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D2.3 – Identifying research needs and R&D priorities supporting the implementation of BSS

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Abstract

The aim of Task 2.7 of CONCERT was to unravel research and innovation needs that might help the implementation process of Council Directive 2013/59/EURATOM of 5 December 2013 laying down basic safety standards for protection against the dangers arising from exposure to ionising radiation and provide input to joint programming of integrative research actions. To achieve our aims we participated in meetings involving the European Commission and national authorities, regulators and Technical Support Organizations (TSOs). The Article 31 expert group of the European Commission was successfully contacted and the group identified six very important areas on the field of radiation protection where additional science and innovation are necessary.

Further actions were the organisation of a teleconference and a workshop and the development of a questionnaire to unravel national needs for new research an innovation.

Finally, we were able to come out with seven topics that should be included in new CONCERT and EURATOM research calls. These are

- Individual justification and optimisation of medical exposures
- New data on radiation-induced health effects
- Low dose irradiation in utero
- Organ doses
- Dosimetry
- Emergency situations
- Communication about the effects of ionising radiation

1. Scope of Task 2.7

The Council Directive 2013/59/Euratom of 5 December 2013 laying down basic safety standards for protection against the dangers arising from exposure to ionising radiation, and repealing Directives 89/618/Euratom, 90/641/Euratom, 96/29/Euratom, 97/43/Euratom and 2003/122/Euratom determines the new safety standards in radiation protection and radiation safety for the member states of the European Union. The member states should implement these new standards to national laws by February 5, 2018. This implementation is obligatory for the member states.

The Council Directive 2013/59/Euratom was based on ICRP recommendations published in ICRP 103 bulletin. The recommendations of ICRP took into account the recent scientific data on radiation protection issues. It is obvious however, that we need more research data to support the implementation process and to help the continuous development of radiation protection.

In Task 2.7: Research and innovation supporting the implementation of the revised European Basic Safety Standards of Work Package 2 the CONCERT project aimed to pay attention to the communication of knowledge from research and innovation conducted within CONCERT and outside that might lay down the scientific basis for the revised European Basic Safety Standards, in order to help those who are involved in the transposition and implementation of these Basic Safety Standards, which will require changes in national regulations and practices.

The key planned activities were

Organizing meetings with EC and national authorities, regulators and Technical Support Organizations (TSOs) to explain the scientific basis of the BSS and to consult on research and innovation needs related to the revision of BSS and its implementation in member states

Identifying research needs at national level and identifying priorities for European R&D

Providing input to Joint Programming of integrative research actions (WP3)

The following CONCERT participants contributed to Task 2.7: OKK-OSSKI (task leader), STUK, UEF, IRSN, BfS, VUJE, ISS, RIVM, IMROH, UT;

2. Achievements

2.1. Organizing meetings with EC and national authorities, regulators and Technical Support Organizations (TSOs)

2.1.1. Contact established with the Article 31 group

The Article 31 - group of experts advises the Commission on all relevant issues related to radiation protection. Obviously they were the advisor of the Commission in preparing the basic standards on radiation protection. Therefore we were obliged to establish contacts with the Article 31 group. Because of the lack of sufficient time so far we were unable to organise a meeting together the representatives of the Article 31 group. However, the group kindly advised us on the research needs that might be important during the implementation process of the 59/2013 EURATOM directive and also on research needs for further development of basic safety standards on the field of radiation research. On September 16, 2016 the Article 31 Working Party on Research Implications on Health and Safety Standards (WPRIHSS) provided a document entitled "Potential topics for research, developments and assessments in support of radiological protection and implementation of Basic Safety Standards". The following members of the Working Party on Research Implications on Health and Safety Standards of the Article 31 Group of Experts contributed to the preparation of this document: H. Janžekovič, L. Lebaron-Jacobs, F. Bochicchio, F. Hardeman, R. Huiskamp, P. Krajewski, J. Pedroso de Lima, and P. Smeesters (Chairman of the WP).

The WPRIHSS identified 6 areas were intensive research is necessary. These are:

- New data on radiation-induced effects
    - Non cancer radiation-induced effects including Nervous Central System and circulatory diseases
    - Combined effects: interaction of ionising radiation with other toxicants
    - Chronic internal exposures
    - Transgenerational mutagenesis
    - development of quantities other than effective dose which could quantify the specific individual risk
- Low dose irradiation in utero

- Organ doses
- Dosimetry, particularly
  - in occupational exposure
  - with respect to radon exposure
- Emergency situations
  - practical implementation of the new reference level approach
  - assessments based on well-defined scenarios
  - optimal equipment and harmonized protocols for first responders
  - strategy for deciding upon a monitoring programme after an emergency
  - post-accident strategies
  - Societal issues, including communication, and stakeholder involvement
  - Methodologies to find back orphan sources
- Communication about the effects of ionising radiation

The entire suggestion of WPRIHSS is provided in Annex I.

2.1.2. Meetings with EC and national authorities, regulators and Technical Support Organizations

Contacts to national authorities

To be involved in the implementation process of the 59/2013 EURATOM directive it is very important to make contacts with national authorities, important stakeholders and participate in events workshops that deal with and help the implementation. Many of the CONCERTS participants (for instance BfS, STUK, etc.) work as a national authority or they are closely linked as a technical support organization (for instance IRSN, OKK-NRIRR, NCRRP, etc.) to national authorities. Those organizations are routinely involved in the implementation process and are participating in national meetings/discussions.

Contacts to HERCA

One of the most important stakeholder in the implementation process is HERCA, the organisation of the Heads of the European Radiological protection Competent Authorities. HERCA established her suggestions and plans for the implementation of the basic safety standards. So far, informal connections was established to HERCA. The leader of Task 2.7 G. Sáfrány, OKK-OSSKI is representing Hungary in HERCA and other organizations, such as CONCERT coordinator BSF, or for instance CONCERT participant organizations such as STUK, PHE, RPE, EEAE, etc. are actively involved in HERCA activities. During the current reporting periods these organizations attended the following HERCA meetings:

- November 9-10, Athene, Greece, Sixteenth meeting of the Heads of European Radiological protection Competent Authorities, HERCA; to discuss RP related European problems including BSS implementation.
- April 28-29, 2016., Den Haag, Netherlands,; Seventeenth meeting of the Heads of European Radiological protection Competent Authorities, HERCA; To discuss RP related European problems including BSS implementation.

Meetings involving the European Commission

The European Commission (EC) is organising activities to prepare, accompany, and monitor the transposition of the Directive. The aim is to evaluate the Member States strategies and plans for transposition, and to facilitate discussion amongst Member States, candidate countries and EFTA states - with a view to identifying problematic areas, exchange of experience, identifying good practices and resolution of issues. The EC conduct surveys, and organise general and topical workshops in order to provide an open and transparent platform for exchanges and discussions. The work related to this will be performed by RISKAUDIT.

RISKAUDIT is a consortium composed of the French, German and Belgian technical support organisations, i.e. the Institut de Radioprotection et de Sûreté Nucléaire (IRSN) and the Gesellschaft für Anlagen- und Reaktorsicherheit (GRS). It provides consultancy services in the field of nuclear safety and protection of the environment. Yann Billarand from IRSN is the contact point between RISKAUDIT and CONCERT Task 2.7. CONCERT members such as OKK-OSSKI, STUK, PHE, etc. actively participated in the following RISKAUDIT workshops:

- December 01-02., Brussels, Belgium. RISKAUDIT Meeting on Enhancing Radiation Protection in the European Union; To identify national problems on BSS implementation
- June 7-9, 2016, Brussels, Belgium; RISKAUDIT Meeting on Enhancing Radiation Protection in the European Union, Workshop on NORM, Radon & Building materials and Reference levels & Dose constraints; To identify national problems on BSS implementation

Other workshops

Task 2.7 members attended and were actively involved in the following workshops intended to help the transposition process of the new EURATOM BSS:

- September 15-16, 2015., Helsinki, Finland, NordicNORM 2015 Workshop; To identify NORM related issues in BSS implementation
- May 23-27, 2016., Tallin, Estonia; IAEA Regional Workshop on Radon in Workplaces as an Element of a National Radon Action Plan; To identify radon related problems on BSS implementation

2.2. Identifying research needs at national level and identifying priorities for European R&D

To identify research needs at the national level we initiated several activities.

2.2.1. Teleconference for WP2.7 task members

A teleconference was organised on August 19, 2015. The participants of the teleconference included most of the members of task 2.7. During the teleconference we shared information on how the BSS implementation had started in the countries of the participants and what kind of synergies there could be found with RISKAUDIT. Yann informed participants about the RISKAUDIT activities: A list of contact points in each country has been established. It has one official up-level contact from the top regulator ("political level") aimed to assure that the countries are committed to participate in the activities of RISKAUDIT. Since it is not mandatory for the countries to participate in RISKAUDIT activities, the top contacts have been selected in order to add credibility to the project. In addition, a general contact having deeper knowledge and understanding of all the topics of the directive have

been identified, and the exchange of most of the information will be performed via the general contact points.

It was noted that there are many initiatives regarding the BSS implementation ongoing, and it is important to be aware of each other and to gain synergies instead of overlaps. The EC call establishing CONCERT requested following:

"*Due attention will be paid to research and innovation necessary for supporting the successful transposition and implementation of the revised European Basic Safety Standards, which will require changes in national regulations and practices that should be done in a co-ordinated manner in order to optimise protection and avoid duplication*."

Potential areas of research supporting the BSS implementation were briefly discussed. As every member state is expected to set up a national action plan for radon, radon epidemiology was proposed as a potential area (radon epidemiology has not been conducted in all MS and there is potential to learn from others). Other topics taken up were threshold dose for cataract among public as well as protection of pregnant women. It was pointed out that the revision of the new BSS was done because of new scientific results on eg. lens opacities and improved understanding on lung cancer risk due to radon. There will be new scientific information coming from research, this will be considered by the ICRP and it may or may not impact future BSS. This basic research addressing low dose risk is largely covered by the MELODI SRA and SRAs of the other platforms. Another aspect is the more short term research, development and innovation related the more practical aspects of BSS implementation.

2.2.2. Task 2.7 activities related workshop

A Workshop was organised after the OPERRA project meeting in Kuopio, Finland at July 9, 2016 to identify Task2.7 related problems, identify national needs, make suggestions for CONCERT calls. At the workshop introductory lectures were presented on the following topics:

- Report on the 1st RISKAUDIT Meeting in Brussels (G. Sáfrány)
- NORM related issues (A. Tkaczyk)
- Radon related issues (O. Holmgren)
- Radiation Protection of Medical Patients (V. Smyth)
- Emergency preparedness (W. Raskob)
- Education and training: medical physicists (A. Schmitt-Hannig)

During the intensive discussions it was concluded that the strategy for reducing radon exposure in dwellings would be a big challenge with high costs. In most countries it was not yet decided whether the national radon plan should determine 300 Bq/m^3 as a reference level or should decide on a lower level considering that some epidemiology studies found that radon levels higher than 100 Bq/m^3 might induce lung cancer risk significantly. It was also established that scientific information on the risk of exposure to radon during childhood (lung cancer and other possible type of cancer, e.g. leukaemia) is far for sufficient. However, the final conclusion was that CONCERT should not spend money on radon issues, because this problem should be solved on a higher European scale. This conclusion is also stands for NORM related issues.

Another difficult area to deal with is the health risks originating from medical radiation exposures. One particularly problematic field is the dosimetry for nuclear medicine therapy. There is a requirement to plan individual doses for individual patients. Diagnostic exposure of the patients should be justified and optimised. In some European countries the reference levels for diagnostic exposures was not yet determined/accepted. However, if CONCRT should deal with the problems of medical exposures more financial support from EU is needed.

On the field of emergency readiness and preparedness we would need efficient scientifically proved technics for decontamination. Current radiation protection rules apply annual dose limits. There are no dose limits or reference levels for lifetime exposures. Some research would be beneficial on this area.

2.2.3. Questionnaire to identify national needs for research during the implementation of the new BSS

We developed a short questionnaire to identify which CONCERT partners are involved in the transposition process of the 59/2013 EURATOM directive, and also to reveal which are the most intriguing problems of the transposition process and what areas would require further research. The short questionnaire included the following questions:

- Name of your organization:
- Your name:
- Is your institute a radiation authority?
- Is your institute linked to a radiation authority?

- Is your institute involved in the implementation of the EURATOM Council directive 59/2013 laying down basic safety standards for protection against the dangers arising from exposure to ionising radiation?
- Has the implementation process started in your country?
- Are research institutes or technical support organizations involved in the implementation process?
- What are the most troublesome problems during the implementation process in your country?
- Have you attended any meetings or workshops related to the implementation process? If your answer is Yes, please, name them!
- What areas would need new research information during the implementation?
- Does your institute has or do you have links to HERCA and/or the EURATOM Article 31 group of experts?
- Would you like to attend workshops on BSS implementation and research needs?

The questionnaire was sent to all CONCERT participants including POMs and linked third parties, altogether to 52 institutions. Very unfortunately only 14 filled questionnaires were returned, so the received results are not comprehensive.

The conclusion was that the new BSS Directive had introduced important changes within several topical areas. The most important areas are the integration of protection against natural radiation sources within the overall requirements; new provisions for NORM industries; introduction of reference levels for radon and criteria for building materials; the drastic change of limit for equivalent dose for the lens of the eye in occupational exposure; the emphasize of the need for justification of acts in the medical area; the enhanced use of dose constraints for the protection of the public; the replacement of the approach based on intervention levels by a more comprehensive system comprising reference levels for the management of emergency exposure situations.

The most problematic areas were financing of the promoted professional procedures; the transposition process includes several ministries and stakeholders, so intensive communication is necessary. Preparation of strategies and action plans in field of existing exposure situations, preparation of referral guidance in medical exposure and recognition of dosimetric services.

Among the issues, the transposition for RPE/RPO is a concern in several countries; for radon, new values have to be adopted and it induces a reflection on the implementation for dwellings. In addition, the management of NORM has to be reinforced compared to the current situation.

In Germany federalism could be one of the issues. Radiation protection is organized by each state following federal rules. This leads to different implementations of the RP System which now all needed to be adapted.

The responses indicated that we need more research on medical exposures (staff and patients), building materials and NORM (art. 75); risk communication during and in aftermath of crisis; emergency response (art 69); radon exposure in workplaces and in dwellings specifically during childhood (lung cancer and other possible type of cancer, e.g. leukaemia), low level exposure of the workers, overall exposure of the patients (including ethical issues) , better regulated NORM issues (including the reuse of the residues and implementing new technologies developed by scientific community in Europe).

We should collect more scientific information on risk as regards organ exposure vs effective dose for the application of dose constraint. We need more info on new research outcomes in dosimetry of the lens of the eye, new findings as regards risk of cardiovascular effects, radon dose calculation in different situations of exposure (public and workers), scientific information on the specific risk linked to pulsed-radiation exposure for the correct application of the need to delimit controlled and supervised areas in facilities, improvement of models needed for calculating the exposure of aircrews during solar proton events, current knowledge on the effectiveness of stable iodine prophylaxis in case of long duration of exposure to radio-iodine, improvement of dispersion model for assessing the dosimetric impact of atmospheric releases to the environment at short distance from the facilities.

Education and Training and Communication with the Public are another branch that should also be investigated.

Radiation protection research for incorporation of radionuclides, the operation of particle accelerators is associated with the production of exotic radionuclides which can cause radiation exposure; not for all produced radionuclides dose coefficients are available.

3. Providing input to Joint Programming of integrative research actions (WP3)

During the work performed in Task 2.7 of CONCERT our general observation was that national authorities are currently heavily occupied by the legal aspects of BSS rather than in research needs helping the implementation process.

One point that constantly shoved up during the consultations was that radiation protection in medical radiations (repository for patient dosimetry, imaging meta-data and bio-banking, integrated with health databases), is a very important unresolved issue. The new BSS emphasizes not only the justification of medical exposure but also requirements that concern provision of information to the patient, recording and reporting doses resulting from medical procedures, using diagnostic reference levels and the provision of equipment that provide data on doses. Such repository would be very useful for research purposes too. Digitalisation of information opens new opportunities.

Other very important points which were raised by the Article 31 group. We are certain and strongly recommend that the following issues raised by the Article 31 group must be seriously considered both by CONCERT and EURATOM research calls:

- New data on radiation-induced health effects (MELODI)
    - Non cancer radiation-induced effects including Nervous Central System and circulatory diseases (MELODI, EURAMED)
    - Combined effects: interaction of ionising radiation with other toxicants (ALLIANCE)
    - Chronic internal exposures (EURADOS, MELODI)
    - Transgenerational mutagenesis (ALLIANCE)
    - development of quantities other than effective dose which could quantify the specific individual risk (EURADOS, EURAMED)
- Low dose irradiation in utero (MELODI, EURADOS)
- Organ doses (EURADOS, EURAMED, MELODI)
- Dosimetry, particularly (EURADOS)
    - in occupational exposure (EURADOS)
    - with respect to radon exposure (EURADOS, ALLIANCE? - NORM)
- Emergency situations (NERIS)

  - practical implementation of the new reference level approach
  - assessments based on well-defined scenarios
  - optimal equipment and harmonized protocols for first responders
  - strategy for deciding upon a monitoring programme after an emergency
  - post-accident strategies
  - Societal issues, including communication, and stakeholder involvement (SSH)
  - Methodologies to find back orphan sources
- Communication about the effects of ionising radiation (SSH)

4. Annex I.

Article 31 Working Party on Research Implications on Health and Safety Standards (WP RIHSS)[1]

Potential topics for research, developments and assessments in support of radiological protection and implementation of Basic Safety Standards

16-09-2016

Foreword:

This list of potential topics is an inventory of various issues linked to radiological protection needs, particularly (but not only) when relevant for the implementation of the new European Basic Safety Standards directive. Not all these issues require real "*research*", some of them are more in the field of *developments* or *assessments* and could be covered by specific studies (as far as possible distinguished in the document, but the boundaries are not always evident).

This list was elaborated by the Article 31 Working Party on Research Implications on Health and Safety Standards after consultation of the Article 31 Group of experts. It does not intend to be exhaustive.

Domain 1: new data on radiation-induced effects

Some *research* topics may have important impact on the protection against radiation-induced risks to the health of population:

- Non cancer radiation-induced effects (including Nervous Central System and circulatory diseases): important potential impact on organ dose limitations: research in this field should be further supported.

-Combined effects: interaction of ionising radiation with other toxicants (that may be present in the daily environment), such as recently illustrated in the EU CEREBRAD results (combined effects of IR and nicotine, methylmercury, the pesticide Paraquat or the flame retardant pentabromodiphenyl ether).

- Chronic internal exposures: as the data on the effects of chronic internal exposure of populations are very limited and as this topic is central in any future nuclear accident, further *research* in this field is needed. In particular, the role of age at exposure and of radiation-induced non-targeted effects should be further explored.

[1] The following members of the Working Party on Research Implications on Health and Safety Standards of the Article 31 Group of Experts contributed to the preparation of this document: H. Janžekovič, L. Lebaron-Jacobs, F. Bochicchio, F. Hardeman, R. Huiskamp, P. Krajewski, J. Pedroso de Lima, and P. Smeesters (Chairman of the WP)

Underlying issues are if there is always equivalence of risk for external and chronic internal exposures at the same doses and if the currently used concept of equivalent/effective dose is a right risk indicator for all types of effects (including all types of non-cancer effects).

- Transgenerational mutagenesis: has up to now been observed only in animals but « lack of human evidence does not mean evidence of lack of effect » and, if such effects would occur in human beings too, they would have wide implications. Possible differences in genetic changes between external and (chronic) internal exposures are another important issue: the vast majority of human data are currently based on follow-up of populations after external exposures (Life Span Study, radiotherapy studies). Further *research* is needed.

- The *development* of quantities other than effective dose which could quantify the specific individual risk (for age, gender and, in case, exposure to other synergistic risk factors, e.g. smoking) for specific health effects

Domain 2: low dose irradiation in utero

There are still many uncertainties and *research* needs regarding the effects of irradiation in utero at low doses: role of genetic disorders in the pathways of DNA-repair, role of radiation-induced epigenetic effects, subtle effects or long term effects particularly after Nervous Central System irradiation, effects of chronic internal exposures.
The potential implications are important, particularly in emergency and post-accidental situations and in medical exposures, and more research is needed in this field.
Complementary to radiobiological studies, preparation and implementation of databases/archives of doses and other relevant information suitable for large-scale epidemiological studies would be very helpful.

Domain 3: organ doses

- Evaluation and optimisation of organ doses, particularly for heart and arteries; use of dose constraints

- Study of field doses induced during radiotherapy leading to second primary malignancies and cardio-vascular effects, particularly in patients exposed during childhood.

Domain 4: dosimetry

Developments are needed in the following domains in occupational exposure:

- Practical eye lens dosimetry

- Development of reliable active neutron dosimeters

Developments would be useful in the following domains with respect to radon exposure:

- Affordable methods and instruments to evaluate long-term radon exposure in selected periods of the day (working hours)

- Models to evaluate contribution to indoor radon concentration from building materials

- Methods for reducing radon concentration in large buildings (including models to evaluate the effects of such methods),

Domain 5: emergency situations

- More *developments* are needed to come to practical implementation of the new reference level approach and to further enhance methods (models and monitoring) for assessing the situation and for better predicting doses in order to be used as an input parameter by decision makers during an emergency. There is in particular a need for better filling the gap between measurable dose rates and contamination levels, and the very generic reference level range of 20-100 mSv/year. The applicability of the models should be assessed taking into account the timeframe of an accident. In addition, uncertainties related to dose predictions should be incorporated in a systematic way enabling decision making in a due time.

- More *assessments* based on well-defined scenarios are needed in the Member States to prepare guidelines for making self-assessments of available equipment, first responders and other staff and procedures needed in emergency response and to make systematic gap analysis. Taking into account the Fukushima accident, a better assessment is needed of possible accident scenarios.

- Despite numerous initiatives related to emergency preparedness and response in the EU MSs as well as worldwide, equipment and protocols to be used by national first responders are not sufficiently known and not harmonized. There is a need of further *development* and guidance on optimal equipment and harmonized protocols for first responders, facilitating preparation of appropriate cooperation of first responders of different Member States in case of an emergency situation. There is also a need of further development of harmonized protocols related to medical management and treatment of first responders, taking into account that a large number of persons initially not planned to help may be acting as first responders, as it was the case during the Chernobyl and Fukushima accidents.

- An issue identified during the 2014 EC seminar on the lessons of Fukushima is related to the monitoring and screening of members of the public exposed during an emergency and their follow-up. This topic is also considered paramount in informing and reassuring the population involved. Therefore, a development that leads to a decision support system to fix the strategy for deciding upon a monitoring programme after an emergency is desirable. Possible aspects for consideration are: the radiological monitoring programme for people exposed to ionising radiation (dose reconstruction) and potentially internally contaminated; development of a

decision support system to define an adequate medical and dosimetric follow-up of population; definition of control groups; stakeholder involvement and communication; feasibility; justification and optimisation issues.

- The complexity of the Fukushima accident revealed among other that post-accident management poses a significant challenge to the society affected. An *assessment* of possible post-accidental strategies is needed in order to identify good practices, leading to the elaboration of a guideline on post-accident strategies. Good practices of proactive actions of members of the public, e.g. by using on-line information on dose rates measured by members of the public, should be taken into account. Furthermore, as radioactive waste management might pose a significant issue which can't be managed by only one MS, additional research is needed on this topic.

- Societal issues, including communication, and stakeholder involvement exercises *(development)* in various MS should be evaluated, with the idea to optimize the policy in various (post-)accident situations already from the preparedness stage.

- Methodologies and techniques to find back orphan sources should be critically evaluated *(assessment)*, leading to guidance allowing development and implementation of national strategies. Lessons learned from accidents and incidents shall be included.

Domain 6: communication about the effects of ionising radiation

Numerous *research* topics in this field have been identified:

- communication of risk at low doses,
- communication of risk evaluation uncertainties,
- comparison with carcinogens other than radiation,
- numerical risk approach in relation to risk perception,
- ethical aspects of communication, including ethical aspects and pitfalls of different numerical risk approaches,
- communication regarding (dose) justification and optimisation,
- the best way to engage stakeholders,
- the use of new media.

Other issues of interest

- Regarding NORM:
    - study of the effect of different regimes in NORM industries in Member States on occupational doses
    - A systematic and updated assessment, in line with the Article 75 of the EU BSS, on building materials and NORM within the EU including import and export of

materials is needed. The proposed study shall include also management of so-called “legacy sites”. Good practices shall be identified as well as challenges due to different regulatory regimes either in the past or among MS today. Guidelines in order to strengthen harmonization among MS shall be prepared identifying key issues and solutions to be used.

- Regarding dosimetry services: study on the lack of specific dosimetry services in Member States, such as internal dosimetry for very specific radionuclides, or arrangements to use dosimetry services from other countries
- Regarding public exposure: The EU BSS is harmonizing basic safety standards in the MSs. However, the Directive deliberately enables a large degree of flexibility when controlling particular use of ionizing radiation sources. As the EU BSS are applicable to MSs with very different inventory of radiation sources, practices, natural occurring radioactive materials and radioactive waste and also very different regulatory infrastructure, such flexibility might lead to different exposures of members of the public in MSs. A systematic study of the flexibility incorporated in the EU BSS, e.g. in applying dose constraints, is proposed in order to evaluate the potential consequences of the variety of approaches applied in MSs. In particular, differences related to consumer products and building materials shall be discussed in detail, taken into account also free movement of goods within the EU as well as import of good to the EU. Such study could identify a need for further development of the EU BSS regarding public exposure.
- Regarding training: Radiation Protection education and training of medical students is fundamental, but *how* is RP told to doctors? An evaluation study is needed.
- Regarding medical equipment:
    - Study on the role of equipment producers on medical exposures in Member States and identification of “good practices”
    - Study of the possible effect of the shortage of Mo-99 for medical treatment of patients and identification of the way forward., also considering the development of alternative means of generating Tc -99m.
- Due to terrorist attacks as well as other reasons, unjustified use of devices causing non-medical exposure is a subject of concern for many regulatory bodies within MSs. A systematic study of the trend in use and development of non-medical exposure devices related to terrorist threats in MSs is proposed aiming to identify “good practices” in justification processes as well as good practices in use of such devices.
- Further development of methods to analyse the consequences for the environment (plants and animals) of exposure to ionizing radiation.