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Report on European reference standards for RPO training

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Contents

Summary

This report covers the Deliverable WD 3.2 of Work Package 3 (*WP3: Define requirements for RPO competencies and establish reference standards for RPO training)*: Report on European reference standards for RPO training.

Employees, appointed to act as RPO in hospitals, industrial companies or teaching and research institutions should have an adequate level of understanding of concepts related to radiation protection and should also be acquainted with the safe and secure use of radiation sources as relevant to the application. Depending on the complexity of the radiation application and the associated radiation protection tasks, RPO need appropriate training in radiation protection and, in some cases, a certain level of work experience tailored to the specific needs to fulfil particular radiation protection tasks. It is therefore essential, on the European level, (i) to define the required competences for RPO according to their area of work and specific radiation protection tasks, and (ii) to establish European reference standards for RPO training.

In order to define requirements for RPO competencies, the issue of definition and role of RPO has been considered on the European level. It should be noted that, other than the issues of general competency and suitability, there is no prescription on the European or international level of the “specification“ of the individual being an RPO. The appropriate route to gaining the level of competence required to become an RPO will usually be a combination of training plus relevant experience in the appropriate area of work. The main areas of RPO work are considered and examples of appropriate elements of building competence of RPO are given which could serve as European reference standards for RPO training.

The European Qualifications Framework for lifelong learning (EQF) and the European Credit system for Vocational Education and Training ECVET might be useful tools in building competence of RPO within Europe. Examples of knowledge, skills and competence elements for various EQF levels are given which may be further developed to fit existing RPO training activities.

1. INTRODUCTION

As part of the ENETRAP project, education and training with respect to the Radiation Protection Officer (RPO) has already been given some consideration [1], although the main focus was on the Radiation Protection Expert (RPE). The RPO has been described as individual appointed by the licensee to "supervise or oversee the execution of the work (practices)". This description has been refined and discussed at EUTERP Workshops (EUTERP = European Training and Education in Radiation Protection Platform) [2] and finally, a definition of the RPO, which found broad acceptance within the radiation protection community, has been suggested to the European Commission (EC). This definition was adopted in the Draft Euratom Basic Safety Standards Directive - Version 30 May 2012 [3] which will supersede the Council Directive 96/29/Euratom [4]:

"Radiation protection officer: an individual technically competent in radiation protection matters relevant for a given type of practice who is designated by the undertaking to oversee the implementation of the radiation protection arrangements of the undertaking."

In the draft directive, it is clearly said that Member States shall require, where appropriate, the establishment of a radiation protection officer to perform radiation protection tasks within undertakings and request undertakings to provide to the radiation protection officers the means necessary for them to carry out their duties.

In Title IV, the EC is requesting an adequate legislative and administrative framework for providing appropriate radiation protection education, training and information to all individuals with specific competences in radiation protection.

In practice, RPO are working in a variety of many different areas of applications of ionising radiation in the medical sector, in industry and research. Therefore, appropriate education, training and experience is being recognized as of primary importance for achieving competence of RPO in any area of work. Persons who are to be responsible for nuclear, radiation, transport or radioactive waste safety should have an adequate level of understanding of concepts relating to radiation protection and should also be acquainted with the safe and secure use of radiation sources. Generally, training has as a prerequisite a specified educational level. In addition, RPO need an appropriate level of work experience to fulfil particular responsibilities.

On the international level, the term RPO is defined in a way similar to the European level in slightly other words as "person technically competent in radiation protection matters relevant for a given type of practice who is designated by the registrant, licensee or employer to oversee the application of relevant requirements" [5]. With regard to building competence in radiation protection, the IAEA has published standards and guidance documents [6, 7] which are also relevant for RPO training.

It is envisaged that the outcome of this project will be instrumental for the cooperation between regulators, training providers and customers (nuclear industry, medical sector, research and non-nuclear industry) in reaching harmonization of the requirements for education and training of RPO within Europe, and will stimulate building competence and career development to meet the demands of the future. However, it has to be kept in mind that at the end of the ENETRAP II project the current version of the Draft Euratom Basic Safety Standards Directive might still be subject to modifications of the text which might have an influence on the considerations in this report.

2. ROLES AND FUNCTIONS OF THE RPO

One of the findings of the ENETRAP project [1] was that there appears to be a sliding scale in approach to the RPO role. At one end of the scale (eg Ireland, the UK,) the role is restricted in effect to local supervision of working practices, requiring only a fairly basic understanding of radiation protection issues. In other countries (eg Germany, Finland, Croatia) the role is more substantial, requiring a more in-depth level of knowledge and ability in order to take a lead on radiation issues on behalf of the employer, which might include provision of training to the workforce, dose analysis, complex measurements etc. In these situations, the RPO is often formally approved by the relevant Regulatory Body. At the top end of the scale (eg France, Czech Republic), the role of the RPO is the primary radiation protection position with the input expected, and the degree of education and training required, being dependant on the complexity of the application.

The results of a questionnaire to the regulatory bodies in EU countries show a blurring of the margins between RPO and RPE. This is a factor that has an influence on the management of radiation protection expertise within a country and on the consequent approach to education and training. RPO and RPE can be the same person but in different roles/functions. For example, the RPO is not legally “responsible” (this is the license holder) and the RPO is not the expert adviser (this is RPE).

With regard to the RPO, it is clearly stated in the Draft Euratom Basic Safety Standards Directive that the establishment of an RPO is required to perform radiation protection tasks within undertakings and that - depending on the nature of the practice - the tasks of the RPO may include the following:

- ensuring that work with radiation is carried out in accordance with the requirements of any specified procedures or local rules;
- oversee the implementation of the programme of workplace monitoring;
- maintain adequate records of radioactive sources held by the practice;
- carry out periodic assessments of the condition of the relevant safety and warning systems;
- oversee the implementation of the personal monitoring programme;
- oversee the implementation of the health surveillance programme;
- give new employees an introduction in local rules and procedures;
- give advice and comments on work plans;
- authorise work plans;
- provide reports to the local management;
- participate in the arrangements for prevention, preparedness and response for emergency exposure situations;
- liaison with the radiation protection expert.

Where appropriate, the task of the RPO can be carried out by a radiation protection unit established within an undertaking. In Appendix 1, examples of typical RPO tasks in specific areas of application are given. The competence required to carry out these tasks depends very much on the nature of the practice and can widely vary.

The RPO is often the point of reference for radiation protection and might even be the only one knowledgeable in radiation protection in an undertaking. As such, the RPO is the main contact point for the RPE as external adviser and for competent authority (for example, for

radiation protection conditions of the license and during on site inspections of the authority). The role of the RPO can be seen as interface between the licensee, the RPE and the regulator.

The RPO concept applies to all sectors. In the medical sector, there might be RPO and MPE (Medical Physics Experts) in the same hospital where the RPO carries out the tasks described above while the role of the MPE is mainly to take care of the radiation protection of the patient. However, some MPE might also have the function of an RPO in a hospital when appropriate.

In most cases, a person carries out the tasks of an RPO on a part-time basis, in addition to his other duties as an employee. For example, in undertakings where the use of radiation is incidental to the company's main work such as gauges, static eliminators etc., the RPO is likely to be an existing employee with a role that already involves supervising general work with the sources of radiation. In industrial organizations where the use of radiation is fundamental to the main work of the company, such as industrial radiography and industrial irradiators, the person appointed by management to be the RPO is likely to have some existing background or some training involving radiation protection. For example, in an industrial radiography company, the RPO is likely to be a senior (or experienced) radiographer; in an industrial irradiator facility the RPO may be a production manager.

In medical facilities that use radiation there is likely to be a range of people with some background in radiation protection who may be suitable for appointment as RPO, for example, medical physicists, technicians, medical doctors etc.

In all cases senior management needs to ensure that the RPO is appropriately trained and competent in radiation protection and should ensure that the RPO is given sufficient time to carry out the required duties.

The specific duties and responsibilities of the RPO will depend very much on the practice being undertaken, and the availability of radiation safety expertise within the practice. In a large facility, for instance, the RPO may have well-defined functions relating to a specific area, with other RPO and radiation protection experts carrying out related duties in different parts of the plant as it is typically the case in nuclear power plants. By contrast, the RPO in a company with a straightforward application like a level gauge may be the only person with any knowledge of radiation safety and may have a wider range of duties to perform.

It follows that the duties of RPO are very dependant on the practice in which they work and the existing safety infrastructure of the facility. However, there are a range of 'core duties' that RPO are likely to carry out, regardless of the practice in which they work:

- Supervision of work to ensure compliance with local rules and national regulations;
- Carrying out, or supervision of, workplace monitoring;
- Supervision of arrangements for individual monitoring;
- Keeping of source records;
- Responsibility for ensuring the maintenance of equipment and safety systems relating to the practice;
- Responsibility for ensuring the performance testing of new installations, or ensuring the validation of new procedures,
- Implementation of emergency plans.

In the majority of practices, the RPO role may only be a small component of the person's work. In more complex practices, the role of RPO may be a full time post, or it may be divided among several people. Regardless of the approach adopted, however, it is very important that RPO receive sufficient training to carry out their function.

3. EUROPEAN REFERENCE STANDARDS FOR RPO TRAINING

The European Qualifications Framework for lifelong learning (EQF) [8] relates different countries' national qualifications systems and frameworks together around a common European reference – its eight reference levels. The levels span the full scale of qualifications, from basic (Level 1, for example school leaving certificates) to advanced (Level 8, for example Doctorates) levels). The eight reference levels are described in terms of learning outcomes. In the EQF a learning outcome is defined as a statement of what a learner knows, understands and is able to do on completion of a learning process. The EQF therefore emphasises the results of learning rather than focusing on inputs such as length of study. Learning outcomes are specified in three categories – as knowledge, skills and competence. This shows that qualifications – in different combinations – capture a broad scope of learning outcomes, including theoretical knowledge, practical and technical skills, and social competences where the ability to work with others will be crucial, as it is the case for RPO. For RPO, learning outcomes relevant for level 3 to level 6 might apply, depending on the tasks and responsibilities of the RPO (see Appendix 1).

The European Credit system for Vocational Education and Training (ECVET) [9] aims to give people greater control over their individual learning experiences and make it more attractive to move between different countries and different learning environments. In this sense, it is a valuable tool for building RPO competence.

The ECVET system is applicable for all learning outcomes which should in principle be achievable through a variety of education and learning paths at all levels of the European Qualifications Framework for lifelong learning ('EQF'), and then be transferred and recognised. This system therefore contributes to the wider objectives of promoting lifelong learning and increasing the employability, openness to mobility and social inclusion of workers and learners. It particularly facilitates the development of flexible and individualised pathways and also the recognition of those learning outcomes which are acquired through non-formal and informal learning. With this flexibility, the differing RPO training requirements in European countries can be overcome. At the end of the day, we have to answer the question: what learning outcomes in terms of knowledge, skills and attitudes are expected from an RPO to make him suitable for the job:

- Knowledge: aware of the regulatory requirements as far as it affects his specific situation (work), basic understanding of hazards and potential of harm, know how to apply local rules, basic understanding of radiation measurement techniques, etc.;
- Skills: ability to communicate in routine and anomalous situations, recognition of situations, where something is going wrong, effective communication with staff and management, keep records, manage documents, use of monitoring instruments and interpret results, etc.;
- Competences: Ability to supervise, ability to open and clear reporting, positive attitude towards safety in general, etc.

Even then, competence alone is not enough, having the required competences does not necessarily mean that a person is suitable to do the job. There are suitability considerations such as, for example, "speaking the language of the work floor", having good and appropriate interpersonal skills and being in a a position to exercise some authority which have to be taken into account as well.

In Appendix 2, examples of learning outcomes of RPO training are given in terms of knowledge, skills and competence elements for various EQF levels. The elements have been discussed with and agreed by the ECVET Team during the ECVET Seminar in September 2012 in Brussels.

3.1 Guidance on building competence of RPO

The RPO is often the relevant point of reference for radiation protection in an undertaking. As such, the RPO is the main contact person for the employer, the RPE as external adviser and for the competent authority for radiation protection issues. Therefore, the employer needs to ensure that a person is appropriately trained and competent in radiation protection before appointed as RPO. In some European countries, their exists a regulatory framework specifying educational prerequisites and training contents and durations as well as the necessary experience needed to be appointed as RPO (for example in Germany, Austria and France). This framework provides guidance for the undertakings which training events are mandatory from the regulatory point of view and which other training activities offered by training providers or during conferences could serve to build additional relevant competence or refresh competence of RPO. In other countries, RPO competence requirements are not prescribed in detail, only core competences are defined. For example, “be aware of the regulatory requirements in as far they affect the RPO’s use of ionising radiation”. A weakness with the latter is that such general requirements can be too open to interpretation.

Educational Requirements

RPO should have as a minimum a secondary educational level corresponding to a scientific or technical curriculum including 10 to 12 years of schooling. However, the educational level of a radiation protection officer will be dependent on the skills and technical requirements of the job as well as on radiation protection needs. For some facilities, i.e. complex situations with the potential for significant dose, a tertiary educational level should be considered appropriate; for example, in some research establishments or, with respect to the appropriate use of advanced nuclear techniques or in some medical facilities.

Training Requirements

The RPO must be provided with sufficient training to enable him to effectively carry out his supervisory duties. However, education and training are only two of a number of attributes that result in a person being both competent and suitable to act as an RPO for a practice. The provision of training covering the core information that is required for all RPO will provide an appropriate level of knowledge, but this will need to be re-enforced with practical experience of the application of this knowledge before the RPO can be said to be competent.

The RPO may need to have further practice-specific training and experience before he is considered suitable for a specific practice. For example, an RPO may be considered to be competent and suitable for a straightforward practice, such as industrial gauges, if he has a good understanding of the core requirements of the RPO role, together with experience of applying this knowledge in the field. However, such a person will not be a suitable RPO for industrial radiography without first receiving additional training and experience on the radiation protection issues associated with this area of work. It follows that RPO training will fall into two categories: core training, common to all practices, and supplementary training related to practice-specific radiation protection elements.

The formal training of RPO should involve covering a core syllabus and, as appropriate, any supplementary content pertinent to the practice in question. The content may be covered separately (ie in modular form, core + specific 1 + specific 2 etc) or combined into a single course.

Classroom based training is unlikely to cover all the practical radiation protection and safety aspects and skills associated with specific work tasks; hence additional experience in the workplace and on the job training can be very effective in the overall training programme for RPO. In this form of training the participant works in the normal place of work either under the direct supervision of, or with indirect input from, an experienced mentor.

The participant's progress and achievements may be recorded on a checklist of topics and tasks. On completion of the training it can be very useful for the trainer and participant to document the participant's progress, the areas of competence gained and any further training needs. The latter is likely to be dependant on the complexities of the practice and the RPO's previous work experience.

Work Experience

Work experience relevant for working as an effective RPO in a specific practice may range between weeks and years, depending on the complexity of the practice, the level of radiation risk involved and the specifics of the working environment. For example:

- A potential RPO in a small facility where only XRF and XRD equipment would only need a few weeks work experience (assuming he was suitably qualified for his "normal" tasks) in order to exercise the RPO role. In this situation the radiation risks are low, the work routine and regulatory compliance straightforward to ensure.
- A potential RPO for industrial radiography employing both x- and gamma techniques would require substantial operational experience before taking on the role. The radiation risk is high, the work (probably) very dynamic in nature and regulatory compliance may be complex.

Skills and Attitudes Requirements

By definition a "competent and effective" RPO will also have specific personal attributes such as good communication skills and the ability to exercise sound judgement i.e. be capable of analysing a situation and coming up with a pragmatic course of action. A complete assessment of the competence of a person to act as RPO will also include an assessment of the person's ability to apply knowledge effectively using these skills. This could be done, for example, by observing the person's performance at work or by setting the person a scenario based exercise, designed to assess overall competence and performance to carry out.

3.2 RPO training in different areas of work

RPO are working in a variety of many different areas of applications of ionising radiation in the medical sector, in industry and research. In order to cover radiation protection training and work experience for all job categories/practices involving ionising radiation, typical competence groups are provided with course contents and duration, as an example for rather detailed regulatory requirements, partly containing elements of the radiation protection competence requirements of RPO in Germany. It should be noted that other sensible proposals for contents and durations may also serve the purpose.

In Appendix 3, example tables for RPO training are given, divided into professional categories or competence groups, and including training contents and duration, covering the following areas :

- handling of radioactive materials and practices on installations producing ionising radiation (incl. accelerators and cyclotrons)
- medicine, dentistry
- operation of x-ray equipment (technical, medical (without patients), veterinary medicine)
- RPO in nuclear power plants/research reactors.

The content of the table "*Training of RPO in the field of handling of radioactive substances, radiation sources, and practices in installations producing ionising radiation: radiation protection courses*" can be described as follows.

The variety of jobs/practices in this field (jobs could be in medicine, industry or research) has been grouped into 8 competence groups with subgroups as bullet points. For each subgroup, radiation protection training courses and work experience are necessary to build competence. For each course the duration is given in hours and the number given in the table indicates the content of the course. There are basic courses for RPO dealing with basic scenarios and basic courses for RPO dealing with complex scenarios. Depending on the practice, there are also special courses for RPO dealing with basic scenarios and less RP responsibilities and special courses for RPO dealing with complex scenarios and more RP responsibilities.
Examples for course content and duration are given.

The content of the table "*Training of RPO in the field of x-ray equipment: radiation protection courses*" can be described as follows.

The variety of jobs/practices in this field (jobs could be in medicine, industry or research) has been grouped into 6 competence groups with subgroups as bullet points. For each subgroup, radiation protection training courses and work experience are necessary to build competence. For each course the duration is given in hours and the number given in the table indicates the content of the course. There are basic courses for RPO dealing with basic scenarios and basic courses for RPO dealing with complex scenarios. Depending on the practice, there are also special courses for RPO dealing with basic scenarios and less RP responsibilities and special courses for RPO dealing with complex scenarios and more RP responsibilities.
Examples for course content and duration are given. (Note: This table does not cover x-ray equipment used for patients.)

The content of the table "*Training of RPO in the medical sector: radiation protection courses*" can be described as follows.

In the medical sector, there are a number of specialities, and each member of a professional category could act as RPO. Therefore, each speciality is considered as separate competence group. There are basic courses and special courses depending on the medical speciality. Radiation protection training courses, their contents and duration are given.

The content of the table "*Training of RPO in nuclear power plants / research reactors: radiation protection courses*" can be described as follows.

There are 2 groups of RPO in NPP/research reactors:

1. RPE working in the installation which have been assigned to act as *RPO with full responsibility in radiation protection* need a university degree, special training in radiation protection, practical experience in radiation protection and an in-plant training at the site

where they will work. For keeping competence up-to-date, participation in refresher courses, conferences, etc. is suggested every 2 years.

2. Other professionals working in the installation which have been assigned to act as *RPO with restricted responsibilities in radiation protection* need some minimum educational level, special training in radiation protection, practical experience in radiation protection and an in-plant training at the site where they will work.

Duration for courses and practical experience are given as well as the content of the special training in radiation protection.

The focus of training is on radiation protection, but also basic knowledge of nuclear safety is important, since these issues are related in nuclear installations.

4 ASSESSMENT OF COMPETENCE

Competence is the ability to undertake responsibilities and perform activities within an occupation or function to an agreed standard on a regular basis. Therefore, competence assessment entails measuring a person's performance against a standard. The assessment of competence before, during and after completion of training events is an ongoing process of continually building knowledge and skills on the basis of work experience. There are a number of different ways of doing competence assessment. The key to competence assessment is that it is based on actual skills and knowledge that a person can demonstrate in the workplace or other contexts. This is different to other approaches where people just answer questions as a test of their knowledge and skills. The problem with testing is that it doesn't guarantee that a person will be able to *do* something – it just verifies that they know something.

It is recommended, that the employers make sure that RPO are able to demonstrate competence on a regular basis, in particular after completion of training events. Training providers and RPE should be able to assist or advise employers in this matter.

A complete assessment of the competence of a person to act as RPO will also include an assessment of the person's ability to apply knowledge effectively using these skills. Again, this could be done by observing the person's performance at work or by setting the person an exercise to carry out or a problem scenario to solve.

5 MAINTENANCE OF RPO COMPETENCE

RPO competence needs to be maintained. Depending on the application, there is an expectation that refresher training is needed on a regular basis; 5 years is generally accepted as an appropriate interval but more frequent refresher training may be prudent in some situations/applications

Employer should provide, as appropriate, necessary means to keep RPO competence up-to date and giving evidence (consult RPE, attend refresher courses, etc). There might be application fields where exchange of information through visits, meetings, dialog with other RPO (in the same type of installation) is valuable or where attending radiation protection conferences is valuable where often refresher courses are offered for different professional groups.

6 MECHANISMS FOR DELIVERY OF RPO TRAINING

There are a number of options for delivery of RPO training. The fact that the required functions and tasks – and required level of knowledge and ability – for RPO varies depending on the application means that there can be quite a degree of flexibility in delivery options. Any one, or (more likely) a combination of the approaches listed below may be appropriate; what is important is that completion of the training process required competences have been acquired.

(i) Attendance at, or participation in, formal courses (classroom training, e-learning, self study;

(ii) Work Experience (WE)/On-the Job Training (OJT);

(iii) The use of simulators etc either as part of taught courses or during OJT can be very effective in creating "real" situations without an associated radiation risk;

(iv) Demonstrations and exercises are always an effective means of consolidating classroom teaching and provide an ideal opportunity for students to develop and demonstrate practical competence.

7 CONCLUSIONS

Employees, appointed to act as RPO in hospitals, industrial companies or teaching and research institutions should have an adequate level of understanding of concepts related to radiation protection and should also be acquainted with the safe and secure use of radiation sources as relevant to the application. Depending on the complexity of the radiation application and the associated radiation protection tasks, RPO need appropriate training in radiation protection and, in some cases, a certain level of work experience tailored to the specific needs to fulfil particular radiation protection tasks. It is therefore essential, on the European level, (i) to define the required competences for RPO according to their area of work and specific radiation protection tasks, and (ii) to establish European guidance on the content and mechanisms for delivery of RPO training.

In order to define requirements for RPO competencies, the issue of definition and role of RPO has been considered on the European level. It should be noted that, other than the issues of general competency and suitability, there is no prescription on the European or international level of the "specification" of the individual being an RPO. The appropriate route to gaining the level of competence required to be appointed as RPO will usually be a combination of training plus relevant experience in the appropriate area of work. The main areas of RPO work are considered and examples of appropriate elements of building competence of RPO are given which could serve as European reference standards for RPO training.

The European Qualifications Framework for lifelong learning (EQF) and the European Credit system for Vocational Education and Training ECVET might be useful tools in building competence of RPO within Europe. Examples of knowledge, skills and competence elements for various EQF levels are given which may be further developed to fit existing RPO training activities.

References

[1] European Network on Education and Training in Radiological Protection (ENETRAP), EU FP6 Contract FI6O-CT2005-516529, Final Report, 2008

ftp://ftp.cordis.europa.eu/pub/fp6-euratom/docs/projrep_enetrap_en.pdf

[2] EUTERP Workshop Vilnius 2008, 23-25 April, Summary and Recommendations, http://www.euterp.eu

[3] Draft Euratom Basic Safety Standards Directive, Version 30 May 2012, COM(2012) 242 final

[4] Council Directive 96/29/Euratom of 13 May 1996 laying down basic safety standards for the health protection of the general public and workers against the dangers of ionizing radiation. (OJ L-159 of 29/06/96 page 1, 1996)

[5] Radiation Protection and Safety of Radiation Sources: International Basic Safety Standards, Interim Edition, General Safety Requirements Part 3, No. GSR Part 3 (Interim), IAEA, 2011

[6] Building competence in radiation protection and the safe use of radiation sources. IAEA Safety Guide No. RS-G-1.4, 2001

[7] Training in radiation protection and the safe use of radiation sources. IAEA Safety Series Report No. 20, 2001

[8] Recommendation of the European Parliament and of the Council of 23 April 2008 on the Establishment of the European Qualifications Framework for lifelong learning (EQF), (2008/C 111/01)

[9] Recommendation of the European Parliament and of the Council of 18 June 2009 on the establishment of a European Credit System for Vocational Education and Training (ECVET), (2009/C 155/02)

Note

The terms “On-the Job Training (OJT)” and “Work experience (WE)” are used in this report as defined in the ENETRAP project [1], in particular in WP4 on OJT.

On-the-Job Training: a form of training in which the trainee works at a suitable environment where the facility or the infrastructure needed for the OJT is available, under the supervision of an experienced supervisor/expert (hands-on experience).

Work Experience: time spent actively working within a specific practice gaining in-depth knowledge of the practice and experience in relevant RP issues.

Practical exercises during training courses do not generally fulfil the definition of OJT/WE in which the duration of OJT/WE is usually several weeks, months or even years.

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Appendix 1 – *Examples of the varying tasks of the RPO and competences required in different areas of work*

RPO are required in all areas where radiation is used. However, the complexity of the role can vary with the application in the relevant sector. The role of the RPO is always the same, but the tasks may vary substantially.

Example – Medical Sector: Dentistry *(Private Practice)*

In general terms the role of the RPO is to assist the Practice with respect to ensuring legislative compliance, by supervision the work to ensure that local rules (and any other relevant procedures) are followed. The number of employees at the Dental Practice is likely to be low, the radiograhy workload also likely to be relatively low and (for non-specialist practices) the equipment used of a standard design. The role of the RPO in this scenario is not onerous. In addition to be the main point of contact with the RPE, specific tasks might include:

- Keeping records (eg training, equipment maintenance, dose records)
- Arranging for appropriate personal dosimetry (as advised by RPE)
- Initiate any investigations (with the RPE) of any accidents or incidents
- Liaise with engineers etc with respect to equipment servicing and maintnence schedules etc
- Ensuring appropriate radiation warning signs, notices etc.

Required competences, therefore, include

- Basic understanding of the nature and properties of x-radiation
- Awareness of the type of equipment (including inherent safety features) used in dental practice and the radiation hazards associated with that equipment
- Basic understandaing of the parameters that affect dose eg mA, kV, filtration
- Awareness of the harmful effects of x-radiation and the importance of keeping exposures ALARA
- Basic understanding of the key principles of times, distance and shielding and how exposures can be kept ALARA in practice
- Knowledge of regulatory requirements that are relevant to x-radiography in dentistry
- Knows and understands the contents of (own) local rule and the importance of following these rules.
- Knows what to do in the event of reasonably foreseen incidents

Example – Industrial Sector: Exploration and Production (E&P) Industry

The Radiation Protection Officer (RPO) is the person on the work floor who has been given the task of supervising work involving NORM to ensure that radiation protection procedures are followed. The RPO reports to the RPE with regard to all NORM matters.

The responsibilities of the RPO include:

- inspection and supervision of work with regard to NORM
- quality assurance with regard to radiation protection
- sampling of NORM and sending of samples for analysis
- (pre)qualification of radioactive waste
- marking radioactive waste and NORM-contaminated equipment
- storage, packing and shipping of these materials in accordance with the regulations and procedures.
- completion of the registration immediately after the work has been completed

Required competences, therefore, include

- Understanding of the nature and properties of NORM
- Awareness of the harmful effects of radiation especially in the case of ingestion of inhalation
- Awareness of the type of measurement equipment suitable when dealing with NORM
- Basic understanding of the key principles of times, distance and shielding and how exposures can be kept ALARA in practice
- Knowledge of regulatory requirements that are relevant to NORM
- Knows and understands the contents of (own) local rules and the importance of following these rules.
- Knows what to do in the event of reasonably foreseen incidents

Example - Research Sector: Research Reactors

At a Research Reactor, the RPO has the main role to provide technical and practical assistance to the RPE and the Reactor Director and to supervise that radiation protection procedures and programme are implemented as established by the employer according to RPE indications and recommendations. He supervises that working procedures are respected and are in compliance with the indications and recommendations provided by the RPE.

Typical routine and practical tasks might include:

- Control of right placement of radiation warning signs;
- Verification of proper functioning of monitoring equipment: external exposure monitors, contamination monitors and air monitors;
- Workplace monitoring, measurement results recording and verification of compliance with reference values;
- Distribution of personal dosemeters and placing of area dosemeters
- Monitoring equipment (fix and mobile) acquisition and maintaining its technical proper operation, including calibration certificate records
- Record and classification of waste, radioactive or contaminated materials resulting from the reactor operation;
- Assist and control for the access procedures to classified areas and to the Reactor itself;
- Assist and control that protection devices and individual monitoring is properly used;
- Assist and control that radiation protection indication and rules are in place and applied by reactor personnel during routine and special conditions.

Records of all executed tasks should be kept in a written form. Any anomalous situation or malfunctions occurring to any equipment or radiation protection device should be recorded and communicated to the employer and to the RPE.

In case of emergency, the RPO should be able to define and give prompt information of the anomalous situations and of the radiation levels estimation or measurements in workplace areas. He/she should also assist in the use of protective clothing and devices. Emergency preparedness should be tested in periodic exercises.

Required competences, therefore, include:

- Understanding of basic concepts of radiation physics
- Basic understanding of radiation effects
- Knowledge of radioactivity and radioactive sources
- Knowledge and understanding of radiation detection and measurement methods
- Awareness of risks associated with the use of radiation sources and risks associated to the exposure to ionizing radiation
- Basic understanding of the principles of radiation protection
- Knowledge and understanding of individual and workplace monitoring techniques
- Knowledge and understanding of the legal framework for the use of ionizing radiation.
- Knowledge and understanding of the contents of local rule and the importance of following these rules.
- Knowledge of what to do in emergency situations.

Appendix 2 - *Examples of knowledge, skills and competence elements for various EQF levels applied to RPO training (agreed with the ECVET Team)*

The range of EQF levels which describe what learning outcomes in terms of knowledge, skills and competences are expected from RPO training to make the RPO suitable for the job.

	learning outcomes in terms of **knowledge** (knowledge is described as theoretical and/or factual)	learning outcomes in terms of **skills** (skills are described as cognitive (involving the use of logical, intuitive and creative thinking) and practical (involving manual dexterity and the use of methods, materials, tools and instruments).	learning outcomes in terms of **competence** (competence is described in terms of responsibility and autonomy)
Level 3	knowledge of facts, principles, processes and general concepts, in a field of work. **In radiation protection**: knowledge of basic radiation effects, general principles of radiation protection, awareness of the associated risks, importance of local radiation protection rules, etc.	a range of cognitive and practical skills required to accomplish tasks and solve problems by selecting and applying basic methods, tools, materials and information. **In radiation protection**: use dosimeters and measuring equipment correctly, interpret results, etc.	• take responsibility for the completion of tasks in work • adapt own behaviour to circumstances in solving problems. **In radiation protection**: responsible for the completion of routine radiation protection tasks in a given time and to a good level of quality.
Level 4	factual and theoretical knowledge in broad contexts within a field of work or study. **In radiation protection**: deeper knowledge of radiation effects, radiation protection principles and radiation risks, the concept of optimisation, ALARA tools, dose limits, etc.	a range of cognitive and practical skills required to generate solutions to specific problems in a field of work or study. **In radiation protection**: carry out routine measurements in the workplace, use ALARA tools effectively, propose measures for dose reduction, etc.	• exercise self-management within the guidelines of work or study contexts that are usually predictable, but are subject to change • supervise the routine work of others, taking some responsibility for the evaluation and improvement of work or study activities **In radiation protection**: exercise self-management in monitoring of the workplace, identification of radiation protection problems, etc.
Level 5	comprehensive, specialised, factual and theoretical knowledge within a field of work or study and an awareness of the boundaries of that knowledge **In radiation protection**: detailed knowledge of radiation protection concepts and their implementation in practice, detailed knowledge of regulatory requirements in radiation protection, etc.	a comprehensive range of cognitive and practical skills required to develop creative solutions to abstract problems **In radiation protection**: propose protective measures in cases of unusual events or emergencies, communicate radiation measurement results and their interpretation as well as corrective actions to the management, etc.	• exercise management and supervision in contexts of work or study activities where there is unpredictable change • review and develop performance of self and others **In radiation protection**: exercise management and supervision in evaluation and communication of radiation protection issues (routine/unusual events), develop and implement agreed performance indicators to measure the success of ALARA measures, radiation protection instruction of colleagues, etc.
Level 6	advanced knowledge of a field of work or study, involving a critical understanding of theories and principles **In radiation protection**: in-depth knowledge of the scientific basis of radiation protection; in depth knowledge of international guidance in radiation protection, etc.	advanced skills, demonstrating mastery and innovation, required to solve complex and unpredictable problems in a specialised field of work or study **In radiation protection**: develop and implement radiation protection procedures and local rules, communicate radiation protections issues to the workforce and the management.	• manage complex technical or professional activities or projects, taking responsibility for decision-making in unpredictable work or study contexts • take responsibility for managing professional development of individuals and groups **In radiation protection**: manage complex radiation protection activities, develop and implement strategies for improving radiation protection.

Appendix 3 - *E*xample tables for RPO training, divided into competence groups, and including training contents and durations

The tables cover the following areas:

- handling of radioactive materials and practices on installations producing ionising radiation (incl. accelerators and cyclotrons)
- medicine, dentistry
- operation of x-ray equipment (technical, medical (without patients), veterinary medicine)
- RPO in nuclear power plants (RPO training in research reactors is similar).

These examples are partly based on some of the competence requirements for RPO used in Germany.

Training of RPO in the field of handling of radioactive substances, radiation sources, and practices in installations producing ionising radiation: radiation protection courses

RPO Competence Groups	**Radiation Protection Courses**				
	Basic courses for RPO dealing with basic scenarios	Basic courses for RPO dealing with complex scenarios	Special courses for RPO dealing with basic scenarios	Special courses for RPO dealing with complex scenarios	Other Special Courses
Practices[1], requiring a license, involving • type-approved devices • devices designed to meet the requirements of type-approval • devices without type-approval containing built-in radioactive substances **Practices requiring notification**	**13 h** *1* (Basic course)				
Handling of sealed radioactive substances requiring a license • Storage, transport and proper use of devices containing built-in sealed radioactive substances with activities exceeding exemption levels by a factor of up to 10^6 • Handling of sealed radioactive substances with activities exceeding the exemption levels by up to a factor of 10^6 • Handling of sealed radioactive substances	**13 h** *1* (Basic course)	**26 h** *2* (Basic course) **26 h** *2* (Basic course)		**13 h** *3* (Special course on handling of sealed radioactive substances)	

Handling and storage of sealed radioactive sources requiring a license in industrial radiography and radioscopy • On-site surveillance (restricted responsibilities) • Control of the entire practice	**14 h** *1* (Basic course)	**26 h** *2* (Basic course)	**18 h** *4* (Special course: Industrial radiography and radioscopy: surveillance of on-site handling)	**12 h** *5* (Special course: Industrial radiography and radioscopy: surveillance Control of the entire practice)	
Handling and storage of unsealed radioactive substances requiring a license • Handling of unsealed radioactive substances with activities exceeding the exemption levels by up to a factor of 10^5 • Handling of unsealed radioactive substances with activities exceeding 10^5 times the exemption levels • Storage and handling of nuclear fuels[2]/material		**26 h** *2* (Basic course) **26 h** *2* (Basic course) **26 h** *2* (Basic course)	**13 h** *6* (Special course: Handling of unsealed radioactive substances)	**28 h** *7* (Special course: Handling of unsealed radioactive substances) **28 h** *7* (Special course: Handling of unsealed radioactive substances)	**6 h** *12* Special course: Criticality

Practices in installations producing ionising radiation • Operation of installations producing ionising radiation requiring notification • Proper operation of installations requiring a license for the production of ionising radiation • Checking, testing, maintenance of installations	**13 h** *1* (Basic course)	**26 h** *2* (Basic course) **26 h** *2* (Basic course)	**13 h** *6* (Special course: Handling of unsealed radioactive substances)		**13 h** *8* (Special course: Operation of installations producing ionising radiation) **13 h** *8* (Special course: Operation of installations producing ionising radiation)
Use of radiation sources in schools (for example for calibration)					**13 h** *9* (Special course: Radiation sources in schools)
Decommissioning and rehabilitation of uranium mining plants and installations		**26 h** *2* (Basic course)			**13 h** *10* (Special course: Decommissioning and rehabilitation of uranium mining plants and installations)
Exploring, exploiting or processing of radioactive mineral resources		**26 h** *2* (Basic course)			**13 h** *11* (Special course: Exploring, exploiting or processing of radioactive mineral resources)

h: course duration in hours, numbers in blue refer to the corresponding module in the course contents

Examples

[1]Proper use of electron-capture detectors (ECD) in gas chromatography equipment using Ni-63 or H-3

[2]Construction, operation or other form of possession, decommissioning, safe entombment of an installation as well as dismantling of an installation or parts of it, in order to refine or process nuclear fuels or reprocess irradiated nuclear fuels, refining, processing and other uses of nuclear fuels outside installations requiring a license

Training of RPO – Radioactive substances / Radiation Sources / Installations

Radiation Protection Course Contents

(1 hour teaching unit = 45 minutes)

1 Basic course for RPO dealing with basic scenarios - 13 h

- Legal foundations, recommendations and guidelines 0.5 h
- Tasks and duties of the Radiation Protection Officer 3.5 h
- Scientific foundations. 4.0 h
- Radiation protection measurement techniques 1.5 h
- Radiation protection technology 1.0 h
- Radiation protection safety 0.5 h
- Demonstration exercise 1.0 h
- Exercises 1.0 h

2 Basic course for RPO dealing with complex scenarios - 26 h

- Legal foundations, recommendations and guidelines 1.0
- Tasks and duties of the Radiation Protection Officer 4.0
- Scientific foundations 6.0
- Radiation protection measurement techniques 4.0
- Radiation protection technology 3.0
- Radiation protection safety 2.0
- Practical training 4.0
- Exercises 2.0

3 Special course for RPO dealing with complex scenarios - 13 h

(successful completion of Course 2 is required)

- Scientific foundations 2.0
- Radiation protection measurement techniques 1.0
- Radiation protection technology 3.0
- Radiation protection safety 1.0
- Practical training 2.0
- Exercises 4.0

4 Special course “Industrial radiography and radioscopy: on-site surveillance” for RPO dealing with basic scenarios - 18 h

(successful completion of Course 1 is required)

- Legal foundations, recommendations and guidelines 0.5
- Tasks and duties of the Radiation Protection Officer 0.5
- Scientific foundations 0.5
- Radiation protection measurement techniques 1.5
- Radiation protection technology 6.0
- Radiation protection safety 1.0
- Practical training 2.0
- Demonstration exercise 2.0
- Exercises 4.0

5 Special course “Industrial radiography and radioscopy: control of the entire practice” for RPO dealing with complex scenarios - 12 h

(successful completion of Course 2 is required)

- Legal foundations, recommendations and guidelines 0.5
- Tasks and duties of the Radiation Protection Officer 0.5
- Scientific foundations 0.5
- Radiation protection measurement techniques 1.0
- Radiation protection technology 2.0
- Management of high activity sources incl. testing 1.0
- Radiation protection safety 1.0
- Practical training 1.0

- Demonstration exercise 0.5
- Exercises 3.0
- Examination 1.0

6 Special course “Handling of unsealed radioactive sources” for RPO dealing with basic scenarios - 13 h

(successful completion of Course 2 is required)

- Legal foundations, recommendations and guidelines 0.5
- Tasks and duties of the Radiation Protection Officer 0.5
- Scientific foundations 1.5
- Radiation protection measurement techniques 2. 0
- Radiation protection technology 2.0
- Radiation protection safety 1.0
- Practical training 3.0
- Exercises 1.5
- Examination 1.0

7 Special course “Handling of unsealed radioactive sources” for RPO dealing with complex scenarios - 28 h

(successful completion of Course 2 is required)

- Legal foundations, recommendations and guidelines 0.5
- Tasks and duties of the Radiation Protection Officer 1.5
- Scientific foundations 4.0
- Radiation protection measurement techniques 5.0
- Radiation protection technology 4.0
- Radiation protection safety 2.0
- Practical training 6.0
- Exercises 4.0

8 Special course “Operation of installations producing ionising radiation requiring no license” - 13 h

(successful completion of Course 2 is required)

- Legal foundations, recommendations and guidelines 0.5
- Tasks and duties of the Radiation Protection Officer 0.5
- Scientific foundations 2.0
- Radiation protection measurement techniques 3.00
- Radiation protection technology 2.0
- Radiation protection safety 1.0
- Practical training and demonstration 2.0
- Exercises 2.0

9 Special course “Radiation protection at schools”– 16 h

(successful completion of Course 2 is required)

10 Special course “Decommissioning and rehabilitation of uranium mining plants and installations” - 16 h

(successful completion of Course 2 is required)

11 Special course “Exploring, exploiting or processing of radioactive mineral resources” - 16 h

(successful completion of Course 2 is required)

12 Special course “Criticality” - 6 h

(successful completion of Course 2 is required)

- Legal foundations, recommendations and guidelines 0.5
- Tasks and duties of the Radiation Protection Officer 1.0
- Scientific foundations 1.0
- Radiation protection measurement techniques 1.0
- Radiation protection technology 1.5
- Radiation protection safety 0.5
- Examination 0.5

Radiation protection safety lectures should include lessons learned from incidents and accidents, transport safety and waste safety where appropriate.

Other sensible proposals for content, duration and distribution of hours may also serve the purpose.

Training of RPO in the medical sector: radiation protection courses

RPO Competence Groups	Radiation Protection Courses			
Radiology	**24 h** *1* (Basic course)	**20 h** *2* (Special course in x-ray diagnostics)	**4 h** *3* (Special course in CT)	**4 h** *4* (Special course in interventional radiology)
Other medical specialities with limited use of diagnostic x-rays	**24 h** *1* (Basic course)	**20 h** *2* (Special course in x-ray diagnostics)		
Radiotherapy (x-ray treatment)	**24 h** *1* (Basic course)	**28 h** *5* (Special course in x-ray therapy)		
Brachytherapy	**24 h** *1* (Basic course)	**18 h** *9* (Special course in brachytherapy, endovascular radiotherapy)		
Teletherapy	**24 h** *1* (Basic course)	**28 h** *10* (Special course in teletherapy)		
Nuclear medicine	**24 h** *1* (Basic course)	**24 h** *8* (Special course in nuclear medicine)		
Dentistry		**24 h** *6* (Basic course for RP in dentistry)	**8 h** *7* (Special course for dentists)	

h: course duration in hours, numbers in blue refer to the corresponding module in the course contents

RADIATION PROTECTION COURSE CONTENTS

(1 hour teaching unit = 45 minutes)

1 Basic course in RP - 24 h

- Basic principles of radiation physics
- Basic principles of radiobiology incl. effects of low doses
- Terms and definitions, dosimetry
- Basic principles of radiation protection (occupational, public and patient protection)
- Natural and artificial radiation exposure
- Regulatory framework, guidelines and recommendations, technical rules in radiation protection, ethical issues
- Lessons learned from incidents and accidents
- Practical exercises and demonstrations

2 Special course in RP with regard to x-ray examinations (diagnostic), duration (incl. practical exercises and examination) - 20 h

(successful completion of Course 1 is required)

- X-ray equipment
- Radiation protection arrangements in diagnostic radiology
- Terms and definitions, dosimetry
- Occupational radiation protection
- Special issues in pediatrics
- Quality assurance and quality control related to RP
- Documentation and image reproduction
- Organisation of radiation protection
- Regulatory framework, guidelines and recommendations
- Practical exercises and demonstrations

3 Special course in RP with regard to computer tomography - 4 h

(successful completion of Courses 1 and 2 is required)

- Equipment and detector technology
- Quality assurance and quality control related to RP
- Dose measurement parameters
- Scan parameters: importance for image quality and radiation exposure
- Specific techniques (cardio CT, CT fluoroscopy, etc.)

4 Special course in RP with regard to interventional radiology - 4 h

(successful completion of Courses 1 and 2 is required)

- Equipment and detector technology
- Dose measurement parameters
- Occupational radiation protection
- Measures for personnel dose reduction
- Special techniques and their requirements

5 Special course in RP with regard to x-ray treatment (x-ray therapy), duration (incl. practical exercises and examination) - 28 h

(successful completion of Course 1 is required)

- Construction and function of medical irradiation devices
- Technical fitting of x-ray devices
- Basic principles of radiotherapy
- Dosimetry and physical irradiation planning
- Radiation protection in x-ray treatment
- Radiation protection monitoring and documentation
- Effects and side effects of radiation in x-ray therapy
- Instruction of personnel
- General overview of medical therapeutical procedures
- Quality assurance of methods and equipment with regard to RP
- Special regulatory requirements, guidelines, recommendations, technical rules
- Inspection procedures by the competent authority, reporting requirements
- Behaviour in emergency situations

6 Basic course for RP in dentistry - 24 h

- Basics principles of radiation physics
- Terms and definitions, dosimetry
- Basic principles of radiobiology incl. effects of low doses
- Natural and artificial radiation exposure
- Equipment and imaging techniques in dentistry
- Radiation protection arrangements in dentistry
- Occupational radiation protection
- Quality assurance and quality control related to RP
- Organisation of radiation protection
- Regulatory framework, guidelines and recommendations
- Practical exercises and demonstrations

7 Special course in RP for dentists - 8 h

(successful completion of Course 6 is required)

- Special Equipment and imaging techniques in dentistry
- Dose measurement parameters
- Radiation protection arrangements in dentistry
- Occupational radiation protection
- Quality assurance and quality control related to RP
- Practical exercises and demonstrations

8 Special course in RP with regard to handling of open radioactive substances in nuclear medicine, duration (incl. practical exercises) - 24 h

(successful completion of Course 1 is required)

- Radioactive substances in medicine
- Radiopharmaceuticals
- Dosimetry and dose calculations
- Radiation protection in applying open radioactive substances
- Radiation protection monitoring and documentation

- Radiation protection of personnel, patient and public
- Storage, transport and disposal of radioactive substances
- Quality assurance of methods and equipment
- Information of patients
- Special regulatory requirements, guidelines, recommendations, technical rules
- Lessons learned from incidents and accidents
- Behaviour in emergency situations, reporting requirements
- Instruction of personnel

9 **Special course in RP with regard to brachytherapy (irradiation devices, radiation sources and endovascular therapy), duration (incl. practical exercises) - 18 h**
(successful completion of Course 1 is required)

- Therapy devices and methods applied
- Basic principles of brachytherapy
- Dosimetry
- Radiation protection in brachytherapy
- Radiation protection applying sealed radioactive substances
- Radiation protection endovaskular radiotherapy
- Radiation protection monitoring and record keeping
- Radiation exposure and risk for patients, personnel and Environment
- Storage, transport, exemption, return of radioactive substances
- Instruction of personnel
- Quality assurance of methods and equipment
- Special regulatory requirements, guidelines, recommendations, technical rules
- Inspection procedures by the competent authority, reporting requirements
- Lessons learned from incidents and accidents
- Behaviour in emergency situations

10 **Special course in RP with regard to teletherapy, duration (incl. practical exercises) - 28 h**
(successful completion of Course 1 is required)

- Construction and function of medical irradiation devices
- Technical fitting of teletherapy devices
- Basic principles of radiotherapy
- Dosimetry and physical irradiation planning
- Radiation protection in teletherapy
- Radiation protection monitoring and documentation
- Effects and side effects of radiation in teletherapy
- Instruction of personnel
- General overview of medical therapeutical procedures
- Quality assurance of methods and equipment
- Special regulatory requirements, guidelines, recommendations, technical rules
- Inspection procedures by the competent authority, reporting requirements
- Lessons learned from incidents and accidents
- Behaviour in emergency situations

Other sensible proposals for contents and durations may also serve the purpose.

Training of RPO in the field of x-ray equipment: Radiation Protection Courses

RPO Competence Groups	Radiation Protection Courses		
	Basic course for RPO dealing with basic scenarios	Basic course for RPO dealing with complex scenarios	Special courses
X-ray equipment in non-destructive testing of materials			
- Operation of x-ray equipment for non-destructive testing of materials: supervision of the entire operation		32 h ***2*** (Basic course)	
- Operation of x-ray equipment for non-destructive testing of materials: operation on-site	14 h ***1*** (Basic course)		10 h ***4*** (Special course: Checking, testing maintenance of x-ray devices)
- Flash X-ray device, portable X-ray scanner for non-destructive testing of materials	14 h ***1*** (Basic course)		10 h ***4*** (Special course: Checking, testing maintenance of x-ray devices)
X-ray scattering, diffraction and analysis			
- X-ray scattering, diffraction and structural analysis		32 h ***2*** (Basic course)	2 h ***5*** (Special course: X-ray structure analysis)
- X-ray scattering, diffraction and analysis (only for handheld x-ray fluorescence spectrometer)	14 h ***1*** (Basic course)		5 h ***3*** (Special course: Handheld x-ray fluorescence devices)
X-ray equipment for teaching purposes			
- Operation of X-ray equipment for teaching purposes	14 h ***1*** (Basic course)		4 h ***7*** (Special course: X-ray equipment for teaching purposes)
Checking, testing, maintenance and repair of X-ray equipment and sources of stray radiation			
- Supervision of the entire practice		32 h ***2*** (Basic course)	
- Operation on-site	14 h ***1*** (Basic course)		10 h ***4*** (Special course: Checking, testing, maintenance of x-ray devices)
Checking, testing, maintenance and repair of X-ray equipment subject to quality assurance			
- Supervision of the entire practice		32 h ***2*** (Basic course)	8 h ***6*** (Special course: Checking, testing, maintenance of x-ray devices and quality assurance)
Technical operation of medical or veterinary x-ray devices			
- Technical operation of medical or veterinary x-ray devices in pathology, forensic medicine or in medical or veterinary research (without application to patients)		32 h ***2*** (Basic course**)**	

h: course duration in hours, numbers in blue refer to the corresponding module in the course contents

Radiation Protection Course Contents

(1 hour teaching unit = 45 minutes)

1. Basic course for RPO dealing with basic scenarios – 14 h

- Legal foundations. recommendations and guidelines 1.0
- Tasks and duties of the Radiation Protection Officer 5.0
- Scientific foundations 2.5
- Radiation protection measurement techniques 0.5
- Practical radiation protection tool 1.0
- x-ray equipment and of stray radiation 1.0
- Practical training 2.0

2. Basic course for RPO dealing with complex scenarios – 32 h

- Legal foundations, recommendations and guidelines 2.0
- Tasks and duties of the Radiation Protection Officer 8.0
- Scientific foundations 6.0
- Radiation protection measurement techniques 3.0
- Practical radiation protection tool 3.0
- x-ray equipment and of stray radiation 4.0
- Practical training 4.0

3. Special course "Handheld x-ray fluorescence devices"– 5 h

(successful completion of Course 1 is required)

- Tasks and duties of the Radiation Protection Officer 0.5
- Scientific foundations 1.0
- Practical radiation protection tool 0.5
- x-ray equipment and of stray radiation 0.5
- Practical training 2.0
- Demonstration exercise 2.0

4. Special course "Checking, testing, maintenance and repair of x-ray devices and sources of stray radiation, operation of portable x-ray scanner and work on-site during mobile operation" – 10 h

(successful completion of Course 1 is required)

- Legal foundations, recommendations and guidelines 0.5
- Tasks and duties of the Radiation Protection Officer 1.5
- Scientific foundations 2.0
- Radiation protection measurement techniques 1.0
- Practical radiation protection tool 1.0
- x-ray equipment and of stray radiation 1.0
- Practical training 2.0
- Demonstration exercise 0.5

5. Special course "X-ray structural analysis incl. adjustment" – 2 h
(successful completion of Course 2 is required)

- Practical radiation protection tool 0.5
- x-ray equipment and of stray radiation 0.5
- Practical training 0.5

6. Special course "Checking, testing maintenance and repair of x-ray devices and quality assurance" – 8 h
(successful completion of Course 2 is required)

- Legal foundations, recommendations and guidelines 0.5
- Radiation protection measurement techniques 0.5
- Practical radiation protection tool 0.5
- x-ray equipment and of stray radiation 1.0
- Quality assurance of medical x-ray equipment 3.0
- Practical training 2.0

7. Special course "X-ray equipment for teaching purposes" – 4 h
(successful completion of Course 1 is required)

- Legal foundations, recommendations and guidelines 0.5
- Tasks and duties of the Radiation Protection Officer 0.5
- Scientific foundations 0.5
- x-ray equipment and of stray radiation 0.5
- Practical training 0.5

Other sensible proposals for content, duration and distribution of hours may also serve the purpose.

Training of RPO in Nuclear Power Plants

RPO Competence Groups	**Training**	**Work Experience**	**Updating**
Radiation Protection Officer (RPO) with overall responsibilities for radiation protection in a NPP University degree required (min. BSc)	Special training in radiation protection including the knowledge required for RPO dealing with complex scenarios (Training Content: Appendix A) **160 h**	**One year practical experience in radiation protection**, acquired in an operating NPP. In-plant training should comprise lectures, discussions, self-study, plant inspections, participation in meetings, participation in emergency exercises, and assumption of practical activities. **One year in-plant training** on the site where the scheduled activity will be carried out with respect to the setup and plant behaviour under normal operation and incident conditions as well as the contents of the operating manual and the special requirements and orders issued by official authorities. (Training content: Appendix B)	**Participation** in appropriate expert meetings (e.g. courses, conferences, symposia) at least every two years If the work as RPO is discontinued for more than 5 years, competence will have to be acquired again by: - participation in a training activity (Training Content: Appendix A) - in-plant training (Training content: Appendix B)
Radiation Protection Officer (RPO) with substantial restriction of responsibilities for radiation protection in a NPP Technician - minimum requirement: national or state-recognized certificate as RPO in a field corresponding to the task assumed, or master craftsman's certificate in a technical field	Special training in radiation protection including the knowledge required for RPO dealing with basic scenarios (Training Content Appendix A) **80 h**	**Six months practical experience in radiation protection** to the extent required for the scheduled responsibilities**.** In-plant training shall comprise lectures, discussions, self-study, plant inspections, participation in meetings, participation in emergency exercises, and assumption of practical activities. To the extent required for the scheduled responsibilities: **six months in plant-training** on the site where the scheduled activity will be carried out.	see above

The requirements for training of RPO in Research Reactors are similar and the training contents can be adopted from the contents in Appendices A and B tailored to the specific needs in a research reactor.

Appendix A

Contents of radiation protection training

The contents should generally be geared to the activities of a Radiation Protection Officer. The digits (1) to (3) stand for the weighting of contents; the higher the digit, the more importance should be assigned to the respective contents.

I. Legal foundations
- Atomic Energy Act (2)
- Radiation Protection Legislation (3)
- Provisions pertaining to transportation (3)
- Other relevant laws and regulations (1)
(e. g. laws pertaining to water and waterways, waste legislation)

II. Recommendations and guidelines
- ICRP (2)
- EURATOM, IAEA, EC (2)
- Nuclear Safety Standards (3)
- Standards (3)
- Guidelines (3)
- Reporting criteria NPP (3)

III. Tasks and duties of the Radiation Protection Officer (RPO)
- Legal status of the RPO (3)
- Responsibilities (3)
- Organisation of radiation protection (3)
- Instruction (3)
- Recording, accounting (3)
- Labelling obligation (3)
- Monitoring and controls (3)
- Maintenance (3)
- Reporting system (3)
- Medical surveillance (3)
- Storage and security of radioactive materials (3)
- Detriment control in accidents (3)
- Treatment of residues and delivery of radioactive waste (3)
- Discharge of waste materials not considered as radioactive from the controlled area (3)
- Employment prohibitions and restrictions (3)

IV. Scientific foundations
- Radiophysical foundations (3)
- Radiobiological foundations (2)
- Concepts of dose (3)
- ALARA principle (3)
- Shielding against radiation (3)
- Human exposure to radiation (3)

V. Radiation protection measurement technique
- Foundations of radiation protection measurement technique (3)
- Measurement of dose rate (3)
- Ambient dose measurement (3)
- Individual dose measurement (3)
- Incorporation measurement and surveillance (3)
- Equivalent dose assessment (3)
- Contamination measurement and surveillance (3)
- Activity assessment (air, water, soil) (3)
- Nuclide identification (3)
- Function test of measuring devices (3)
- Possibilities of error during measurement (3)
- Evaluation and judgement (3)

VI. Radiation protection technology
- Work planning and radiation protection planning (3)
- Work methods (3)
- Discharge of radioactive materials to the environment (3)
- Material decontamination (3)
- Treatment of residues and waste (3)
- Leakage test of sealed radioactive sources (3)
- Radiation protection areas (3)
- Laboratory equipment (3)

- Packaging, transportation (3)

VII. Radiation protection safety
- Medical radiation protection (3)
- Individual protective equipment (3)
- Requirements fort he use of individual protective equipment (3)
- Decontamination of individuals (3)
- Technical radiation protection(3)
- Emergency planning, measures and behaviour in incidents and accidents (3)
- Theft protection (3)
- Safety measures (3)

VIII. Reactor physics
- Nuclear fission (1)
- Criticality (1)
- Reactivity (1)
- Possibilities of reactor control (1)

IX. Reactor chemistry
- Properties of nuclides (2)
- Chemical system parameters (specifications) (2)
- Possibilities of influencing chemical parameters (2)
- Radionuclide measurement techniques (2)
- Techniques of chemical analyses (2)

X. Reactor technology
- Reactor setup (1)
- Nuclear instrumentation (1)
- Heat transfer between fuel rod and coolant (1)

XI. Reactor safety
- Design basis accidents (DBA) (1)
- Design principles (1)
- Safety equipment (1)
- Reactor protection (1)

XII. Radiation exposure of the environment
- Dispersion meteorology (3)
- Dispersion of harmful agents in air and water (3)
- Radionuclide transfer, fallout, washout (3)
- Exposure at the most unfavourable receiving point (3)

XIII. Fire protection
- Fire-fighting (1)
- Fire alarm systems (1)
- Fire fighting installation (1)

XIV. Occupational health and safety
- Provisions and standards (2)
- Possible risks of accident (2)

XV. General information on the setup of a nuclear power plant or other installations for the fission of nuclear fuel
- Building and building equipment (1)
- Setup and functioning of the installation (1)
- Functioning of proper systems (1)

XVI. General information on the behaviour of a nuclear power plant or other installations fort he fission of nuclear fuel during normal operation or incidents
- Normal operation (1)
- Operating failures of important systems (1)
- Incidents and accidents (1)
- External hazards (1)

XVII. General information on nuclear technical emergency response
- In-plant emergency response (2)
- Emergency management by the administrative authorities (2)
- Radiation protection instrumentation for emergency response (2)

XVIII. General information on provisions and administrative measures in nuclear power plants or other installations for the fission of nuclear fuel
- Special requirements and orders issued by competent authorities, provisions concerning administrative fines (1)
- Operating manual, including safety specifications (1)
- Operating organisation (1)

Appendix B

Contents of in-plant training

I. Plant setup

1. Introduction into the setup and functioning of the plant

2. Systems
2.1 Main systems
2.2 Auxiliary systems
2.3 Systems for the treatment of radioactive materials
2.4 Systems for the prevention and control of incidents

3. Control rooms and master control stations

4. Radiation protection relevance of the systems; radiation protection areas

II. Plant operation

1. Operating behaviour
1.1 Power operation
1.2 Outages

2. Incidents and accidents
2.1 In-plant releases of activity
2.2 Effects on the environment

III. Organisation within the plant

1. General organisation

2. Radiation protection organisation

IV. Radiation protection within the plant and its environment

1. Radiation protection measuring devices and activity measuring devices

2. Physical radiation protection control and medical surveillance

3. Practical radiation protection activities

4. Treatment of residues and radioactive waste

5. Emission and immission (environmental monitoring)

V. Provisions and special requirements

1. Licenses

2. Operating manual
2.1 Plant regulations
2.2 Provision relevant for radiation protection
2.3 Chapter on incidents

3. Testing manual (retest relevant for radiation protection)

Not all topics listed here need the same amount of lecture time (number of hours): topics directly related to radiation protection need more time, topics indirectly related to radiation protection can be dealt with in less time.