Qualification Descriptors
for the training of
Radiation Protection Officer
for
Dispersible Radioactive Materials
Level D
(RPO-DRM D)

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The Authority for Nuclear Safety and Radiation Protection (ANVS) requested the field to revise the training system for Radiation Protection Officers. The core of these revisions, which derive from the European Basic Safety Standards (EU-BSS)[1], is that the training for Radiation Protection Officers should be application specific. During the past two years, a start has been made on these revisions[2]. As an outcome of these revisions, the University of Groningen has decided to form a workgroup whose task is to formulate the qualification descriptors for the training of Radiation Protection Officers of Dispersible Radioactive Materials, abbreviated as RPO-DRM. In this workgroup, it was discovered that it is desirable to have different levels of RPO-DRMs. In the document Qualification Descriptors RPO-DRM, a proposal is made for a classifcation system with three levels (level B, C and D). In the present document, the qualification descriptors for the Radiation Protection Officer are described for applications in which very limited amounts of radioactivity are used, namely RPO-DRM level D (RPO-DRM D).
The contents of this document are in part borrowed from the Qualification Descriptors RPO-DRM level C.

These qualification descriptors are primarily meant for the tasks of the Radiation Protection Officer of Radioactive Materials in dispersible form in very limited quantities, provided that they work under the direct responsibility of a Coordinating Radiation Protection Expert (RPE)[3]. "Very limited" here means: the supervision of an isotope laboratory at D-level (A_{max} = 0,2 Re_{inh} for p=-1). This classification is described in detail in the document Qualification Descriptors for RPO-DRM.
These qualification descriptors can also be applied to the training of exposed workers who work with radioactive materials in dispersible form in radionuclide laboratories at B-, C- and D-levels.

The definition and tasks of the Radiation Protection Officer are given in the Radiation Protection Decree. The definition reads: "A Radiation Protection Officer is an expert that performs or conducts work, or under whose supervision an act or work is carried out (art. 1)". The description of the tasks can be found in Articles 9 through 11 and 13 of the Radiation Protection Decree (Bs)[4].

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[1] Council Directives 96/29/Euratom (13 May 1996) and 2013/59/Euratom (5 December 2013)
[2] See B.C. Godthelp and A.M.T.I. Vermeulen, Ned. Tijdschrift voor Stralingshygiëne, jg.6, nr.3 (2015), p.9 and references therein
[3] S. van Dullemen and group members, 'Eindtermen voor de opleiding Stralingsbeschermingsdeskundige', 17 januari 2013.
[4] Radiation Protection Decree 16 July 2001, Staatsblad 397 (2001), http://wetten.overheid.nl/BWBR0012702/2015-01-01/0

Radioactive materials in dispersible form are applied or play a role in the following areas:

- Research, analysis and material research
- Human radiodiagnostics, radiotherapy and nuclear medicine

An RPO-DRM D can supervise in the medical sector as long as he does not administer radioactive materials to the patient (no direct patient contact). If direct patient contact is necessary, then the supervisor should be successfully trained as an RPO for Medical Applications. The workgroup recomments that in situations in which patient contact is limited, a simple step from an RPO-DRM D to the relevant RPO-MT mogelijk should be possible.
The RPO-DRM D may not carry the ultimate reponsibility for performing leakage testing due to the large potential risk if a leaking source is found.
The RPO-DRM D may be responsible for the release of material, waste or equipment and the performance of control measurements on any residual contamination in the laboratory, but the RPE is ultimately responsible for the release of the laboratory and the technical facilities outside of the laboratory (such as sewer pipes and ventilation system). The release or dismantling of rooms and technical facilities (during decommissioning) where there is a risk of activated material also falls under the responsibility of a RPE.
In many radionuclide laboratories, small calibration sources are present. The qualification descriptors for an RPO-DRM D should also be sufficient to function as a Radiation Protection Officer for these sources.

The field of radiation protection in fact encompasses multiple disciplines, including such diverse subjects as radiation physics, radiobiology, dosimetry of internal contamination, medical and industrial applications of ionizing radiation, and laws and regulations. The RPO-DRM D fulfills diverse rolls:

- Supervisor
- Advisor / instructor
- Producer of work procedures / protocols
- Intermediary between worker and RPE

The RPO-DRM D are experts in the safe way of working with radioactivity and in the correct manner of measuring activity, radiation levels, (skin) contamination, and in interpreting measurements and making dose estimates. The RPO-DRM D can perform dose and shielding calculations at a basic level. This requires an appropriate amount of current, ready knowledge and understanding (knowledge) from both professional aspects of the field (such as basic hard core physics), skills to support the RPE in an appropriate manner (skills), and insight and professional expertise (competence).

The training for an RPO-DRM D is a MBO-level education. The prerequisites for a course participant will in many cases be MBO or HBO level. The point of formulating competencies is to form a better picture of what the tasks are, in which context they must be performed and the quality with which someone must be able to do them. A competent professional is someone who can perform specific tasks in a particular context with certain qualities. In looking at the context in which the RPO-DRM D works, a distinction can be made between three important work situations.

- The RPO-DRM D supervises and enforces the relevant laws and regulations in the area of ionizing radiation and gives content-appropriate advice of a preventative nature in consultation with the RPE.
- The RPO-DRM D contributes appropriately to the processing by the RPE of a (threatened) incident or undesired happening.
- The RPO-DRM D works actively on the maintenance of his own expertise and that of others within applications for which he is responsible.

The draft qualification descriptors for the basic competencies of an RPO-DRM D are therefore grouped in four clusters: ***Prevention (proactive), Crisis Management (reactive), Professionalization, and Specialization (open sources),*** for the different tasks of the expert, such as informing, supervising, monitoring and measuring, estimating risks of working with radioactive materials, making work protocols, managing a comprehensive KEW administration system, etc.

When drafting the qualification descriptors, the workgroup realized that the former Level 5B training had been used the last few years to train workers who may in large part work independently in radionuclide laboratories and may even be deployed occasionally as an RPO. One can therefore assume that there is a large overlap with the qualification descriptors of the training Radiation Expert Level 5B[5] and those for an RPO-DRM D. The length of the training course should be about 3-4 days for someone with a HBO education, and 1 or more days for a participant with a lower education. This nominal training period can vary per educational institute according to the didactic interpretation (schedule, contact hours versus self study, contact hours versus e-learning/blended-learning, the use of web lectures, etc). The radiation practical should consist of one to two days out of the total course length.

[5] Appendix 3.2, Uitvoeringsregeling Stralingsbescherming EZ 2013 (Staatscourant 2013, 32478)

The draft qualification descriptors and an appendix in which the key terms from the material are listed follow.

Qualification descriptors

Core competency 1:

The RPO-DRM D supervises and enforces (for the applications for which he[6] is responsible) the relevant laws and regulations in the area of ionizing radiation and gives content appropriate advice of a preventative nature to the workers and the organization in consultation with the RPE.

Further characterization of the context

This preventative work is for the most part performed in or near the laboratory. The work also includes administrative tasks and participation in regular consultations. For the RPO-DRM D, this is usually an important secondary component of his remaining work. The RPO-DRM D involves the RPE for those tasks the RPE is responsible for and proceeds within the framework specified by the RPE. The RPO-DRM D consults with him professionally if necessary to safeguard the quality of the radiation protection for the application for which he is responsible.

In this context, it is important that the RPO-DRM:

1. has an overall understanding of risk inventory and evaluation (RI&E) and can act on it;
2. contributes to the setting, evaluation and improvement of appropriate work protocols according to the principle of a Plan-Do-Check-Act-cycle;
3. implements a source-oriented, practical approach;
4. gives advice for policy focused on risk limitation and the practical implications thereof for employees;
5. realizes his position within the radiation protection organization and his relationship to the RPE and therefore acts appropriately;
6. advises on and assesses the use/application of certain work methods for radiation sources, based on a general knowledge of various detection methods and in consultation with the RPE;
7. reliably and reproducibly measures the radiation level (surface contamination, dose rate);
8. advises on the appropriate personal protective devices and their use for distinct activities/actions (manner of exposure) and situations;

[6] In the explanation of the qualification descriptors, the masculine pronoun "he" is used, but of course we mean "he or she".

9. estimates risks for pregnant exposed workers and gives appropriate advice in consultation with a RPE;
10. issues the most suitable form of personal dosimetry to exposed workers in consultation with the RPE;
11. interprets obtained measurement data and relates it in context to norms and limits;
12. determines the effective dose for external irradiation via rules of thumb and gives advice regarding shielding;
13. determines the effective (committed) dose for internal contamination based on simple calculations;
14. calls on the RPE for the tasks that are his responsibility and professionally uses his contact with the RPE.

Therefore it is necessary that the expert:

15. has knowledge of the mathematics, physics and chemistry at the exam level of HAVO (NG/NT profile) / MBO (technical);
16. has knowledge of the three main principles of radiation protection (justification, optimization/ALARA, limits);
17. possesses general knowledge of basic human anatomy and physiology;
18. can interpret shielding calculations for all types of radiation used and can make simple shielding calculations;
19. knows the requirements that are set in the Nuclear Energy Act file and the respective administrative requirements and can apply these to his work situation;
20. has knowledge of the current and relevant legislation and regulations;
21. understands dose concepts and other related concepts stated in the Nuclear Energy Act and is able to work with them;
22. knows the rules and applies them to the appropriate portion of the lifecycle/logistics management chain of radioactive materials;
23. knows the division of supervised and controlled zones;
24. is generally familiar with transport regulations (ADR7) with regards to radioactive materials;
25. is familiar with the nuclide chart and can use the given data in calculations;
26. has sufficient knowledge and insight in radiobiology to interpret risk estimates;
27. gives effective, individually-oriented (work) instructions;
28. possesses general knowledge of the physical and radiobiological properties of alpha-radiation, beta-radiation, positrons and photons;
29. has general knowledge of the secondary effects of high-energy radiation (bremsstrahlung);
30. has general knowledge of background radiation.

Core competency 2:

De RPO-DRM D contributes to the appropriate management of an unintentional event or (imminent) incident for the applications for which he is responsible.

Further characterization of the context

Appropriate prevention and precautions do not eliminate the possibility that an incident, in which radiation plays a role, will threaten to develop or actually does occur. In such a situation, it is expected that the RPO-DRM D undertakes first line actions, informs the RPE and subsequently follows his instructions.

In this context, it is important that the expert:

31. makes an appropriate estimate of the urgency/risk for an (imminent) incident in consultation with the RPE;
32. prevents (further) contamination of the environment by applying the appropriate measures;
33. chooses, initiates and/or applies the appropriate measures, detection methods and measuring methods;
34. drafts a decontamination plan and carries it out in consultation with the RPE;
35. actively takes responsibility for his role;
36. gives timely and conservative dose estimates based on measured values and data on the radioactive materials used;
37. contributes to the evaluation of the incident.

Therefore it is necessary that the expert:

38. quickly reviews the situation because he is familiar with the sources, locations, and procedures;
39. knows the practical rules of thumb for both internal contamination and external irradiation and can quickly apply them;
40. informs exposed (or those who think they are exposed) people appropriately based on factual information.

Core competency: 3

The RPO-DRM D actively works on furthering his own expertise and those of others for whom he is responsible.

Further characterization of the context

Knowledge can quickly become outdated, especially with regards to regulations and work methods/applications, and therefore must be continually updated and expanded. This not only applies for the expert himself but also for the workers who are under his supervision. The RPO-DRM D has legal responsibilities (Decree on radiation protection) with regards to the information and instruction of (exposed) workers (whether or not they are pregnant).
The RPO-DRM D will also be involved in disaster drills and contributes to the preparation and guidance of governmental inspections as directed by the RPE.

In this context, it is important that the expert:

41. effectively communicates about radiation risks, work procedures, etc, with all involved parties (his own workers and the RPE);
42. sufficiently oversees his own area of radiation protection and therefore can give convincing and factual advice and information;
43. compares the relationship between radiation risks and those of other agents and risks on the work floor with the occupational health and safety risk policy, and therefore takes into account the differences in risk perception;
44. contributes to the composition and assessment of understandable work protocols;
45. reflects on his own norms and values, integrity and ethics;
46. recognizes the limits of his own expertise and expands his training;
47. is open to, or should he doubt his own expertise, actively seeks intervision, critical feedback or advice from the RPE;
48. reflects on his own risk perception regarding radiation exposure.

Therefore it is necessary that the expert:

49. gives practical interpretation on the system of radiation protection within his application;
50. is sufficiently familiar with the literature and internet information in order to keep his knowledge current and retrains as necessary in consultation with the RPE;
51. is aware of the critical success factors in (risk) communication tailored to different target groups;

52. is aware of (the limits of) his own skills and competencies.

Core competency 4:

The RPO-DRM D possesses knowledge, skills, attitudes and competencies that specifically apply to radioactive materials in dispersible form.

Further characterization of the context

Core competencies 1 through 3 generically describe the basic competencies that RPO-DRM D should have. The elaboration of these competencies is in most cases - but not all - general in nature. The RPO-DRM D should have specific knowledge with regards to the dispersible character of radiactive materials.

In this context, it is important that the expert:

53. stays current on the best practices and appropriate measures to prevent dispersion of radioactive materials, and acts on them;
54. during unforeseen events or incidents, prevents (further) contamination of the environment by applying the correct measures, contributes to the composition of a decontamination plan and enacts this or has it enacted.
55. sufficiently oversees the focus area "working with radioactive materials in dispersible form";
56. applies RI&E methods for dispersible radioactive materials;
57. contributes to the implementation of an administrative system for radioactive materials;
58. initiates contamination surveys and performs them or has them performed.

Therefore it is necessary that the expert:

59. is generally familiar with the application of radioactive materials in dispersible form in research, and in medical or industrial settings;
60. has general knowledge of (the working of) contamination monitors and liquid scintillation counters, and can use them;
61. has knowledge of and possesses skills to use (external) decontamination methods for people and material;
62. possesses sufficient organizations skills for the administration of the purchasing, use, waste disposal and inventory of radioactive materials.

Learning outcomes for radiation practicals

Due to the importance of including a lab practical in the training course, a summary of the specific and practical learning outcomes based on the stated qualification descriptors is given.

The Radiation Protection Officer:

- has a command of various measuring techniques such as liquid scintillation counting and common detectors (Geiger-Müller counters, proportional counters, NaI, ionization chambers, etc.);
- works with contamination monitors;
- performs reliable dose rate measurements;
- decontaminates objects;
- uses radioactive sources in a safe manner;
- performs wipe tests;
- has a general understanding of the physical properties and generic radiation characteristics of radioactive materials (penetration, penetration power, spectral distribution, shielding of alpha-, beta-, and gamma-radiation and bremsstrahlung radiation).

Testing

In order to qualify for a diploma RPO-DRM D, a successful candidate must have achieved a sufficient grade for at least the following:

1. the exam;
2. the radiation practical;

The details of the assessment procedure and method are established in the exam regulations from the authorized organization.

In addition, skills such as instructing, advising, writing protocols, etc., may also be assessed through submitted (practical) assignments, giving talks, active (and required) participation in discussion meetings (360 degree feedback), etc.

Ad 1

The exams test in an objective manner various aspects, including ready knowledge; calculation skills; understanding of, insight in and application of aspects of physics; dosimetry; and practical aspects of radiation protection. The methods of testing can include, for example, multiple choice questions or a combination of both multiple choice questions and open questions on practical case studies.

Ad 2

The assessment (including practical reports, answered questions, observations or presentations, and 100% required participation) will be judged either sufficient or insufficient based on established criteria as described in the exam regulations.

Appendix 1: Table of keywords from the lesson material

This table should only be viewed in the context of this report and cannot be used or cited as an independent entity. The table does not pretend to be complete but gives a minimum number of subjects that should be addressed in the training program. The column headings K, S and C stand for Knowledge, Skills and Competencies. These three categories are listed hierarchically: K<S<C. Thus without knowledge, there can be no skills and without skills there can be no competencies. This hierarchy should be applied with some reservation. To be competent in some subjects, one must also have a professional attitude. Therefore, the three categories are sometimes given as Knowledge, Skills and Attitudes. In this document, we adhere to the definition of competencies as is given by the IAEA[7]: "Competence is the ability to apply skills, knowledge and attitudes in order to perform an activity or a job to specified standards in an effective and efficient manner". Additionally, one also asks to what measure the RPO-DRM must explain the subject to his colleagues while giving instruction. In this case, instruction is also listed under the category "Competencies". From a historical perspective and to keep uniformity with other tables, we have chosen to keep the K<S<C designations.

This list has been aligned, with a few amendments, with the list for the former Level 5B training program as described in the Implementation regulation radiation protection EZ. This list gives a gradation in 3 levels of which 1 is the lowest (general knowledge) and 3 is the highest (specific knowledge). As will be seen, level 3 can not always be translated directly into competency.

[7] https://www.iaea.org/km/documents/05_W_Kossilov_2226Aug05.pdf

General	**K**	**V**	**C**
atom structure	X		
ionization, excitation	X		
proton / neutron ratio	X		
radioactive decay, half-life	X	X	
decay formulas and decay constant	X	X	
mother-daughter connections	X		
specific activity	X		
α-, β, γ-decay, electron capture, internal conversion	X		
characteristic X-ray radiation	X		
Bremsstrahlung radiation	X		
decay schemes	X		
nuclear reactions	X		
energy spectra α-, β-, γ-emitters and Bremsstrahlung	X		
penetrance	X		
inverse square law	X	X	
half-thickness	X		
interaction mechanisms for α-, β-, γ-emitters	X		

Basic competencies	**K**	**V**	**C**
physics (including electromagnetic radiation, duality, wave/particle)	X		
biology (human anatomy, physiology, DNA, cell division)	X		
epidemiology (risks)	X		
justification	X	X	
optimalisation/ALARA	X	X	
dose limits	X		
exposure situations (planned, existing, incident)	X		
procedures /work situation	X		

Natural radioactivity	**K**	**V**	**C**
U- and Th-decay chains	X		
natural radionuclides	X		
cosmic radiation, terrestrial radiation	X		
doses as a consequence of natural radioactivity	X		
radon	X		

Detection	**K**	**V**	**C**
gas-filled detectors	X		
- ionization chambers	X		
- proportional counters	X		
- Geiger-Müller counters	X		
scintillation detectors	X		
- ZnS	X		
- plastic scintillators	X		
- liquid scintillation counters	X		
- thermoluminescence detectors			
semi-conductor detectors such as Ge, Si, CCD, etc.	X		
dead time, geometry, self-absorption	X		
counting efficiency, (intrinsic-)	X		
counting statistics	X		
minimal detectable activity / counting rate	X		
spectrometry, pulse height analysis	X		
total body counters	X		

measuring devices for surface contamination	X	X	
measuring devices for dose rate	X	X	
personal control devices (both active and passive)	X	X	
Dosimetry	**K**	**V**	**C**
absorbed dose	X	X	
weighting factors	X		
equivalent dose	X		
effective (committed) dose	X		
exposure	X		
ambient dose equivalent	X		
personal dose equivalent	X		
rules of thumb average energy bèta-emitters	X	X	
rules of thumb penetration bèta-emitters	X	X	
rules of thumb regarding β-dosimetry	X	X	
rules of thumb regarding γ-dosimetry	X	X	
principle protection regulations (time, distance, shielding)	X	X	X
source constant	X		
interpretation of measurements	X	X	
Biological consequences of radiation	**K**	**V**	**C**
stochastic/deterministic effects	X		
factors that influence the biological effect:			
- radiation conditions, tissue properties and environmental factors	X		
irradiation of the entire body and partial irradiation	X		
direct/indirect effects, free radicals, DNA-damage, repair mechanisms	X		
genetic effects	X		
teratogenic effects	X		
dose-effect relationships	X		
risk estimates	X		
risk numbers	X		
Organization and legislation	**K**	**V**	**C**
norms and legal regulations, (inter)national organizations	X		
(inter)national organizations with regards to radiation safety, consistency	X		
historical developments	X		
legislation:			
- Directives European Union	X		
- Nucelar Energy Act (Kew)	X		
- Decision Radiation Protection (Bs)	X		
- Decision Transport Fissionable Materials, Ores, and Radioactive materials	X		
- Environmental Management Act	X		
- Dutch Occupational Health and Safety Act	X		
ministerial regulations:			
- Implementation regulation SB EZ	X		
- MR for the provision of radiation protection workers	X		
- MR publication justification of use of ionizing radiation	X		
justification, optimization (ALARA) and dose limits	X		
permit application (document ANVS)	X		
procedures / work activities	X		
source-oriented approach	X	X	
exclusion / exemption	X		
radiotoxicity equivant, Re	X		

supervised and controlled zones	X		
determination of yearly dose for rooms, workers and others	X		
A and B workers	X		
outfitting requirement for nuclide laboratories	X	X	
definition closed source	X		
ISO 2919 for requirements on closed sources	X		
practical implementation for transport of radioactive materials	X		
Organizational aspects radiation protection	**K**	**V**	**C**
responsibilities within the radiation protection unit	X	X	
Nuclear Energy Act file (i.e. from the Directive on radionuclides or analogs)	X	X	
disposal routes	X	X	
dose calculations for simple cases (Implementation regulation SB EZ, appendix 1.5, part I)	X		
External irradiation	**K**	**V**	**C**
small beam and broad beam geometries for photon radiation	X		
build-up factor for non-composite materials	X		
choice of material for shielding as a function of photon energy	X		
calculation of radiation scattering by objects	X		
use of graphs and tables with regards to attenuation and transmission for sources	X		
shielding of neutron radiation (qualitative)	X		
Internal contamination	**K**	**V**	**C**
incorporation routes; retention and excretion	X		
general transport model of the ICRP	X		
inhalation and ingestion	X		
wound contamination	X		
selection e(50) from the Handbook of Radionuclides or analogs	X		
Practical aspects	**K**	**V**	**C**
maximal permissable surface contamination	X	X	
personal protection measures	X	X	
control methods:			
- surface contamination	X	X	
- discharges	X		
retrospective inventory and evaluation of incidents	X		
practical skills in contamination measuring	X	X	
practical skills in release of contaminated work areas	X	X	
practical skills in release of contaminated people	X		
knowledge and practical skills of different cordoning off levels (map, tape, barricade)	X	X	
waste handling	X		
discharge standards according to regulations and permits	X		
position COVRA	X		
Risk-inventory and evaluation	**K**	**V**	**C**
- open sources	X	X	
- p,q,r-formula	X		
- RI&E-description	X	X	
- control of risks during procedures with open sources in laboratories	X	X	
Organizational	**K**	**V**	**C**
give short, succinct and target-group oriented knowledge transfer	X	X	
write work protocols/internal protocols	X	X	

determination of risk perception	X	
organizational behavior (formal/informal organization; organization structure, role of the expert, role of the RPE)	X	
support and inform the RPE	X	X