HERCA

HEADS OF THE EUROPEAN RADIOLOGICAL PROTECTION COMPETENT AUTHORITIES

Sv/Bq

222 Rn

Geneva October 2015

HERCA Workshop

Radon in Workplaces

GENEVA / 12-14 October 2015
ILO Headquarters Geneva – 4, route des Morillons
CH 1211 Genève - Switzerland

REPORT on the HERCA Workshop

Organised by ASN, FOPH and NRPA
in the framework of the HERCA Action Plan in relation to the transposition and implementation of Directive 2013/59/Euratom (Euratom-BSS)

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Main findings

In the framework of its Action Plan for the Transposition and the Implementation of the Directive 2013/59/Euratom, HERCA organised in Geneva, 12/14 October 2015, a specific workshop on radon in workplaces. The organisation of this event has been ensured by the Public Health Federal Office from Switzerland (FOPH), the Norwegian Radiation Protection Authority from Norway (NRPA) and the Nuclear Safety Authority from France (ASN). The International Labour Organization (ILO) hosted the workshop.

After a 1st session dedicated to international and national experience sharing, different points of view have been presented on how to understand the BSS specific requirements dealing with radon exposure in workplaces. The issues raised were mainly focused on:

- The justification of actions to reduce radon exposures in the establishment and implementation of the Radon National Action Plan, being under the responsibilities of the Government and regulators;
- The employer's and/or the undertaking's responsibilities depending on workplace type;
- The use of the reference level concept and its articulation with the dose limitation.

During the 2nd session, 16 recommendations have been defined and then submitted, for approval, to HERCA board. The main findings are summarized below:

- "HERCA considers that the strategy for reducing radon exposure in workplaces is an important priority and should be based on both preventive and educative actions and on a regulatory approach".
- "For HERCA, radon risk communication is a key-aspect for which appropriate information should be prepared; with a specific attention paid for workplaces with public access, in a situation where the radon concentration remains above the reference level even after optimization".
- "To facilitate the BSSD implementation, HERCA should ask the European Commission to prepare a European Guidance based on good practices and, in relation with ICRP and IAEA, to issue international guidelines to calculate the annual effective dose due to radon exposure in different workplaces".
- "HERCA recommends to include in the National Action Plan the assessment modalities of the radon regulatory requirement implementation, and of the collection and use of the radon measurements results, in order to assess the impact of the plan".

Background

Radon is a proven lung carcinogen for humans (classified in group 1 in the IARC classification). Recent epidemiological findings from residential studies demonstrate a statistically significant increase of lung cancer risk from prolonged exposure to indoor radon at low level of exposure. In many countries, exposure to radon is, before medical exposure, the primary source of exposure to ionising radiation.

For several years, in many European countries, national authorities have promoted actions for measuring indoor radon concentration and reducing radon exposure in dwellings, buildings with public access and other workplaces. Many advances have been carried out for the development of measurement methods, the knowledge of population exposure or the radon civil engineering.

The Council directive 13/59/Euratom laying down basic safety standards for protection against the dangers arising from exposure to ionising radiation (European BSS) introduces the new concept of National Radon Action Plan for addressing long-term risks from radon exposures in dwellings, buildings with public access and workplaces for any source of radon ingress, whether from soil, building materials or water. Specific requirements deal with radon in workplaces.

A 1st radon workshop dedicated to National Radon Action Plan has been organised in Montrouge (France), 30 September-2 October 2014, by NRPA (Norway) and ASN (France); the final report is available on NRPA and ASN websites.

At the 14th HERCA meeting (Oct. 2014) , on the basis of this workshop's main findings, it has been decided to organise a 2nd workshop to deepen BSS requirements dedicated to radon in workplaces, including radon in buildings with public access and radon produced by materials in NORM activities, in order to facilitate the transposition works. Consequently, ASN and NRPA decided to collaborate with FOPH (Switzerland) in the organisation of this second workshop. Relevant international organizations such as WHO, IAEA, ILO and ICRP also participated in this workshop.

Workshop objectives

The main objective of this workshop was to provide a forum for European countries to exchange points of view on the transposition of the specific requirements of the BSS dealing with radon exposure in workplaces (articles 5, 9, 23, 25, 31, 35, 54, 103, annex XVIII (2, 3, 4, 5, 6, 10)) and the impact on the existing national approach and strategy.

The workshop focused on the following items covered by BSS requirements, mainly:

- Radon reference level (art 54 and Annex XVIII, 4)
- Dose limit for occupational exposure (art 9), including the dose calculation methodology
- Radon risk management in NORM activities
- Relevancy of radon prone areas for certain workplaces (Annex XVIII, 2)
- Identification of types of workplaces and buildings with public access (Annex XVIII, 3)
- Notification procedure (art 25)
- Arrangements in workplaces for planned exposure situation because of high level of radon (art 35)
- Assignment of responsibilities (art 31 and Annex XVIII, 5)
- Strategy/Regulation for reducing radon ingress in workplaces
- Strategy/Regulation for reducing radon ingress in building with public access (art 103), taking into account the risk for the public and for employees
- Strategy for communication to inform employers and employees of the risks of radon Annex XVIII, 10)

Sharing international experience

Organisation ILO

Introduction and official welcome of the workshop was done by Dr Shengli NIU, Senior Specialist on Occupational Health Labour Administration, Labour Inspection and Occupational Safety and Health Branch (LABADMIN/OSH), International Labour Organization.

Organisation WHO

Radon in workplaces - A WHO perspective

Emilie VAN DEVENTER (WHO)

Primary prevention of both public and occupational health hazards is a priority for the World Health Organization, in particular since the workplace can serve as a setting for delivery of essential public health interventions. In recognition of the health impacts of air pollution - the world's largest single environmental health risk - a new resolution was adopted by WHO Member States as this represents annually 4.3 million deaths from exposure to indoor air pollution and 3.7 million deaths from outdoor air pollution.

Radon is an important source of indoor air pollution. It was firmly established as a cause of lung cancer in miners in the 1950s, and on the basis of these occupational exposures, IARC classified radon as carcinogenic to humans in 1988. This classification was re-iterated in 2001 and 2012 on the basis of further epidemiological evidence from both miners and residential settings, which highlighted a statistically significant association between radon concentration and lung cancer, even when the analysis was restricted to places with measured radon levels less than 200 Bq/ m^3. This prompted WHO to recommend a reference level of 100 Bq/m^3, with the proviso that, if this level cannot be implemented because of country-specific factors, the reference level should not exceed 300 Bq/m^3.

While the IAEA International Basic Safety Standards set an annual average activity concentration limit for occupational exposures at 1000 Bq/m^3, exposure limits are evolving to lower values of 300 Bq/m^3 for both workers and members of the public in the European Council Directive 2013/59/EURATOM and in the ICRP Publication 126.

One of the challenges in implementing the EC Directive will be to identify workplaces with high radon exposure. In a global context, such task would be even more arduous when considering artisanal and small-scale mining in low and middle-income countries with around 100 million artisanal miners (compared to about 7 million in industrial mining).

Through the EC Directive, it is expected that the European Union will implement pragmatic and effective actions to reduce the health effects from radon. Experiences in Europe may prove useful to policy-makers in other parts of the world.

Organisation IAEA

Managing Radon Exposure in Workplaces: Requirements in the International Basic Safety Standards

Tony Colgan, Head, Radiation Protection Unit, International Atomic Energy Agency

The approach to managing exposure due to radon in workplaces depends on many factors. These factors include whether or not the presence of radon is directly related to the work activity being undertaken, whether or not the facility is currently in operation or is being planned, and the activity concentration of radon that is present. Depending on the circumstances, it may be appropriate to manage the exposure as either a planned exposure situation or as an existing exposure situation.
The International Basic Safety Standards establish the requirements that apply to the control of radon in workplaces. Exposure due to natural sources is in general considered an existing exposure situation. However, in some circumstances the relevant requirements for planned exposure situations apply. In workplaces in which occupational exposure due to other radionuclides in the uranium or thorium decay chains is controlled as a planned exposure situation, worker doses from both gamma radiation and radon are controlled through the annual dose limit. This is always the case for uranium mining activities and may also apply to certain other mining and milling activities, depending on the specific circumstances.
In existing exposure situations, radon exposure is controlled through the use of reference levels. Where the exposure due to radon is adventitious (i.e. it is not directly associated with the work practice) and the national reference level is exceeded, employers are required to take all reasonable efforts to reduce the radon concentration to below the reference level. If such efforts are not effective, the relevant requirements for occupational exposure in planned exposure situations apply.
The presentation summarizes the main requirements and the circumstances in which they apply. Challenges in applying the requirements are also discussed.

Organisation ICRP

Radon in workplaces

Margot Tirmarche
Commissioner at ASN (France)
Member of committee 1 of ICRP

ICRP publication 115 realized a review of recently published studies of workers exposed to radon and its decay products. A precise individual registration of annual radon exposure was one of the criteria of selection for this review. All these studies had a long term follow-up of health and vital status of the individuals; consequently the lung cancer risk was estimated precisely, taking in account time since exposure and expressed as an excess risk per unit of exposure.
Radon is radioactive gas that can be inhaled as well as its decay products; ICRP will publish in the next months a modified lung model illustrating the energy distribution of the alpha emitters and specifically the radon decay products, in the different parts of the lung.

ICRP considered also different scenarios of exposure, close to the actual conditions in workplaces (like mines, underground situations, indoor workplaces…) in order to calculate the lifelong risk attributable to radon, to compare this result with the lifelong risk obtained if the population of the same age structure was only exposed to external gamma exposure. This was one way to estimate the effective dose related to radon decay exposure.
A second way for the calculation of the effective dose is to use the recent ICRP lung model approach, to calculate, for the same scenarios of exposure the energy deposition in the lung, to consider an RBE of 20 for the alpha emitters as well as the ICRP weighting factor for the lung.
Both the energy deposition lung model and the epidemiological approach gave quite similar results, if some criteria were respected : size of inhaled particles, attached or unattached fraction, inhalation rate, equilibrium factor: 0,4 in the houses, 0,2 in highly ventilated mines.
Conclusion : In Publication 115, the review of recent epidemiological data, focusing on low levels of exposure and low exposure rates in mines propose a revised nominal risk coefficient of 5 x 10-4 per WLM (14 x 10-5 per mJ h m^{-3}) Using this revised nominal risk coefficient, and the detriment values of Publication 103 (ICRP, 2007), dose conversion convention values of 12 mSv effective dose per WLM for adults and 9 mSv per WLM for all ages were derived. For an adult with a breathing rate of 1.2 m^3 h-1 , this values can vary by a factor of 2, depending if he is in a highly ventilated mine with a very low unattached fraction or if he is in indoor workplaces, with a poor ventilation. But for sedentary occupations such as office workers, this reference breathing rate is likely to be an over-estimate.
For simplification in risk management, the ICRP Commission recommends the use of a single dose conversion coefficient of 12 mSv per WLM (3.4 mSv per mJ h m^{-3}) for the calculation of doses following exposure to radon and radon progeny in workplaces. This reference dose coefficient is considered to be applicable to the majority of circumstances with no adjustment for aerosol characteristics. Duration of exposure may influence this value, as the conversion coefficient is integrating the duration in the WLM definition or the corresponding mJ h m^{-3}
During the discussion, it was concluded that a rather simple tool for the calculation of the effective dose related to different conditions of exposure, was necessary and should be developed .

Country United States of America

Radon in the Workplace in the United States: A Mix of Standards and the Need for Harmonization

Ruth E. McBurney, Conference of Radiation Control Program Directors

In the United States, several federal agencies are responsible for the safety of workplaces from radiation exposure. Primarily, the Occupational Safety and Health Administration (OSHA) is the federal agency responsible for the safety of American workers. This includes protection of the American workforce from unnecessary exposure to ionizing radiation. OSHA covers all radiation sources not regulated by the U.S. Atomic Energy Act of 1954, as amended. The current U. S. Nuclear Regulatory Commission (NRC) is responsible for radiation workers and members of the public for radiation sources under the Atomic Energy Act. Activities regulated by NRC, and by states that have an Agreement with NRC to regulate radioactive material in their states, in which radon could pose a workplace risk include uranium extraction and milling facilities. NRC regulates the licensee for health and safety of the workforce and the public, and does not include background radiation. On the other hand, OSHA regulates the employer for health and safety of the employee, and may include workplaces where natural concentrations of radon may be significantly enhanced, such as inside buildings.

The OSHA radiation regulations have not been updated since they were first put in place in 1971. Their standard for radon referenced the standards of those of the U.S. Atomic Energy Agency (now the NRC) at the time, but have not changed as those of NRC have changed.

In addition, other agencies and organizations responsible for developing standards, such as the U.S. Environmental Protection Agency (EPA), for general radiation protection standards and recommendations; the General Services Administration (GSA), for action levels for childcare centers and GSA-controlled Federal and leased facilities; the American Conference of Governmental Industrial Hygienists (ACGIH); and the Conference of Radiation Control Program Directors, for facilities containing technologically enhanced radioactive material and general radon guidance to states, including model state regulations. The EPA is attempting to work with OSHA, NRC, GSA, and ACGIH in order to encourage harmonization of the national standards for radon in the workplace, using current scientific basis for the standards.

Some progress in radon reduction in workplaces through the Federal Radon Action Plan, and especially in childcare facilities, has been made over the past few years. The Federal Radon Action Plan is a multi-year collaborative effort of several federal agencies for radon reduction. Each agency provided strategies within its purview, and the progress is being tracked on those strategies. Under the GSA's Federal Radon Action Plan commitment, the agency has completed testing of 92% of its childcare centers and developed a video announcement to promote professional radon services to federal building tenants. Also, at least one of the national accreditation programs for childcare centers has included testing for radon as a part of their accreditation process. Progress on other activities under the FRAP, and additional strategies under the National Radon Action Plan, an initiative of several non-governmental organizations, is being tracked. Updates on these activities will be reported.

Sharing experience between HERCA members

Country BELGIUM

Radon in workplaces, current practices and future regulations in Belgium

Dehandschutter Boris, Federal Agency for Nuclear Control, Ravensteinstraat 36, 1000 Brussels, Belgium

Radon in workplaces has been regulated in Belgium since 2001, implementing the 96/29/Euratom Directive. Specific types of workplaces (called 'professional activities') in radon risk areas are required to measure radon and introduce a declaration to FANC. In the case of exceeding the exposure of 800 kBqh/m³ or 3 mSv/y for one specific worker, corrective measures have to be taken. If these measures cannot result in sufficient reduction of the exposure, the activities should be regulated as a practice (planned exposure). Several juridical and practical issues had to be solved in order to apply the regulations appropriately. Definition of radon risk areas, measurement and declaration protocols and the responsibilities of owners and employers had to be cleared out. The current paper gives an overview of the approach followed during the last 14 years, and addresses the challenges for the future. The implementation of the new EU BSS in national regulations, mandatory before February 2018, presents new challenges concerning notably the juridical meaning and use of the reference level, the protection of new buildings (a regional competence, leading to obligations for architects/builders, with consequences for the measurement protocols), and the implementation of the radon action plan. Finally, the BSS impose to the member states a legal regime of regulatory control, including justification of the protective measures for existing exposure.

Country CZECH REPUBLIC

Delineation of radon prone areas and specification of workplaces for mandatory radon measurement in the Czech Republic

Jana Davídková, Karla Petrová, State Office for Nuclear Safety

The new European directive No. 13/59/EURATOM laying down basic safety standards for protection against the dangers arising from exposure to ionising radiation introduces the new obligations in the fields of protection from radon exposure. Radon measurements should be mandatory in workplaces within the radon prone areas identified and located on the ground floor or basement level.

This presentation shows the approach and criteria used for the delineation of radon prone areas in the Czech Republic. The base for identification of the radon prone areas was previous measurements in buildings within the country, geological data and information from radiometric survey. By using statistic method called "neuron network" the probability of the percentage of the building exceeding reference level in selected territorial unit was predicted. Different results (for 10%, 20%, 30%, 50% of exceeding buildings in different territorial units - such as municipalities or districts) presents different numbers of potentially affected workplaces varying approximately from 5000 to 50 000.

Also other different criteria, conditions and parameters for specification of type of workplaces with potentially high exposure to radon had been considered.

Then the results had been compared with the objective to find the most effective way for regulation, which would be manageable for the workplaces and also for the regulatory body.

Country FRANCE

Measurement of radon in underground workplaces in France: methodological aspects and feedback

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The French Regulation requires that in underground workplaces, located in priority areas where workers are exposed to radon according to the situation of their workplaces, the employer makes proceed to measurement of the radon activity concentration by an agreed body or the Institute for Radiological Protection and Nuclear Safety (IRSN). When the results of the measurements exceed the reference levels fixed by the Authority of Nuclear safety, the employer operates the necessary actions to reduce the exposure at a level as low as reasonably possible. The radon measurements must be renewed at least every 5 years to control the sustainability of the situation. The professional activities concerned are listed in the regulation (for example: maintenance and supervision of traffic lanes, parking areas, hotels and restaurant, organization of visit of places with tourist, cultural or scientific vocation etc.) and are those performed at least one hour a day. The concerned workplaces are caves, mines and underground quarries (no more in operation) and some underground utilities (road or railway tunnels, laboratories, military utilities etc.). The radon measurements are realized according to the national standard NF M60-772 (2012) entitled "Radon 222 in caves and underground buildings: methodology applied for the screening”. The objective of the screening is to determine if all or part of an underground workplace presents an annual average activity concentration of radon exceeding the reference levels. The principles and the different steps of this methodology are presented and illustrated by an application realized in a touristic cave. The field experience feedback gained by the IRSN, from measurements realized in underground tunnels, caves and quarries, showed that this methodology can be applied to different cases. For some situations, nevertheless, flexibility is necessary to find the best compromise between the requirements of the standard and the field constraints.

Country	FRANCE

Radon exposure in underground workplaces: feedback of an agreed body in applying the regulation in France

R. Améon
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Under French regulation, employers of specific occupational underground activities in Rn prone areas must review the potential radon hazard in their premises. Measurement shall be performed by agreed bodies and shall followed the requirements of standardized protocols (ISO 11665 part 1 to 8) control the atmospheres of the workplaces.
Since 2010, more than 60 workplaces (hydroelectric power plants, caves, spas, car parks) have been investigated by ALGADE company. The majority of them (70%) are not concerned by Rn activity concentration higher than 400 Bq.m-3. Following the regulation requirements, remediation actions based mainly on ventilation systems have been implemented in the workplaces with Rn activity concentrations higher than the reference level. Neverthless, in some of them as prehistoric caves, confinement of the internal atmosphere cannot be disrupted without inducing irreversible degradations of paintings. In that specific case, workplaces studies have been performed in order to determine the occupational exposure to ionizing radiation. Exposure of the workers has been

determined using a specific dosimeter developed for uranium miners. The Personal Alpha Dosimeter worn at the belt of workers is specifically designed to measure the internal exposure through inhalation of both Rn decay products and long-lived radioactive dusts, and the external exposure to gamma radiations. 4 workplace studies were performed by ALGADE over 1 year in workplaces with Rn activity concentration higher than 1 000 Bq.m-3. Dose assessment show effective doses ranged between 0.17 and 9 mSv depending on exposure time. Occupational dosimetry was implemented for those with an additional effective dose higher than 1 mSv.
In France, the Rn risk in workplaces is managed only through the Rn activity concentration. In that way, workplaces with Rn levels comprised between 400 and 1000 Bq.m-3 are not obliged to perform workplace studies. Consequently, workers are not monitored for IR exposure even if effective dose may be higher than 1 mSv due to high exposure time.
As an expert in the field of radiation protection, ALGADE was many times asked by employers on the Rn risk for temporary maintenance works in underground galleries. As the exposure time does not exceed 200 h over the year and as the galleries are placed out of the Rn prone areas, these specific cases are not covered by the regulation and Rn integrated measurements following ISO 11665-4 can't be performed. Following a specific mapping protocol, based on both spot Rn and decay products measurements (ISO 11665-3 and ISO 11665-6), Rn exposure has been estimated in more than 50 sites over 3 years for the same company. Rn activity concentration up to 400 kBq.m-3 and Potential Alpha Energy Concentration up to 160 µJ.m-3 were measured. Implementation of an appropriate ventilation to limit Rn accumulation in the galleries was first recommended. Then, depending on the level of PAEC, the time workers may stay in the underground gallery without exceeding 1 mSv was determined. This Rn risk management tool has permitted to protect the workers of the major employer but not the ones depending on temporary employment agencies subject to be exposed in "not characterized" underground workplaces.
ALGADE's feedback shows that using the reference level of 1000 Bq.m-3 as the only key to conduct workplace studies without taking into account the exposure time is not sufficient. Temporary underground workplaces in or out of the Rn prone areas may also present Rn risk. The Personal Alpha Dosimeter commonly used worldwide by uranium miners remains the best way to estimate Rn exposure of workers.

Country IRELAND

Radon in workplaces in Ireland - Lessons learned and future opportunities

David Fenton, Environmental Protection Agency, Dublin, Ireland

National legislation, which implements European Council Directive 96/29/EURATOM in Ireland, sets a reference level of 400 Bq m^{-3} averaged over any 3 month period for radon exposure in the workplace and also empowers the Environmental Protection Agency to direct employers to have radon measurements carried out. Between 2001 and 2004, different approaches were adopted aimed at encouraging radon testing in above ground workplaces. As a first step, some 2600 employers in two known high radon areas were directed to have radon measurements carried out. This programme had limited success because of problems in obtaining accurate workplace databases and a general lack of awareness on the part of employers of the issues involved. As a result, a repeat of such large scale regulatory effort could not be recommended. Therefore, in 2004 a smaller scale regulatory campaign was undertaken when 60 employers were directed to carry out radon measurements. This resulted in eight cases going to court of which convictions were handed down in the case of three. Another three employers received the probation act and the remaining two cases were dismissed. The resources to execute this campaign were significant taking about one man year of work however there were some positive outcomes. It showed the EPA was serious about radon. It made radon real to stakeholders and to other agencies and it highlighted some weaknesses in the legislation that otherwise might not have arisen. It is proposed to strengthen these weaknesses through the implementation of the new BSS Council Directive 2013/59/Euratom.

Between 2006 and 2012 significant efforts were made to raise awareness of radon in workplaces. These include measurement by State employers encouraged by the State Claims Agency who had identified radon in state workplaces as a potential source of litigation against the state. Comprehensive guidance for employers was developed during this period and radon is now included in routine workplace inspections carried out by the Health and Safety Authority and of EPA radiological licensees. This type of interagency co-operation was vital in developing the National Radon Control Strategy (NRCS) for Ireland between 2011 and 2014. The NRCS, which was published in 2014, makes specific recommendations for new / amended regulations on the duties of employers regarding measurement, remediation as well as ongoing risk assessment. It calls for a risk based approach including specific regulations for underground workplaces. Such regulations will coincide with implementation of the EU BSS. The IRRS mission to Ireland took place in September 2015. This mission welcomed the provisions of the NRCS but also noted the need to review and revise the specific regulations addressing radon in workplaces to enhance their effectiveness.

The lack of clarity, internationally, surrounding the dose conversion factor for radon in a matter of some concern to all those involved in the regulation of radon in workplaces. Implementation of the new BSS across Europe provides an opportunity for an agreed approach to dose conversion to be developed and this would be welcomed in Ireland.
In summary, various measures have been attempted in implementing regulations on radon in workplaces. Lessons have been learned, and in the context of the NRCS, the implementation of the EU BSS and IRRS recommendations, there is a unique opportunity to improve regulations in Ireland.

Country ITALY

Radon exposure in workplaces: Some experiences in Italy and issues for the transposition (and implementation) of the directive 2013/59/Euratom

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* Presenter

Italy has introduced protection from radon exposure in workplaces (including schools) in 2000, by the transposition of the European Directive 96/29/Euratom. Moreover, in 2002 the Italian National Action Plan has been approved by the Ministry of Health. Therefore some experiences on several related issues has been acquired and data has been collected in the National Radon Archive. In this presentation, some data on radon surveys and remedial actions carried out in workplaces, as well as experience on implementation of the Italian legislation on radon protection in workplaces, are reported and discussed. On this basis, several issues concerning the transposition and implementation of the directive 2013/59/Euratom, as regards radon protection in workplaces, are presented and discussed, such as the process for the implementation of the directive and for the development of the new National Radon Action Plan, dose coefficients for radon in workplaces, the use of the "radon-prone area" as a "priority area", building materials as source of indoor radon, notification, national radon archive, etc.

Country NORWAY

Radon measurements in Norwegian schools and kindergartens – an example of radon issue at workplaces

Jelena Mrdakovic Popic, Maria Larsson and Bård Olsen, Norwegian Radiation Protection Authority (NRPA)

Introduction

The Norwegian government adopted its national strategy for reducing radon exposure in 2009.

Two strategic goals in the national radon strategy were set as:

1. Work towards reducing radon levels in all buildings and premises to below the stated limits.
2. Contribute to reducing radon exposure in Norway as low as reasonably achievable.

Based on annual national budgets, grant schemes and relevant government documents, the five-year period (2009-2014) was primarily set for the implementation of national strategy. After the evaluation of results in June 2014, prolongation of the strategy implementation period was approved for new five years (2015-2020).

Within the radon strategy, one of the defined sub-strategies is 'Radon in the workplace'.

The Norwegian Labour Inspection Authority has the responsibility over radon related issues at workplaces. Document 'Guidance on radon at workplaces' was published in 2011 and updated in 2014 by this authority. Radon topics like health effects and risk from radon, national regulation concerning radon in general, responsibility and duties of employers, monitoring and measuring of radon at workplaces and examples of remediation measures are given in this guiding document. It should be highlighted that there are no legally binding radon limits, but recommended levels for workplaces in Norway. However, certain exceptions are existing binding limits for radon in schools and kindergartens, as well as binding limits for radon at workplaces situated in new build. These limits are given in the radiation protection regulations and the technical building regulations. The Norwegian Radiation Protection Authority (NRPA) and Directorate for Buildings Quality (DBK) are responsible authorities for these regulations.

Radon in schools and kindergartens in Norway

Radon levels in schools and kindergartens are, from January 2014, regulated with legally binding indoor limits (100 Bq/m^3 and 200 Bq/m^3 as action and maximum level, respectively) that are part of recent radiation protection regulations (2010).

The Directorate of Health and the NRPA are currently working together to develop a guiding document for the municipalities on how to perform radon inspections. The Norwegian Radiation Protection Authority will act as a supervisor towards the municipalities, but will also do inspections according to radiation protection regulations. The municipalities have the role of inspection according to the public health regulations, which refers to the limits in the radiation protection regulations.

The NRPA has issued and renewed in 2012 and 2015, respectively, standard measurement protocol for indoor radon in schools and kindergartens. This protocol consists of two steps; first long-lasting measurement that should eventually show higher radon levels in the air and second, short time measurement that should show the possible effects of air ventilation and value of radon in the air in working period / active period during the day. Furthermore, all the necessary practical measurement details for types of buildings schools and kindergartens are given in this guiding document.

Recently, the NRPA has carried out two important projects. The first was to check the validity and justification of use of the current correction factor for seasonal variation. The project includes 1450 radon measurements in 67 buildings in different schools and kindergartens all over the country. In the second project, 14000 measurements in 215 schools were analysed to give information on how many rooms that needs to be measured in order to decide if a school has a radon problem or not. Results of the projects and details of recently updated measurement protocol will be presented during the workshop.

Country	NORWAY

Mapping of Radon and implementing measures in buildings owned by the Norwegian Defence Estate Agency

Camilla DAHL RUSTAD (NDEA)

To comply with the Norwegian regulations of radon, the Norwegian Defence Estate Agency started a project in 2012, to map radon levels in all of the Defence estates where personnel work or stay for more than 2 hours per day. Due to the amount of buildings, the project was divided into several stages: 2012/2013 – mapping of houses/residences and mountain complexes, 2013/2014 - offices and work places and 2014/2015 – remaining buildings from the first two stages. All buildings have been mapped using closed CR-39 track-etch detectors for two months, during the winter time. The mapping has been conducted according to the recommendations from the Norwegian Radiation Protecting Authority (NRPA) For control and evaluating the effectiveness of radon reducing measures, both closed CR-39 track-etch detectors and digital detectors have been used.

The requirements for radon level in rental houses/residences, schools and kindergartens and the recommendations for other buildings, given by the NRPA, have been followed. All buildings which have a radon level above 100 Bq/m^3 are closely evaluated and radon reducing measures are implemented if needed. The main objective is to have radon levels as low as possible in all the Defence estates and under the maximum limit at 200 Bq/m^3.

Buildings are evaluated as soon as possible after the results are received. Measures to reduce the radon concentration are implemented if needed. New control measures are done to check if the measures to reduce the radon concentration have had a positive effect. If not, new measures are performed. For buildings with balanced ventilation, which are used as work places, control measurements are performed with digital detectors to see whether the radon concentration is below the limit during working hours. These control measures have shown that in most cases the balanced ventilation gives enough effect to reduce the radon level to acceptable concentrations during daytime, and no additional measures are required. Some work places and especially mountain complexes require comprehensive and expensive constructional measures. There are still some of these buildings/complexes that are not under the acceptable level as today. In work places where it`s impossible to reduce the radon concentration below the maximum limit, the exposure might be regulated by reducing the working hours or buildings will be closed.

STATUS

2478 of the Norwegian Defence estates have now been mapped for radon. About 170 buildings remain. It has been found radon levels above the limit of 100 Bq/m^3 in 966 buildings. Until now 818 of the 966 buildings have been evaluated and radon reducing measures performed. 442 of these buildings have radon levels below the maximum limit of 200 Bq/m^3. Measures to reduce the radon concentration in 524 buildings, distributed on 176 working places/offices and 348 houses/residences, remain.

Table 1: Results from mapping of radon in the Norwegian Defence Sectors buildings, 2012-2015. The numbers are the amount of buildings with given radon concentrations in Bq/m^3.

	Total	<100 Bq/m^3	> 100 Bq/m^3	100-200 Bq/m^3	>200 Bq/m^3	>1000 Bq/m^3
Work places/offices	1035	582	453	193	216	44
Houses/residences	1443	930	513	246	246	21
Total	2478	1512	966	439	462	65

Country SPAIN

CSN guidance on assessing radon exposure at the workplace

M. García-Talavera (CSN)

In 2012, CSN issued Safety Guide 11.04 on "Methodology to conduct radon exposure assessments at the workplace". Recommendations include i) dividing the workplace into homogeneous radon concentration zones (HZ), ii) placing a minimum number of detectors per HZ depending on its surface, and iii) setting exposure timing and duration.

A statistical decision framework is also provided to demonstrate compliance with the radon reference level. At certain types or workplaces, or where the reference level is exceeded, guidance is given on how to characterize radon short-term variations (day/night and occupied/unoccupied effect) and on how to measure the equilibrium factor.

Finally, the need is emphasized for worker information and consultation while planning and conducting the study.

Country SWEDEN

Measurement and management of radon in different occupational environments in Sweden

Kirlna Skeppström, Magnus Ahnesjö, Erik Wåhlin

1. Introduction

Radon concentration at workplaces in Sweden has not been thoroughly studied as compared to radon concentration in dwellings. An accurate picture of the extent of the problem at workplaces is lacking at present. The risk of encountering an increased level of radon in an indoor environment is however the same for dwellings as for workplaces; the source of radon is the same for both cases. Goals at national level to ensure low radon levels at workplaces are non-existent. The situation is however likely to change in the future because the basic safety standards (BSS) from the EU require a strategy in national action plans for measurement and management of radon at workplaces.

It is the employer's responsibility to ensure a good occupational environment. The Swedish Work Environment Authority issues regulatory limits for radon at workplaces and has the supervisory role. Present legislation on radon at workplaces (excluding schools and some buildings with public access) imposes three regulatory limits on radon exposure depending on the work environment. These limits, which are expressed as annual exposures, are for workplaces above ground 0.36 MBqh/m^3 (corresponding to an average radon level of 200 Bq/m^3 during 1800 working hours a year), and for workplaces located in specially prepared underground rooms, 0.72 MBqh/m^3 (400 Bq/m^3 and 1800 h/year). For mining operations under ground the limit is 2.1 MBqh/m^3 (1300 Bq/m^3 and 1600 h/year). These limits imply that increased radon levels in any occupational environment do not necessarily require remediation measures to reduce radon levels below a reference level. Increased radon levels can be allowed to prevail in an environment provided that the annual exposure limit is not exceeded. However, since employers are relatively inflexible regarding the number of working hours, efforts are instead often made to reduce the radon concentration at a workplace.

The aim of this paper is to provide an overview of how measurements are carried out in different occupational environments in Sweden and how the exposure situations are managed. It also discusses the challenge that emerges when radon is to be dealt with as a planned exposure situation.

1. Guidelines for measurement of radon at different workplaces

Guidelines on how to measure radon at workplaces are issued by the Swedish Radiation Safety Authority in collaboration with the Swedish Work Environment Authority. These guidelines are however not applicable to underground occupational environments, such as mines.

Measurements are to be conducted in two steps. The first step is called an 'orientation measurement' and is to be conducted over at least two months. Passive detectors (etch track detectors) are usually used for that purpose. If measurement results are below the regulatory limits, no further actions are required. It has been shown that the orientation measurements often lead to an overestimation of the actual radon concentrations at workplaces. This is due to the fact that ventilation systems are often switched off after working hours and over weekends. Passive detectors thus register an increased radon concentration during a period when employees are not exposed to radon. 'Follow-up' measurements are therefore required and should be carried out in a second step if orientation measurements reveal high radon levels exceeding regulatory limits. Short-term measurements over approximately one week are carried out during that second step using either passive detectors or active detectors. It should be ensured that ventilation is switched on during the whole measurement period (even after working hours) if passive detectors are to be used in the follow-up measurements. Remediation measures are required if follow-up measurements show that the regulatory limits are exceeded.

All measurements are performed during the heating season. One difficulty that is often encountered regards the strategy for choosing the location where detectors are to be placed, especially at workplaces comprising of several buildings and several rooms. It is not feasible to require measurement in all rooms. The recommendation is to get an overview of the situation in the first step. Radon concentrations are to be measured in a couple of rooms located on the ground floor, with at least one measurement per floor. There is also a recommendation to measure the gamma dose rate in a building to determine whether the building is built of alum shale concrete, a uranium-rich building material used in Sweden between the 1930s and late 1970s. If the gamma dose rate exceeds 0.3 µSv/h, radon measurements should be carried out. Should high levels of radon be encountered in one or more rooms, the employer has two options: Either to remediate the whole building or to carry out additional measurements in the building if remediation is intended only in those spaces.

2. Management of radon at different workplaces

3b) How does a mining company deal with radon?

The guidelines for measuring radon do not apply to underground mines, so mining companies have to implement a satisfactory radon monitoring system on their own. Some examples of worker protection against radon can be found in reports to the Swedish Work Environment Authority on personnel exceeding exposure limits. (LKAB, 2014).

LKAB is a mining company that operates mines in the north of Sweden; among the most well-known are the Malmberget and Kiruna iron ore mines. They have a well-developed system for checking radon exposure of workers in order to comply with the yearly exposure limit of 2.1 MBqh/m^3 (1300 Bq/m^3 during 1600 h) set by the Swedish Work Environment Authority.

Key locations in the mines are monitored by alpha track detectors that are replaced and sent for analysis four times a year. The fixed measurement points serve to monitor long-term radon concentrations in the air. LKAB has set an internal action limit at 660 Bq/m^3 for when they are to take actions to reduce the concentration of radon in the air. If values at the fixed measuring points are above this action limit, a closer investigation in the area is performed using a time-resolved instrument. When a more detailed picture of the situation is obtained, appropriate actions are taken. Examples of these might include expanding the ventilation system or moving worksites to more suitable locations.

A number of workers from different working groups also carry personal dosimeters in the form of alpha track detectors. Not all workers carry dosimeters; instead, representatives from each working group carry them in order to identify groups with high radon exposure. If a worker is reported to have exceeded the yearly exposure limit of 2.1 MBqh/m^3, a number of measures are taken. Examples of these measures include giving work assignments above ground to workers exceeding the limit, giving dosimeters to all workers in the working group in question, performing control measurements in workers' homes, and consulting with the Swedish Radiation Safety Authority.

3b) The radon situation in schools and preschools

Schools and preschools are at the same time both public places and workplaces, and thus have to comply with regulations for both these categories of buildings. For public places, municipalities are responsible for operational supervision, whereas for workplaces, as stated earlier, the Swedish Work Environment Authority has this responsibility. In practice, the municipalities perform the most active supervision, and both regulations are complied with by ensuring that radon levels are below 200 Bq/m^3 during the occupancy time of the building.

This control of radon levels in schools is further emphasized by including the radon levels of schools as an indicator in Sweden's environmental objectives. Previously, there was a specific sub-target within the environmental objectives that radon levels in schools and preschools should be below 200 Bq/m^3 no later than 2010. In 2009, the Swedish National Board of Housing, Building and Planning published the results of a large study (BETSI, 2009) on the technical status and indoor environments of Swedish buildings. The study showed that approximately 1,000 out of a total of 25,000 schools and preschools (around 4%) had radon levels above the target value.

In general, the radon situation is better in schools than in dwellings. With larger rooms, the ratio of wall surface to room volume is smaller, implying that radon-emanating construction materials such as alum shale concrete are less of a problem. Schools are also generally better ventilated than dwellings.

The Swedish Radiation Safety Authority recommends that measurements in schools and preschools be carried out according to the guidelines for radon measurements at workplaces. Since time-controlled ventilation is often used in school buildings, this is dealt with as described in section 2.

3c) Special occupational environments

There is a general tendency to assume low radon concentrations in occupational environments above ground, and due to the fact that forced ventilation is often in place. There are, however, some occupational environments where either measurement or management of high radon levels is a difficult task. One such example is how mitigation measures are difficult in a cathedral located in the city of Uppsala. Uppsala Cathedral is situated on a hotspot, a uranium-rich esker. Radon levels measured previously in the church exceeded 1000 Bq/m^3. This increased level of radon is above all a problem for guides and other personnel working there. Several remediation techniques have been tested and the level presently varies around 400 Bq/m^3. The historical value and architecture of the building must be preserved, which limits the extent of remediation measures.

There is a special category of workers which is regularly exposed to increased levels of radon over a relatively short period of time when they are on the job. Due to the nature of their work, they are regularly exposed to high levels of radon during different work assignments. Examples of these workers might include those inspecting underground spaces in connection with remediation measures for radon. The problem is twofold in that the exposure is difficult to quantify unless these workers carry personal dosimeters, and these workers are often not under the responsibility of any employer, as they are consultants. It is a challenge to manage radon exposure for such workers and there is a need for additional information and education to increase their awareness about the health risks of radon.

In fact, this is not only a challenge for "special" working environments, but a problem which extends to all cases where employees perform work in locations that are not under an employer's control. In some special cases where high radon levels are expected, it can be reasonable to use personal dosimeters for these workers, but it is generally difficult to accept that an employer can take any responsibility for the radon exposure of the personnel in such cases.

4. Upcoming challenges due to BSS

The BSS will lead to amendments of a couple of Swedish regulations regarding radon in workplaces. With a first approach to an implementation of the BSS, the previous exposure limits given in section 1 might be omitted and replaced by a reference value of 200 Bq/m^3 for the radon activity concentration instead. If the reference value is exceeded, the radon levels should be monitored and attempts should be made to mitigate the radon concentration. If the levels are consistently high and workers risk an exposure to radon exceeding that of 6 mSv per year, the occupational environment is to be considered a planned exposure situation. In practice, this means that the operation in question should be considered an operation involving radioactivity and is to be treated accordingly. This can involve individual monitoring of personnel exposure.

As regards current Swedish regulations, there will be a gap when it comes to regulating treatment of different occupational environments. For example, workplaces that currently comply with the 0.72 MBqh/m^3 limit will have limits that are less clear, as the exposure will probably not exceed the annual 6 mSv limit. But at the same time, they will exceed the reference value of 200 Bq/m^3 of radon concentration and be recommended to attempt lowering the radon concentration. However, lowering the radon concentration might be very difficult and there is no clear, actual incentive other than the recommendation to lower radon levels.

Occupational environments that exceed the 6 mSv annual limit (for example, mining operations) will have an increase in worker monitoring though the new dose limits will instead be 20 mSv/y, which is higher than the current exposure limit. As a result, the worker protection for an individual worker might be reduced, but seen as part of a larger picture, worker protection will improve through an expanded control system.

5. References

BETSI, 2009, Så mår våra hus, report in Swedish, ISBN 978-91-86342-29-6.

LKAB, 2014, personal communication and measurement protocols in Swedish.

Country SWITERLAND

High radon levels at a workplace due to radium contaminations caused by a former watch workshop

F. Barazza (FOPH)

In the context of the new radium action plan implemented in Switzerland, significant radium contaminations have been found at an estate agent in the city of Biel. The radium found at different locations in the offices stems from a former watch workshop. During the investigations of the radium residues rather high radon levels have also been detected in the offices located at the first floor. Continuous radon measurements during the remedial work aimed at removing the radium contaminations have shown that the high radon concentrations have been caused by the presence of radium and are not due to a high radon potential in the underground. The results also provide evidence that specific operations during the remedial work have a strong impact on the radon levels. After the removal of the radium contaminations the radon levels in the affected locations are now generally below 100 Bq/m^3.

Country	SWITERLAND

Radon Exposure at Workplaces in Switzerland — Focus on Water Supply Systems

Stephan BUECHI (SUVA)

The Suva has launched a programme to measure and to reduce radon exposure of workers in water supply systems. We started with a brochure which was sent to all operators of water supply systems in Switzerland together with an accompanying letter and a feedback form. In summer 2015 we started with measurements in selected water supply systems. First results show, that typical radon concentrations are about 10’000 Bq/m^3 in spring collection chambers, 1000 Bq/m^3 in groundwater pumping stations and 100 Bq/m^3 in lake water purification facilities.

We present practical considerations on optimisation measures and how suitable reference values can be established.

Common understanding of the BSS requirements and Recommendations

The Council directive 2013/59/Euratom laying down basic safety standards for protection against the dangers arising from exposure to ionising radiation (BSS) introduces the new concept of national action plan for reducing radon exposure. The radon exposures in workplaces and buildings with public access have to be considered in the national radon action plan.

On the basis of the analysis of the BSS requirements, HERCA members:

- Propose a common understanding of these requirements in order to bring clarification when it seems to be necessary and useful,
- And nevertheless, taking into account the flexibility introduced in the BSS, formulate 15 recommendations in order to support the preparation or the updating of the national action plans, and associated regulations.

Common understanding of BSS requirements

- For the national action plan preparation, Member States should consider the indicative list of items defined in the BSS, annex XVIII. This list is not exhaustive, and Member States may include further topics.
- The actions included in the national radon action plan (Article 103), in particular those under the responsibility of a national authority, should allow for the principle of justification applied to existing exposure situations in general (Article 100.2). Also, any decisions on remedial action in a specific workplace should be justified, in the sense that it should do "more good than harm" (BSS Article 5 (a)).
- The responsibility for the establishment and implementation of the national radon action plan is assigned by the Government/Regulator. This relates in particular to the introduction of the national reference level value(s), the identification of areas mentioned in BSS, annex XVIII item 2[1], and requirements on workplaces located in these areas on the ground floor or basement level, as well as to the identification of specific types of workplaces of interest (inside or outside these areas, taking into account parameters listed in the national radon action plan). Such decisions can be introduced in the national radon action plan and/or in specific regulations.
- The identification of specific types of workplaces and buildings with public access should be achieved on the basis of a risk assessment, considering for instance occupancy hours, building type, location (geology), etc.
- Radon in workplaces that may arise from the presence of naturally occurring radioactive materials (NORM) that are considered within a planned exposure situation is not covered by the national radon action plan. The identification of individual industrial sectors or processes, taking into account sectors listed in Annex VI of the BSS, should be organised in parallel.
- In ordinary workplaces and workplaces such as mines, caves, spas (not considered as practices), for which there is no link between the type of work and the exposure to radon, radon measurements and remedial actions should be placed under the employer's responsibility.
- For NORM practices (as for all practices), the first responsibility for the protection of workers exposed to radon should be clearly allocated to the undertaking or the employer (BSS Article 31.1/31.2).
- In addition to the employer's responsibility, particularly in the context of rented buildings, the building owner's role, for new-built possibly in conjunction with the construction company, can be considered.
- The term "new buildings", introduced in BSS Article 103(2)), and for which appropriate measures have to be in place to prevent radon ingress, includes the ordinary workplaces, with or without public accesses, but excludes underground workplaces.

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[1] Different terminologies are used for the designation of these areas: for instance, "radon prone areas", "priority areas"…

- The reference level for radon exposure in workplaces (considered as an existing exposure situation), as defined in BSS Article 7, is not considered as a limit but as a tool for optimisation. As a principle, it will be applied as follows: above this level, the employer or the undertaking has to take justified measures for reducing the radon concentration. The optimisation principle continues to apply also below the reference level that means that the employer needs to consider taking measures to reduce exposures also below the reference level.

  The reference level for the annual average activity concentration in air shall not be higher than 300 Bq/m^3. A Member State may choose a higher reference level if it is warranted by national prevailing circumstances (BSS Article 54.1). The same reference level is meant to apply to all workplace types even though in some types of workplaces it may not be possible to reduce the radon concentration so as to be below the reference level.

- Occupational exposure to radon in workplaces requires a notification in those situations where the radon concentration continues to exceed the national reference level, after optimisation (BSS article 54.3 in conjunction with article 25.2).
- Where the radon concentration (as an annual average) continues to exceed the national reference level, after optimisation, in a situation where the exposure of workers is liable to exceed an effective dose of 6 mSv per year (or a corresponding time-integrated radon exposure value), the radon exposure at work needs to be managed in the same way as a planned exposure situation .The Member States determine which requirements set out for occupational exposure are appropriate (BSS, Article 35.2).
- The calculation of the annual dose in general does not take into account the radon dose, except if a notification is required for occupational exposure to radon under article 54.3, and except for NORM practices which are not exempted from notification and for which radon exhaling from NORM materials may be a pathway that needs to be considered.
- For NORM practices, the dose calculation needs to take into account all the exposure pathways: external exposure due to gamma radiation, internal contamination by inhalation or ingestion of (dust) particles, and inhalation of radon and thoron decay products exhaled from the material.

Recommendations (National Action plan, justification and responsibilities and risk communication)

Rec. I.
Radon exposure, including exposures of workers during all their professional and domestic life, is a public and occupational health issue. The implementation of the national action plan has the potential to save lives and should therefore be given an important priority by Member States. The long-term goal is a reduction of lung cancer risk.

Rec. II.
The national action plan for radon should aim to:

- reduce the individual lung cancer risk by reducing high radon exposures;
- reduce the overall lung cancer risk by reducing the average radon concentrations to well below the reference level.

Rec III.
The national action plan should include preventive and educative actions developed for all employees, involving stakeholders such as Labour Unions and Employers Associations. To allow the effective performance of radon measurements and remedial actions as well as better overall supervision and monitoring, a clear responsibility assignment for radon control in workplaces should be addressed.

Rec. IV.
While in general radon mitigation strategies in the national action plan may include both voluntary and mandatory approaches, HERCA supports the regulatory approach for radon measurement and mitigation in workplaces, including those in buildings with public access.

Rec. V.
Radon risk communication is a key aspect of any radon action plan. As a part of the action plan, customized information should be prepared for employers, employees and their representatives, and other stakeholders. Appropriate communication channels should be used, with particular attention given to small and medium-sized enterprises.

Rec VI.
Mechanisms for worker participation in managing radon risk should be encouraged.

Rec. VII.
HERCA draws national authorities' attention to the radon risk management in workplaces with public access, particularly on the issue of risk communication. In a situation where the radon concentration remains above the reference level, even after optimization, risk communication should cover both the public and workers' exposures. The communication should allow for the difference between the regulatory frameworks (existing exposure situation without dose limitation on the one hand and an existing exposure situation deliberately managed as a planned exposure situation under certain circumstances, with dose calculation, on the other hand). The elements for risk communication toward the workers and the public should be generally prepared in advance, particularly in schools and kindergartens.

Recommendations (Identification of workplaces, radon measurements and control)

Rec. VIII.
Since the radon measurement results are meant to be representative of the annual average activity concentration in air, HERCA recommends to carry out measurements of radon activity concentrations according to national protocols, taking into account international standards, considering for example the relevant ISO standards[2].

Rec. IX.

[2] EN ISO 11665-1 to EN ISO 11665-8 and EN ISO 13164-1 to EN ISO 13164-3.

HERCA strongly recommends that radon measurement in workplaces, in the case where these measurements are mandatory, should have to be carried out by bodies recognized by national authorities. The qualification and training of bodies in charge of remedial actions should also be considered.

For these radon measurements, HERCA recommends to collect and use the results as a tool to assess the impact of the regulations and/or the national strategy put in place and to evaluate the national action plan. HERCA suggests to explore opportunities to collect this results in a database.

Rec. X.
The regulatory procedure should define appropriate time schedules for the implementation of the requirements related to measurement, notification and optimisation.

Rec. XI.
HERCA considers that a regular assessment of the implementation of the regulation related to radon in workplaces and buildings with public access has to be carried out. This assessment should be integrated into other issues related to health and safety at the workplace. Relevant inspectors' training with regard to the concerns about radon has to be ensured.

Recommendations (Graded approach for radon exposure in workplaces)[3]

Rec. XII
HERCA recommends the use of international guidelines, and associated tools, to calculate annual effective doses from the time integrated radon concentration, for different situations such as mines, caves, spas as well as ordinary workplaces and NORM activities. HERCA should ask the European Commission, with reference to the procedure described in the BSS (recitals (9) and (11)), to put this issue on the agenda of article 31 Experts Group as soon as possible.

Rec. XIII.
In order to verify whether the dose limit is complied with, since the duration of exposure should be taken into account in the evaluation of the effective dose or of the corresponding time-integrated radon exposure, HERCA recommends to define, at national level, in which situations a recording of the individual exposure times is necessary.

Rec. XIV.
In case of doses exceeding 6 mSv per year or a corresponding time-integrated radon exposure, requirements set out for occupational exposure need to be laid down; HERCA recommends to apply the occupational exposure requirements related to optimisation, to the radiological surveillance of workplaces (adapted to radon exposure), to workers' information and, in some cases, to individual monitoring.

[3] *A flow chart should be useful for people who are not familiar with radiation protection terminology and concepts.*

Information should be given to occupational health services in order to allow them to inform workers of the specific radon risk, in particular in combination with smoking. To facilitate the workers' information, employers should ensure that there is sufficient internal expertise on radon, or that external expertise can be called upon.

Rec. XV.
To facilitate the implementation of the BSS requirements on radon in workplaces, HERCA should ask the European Commission to prepare European Guidance (to be published in the Radiation Protection Series) based on good practices. Taking into account the different types of concerned workplaces, this guidance should focus on the identification of workplace types, on measurements protocols and on adequate approaches to optimisation.

Annex 1 : Programme

Monday October 12, 2015

Opening Session -

Chairperson: Per Strand (NRPA)
Co-chairperson: Christophe Murith (FOPH)

Time	Topic	Speaker
13:00-13:30	Registration opening	-
13:30-13:50	Introduction - Official welcome - ILO	**Nancy LEPPINK**
13:50-14:10	▸ WHO : Radon in workplaces - A WHO perspective	**Emilie VAN DEVENTER**
14:10-14:30	▸ IAEA : Managing radon exposure in workplaces, requirements in the international Basic Safety Standards	**Tony COLGAN**
14:30-15:30	▸ ICRP ▸ Discussion	**Margot TIRMARCHE**
15:30-16:00	Questions to speakers	-
16:00-16:20	*Coffee*	-

Session I - Presentations - General aspects of radon issue at workplaces

Chairperson : Tony Colgan (IAEA) / Boris Dehandschutter (FANC)
Co-chairperson: Margot Tirmarche (ASN)

Time	Topic	Speaker
16:20-16:40	Presentation 1 (Sweden) Measurement and management of radon in different working environments in Sweden.	**Kirlna SKEPPSTRÖM** (From SSM)
16:40-17:00	Presentation 2 (Czech Republic) "Delineation of radon prone areas and specification of workplaces for mandatory radon measurement in the Czech republic"	**Jana DAVIDKOVA** (From SUJB)
17:00-17:20	Presentation 3 (Italy) "Radon exposure in workplaces : Some experience in Italy and issues for the transposition of the directive 2013/59/Euratom"	**Francesco BOCHICCHIO** and **Giancarlo TORRI** (From Italian national institute of health and ISPRA)
17:20-17:40	Presentation 4 (Belgium) "Radon in workplaces, current practices and future regulations in Belgium"	**Boris DEHANDSCHUTTER** (From FANC)
17:40-18:10	Questions to speakers	-
18:10	*End of the day*	-
18:30	*Cocktail*	-

Tuesday October 13, 2015

Session 1 - continue

Time	Topic	Speaker
09:30-09:50	Presentation 5 (Spain) "CSN's guidance on assessing radon exposure at the workplace"	**Marta GARCIA-TALAVERA** (From CSN)
09:50-10:10	Presentation 6 (Ireland) "Ireland's experience on radon in workplaces – lessons learned and future opportunities", David Fenton from EPA	**David FENTON** (From EPA)
10:10-10:30	Presentation 7 (Norway),"Radon measurements in Norwegian schools and kindergartens – an example of radon issue at workplaces"	**Bard OLSEN** (From NRPA)
10:30-11:00	Questions to speakers	-
11:00-11:20	*Coffee*	-
11:20-11:40	Presentation 8 (Norway),"Mapping of radon and implementing measures in buildings owned by the Norwegian Defence Estate Agency"	**Camilla DAHL RUSTAD** (From NDEA)
11:40-12:00	Presentation 9 (Switzerland),"High radon levels at a workplace due to radium contaminations in a former watch workshop"	**Fabio BARAZZA** (From FOPH)

Time	Topic	Speaker
12:00-12:20	Presentation 10 (Switzerland), "Radon exposure at workplaces in Switzerland: focus on water supply systems"	**Stefan BUECHI** (From SUVA)
12:20-12:50	Questions to speakers	-
12:50-14:00	*Lunch*	-
14:00-14:20	Presentation 11 (France), "Measurement of radon in underground workplaces in France : methodological aspects and feedback	**Geraldine IELSCH** (From IRSN)
14:20-14:40	Presentation 12 (France), "Radon exposure in underground workplaces : feedback of an agreed body in applying the regulation in France"	**Roselyne AMEON** (From Algade)
14:40-15:00	Presentation 13 (US), Radon in the Workplace in the United States : A Mix of Standards and the Need for Harmonization	**Ruth McBURNEY** (From CRCPD)
15:00-15:30	Questions to speakers	-

Session II - Working groups

Chairperson: Augustin Janssens
Co-chairperson: Emilie Van Deventer (WHO)

Working group 1: National action plan, justification and responsibilities

Working group 2: Identification of workplaces, radon measurements and control

Working group 3: Reference level vs dose limit

Time	Topic	Speaker
15:30-15:40	Working groups organisation and goals	**Jean-Luc GODET (ASN)**
15:40-16:00	*Coffee*	-
16:00-18:00	Working groups	-
18:00	*End of the day*	-
18:00-20:00	Report work of working groups (WG leaders and secretary)	-

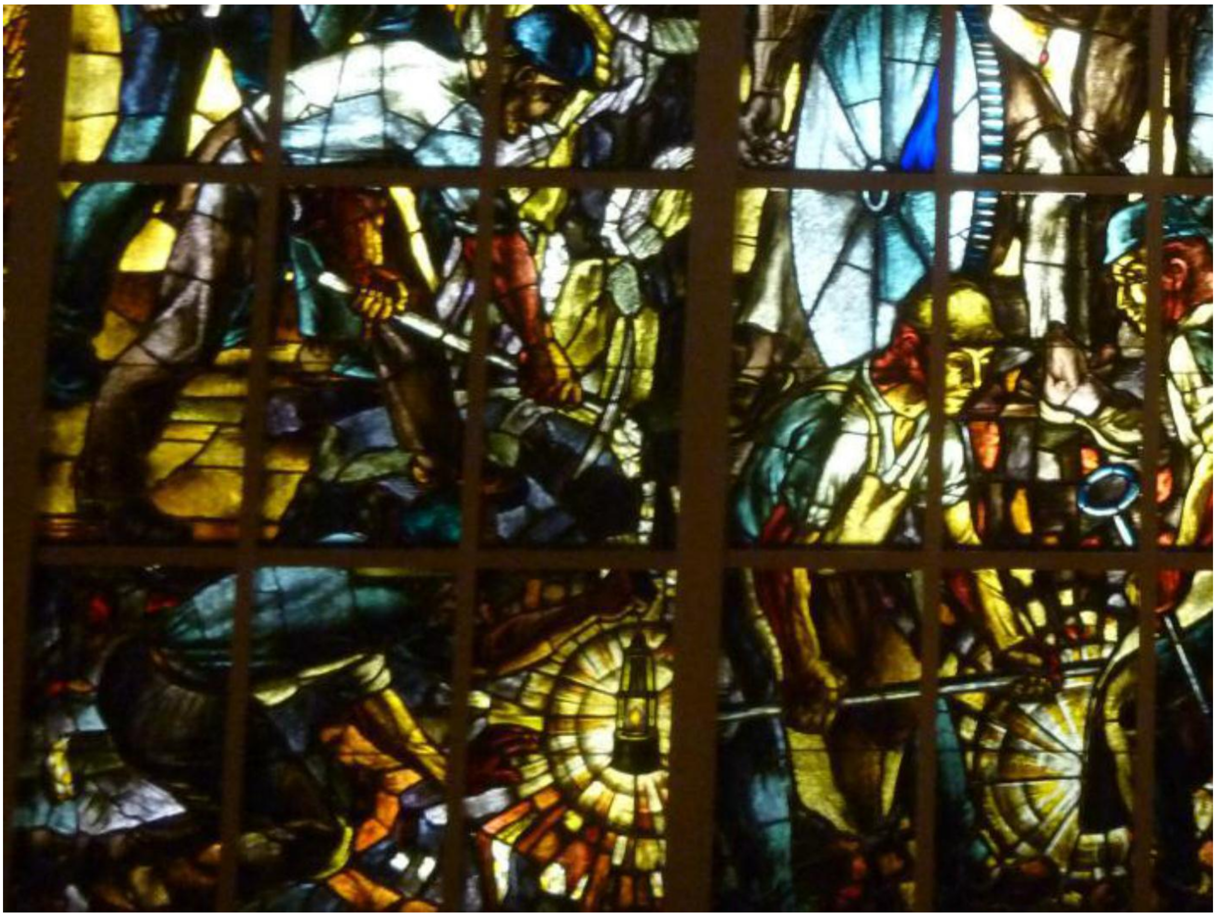
Wednesday October 14, 2015

Time	Topic	Speaker
09:30-09:45	Report from working group 1	**WG1 Pilote** **Barbara RAFFERTY**
09:45-10:05	Discussion	-
10:05-10:20	Report from working group 2	**WG2 Pilote** **Shengli NIU**
10:20-10:40	Discussion	-
10:40-11:00	*Coffee*	-
11:00-11:15	Report from working group 3	**WG3 Pilote** **Margot TIRMARCHE**
11:15-11:35	Discussion	-
11:35-12:00	Main findings of the workshop	**Christophe MURITH** (From FOPH)
12:00	*End of the workshop*	-

Annex 2: Participants

Participant list

	Country	Name of the participant	Entity
1	*Sweden*	AHNESJÖ Magnus	SSM
2	*Netherlands*	ALPHENAAR Miranda	Ministry of Social Affairs and Employment
3	*France*	AMEON Roselyne	Algade
4	*Switzerland*	BARAZZA Fabio	FOPH
5	*Italy*	BOCHICCHIO Francesco	Italian National Institute of Health
6	*Switzerland*	BUECHI Stefan	SUVA
7	*Taiwan*	CHEN Ching-Jiang	I-Shou University
8	*Austria*	COLGAN Tony	IAEA
9	*France*	COLLIGNAN Bernard	ERA
10	*Norway*	DAHL RUSTAD Camilla	Norwegian Defence Estate Agency
11	*Czech Republic*	DAVIDKOVA Jana	SUJB
12	*France*	DECHAUX Eric	Autority Safety Nuclear (ASN)
13	*Belgium*	DEHANDSCHUTTER Boris	Federal Agency for Nuclear Control
14	*Germany*	DUBSLAFF Martin	BFS
15	*Norway*	DYSVIK Solveig	NRPA
16	*Ireland*	FENTON David	Envrironmental Protection Agency
17	*Spain*	GARCIA GOMEZ Montserrat	Ministry of Health
18	*Spain*	GARCIA-TALAVERA Marta	CSN
19	*France*	GODET Jean-Luc	Autority Safety Nuclear (ASN)
20	*France*	IELSCH Géraldine	IRSN
21	*Luxembourg*	JANSSENS Augustin	Expert
22	*France*	JAUNET Pierrick	Autority Safety Nuclear (ASN)
23	*Austria*	KUNTE Angelika	Austrian Agency for Health and Food Safety (AGES)
24	*Finland*	KURTTIO Päivi	STUK
25	*Norway*	LARSSON Maria	NRPA
26	*Luxembourg*	LECOMTE Marielle	Ministère de la Santé
27	*Switzerland*	LEPPINK Nancy	ILO
28	*Spain*	MARTIN MATARRANZ José-Luis	CSN
29	*France*	MATHIEU Peggy	DGT
30	*USA*	McBURNEY Ruth	Conference of Radiation Control Program Directors
31	*Switzerland*	MURITH Christophe	FOPH
32	*Switzerland*	NIU Shengli	ILO
33	*Norway*	OLSEN Bard	NRPA
34	*Switzerland*	PALACIOS Martha	FOPH
35	*Czech Republic*	PETROVA Karla	SUJB
36	*Greece*	POTIRIADIS Constantinos	Greek Atomic Energy Commission (EEAE)
37	*Ireland*	RAFFERTY Barbara	Environmental Protection Agency - Office of Radiological Protection (Ireland)
38	*Austria*	RINGER Wolfgang	Austrian Agency for Health and Food Safety (AGES)
39	*France*	SCHIEBER Caroline	CEPN
40	*Sweden*	SKEPPSTRÖM Kirlna	SSM
41	*Slovenia*	SKRK Damijan	Slovenian Radiation Protection Administration
42	*Germany*	STEGEMANN Ralf	Federal Ministry for the Environment, Nature Conservation, Building and Nuclear Safety
43	*Norway*	STRAND Per	NRPA
44	*UK*	TAYLOR James	Health and Safety Executive
45	*France*	TIRMARCHE Margot	ASN
46	*Italy*	TORRI Giancarlo	Italian National Institute of Health
47	*Switzerland*	VAN DEVENTER Tahera Emilie	OMS
48	*Germany*	VOGEL Julian	Federal Ministry for the Environment, Nature Conservation, Building and Nuclear Safety
49	*Austria*	WIDNER Birgit	Federal Ministry of Agriculture, Forestry, Environment and Water Management
50	*Japan*	YONEHARA Hidenori	Nuclear Regulation Authority (NRA)
51	*Lituania*	ZILIUKAS Julius	Radiation Protection Centre



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