

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