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Mitgliedsgesellschaft der International Radiation Protection Association (IRPA)
für die Bundesrepublik Deutschland und die Schweiz



CATALOG OF LEARNING OBJECTIVES

for the Expert Knowledge Directive
for General Managers of Radiation Protection or
Radiation Protection Supervisors
in the Non-medical Field
(Extract)

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CATALOG OF LEARNING OBJECTIVES

for the Expert Knowledge Directive
for General Managers of Radiation Protection or
Radiation Protection Supervisors in the Non-medical Field

General Handling
Radiation Protection Supervisor with
overall responsibility

No. 3.2

Catalog of Learning Objectives

The catalog of learning objectives provides information about the entire know-how and skills of the respective expert knowledge group which are required for radiation protection.

The verbs selected to formulate the learning objectives possess a meaning that is tantamount to the scope of the know-how and skills.

The verbs *state, define, list, trace* mean:

INSIGHT INTO THE FIELD OF KNOWLEDGE

The verbs *explain, describe, distinguish, compare, write down* mean:

OVERVIEW OF THE FIELD OF KNOWLEDGE

The verbs *evaluate, judge, develop, compile, summarize, determine, interpret, conclude, draw up* mean:

OVERALL KNOWLEDGE OF THE FIELD OF KNOWLEDGE

The verbs *perform, apply, operate, estimate* mean:

BASIC PERFORMANCE SKILLS

The verbs *plan, evaluate* mean:

SKILL IN THE SENSE OF WARRANTY

1. Legal Basics

1.1 ATOMIC ACT

- 1.1.1 Define the legal nature of regulations (law, ordinance, approval, directive, standard, recommendation)
- 1.1.2 Describe the purpose and meaning of the Atomic Act
- 1.1.3 Explain basic regulations made in the Atomic Act

1.2 RADIATION PROTECTION ORDINANCE

- 1.2.1 Explain the area of application of the Radiation Protection Ordinance in terms of location and subject matter
- 1.2.2 Define the protection goals radiation protection is aiming for when handling ionizing rays and state the radiation protection principles
- 1.2.3 Describe who is General Manager of Radiation Protection and who is Radiation Protection Supervisor in accordance with the Radiation Protection Ordinance (§ 29 (1) and (2) StrlSchV)
- 1.2.4 Explain the paragraphs and sections of the Radiation Protection Ordinance pertinent to the present activities
- 1.2.5 Define the appropriate authorities in accordance with the Radiation Protection Ordinance
- 1.2.6 Describe the legal consequences of the violation of regulations in accordance with the breach of the law paragraph of the Radiation Protection Ordinance (fine or penalty)
- 1.2.7 Explain the purpose of § 20a of the Radiation Protection Ordinance
- 1.2.8 Describe the procedure for type approval
- 1.2.9 State the duties of the owner of a type-approved device

- 1.2.10 Explain the division of the Radiation Protection Ordinance into monitoring regulations, protection regulations, fine regulations and transition and conclusion regulations

1.3 OTHER ORDINANCES REGARDING THE ATOMIC ACT

- 1.3.1 State other important ordinances for radiation protection (e.g. X-ray regulations, coverage provisions regarding the Atomic Act, rules of procedure regarding the Atomic Act) and describe the scope of application

1.4 SHIPMENT REGULATIONS

- 1.4.1 State the laws and ordinances that are valid for transportation of the radioactive materials to be transported in the expert knowledge field
- 1.4.2 Compile the terms of the respective transportation regulations that apply to the transportation of the items or materials to be transported in the expert knowledge field
- 1.4.3 Explain the prerequisites for the storage of radioactive materials in parked vehicles

1.5 APPROVALS

- 1.5.1 Explain the meaning of approvals
- 1.5.2 Explain the meaning of model approvals
- 1.5.3 Explain individual approval regulations (according to Radiation Protection Ordinance, Atomic Act)
- 1.5.4 List all activities requiring approval according to the Radiation Protection Ordinance

- 1.5.5 Explain which legal effects approval requirements have for activities requiring approval, for the General Manager of Radiation Protection and the Radiation Protection Supervisor

- 1.5.6 Describe the major types of approval requirements

- 1.5.7 State the essential contents of model approvals that are relevant to the expert knowledge field (§20 a; transportation, use and storage of material test sources)

1.6 COMMUNICATIONS

- 1.6.1 Explain the meaning of the communication procedure (handling, import and export)
- 1.6.2 List all activities that need to be communicated in accordance with the Radiation Protection Ordinance

1.7 OTHER PERTINENT LAWS AND ORDINANCES

- 1.7.1 State the regulations defining the radiological units and the calibration of measuring systems (e.g. implementing regulations regarding the law on units in metrology, second ordinance on the calibration obligation of measuring systems, calibration validity ordinance)
- 1.7.2 State the consequences resulting from these regulations for everyday radiation protection

2. Recommendations and Directives

2.1 ICRP

- 2.1.1 State task and objective of ICRP (ICRP: International Commission on Radiological Protection)

- 2.1.2 State legal status of the ICRP recommendation

2.2 IAEA, NEA, EURATOM

- 2.2.1 State these organizations and their area of operation (IAEA: International Atomic Energy Agency; NEA: Nuclear Energy Agency; EURATOM)
- 2.2.2 Using examples, define which type of recommendations and directives have been issued by these organizations (transport container, encapsulated sources)

2.3 STANDARDS

- 2.3.1 Describe the DIN standards relevant to the respective expert knowledge group (DIN: German Institute for Standards) (DIN 54 115, page 1 – 5; DIN 6814; DIN 25400)

2.4 DIRECTIVES

- 2.4.1 Describe the directives relevant to the respective expert knowledge group (e.g. accident prevention regulations of the trade association "Precision Engineering and Electrical Engineering"; Directive of the Department of the Interior)

3. Tasks and Duties of the Radiation Protection Supervisor

3.1 LEGAL STATUS OF THE RADIATION PROTECTION SUPERVISOR

- 3.1.1 Explain the legal status of the Radiation Protection Supervisor and the General Manager of Radiation Protection

- 3.1.2 Explain the basic tasks of the Radiation Protection Supervisor ("Management and supervision" § 29 (2) StrlSchV)
- 3.1.3 Describe the prerequisites for appointing a Radiation Protection Supervisor (expert knowledge, area of competence, competence, ...)
- 3.1.4 Explain the meaning of the area of competence of a Radiation Protection Supervisor (responsibility and competence)
- 3.1.5 Define who appoints the Radiation Protection Supervisor, who will be notified about this appointment and which information has to be provided
- 3.1.6 Explain which conflict solution model the Radiation Protection Ordinance (§ 30) foresees if Radiation Protection Supervisor and General Manager of Radiation Protection do not come to an agreement concerning a radiation protection provision

3.2 ORGANIZING RADIATION PROTECTION

- 3.2.1 State the requirement for defining areas of competence and describe them in writing
- 3.2.2 Explain the meaning and purpose of a radiation protection instruction (§ 14 StrlSchV)

3.3 INSTRUCTION

- 3.3.1 State the subject catalog for radiation protection instructions

3.4 RECORDS, BOOK-KEEPING

- 3.4.1 Describe the documentation regulations for acquisition, possession and disposal of radioactive materials

- 3.4.2 Explain which records have to be made, who has access to them and who is responsible for them
- 3.4.3 Define how long records have to be kept on file
- 3.4.4 Describe the purpose of a personal dose file as well as the information it should contain
- 3.4.5 Define the purpose of a registered radiation passport and the information it should contain

3.5 LABELING DUTY

- 3.5.1 Describe what is to be labeled (facility, radioactive substances)
- 3.5.2 Explain how and by whom labeling is performed and which references are used
- 3.5.3 Explain the radiation risks the labeling should warn against
- 3.5.4 Describe standards and requirements for labeling
- 3.5.5 Define which items are to be labeled in particular and which areas require special shielding off
- 3.5.6 Define in which cases labeling is to be removed

3.6 AREAS OF COMPETENCE

- 3.6.1 Explain that the area of competence has to be defined in writing
- 3.6.2 Explain the intra-company area of competence in accordance with the Radiation Protection Ordinance
- 3.6.3 Explain how an assessment is made whether the area of competence corresponds to the tasks that have to be guaranteed
- 3.6.4 Explain the required competence

- 3.6.5 Explain the type of definition of the areas of competence and the notification of persons and authorities and give examples
- 3.6.6 Explain why areas of competence must not overlap
- 3.6.7 Define how duties can be transferred

3.7 MONITORING AND CONTROLS

- 3.7.1 Describe which monitoring and control provisions are required (persons, workplaces, environment)
- 3.7.2 Describe how monitoring and controls are to be performed in individual cases
- 3.7.3 Develop plans and instructions for controls and monitoring
- 3.7.4 Interpret the meaning of reinsuring measures to avoid the consequences of human or machine failure or diminish their consequences

3.8 MAINTENANCE

- 3.8.1 Explain which maintenance has to be performed for radiation protection
- 3.8.2 Explain the duties of the General Manager of Radiation Protection with regard to maintenance and operational checks of facilities and devices
- 3.8.3 Describe how to document maintenance
- 3.8.4 Explain which intra-company maintenance requirements have to be adhered to and which personal dosimetry shall be used for this purpose

3.9 ANNOUNCEMENTS

- 3.9.1 List the state of affairs of the area of competence about which the appropriate authority or the General Manager of Radiation Protection have to be informed
- 3.9.2 Describe how announcements have to be drafted at a given occasion
- 3.9.3 Explain the provisions regarding announcement duty

3.10 MEDICAL MONITORING

- 3.10.1 Define the provisions for medical monitoring
- 3.10.2 State what kind of information has to be provided to the physician in charge
- 3.10.3 Explain the purpose of medical monitoring and the possible consequences
- 3.10.4 Define the usual time period between two medical checks for occupationally exposed persons
- 3.10.5 Describe the criteria which are relevant for classifying occupationally exposed persons in category A and B

3.11 STORAGE AND SAFEKEEPING

- 3.11.1 Explain aspects which have to be observed when storing sources (radioactive substances, minerals, sources)
- 3.11.2 List aspects which have to be observed in addition when safekeeping encapsulated radioactive substances with leaky jacketing
- 3.11.3 Define standards and rules for storing and safekeeping radioactive substances

- 3.11.4 Explain who is responsible for storage and how storage has to be monitored (unauthorized access)

3.12 DAMAGE CONTROL IN CASE OF ACCIDENTS AND MALFUNCTIONS

- 3.12.1 Define the regulations for damage control in case of accidents and malfunctions
- 3.12.2 Describe actions that have to be taken immediately in case of accidents and malfunctions to limit the risks for life, health and belongings to a minimum

3.13 PROHIBITIONS AND RESTRICTIONS OF OPERATION

- 3.13.1 Explain which persons may or may not access certain areas and who may work there
- 3.13.2 Define under which conditions an occupationally exposed person may enter a restricted area
- 3.13.3 Explain the conditions for the further occupation of persons in case the dose is exceeded
- 3.13.4 Explain to which extent restrictions or prohibitions of operation can be issued as a result of a medical examination
- 3.13.5 Define how the appropriate authority can issue prohibitions or restrictions of operation
- 3.13.6 Distinguish prohibition to stay in restricted areas, restrictions and prohibitions of operation

4. Scientific Basics

4.1 BASICS OF RADIATION PHYSICS

- 4.1.1 Explain origination and physical properties of ionizing rays encountered in the expert knowledge field
- 4.1.2 Give examples of electromagnetic radiation (radio waves, visible light, UV light, X-ray-, Gamma and bremsstrahlung)
- 4.1.3 Explain the term "Radiation Energy" and "Energy Spectrum" and define units of energy
- 4.1.4 Explain the terms "Radioactivity", "Activity", "Radioisotope" and "Radio-nuclide" as well as radioactive units
- 4.1.5 Explain ways of decay, decay schemes and the law of radioactive decay as well as the term "Half-life period"
- 4.1.6 Estimate the activity of a radioactive substance from a given nominal activity and the decay time
- 4.1.7 Explain the interaction of radiation encountered in the expert knowledge field with matter and the consequences for radiation protection
- 4.1.8 Explain the detection principles for ionizing radiation encountered in the expert knowledge field
- 4.1.9 Explain the data of X-ray devices and Gamma radiation sources that are important to radiation protection

4.2 BASICS OF RADIATION BIOLOGY

- 4.2.1 State the basic component of the human body (cell) and define the essential components (membrane, plasma, nucleus)
- 4.2.2 Describe the biological effect of radiation

- 4.2.3 Explain the fundamental difference between somatic and genetic radiation effects
- 4.2.4 Explain early and late effects
- 4.2.5 Describe the difference between stochastic and non-stochastic effects
- 4.2.6 Give examples for acute radiation-induced injuries and the doses causing these injuries
- 4.2.7 Define the relationship between dose and effect (late effects, genetic injuries)
- 4.2.8 Explain unique exposure and accumulated doses in connection with recovery effects

4.3 DOSE TERMS

- 4.3.1 Define the physical units "Ion Dose" and "Energy Dose" and the associated legal units
- 4.3.2 Define the term "Equivalent Dose" and the associated legal unit
- 4.3.3 State the terms "Dose" and "Dose Rate" and define their relationship
- 4.3.4 Define the calculations of the equivalent dose
- 4.3.5 State the quality factor for external exposure for various types of radiation
- 4.3.6 Explain the relationship between activity and dose rate (dose rate constant)
- 4.3.7 Explain the terms "Personal Dose" and "Area Dose"
- 4.3.8 Explain the term "Body Dose" (partial and whole-body dose)

4.4 SHIELDING OF RADIATION

- 4.4.1 Describe the shielding effect of matter versus the types of radiation encountered in the expert knowledge field
- 4.4.2 Explain the distance law for photon radiation and its importance for radiation protection
- 4.4.3 Explain the terms "Attenuation Factor", "Attenuation Coefficient", "Half-value Depth", "Tenth-value Thickness" and "Dose Build-up Factor"
- 4.4.4 List suitable shielding materials for the various types of radiation and interpret their properties
- 4.4.5 Using the half-value depth and the tenth-value thickness, calculate the shielding of radiation sources (point-shaped Gamma and X-rays) encountered in the expert knowledge field
- 4.4.6 Using tables and diagrams, calculate the attenuation factor of a material layer for the types of radiation (point-shaped Gamma and X-ray radiation sources) encountered in the expert knowledge field
- 4.4.7 Describe the scattering of the types of radiation (Gamma, X-ray and Neutron radiation) encountered in the expert knowledge field and explain their dependence on the atomic number of the shielding material and on the energy

4.5 THE RADIATION EXPOSURE OF HUMAN BEINGS

- 4.5.1 Define the types of radiation exposure (natural, civilizational, medical, occupation)
- 4.5.2 State the natural radiation exposure from external and internal sources
- 4.5.3 State the external and internal radiation exposure due to civilizational activities (medicine, technique, fall-out, ...)
- 4.5.4 List the dose limit values according to the Radiation Protection and X-Ray Ordinance

5. Radiation Protection Measuring Technique

5.1 BASICS OF RADIATION PROTECTION MEASURING TECHNIQUE

- 5.1.1 Explain the purpose of radiation protection measurements
- 5.1.2 List various tasks of radiation protection measuring technique (area dose, area dose rate, personal dose)
- 5.1.3 Explain physical effects and principles on which typical measurement methods for the types of radiation encountered in the expert knowledge field are based

5.2 DOSE RATE MEASUREMENTS

- 5.2.1 Explain the fundamental design of a dose rate measuring system
- 5.2.2 State suitable dose rate measuring systems for the types of radiation encountered in the expert knowledge field
- 5.2.3 Perform a dose rate measurement and explain its results
- 5.2.4 Using a dose rate measurement, calculate the activity of a point-shaped Gamma source
- 5.2.5 Explain the design and the principle of function of radiation warning instruments and explain their potential application
- 5.2.6 Explain potential errors in a dose rate measurement

5.3 PERSONAL DOSE MEASUREMENT

- 5.3.1 Define suitable measuring systems for personal dose measurement
- 5.3.2 Explain the principle of function of personal dosimeters
- 5.3.3 Explain potential errors in a personal dose measurement

- 5.3.4 Evaluate a radiation-exposed personal dosimeter and estimate the measurement error of the result
- 5.3.5 Explain the difference between official personal dose measurement and self-monitoring
- 5.3.6 Define which personal dosimeters have to be carried how and where

5.4 BODY DOSE MEASUREMENT

- 5.4.1 Define when the body dose can be determined through estimation (directive)
- 5.4.2 Define how a body dose is estimated on the basis of personal and area dose measurements

5.5 OPERATIONAL CHECK OF MEASURING SYSTEMS

- 5.5.1 Define to which area of competence the calibration obligation and the operational check of radiation protection measuring systems belong
- 5.5.2 Define the meaning and purpose of an operational check
- 5.5.3 Perform the operational check of a direct-reading personal dosimeter
- 5.5.4 Define the necessity of book-keeping when performing an operational check
- 5.5.5 Explain how the working order of measuring systems can be ensured organizationally
- 5.5.6 Perform the operational check of a dose rate measurement and dose rate warning instrument

5.6 POTENTIAL ERRORS DURING RADIATION MEASUREMENT

- 5.6.1 Explain provisions to avoid errors during radiation measurement

5.7 EVALUATION AND ASSESSMENT

- 5.7.1 Compare measured results with the values defined in the legal requirements

6. Radiation Protection Technique

6.1 RADIATION PROTECTION PLANING (SEQUENCE OF OPERATIONS)

- 6.1.1 Explain basic rules of radiation protection (distance, shielding, duration of stay, preventing incorporation, restricting activity)
- 6.1.2 Define why any unnecessary radiation exposure has to be avoided
- 6.1.3 Describe monitoring of persons and workplaces (also for external personnel)
- 6.1.4 Explain critical situations in the sequence of operations and provide examples of possible malfunction or accident situations
- 6.1.5 From a measured dose rate with given duration of stay, calculate the radiation dose, and with given dose limit, calculate the duration of stay of the operating personnel
- 6.1.6 Define the importance of an radiation protection instruction
- 6.1.7 Define the organization concerning receipt and whereabouts of radioactive substances in the area of competence

6.2 WORK SCHEDULING

- 6.2.1 Describe work schedule which ensures that the radiation exposure due to performing work is kept as low as possible
- 6.2.2 Define what has to be provided prior to starting special operations (e.g. measuring systems, shielding materials and other ancillary devices)
- 6.2.3 Explain typical errors in work scheduling which increase the radiation exposure (e.g. not planning of time and location, not planning the use of tools and ancillary devices, false personnel planning (inadequate deployment of personnel))

6.3 WORKING METHODS

- 6.3.1 Describe provisions and working methods to reduce radiation exposure
- 6.3.2 Describe option to utilize tools, instruments and facilities that are important to radiation protection

6.4 LEAK TEST OF ENCAPSULATED RADIOACTIVE SUBSTANCES

- 6.4.1 Define when a leak test of an encapsulated radioactive substance is necessary
- 6.4.2 Define who performs the leak test

6.5 RADIATION PROTECTION AREAS

- 6.5.1 Explain radiation protection areas and their essential distinguishing features
- 6.5.2 Describe how radiation protection areas are defined and how they have to be labeled

- 6.5.3 Explain access rules for radiation protection areas.

6.6 MATERIAL BEHAVIOR UNDER RADIATION EXPOSURE

- 6.6.1 State changes in the property of materials (e.g. oil, concrete, glasses, plastics, metals) under the influence of ionizing rays and define the resulting consequences for maintenance

6.7 PACKAGING, TRANSPORT

- 6.7.1 Explain provisions while receiving radioactive substances.
- 6.7.2 Define labeling of shipped goods containing radioactive substances
- 6.7.3 Explain provisions for packaging and shipping
- 6.7.4 Explain packaging type A and B and define the type approval for the type B container
- 6.7.5 Define that the sources are generally available in materials testing as so-called highly safe sources in special form
- 6.7.6 Explain the labeling of vehicles and the carrying along of persons when transporting radioactive substances
- 6.7.7 List which documents must be available in a vehicle when transporting tools containing radioactive sources and where these documents have to be kept

7. Radiation Protection Safety

7.1 MEDICAL SAFETY PRECAUTIONS

- 7.1.1 Define need for medical monitoring

7.1.2 Explain prohibition and restriction of operation

7.1.3 Describe provisions in case of exceeding the dose limit value (also in case of suspected exceeding)

7.2 TECHNICAL SAFETY PRECAUTIONS

7.2.1 Describe safety precautions for instruments and buildings (locking, seal, blocking, warning device, remote control) and how these safety precautions can be controlled

7.3 ALARM PLANNING, ACTIONS AND BEHAVIOR IN CASE OF ACCIDENTS AND MALFUNCTIONS

7.3.1 Explain the terms "Malfunction" and "Accident" in accordance with the Radiation Protection Ordinance

7.3.2 State potential malfunctions and accidents and explain their cause

7.3.3 Explain when the consequences of a malfunction can be remedied by the Radiation Protection Supervisor him/herself

7.3.4 Explain how to proceed when the Radiation Protection Supervisor cannot remedy the consequences of a malfunction him/herself

7.3.5 Describe the procedure for guarding the site if a source cannot be returned into its special container

7.3.6 Explain under which conditions an occupationally exposed person may be exposed to an extraordinary high level of radiation or when this can be permitted

7.3.7 Explain who is to be notified immediately about the occurrence of a malfunction or accident

7.3.8 Explain how the progress of a malfunction or accident has to be documented

7.4 ANTI-THEFT PROVISIONS

7.4.1 Describe organizational and constructional provisions to prevent theft

7.4.2 Define which steps are to be taken in the event radioactive substances have been stolen

7.5 SAFETY MEASURES

7.5.1 Define which steps have to be taken in the event radioactive substances get lost.

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CATALOG OF LEARNING OBJECTIVES

for the Expert Knowledge Directive
for General Managers of Radiation Protection or
Radiation Protection Supervisors in the Non-medical Field

Handling Activities Requiring Approval
between 10^2 and 10^5 -times the Clearance Limit

No. 4.2

Catalog of Learning Objectives

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OVERALL KNOWLEDGE OF THE FIELD OF KNOWLEDGE

The verbs *perform, apply, operate, estimate* mean:

BASIC PERFORMANCE SKILLS

The verbs *plan, evaluate* mean:

SKILL IN THE SENSE OF WA

Legal Basics

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- 1.2.3 Describe who is General Manager of Radiation Protection and who is Radiation Protection Supervisor in accordance with the Radiation Protection Ordinance (§ 29 (1) and (2) StrlSchV)
- 1.2.4 Explain the paragraphs and sections of the Radiation Protection Ordinance pertinent to the present activities
- 1.2.5 Define the appropriate authorities in accordance with the Radiation Protection Ordinance
- 1.2.6 Describe the legal consequences of the violation of regulations in accordance with the breach of the law paragraph of the Radiation Protection Ordinance (fine or penalty)
- 1.2.7 Explain the purpose of § 20a of the Radiation Protection Ordinance
- 1.2.8 Explain the division of the Radiation Protection Ordinance into monitoring regulations, protection regulations, fine regulations and transition and conclusion regulations

1.3 SHIPMENT REGULATIONS

- 1.3.1 State the laws and ordinances that are valid for transportation of the radioactive materials to be transported in the expert knowledge field
- 1.3.2 Explain the paragraphs and ciphers of the respective transportation regulations that apply to the transportation of the items or materials to be transported in the expert knowledge field

1.4 WATER ACT

- 1.4.1 Define for which areas of radiation protection the regulations of the Water Act have to be observed

1.5 APPROVALS

- 1.5.1 Explain the meaning of approvals
- 1.5.2 Explain individual approval regulations (according to Radiation Protection Ordinance, Atomic Act)
- 1.5.3 List all activities requiring approval according to the Radiation Protection Ordinance
- 1.5.4 Define which legal effects approval requirements have for activities requiring approval, for the General Manager of Radiation Protection and the Radiation Protection Supervisor
- 1.5.5 Define the major types of approval requirements
- 1.5.6 State the essential contents of the model approvals that are relevant to the expert knowledge field (§20 a; transportation, use and storage)

1.6 COMMUNICATIONS

- 1.6.1 Explain the meaning of the communication procedures (handling, import and export)
- 1.6.2 List all activities that need to be communicated in accordance with the Radiation Protection Ordinance

1.7 OTHER PERTINENT LAWS AND ORDINANCES

- 1.7.1 State the regulations defining the radiological units and the calibration of measuring systems (e.g. implementing regulations regarding the law on units in metrology, second ordinance on the calibration obligation of measuring systems, calibration validity ordinance)
- 1.7.2 State the consequences resulting from these regulations for routine radiation protection

2. Recommendations and Directives

2.1 ICRP

- 2.1.1 State task and objective of ICRP (ICRP: International Commission on Radiological Protection)
- 2.1.2 Define the major recommendations and the areas affected by these recommendations

2.2 STANDARDS

- 2.2.1 Define the DIN standards relevant to the respective expert knowledge group (DIN: German Institute for Standards) (DIN 54 115, page 1 – 5; DIN 6814; DIN 25400)

2.3 DIRECTIVES

- 2.3.1 State the directives relevant to the respective expert knowledge group (e.g. accident prevention regulations of the trade association "Precision Engineering and Electrical Engineering"; Directive of the Department of the Interior)

3. Tasks and Duties of the Radiation Protection Supervisor

3.1 LEGAL STATUS OF THE RADIATION PROTECTION SUPERVISOR

- 3.1.1 Define the legal status of the Radiation Protection Supervisor and the General Manager of Radiation Protection
- 3.1.2 Explain the basic tasks of the Radiation Protection Supervisor ("Management and supervision" § 29 (2) StrlSchV)
- 3.1.3 Describe the prerequisites for appointing a Radiation Protection Supervisor (expert knowledge, area of competence, competence, ...)
- 3.1.4 Explain the meaning of the area of competence of a Radiation Protection Supervisor (responsibility and competence)
- 3.1.5 Define who appoints the Radiation Protection Supervisor, who will be notified about this appointment and which information has to be provided
- 3.1.6 Explain which conflict solution model the Radiation Protection Ordinance (§ 30) foresees if Radiation Protection Supervisor and General Manager of Radiation Protection do not come to an agreement concerning a radiation protection provision

3.2 ORGANIZING RADIATION PROTECTION

- 3.2.1 Describe the possibility of dividing the radiation protection tasks between several Radiation Protection Supervisors

- 3.2.2 Explain the requirement for defining areas of competence and describe them in writing
- 3.2.3 Define that alarm plans have been set up for incidents and that these plans have been discussed with the relief organizations
- 3.2.4 State the legal status, duties and responsibility of a Radiation Protection Supervisor
- 3.2.5 Explain the purpose of the necessary regulations between the operating company and an external company (distinction between facility-related and not facility-related**)
- 3.2.6 Explain the meaning and purpose of a radiation protection instruction (§ 34 StrlSchV)
- 3.2.7 Explain the possibility to support the Radiation Protection Supervisor by assistants and the prerequisites for this
- 3.2.8 State the differences between occupationally exposed persons of category A and B

3.3 INSTRUCTION

- 3.3.1 State the subject catalog for radiation protection instructions

^{*} "Facility-related radiation protection"

Radiation protection provisions which have to be observed during operation requiring permission of an occupationally exposed person in a facility (e.g. nuclear power plant) and which have to be ensured by the Radiation Protection Supervisor of the facility as per agreement

^{**} "Not Facility-related radiation protection"

Radiation protection provisions which essentially have to be observed before starting and after finishing an operation requiring permission in a facility (e.g. nuclear power plant) and which have to be ensured by the authorized person in accordance with § 20a StrlSchV

3.4 RECORDS, BOOK-KEEPING

- 3.4.1 Describe the documentation regulations for acquisition, possession and disposal of radioactive materials
- 3.4.2 Explain which records have to be made, who has access to them and who is responsible for them
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- 3.6.5 Explain the type of definition of the areas of competence and the notification of persons and authorities and give examples
- 3.6.6 Explain why areas of competence must not overlap
- 3.6.7 Define how duties can be transferred

3.7 MONITORING AND CONTROLS

- 3.7.1 Describe which monitoring and control provisions are required (persons, workplaces, environment)
- 3.7.2 Describe how monitoring and controls are to be performed in individual cases
- 3.7.3 Develop plans and instructions for controls and monitoring
- 3.7.4 Interpret the meaning of reinsuring measures to avoid the consequences of human or machine failure or diminish their consequences

3.8 MAINTENANCE

- 3.8.1 Explain which maintenance has to be performed for radiation protection
- 3.8.2 Explain the duties of the General Manager of Radiation Protection with regard to maintenance and operational checks of facilities and devices

3.9 ANNOUNCEMENTS

- 3.9.1 Explain the state of affairs of the area of competence about which the appropriate authority or the General Manager of Radiation Protection have to be informed
- 3.9.2 Describe how announcements have to be drafted at a given occasion
- 3.9.3 Define the provisions regarding announcement duty

3.10 MEDICAL MONITORING

- 3.10.1 Define the provisions for medical monitoring
- 3.10.2 State what kind of information has to be provided to the physician in charge
- 3.10.3 Define the purpose of medical monitoring and the possible consequences
- 3.10.4 Define the usual time period between two medical checks for occupationally exposed persons
- 3.10.5 Describe the criteria which are relevant for classifying occupationally exposed persons in category A and B

3.11 STORAGE AND SAFEKEEPING

- 3.11.1 List aspects which have to be observed when storing sources (radioactive substances, minerals, sources)
- 3.11.2 Describe standards and rules for storing and safekeeping radioactive substances
- 3.11.3 Explain who is responsible for storage and how storage has to be monitored (unauthorized access)

3.12 DAMAGE CONTROL IN CASE OF ACCIDENTS AND MALFUNCTIONS

- 3.12.1 Define the regulations for damage control in case of accidents and malfunctions
- 3.12.2 Define important features of the radiation protection technical organization of damage control
- 3.12.3 Define which priorities have to be observed during accidents
- 3.12.4 Explain which preparations have to be taken for damage control
- 3.12.5 Describe actions that have to be taken immediately in case of accidents and malfunctions to limit the risks for life, health and belongings to a minimum
- 3.12.6 State the prerequisites under which the obligation of retaining employees and the obligation of providing proof can be omitted (activity limits, cooperation in various areas)
- 3.12.7 State the danger classes to be distinguished in order to prepare of fire fighting
- 3.12.8 State which locations inside and outside the company cooperate in case of accidents and malfunctions and explain the fundamentals of this cooperation

3.13 DISPOSAL OF RADIOACTIVE WASTE

- 3.13.1 Explain the legal procedures for disposal of radioactive waste
- 3.13.2 Define the definition of radioactive waste according to the Atomic Act
- 3.13.3 Explain the obligation to dispose radioactive waste properly and the prohibition to dump radioactive waste
- 3.13.4 Explain the directives and conditions for disposal of radioactive waste

3.14 PROHIBITIONS AND RESTRICTIONS OF OPERATION

- 3.14.1 Explain which persons may or may not access certain areas and who may work there
- 3.14.2 Define under which conditions an occupationally exposed person may enter a restricted area
- 3.14.3 Explain the conditions for the further occupation of persons in case the dose is exceeded
- 3.14.4 Explain to which extent a restriction or prohibition of operation can be issued as a result of a medical examination
- 3.14.5 Define how the appropriate authority can issue prohibitions or restrictions of operation
- 3.14.6 State prohibition to stay in restricted areas, restrictions and prohibitions of operation

4. Scientific Basics

4.1 BASICS OF RADIATION PHYSICS

- 4.1.1 Explain origination and physical properties of ionizing rays encountered in the expert knowledge field
- 4.1.2 Give examples for electromagnetic radiation (radio waves, visible light, UV light, X-ray-, Gamma and bremsstrahlung)
- 4.1.3 Explain the term "Radiation Energy" and "Energy Spectrum" and define units of energy
- 4.1.4 Explain the terms "Radioactivity", "Activity", "Radioisotope" and "Radionuclide" as well as radioactive units
- 4.1.5 Explain ways of decay, decay schemes and the law of radioactive decay as well as the term "Half-life period"

- 4.1.6 Give examples of naturally occurring nuclides
- 4.1.7 Calculate the activity of a radioactive substance from a given nominal activity and the decay time
- 4.1.8 Explain the terms "Nuclear Fission" and "Criticality"
- 4.1.9 Explain detection principles for ionizing radiation encountered in the expert knowledge field
- 4.1.10 Describe typical activation and nuclear reactions
- 4.1.11 Define the interaction of ionizing radiation encountered in the expert knowledge field with matter and the consequences for radiation protection

4.2 BASICS OF RADIOCHEMISTRY

- 4.2.1 Define the major terms and definitions in radiochemistry (e.g. specific activity, activity concentration, carrier, tracer, radiochemical purity)
- 4.2.2 Define the major methods to determine the specific activity
- 4.2.3 State possible chemical changes of compounds and materials caused by ionizing radiation
- 4.2.4 Describe typical reaction processes with regard to the release of activity
- 4.2.5 Define common labeling principles
- 4.2.6 Describe the activity balance of a chemical reaction

4.3 BASICS OF RADIATION BIOLOGY

- 4.3.1 State the basic component of the human body (cell) and define the essential components (membrane, plasma, nucleus)
- 4.3.2 Describe the biological effect of radiation

- 4.3.3 Explain the fundamental difference between somatic and genetic radiation effects
- 4.3.4 Explain early and late effects
- 4.3.5 Describe the difference between stochastic and non-stochastic effects
- 4.3.6 Give examples for acute radiation-induced injuries and the doses causing these injuries
- 4.3.7 Define the relationship between dose and effect (late effects, genetic injuries)
- 4.3.8 Explain unique exposure and accumulated doses in connection with recovery effects
- 4.3.9 Define the terms "physical, biological and effective half-life period"
- 4.3.10 Define the term "Radiotoxicity"

4.4 DOSE TERMS

- 4.4.1 Explain the physical units "Ion Dose" and "Energy Dose" and the associated legal units
- 4.4.2 Explain the term "Equivalent Dose" and define the associated legal unit
- 4.4.3 Define the terms "Dose" and "Dose Rate" and define their relationship
- 4.4.4 Define the calculation of the equivalent dose
- 4.4.5 Define the quality factor for various types of radiation
- 4.4.6 Define the relationship between activity and dose rate (dose rate constant)
- 4.4.7 Define the terms "Personal Dose" and "Area Dose"
- 4.4.8 Define the term "Body Dose" (partial and whole-body dose)

- 4.4.9 Define the term "Committed Equivalent Dose"

4.5 SHIELDING OF RADIATION

- 4.5.1 Define the shielding effect of matter versus the types of radiation encountered in the expert knowledge field
- 4.5.2 Explain the distance law for photon radiation and its importance for radiation protection
- 4.5.3 Explain suitable shielding materials for the various types of radiation and their properties

4.6 THE RADIATION EXPOSURE OF HUMAN BEINGS

- 4.6.1 Define the types of radiation exposure (natural, civilizational, medical, occupation)
- 4.6.2 State the natural radiation exposure from external and internal sources
- 4.6.3 State the external and internal radiation exposure due to civilizational activities (medicine, technique, fall-out, ...)
- 4.6.4 Describe the dose limit values according to the Radiation Protection Ordinance
- 4.6.5 Explain the terms "Incorporation", "Ingestion", "Inhalation" and "Submersion"
- 4.6.6 Describe the "30 mrem concept"

5. Radiation Protection Measuring Technique

5.1 BASICS OF RADIATION PROTECTION MEASURING TECHNIQUE

- 5.1.1 Explain the purpose of radiation protection measurements
- 5.1.2 List various tasks of radiation protection measuring technique (area dose, area dose rate, personal dose)
- 5.1.3 State principle and application of radiation protection measuring instruments for various types of radiation
- 5.1.4 Define physical effects and principles on which typical measurement methods for the types of radiation encountered in the expert knowledge field are based

5.2 DOSE RATE MEASUREMENTS

- 5.2.1 Define the fundamental design of a dose rate measuring system
- 5.2.2 State suitable dose rate measuring systems for the types of radiation encountered in the expert knowledge field
- 5.2.3 Perform dose rate measurements and estimate their results
- 5.2.4 Using a dose rate measurement, calculate the activity of a point-shaped Gamma source
- 5.2.5 Define why usually the dose rate of a Beta source cannot be measured using conventional dose rate measuring systems
- 5.2.6 Define the design and the principle of function of radiation warning instruments and their potential application
- 5.2.7 Explain potential errors in a dose rate measurement

5.3 AREA DOSE MEASUREMENT

- 5.3.1 State measuring methods, instruments and detectors that can be used for the area dose measurement of the types of radiation encountered in the expert knowledge field
- 5.3.2 Explain the purpose of performing an area dose measurement (definition of radiation protection areas, determination of body doses)

5.4 PERSONAL DOSE MEASUREMENT

- 5.4.1 Define suitable measuring systems for personal dose measurement
- 5.4.2 Define the principle of function of personal dosimeters
- 5.4.3 Explain potential errors in a personal dose measurement
- 5.4.4 Evaluate a radiation-exposed personal dosimeter and estimate the measurement error of the result
- 5.4.5 Define the difference between official personal dose measurement and self-monitoring
- 5.4.6 Define the purpose and use of the measuring method foreseen for personal dose measurement
- 5.4.7 Explain which personal dosimeters have to be carried how and where

5.5 INCORPORATION MEASUREMENT AND MONITORING

- 5.5.1 Define suitable methods for incorporation monitoring
- 5.5.2 Define when there is a suspected incorporation and what has to be done about it (e.g. perform urine or whole-body measurements)
- 5.5.3 List suitable methods for incorporation measurement

5.5.4 Define the result of an incorporation measurement

5.6 BODY DOSE MEASUREMENT

5.6.1 Define when to determine the body dose through estimation (directive)

5.6.2 Define how to estimate a body dose on the basis of personal and area dose measurements

5.7 CONTAMINATION MEASUREMENT AND MONITORING

5.7.1 Define the term "Contamination"

5.7.2 Define when and how contamination measurements are to be performed

5.7.3 Define the design of a contamination measuring system

5.7.4 State suitable measuring methods for contamination monitoring and perform measurement

5.7.5 Explain the result of a contamination measurement

5.7.6 State the limit values for surface contamination stipulated by the Radiation Protection Ordinance

5.7.7 Describe the provisions to be taken and the measuring methods to be used in case contamination is detected

5.7.8 Describe potential errors in contamination measurement

5.7.9 Define the relationship between surface and air contamination (aerosols)

5.8 ACTIVITY MEASUREMENT (AIR, WATER, SOIL)

5.8.1 Describe suitable measuring methods for activity determination in solid substances, air and waste water

5.8.2 Explain how a representative sample is taken and define the sample preparation method

5.8.3 Define the accuracy of the measuring methods of the activity determination

5.8.4 Explain how by means of the Radiation Protection Ordinance the concentration values are determined for inhalation and ingestion from the limit values of the annual activity supply

5.8.5 Explain provisions to be taken in case the limit value is exceeded

5.9 NUCLIDE IDENTIFICATION

5.9.1 Define the physical basis for nuclide identification

5.9.2 Explain suitable methods for qualitative distinction of various types of radiation

5.9.3 Evaluate a Gamma spectrum quantitatively

5.9.4 State suitable measuring systems for nuclide identification

5.9.5 Describe and perform an identification of the nuclides frequently used in tracer laboratories

5.10 OPERATIONAL CHECK OF MEASURING SYSTEMS

5.10.1 Define to which area of competence the calibration obligation and the operational check of radiation protection measuring systems belong

5.10.2 Define the meaning and purpose of an operational check

- 5.10.3 Define the necessity of book-keeping when performing an operational check
- 5.10.4 Perform the operational check of a dose rate measuring system
- 5.10.5 Perform the operational check of a direct-reading personal dosimeter
- 5.10.6 Perform the operational check of a contamination measuring system
- 5.10.7 Explain how the working order of measuring systems can be ensured organizationally

5.11 POTENTIAL ERRORS DURING RADIATION MEASUREMENT

- 5.11.1 Define potential errors of various types of measuring systems
- 5.11.2 Define the accuracy of frequently used measuring systems
- 5.11.3 Define provisions to avoid errors during radiation measurement

5.12 EVALUATION AND ASSESSMENT

- 5.12.1 Explain the importance of measured results.
- 5.12.2 Compare measured results with the values defined in the legal requirements

6. Radiation Protection Technique

6.1 RADIATION PROTECTION PLANING (SEQUENCE OF OPERATIONS)

- 6.1.1 Explain basic rules of radiation protection (distance, shielding, duration of stay, preventing incorporation, restricting activity)

- 6.1.2 Define why any unnecessary radiation exposure has to be avoided
- 6.1.3 Describe monitoring of persons and workplaces (also for external personnel)
- 6.1.4 Explain how to carry out monitoring programs
- 6.1.5 Define critical situations in the sequence of operations and provide examples of possible malfunction or accident situations
- 6.1.6 From a measured dose rate with given duration of stay, calculate the radiation dose and with given dose limit value the duration of stay of the operating personnel
- 6.1.7 Explain protective precautions for work in slightly contaminated rooms
- 6.1.8 Define protective precautions to eliminate high contamination
- 6.1.9 Describe waste collection and treatment
- 6.1.10 Define the importance of a radiation protection instruction
- 6.1.11 Define the organization concerning receipt and whereabouts of radioactive substances in the area of competence
- 6.1.12 Explain a measurement schedule for area dose monitoring in a facility

6.2 WORK SCHEDULING

- 6.2.1 Define work schedule which ensures that the radiation exposure due to performing work is kept as low as possible
- 6.2.2 Define what has to be provided prior to starting special operations (e.g. measuring systems, shielding materials and other ancillary devices)
- 6.2.3 State typical errors in work scheduling which increase the radiation exposure (e.g. not planning of time and location, not planning the use of tools and ancillary devices, false personnel planning (inadequate deployment of personnel))

- 6.2.4 Explain benefits of blind experiments with inactive material and training on models before starting "active" work
- 6.2.5 Explain possibilities of releasing activities in a given work cycle
- 6.2.6 Estimate resulting body doses from possible incorporations

6.3 WORKING METHODS

- 6.3.1 Describe provisions and working methods to reduce radiation exposure
- 6.3.2 Define work to be performed in special vacuum devices (vent, glove compartment)
- 6.3.3 Describe option to utilize tools, instruments and facilities that are important to radiation protection
- 6.3.4 State the importance of the accessibility of workplaces and the freedom of movement at the workplace
- 6.3.5 Define the use of personal equipment
- 6.3.6 Describe workplace protection and provisions against carry-over of activity

6.4 RELEASE OF RADIOACTIVE SUBSTANCES INTO THE ENVIRONMENT

- 6.4.1 List exposure paths
- 6.4.2 Define provisions to be taken to protect air, water and soil
- 6.4.3 Define the environmental pollution due to the release of activity (directive)

6.5 MATERIAL DECONTAMINATION

- 6.5.1 State the difference between contaminated and non-contaminated material
- 6.5.2 State the prerequisite for good decontamination
- 6.5.3 Explain which provisions have to be taken to decontaminate rooms and equipment
- 6.5.4 Explain what is to be done with work areas which were not decontaminated adequately
- 6.5.5 Describe which decontamination methods are meaningful for the various types of material
- 6.5.6 Explain what is to be done with material which cannot be decontaminated adequately
- 6.5.7 Define decontamination methods and state some decontamination agents
- 6.5.8 Explain the prerequisites for the disposal and release of tools and instruments from controlled areas

6.6 WASTE TREATMENT

- 6.6.1 Describe what is to be done with radioactive substances or devices that are no longer needed
- 6.6.2 Describe various types of radioactive waste
- 6.6.3 Describe suitable waste containers for the laboratory, the waste depot and transport within the company
- 6.6.4 Describe how to collect, sort and transport radioactive waste
- 6.6.5 Describe setup, organization and function of a waste depot

6.7 CRITICALITY

- 6.7.1 Define the radionuclides where criticality may occur
- 6.7.2 Define suitable provisions to rule out criticality
- 6.7.3 State the parameters that are decisive for the critical status of an arrangement
- 6.7.4 Define critical masses for some types of nuclear fuel

6.8 RADIATION PROTECTION AREAS

- 6.8.1 Explain radiation protection areas and their essential distinguishing features
- 6.8.2 Describe how radiation protection areas are defined and how they have to be labeled
- 6.8.3 Explain access rules for radiation protection areas.

6.9 LABORATORY FACILITIES

- 6.9.1 Describe the types of laboratories encountered in the expert knowledge field and explain the differences (type A, B and C)
- 6.9.2 Describe special protection and control devices for laboratories handling open radioactive sources
- 6.9.3 Describe the measuring systems and monitors required for these laboratories
- 6.9.4 Describe which ancillary devices have to be available for radiation protection in radionuclide laboratories (e.g. decontamination agent)

6.10 MATERIAL BEHAVIOR UNDER RADIATION EXPOSURE

- 6.10.1 State changes in the property of materials (e.g. oil, concrete, glasses, plastics, metals) under the influence of ionizing rays and define the resulting consequences for maintenance

6.11 RESPIRATORY EQUIPMENT

- 6.11.1 Define when and where the use of respiratory equipment is stipulated
- 6.11.2 State common filter types with their identification which are used when working with open radioactive substances
- 6.11.3 Define operational check, cleaning and maintenance of respiratory equipment and their ancillary devices

6.12 PACKAGING, TRANSPORT

- 6.12.1 Define provisions while receiving radioactive substances.
- 6.12.2 Define labeling of shipped goods containing radioactive substances
- 6.12.3 Explain provisions for packaging and shipping
- 6.12.4 Explain prerequisites for shipping radioactive substances
- 6.12.5 Explain the meaning and definition of shipping categories and the transport factor
- 6.12.6 Explain the types of packaging and the assignment of various types of radioactive substances

7. Radiation Protection Safety

7.1 MEDICAL SAFETY PRECAUTIONS

- 7.1.1 Define need for medical monitoring
- 7.1.2 State prohibition and restriction of operation
- 7.1.3 Define provisions in case of exceeding the dose limit value (also in case of suspected exceeding)

7.2 PERSONAL PROTECTION EQUIPMENT

- 7.2.1 List items of personal protection equipment and describe when to use them
- 7.2.2 Define what is to be done with personal protection equipment after use
- 7.2.3 Describe the effects of protective clothing and explain the protection equipment for eyes, hands and torso and estimate the effectiveness (eye glasses, lead gloves and aprons)

7.3 PREREQUISITES FOR THE USE OF PERSONAL PROTECTION EQUIPMENT

- 7.3.1 State prerequisites for using personal protection equipment
- 7.3.2 List impediments while wearing personal protection equipment (heat accumulation, ...)
- 7.3.3 Define when and under which conditions persons should not work alone in radiation protection areas

7.4 PERSONAL DECONTAMINATION

- 7.4.1 Describe the operational sequence for personal decontamination
- 7.4.2 State decontamination agents (e.g. washing)
- 7.4.3 Explain how to decontaminate eyes
- 7.4.4 Define provisions in case of open wounds
- 7.4.5 Define when to consult a physician

7.5 TECHNICAL SAFETY PRECAUTIONS

- 7.5.1 Explain technical safety precautions against incorporation, contamination and external irradiation
- 7.5.2 List activities which may be performed only when employing technical safety precautions
- 7.5.3 Describe safety precautions for instruments and buildings (locking, seal, blocking, warning device, remote control) and how these safety precautions can be controlled
- 7.5.4 Describe technical safety precautions for setting up a workplace where high activity is being handled
- 7.5.5 Plan a permanent facility taking into account the duration of stay of occupationally exposed persons

7.6 ALARM PLANNING, ACTIONS AND BEHAVIOR IN CASE OF ACCIDENTS AND MALFUNCTIONS

- 7.6.1 Explain the terms "Malfunction" and "Accident" in accordance with the Radiation Protection Ordinance
- 7.6.2 State potential malfunctions and accidents and explain their cause

- 7.6.3 Define when the consequences of a malfunction can be remedied by the Radiation Protection Supervisor him/herself
- 7.6.4 Define how to proceed when the Radiation Protection Supervisor cannot remedy the consequences of a malfunction him/herself
- 7.6.5 Describe the procedure for guarding the site if a source cannot be returned into its special container
- 7.6.6 Write down the essential contents of an alarm plan
- 7.6.7 Explain under which conditions an occupationally exposed person may be exposed to an extraordinary high level of radiation or when this can be permitted
- 7.6.8 Explain who is to be notified immediately about the occurrence of a malfunction or accident
- 7.6.9 Explain how the progress of a malfunction or accident has to be documented

7.7 ANTI-THEFT PROVISIONS

- 7.7.1 Describe organizational and constructional provisions to prevent theft
- 7.7.2 Define which steps are to be taken in the event radioactive substances have been stolen

7.8 SAFETY MEASURES

- 7.8.1 List organizational provisions for prophylactic fire prevention
- 7.8.2 Describe the involvement of the appropriate authorities and relief organizations in drawing up alarm plans for the event of a fire
- 7.8.3 Write down alarm plan for fighting a fire where radioactive substances are affected
- 7.8.4 Define which steps have to be taken in the event radioactive substances get lost.

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CATALOG OF LEARNING OBJECTIVES

for the Expert Knowledge Directive
for General Managers of Radiation Protection or
Radiation Protection Supervisors in the Non-medical Field

Employment of Company Personnel
as Occupationally Exposed Persons
in External Facilities

No. 5

Catalog of Learning Objectives

The catalog of learning objectives provides information about the entire know-how and skills of the respective expert knowledge group which are required for radiation protection.

The verbs selected to formulate the learning objectives possess a meaning that is tantamount to the scope of the know-how and skills.

The verbs *state, define, list, trace* mean:

INSIGHT INTO THE FIELD OF KNOWLEDGE

The verbs *explain, describe, distinguish, compare, write down* mean:

OVERVIEW OF THE FIELD OF KNOWLEDGE

The verbs *evaluate, judge, develop, compile, summarize, determine, interpret, conclude, draw up* mean:

OVERALL KNOWLEDGE OF THE FIELD OF KNOWLEDGE

The verbs *perform, apply, operate, estimate* mean:

BASIC PERFORMANCE SKILLS

The verbs *plan, evaluate* mean:

SKILL IN THE SENSE OF WARRANTY

1. Legal Basics

1.1 ATOMIC ACT

- 1.1.1 Define the legal nature of regulations (law, ordinance, approval, directive, standard, recommendation)
- 1.1.2 Describe the purpose and meaning of the Atomic Act

1.2 RADIATION PROTECTION ORDINANCE

- 1.2.1 Explain the area of application of the Radiation Protection Ordinance in terms of location and subject matter
- 1.2.2 Define the protection goals radiation protection is aiming for when handling ionizing rays and state the radiation protection principles
- 1.2.3 Describe who is General Manager of Radiation Protection and who is Radiation Protection Supervisor in accordance with the Radiation Protection Ordinance (§ 29 (1) and (2) StrlSchV)
- 1.2.4 State the paragraphs and sections of the Radiation Protection Ordinance pertinent to the present activities
- 1.2.5 Define the appropriate authorities in accordance with the Radiation Protection Ordinance
- 1.2.6 Describe the legal consequences of the violation of regulations in accordance with the breach of the law paragraph of the Radiation Protection Ordinance (fine or penalty)
- 1.2.7 Explain the purpose of § 20a of the Radiation Protection Ordinance

1.3 OTHER ORDINANCES REGARDING THE ATOMIC ACT

- 1.3.1 State other important ordinances for radiation protection (e.g. X-ray regulations, coverage provision ordinance regarding the Atomic Act, rules of procedure regarding the Atomic Act) and describe the scope of application

1.4 APPROVALS

- 1.4.1 Explain the meaning of approvals
- 1.4.2 Explain the meaning of model approvals
- 1.4.3 Explain individual approval regulations (according to Radiation Protection Ordinance, Atomic Act)
- 1.4.4 List all activities requiring approval according to the Radiation Protection Ordinance
- 1.4.5 State the essential contents of the model approvals that are relevant to the expert knowledge field (§20 a; transportation, use and storage of material test sources)

2. Tasks and Duties of the Radiation Protection Supervisor

2.1 LEGAL STATUS OF THE RADIATION PROTECTION SUPERVISOR

- 2.1.1 Explain the legal status of the Radiation Protection Supervisor and the General Manager of Radiation Protection
- 2.1.2 Explain the basic tasks of the Radiation Protection Supervisor ("Management and supervision" § 29 (2) StrlSchV)
- 2.1.3 Describe the prerequisites for appointing a Radiation Protection Supervisor (expert knowledge, area of competence, competence, ...)

- 2.1.4 Explain the meaning of the area of competence of a Radiation Protection Supervisor (responsibility and competence)
- 2.1.5 Define who appoints the Radiation Protection Supervisor, who will be notified about this appointment and which information has to be provided
- 2.1.6 Describe which conflict solution model the Radiation Protection Ordinance (§ 30) foresees if General Manager of Radiation Protection and Radiation Protection Supervisor do not come to an agreement concerning a radiation protection provision

2.2 ORGANIZING RADIATION PROTECTION

- 2.2.1 Define the possibility of dividing the radiation protection tasks between several Radiation Protection Supervisors
- 2.2.2 State the requirement for defining the areas of competence and describe them in writing
- 2.2.3 Interpret the purpose of the necessary regulations between the operating company and an external company (distinction between facility-related and not facility-related*)
- 2.2.4 Explain the meaning and purpose of a radiation protection instruction (§ 34 StrlSchV)
- 2.2.5 State the differences between occupationally exposed persons of category A and B

* "Facility-related radiation protection"

Radiation protection provisions which have to be observed during operation requiring permission of an occupationally exposed person in a facility (e.g. nuclear power plant) and which have to be ensured by the Radiation Protection Supervisor of the facility as per agreement

** "Not Facility-related radiation protection"

Radiation protection provisions which essentially have to be observed before starting and after finishing an operation requiring permission in a facility (e.g. nuclear power plant) and which have to be ensured by the authorized person in accordance with § 20a StrlSchV

2.3 INSTRUCTION

- 2.3.1 State the subject catalog for radiation protection instructions

2.4 RECORDS, BOOK-KEEPING

- 2.4.1 Define which records have to be made, who has access to them and who is responsible for them
- 2.4.2 Define how long records have to be kept on file
- 2.4.3 Define the purpose of a personal dose file as well as the information it should contain
- 2.4.4 Describe the purpose of a registered radiation passport and the information it should contain

2.5 LABELING DUTY

- 2.5.1 Define what is to be labeled (facility, radioactive substances)
- 2.5.2 Define how and by whom labeling is performed and which references are used
- 2.5.3 Explain the radiation risks the labeling should warn against

2.6 AREAS OF COMPETENCE

- 2.6.1 Define that the area of competence has to be defined in writing
- 2.6.2 Define the intra-company area of competence in accordance with the Radiation Protection Ordinance

2.7 ANNOUNCEMENTS

- 2.7.1 List the state of affairs of the area of competence about which the appropriate authority or the General Manager of Radiation Protection has to be informed
- 2.7.2 Describe how announcements have to be drafted at a given occasion

2.8 MEDICAL MONITORING

- 2.8.1 Define the provisions for medical monitoring
- 2.8.2 Define the purpose of medical monitoring and the possible consequences
- 2.8.3 Define the usual time period between two medical checks for occupationally exposed persons
- 2.8.4 Define the criteria which are relevant for classifying occupationally exposed persons in category A and B

2.9 PROHIBITIONS AND RESTRICTIONS OF OPERATION

- 2.9.1 Define which persons may or may not access certain areas and who may work there
- 2.9.2 Explain under which conditions an occupationally exposed person may enter a restricted area
- 2.9.3 Explain to which extent a restriction or prohibition of operation can be issued as a result of a medical examination

3. Scientific Basics

3.1 BASICS OF RADIATION PHYSICS

- 3.1.1 List the types of radiation and state their properties
- 3.1.2 State the unit for the activity

3.2 BASICS OF RADIATION BIOLOGY

- 3.2.1 Define the biological effect of radiation
- 3.2.2 Define the fundamental difference between somatic and genetic radiation effects
- 3.2.3 Define early and late effects
- 3.2.4 Give examples for acute radiation injuries and the doses causing these injuries
- 3.2.5 Define the relationship between dose and effect (late effects, genetic injuries)
- 3.2.6 Define unique exposure and accumulated doses in connection with recovery effects

3.3 DOSE TERMS

- 3.3.1 Define the term "Equivalent Dose" and the associated legal unit
- 3.3.2 State the terms "Dose" and "Dose Rate" and define their relationship

3.4 THE RADIATION EXPOSURE OF HUMAN BEINGS

- 3.4.1 Define the types of radiation exposure (natural, civilizational, medical, occupation)
- 3.4.2 State the natural radiation exposure from external and internal sources
- 3.4.3 State the external and internal radiation exposure due to civilizational activities (medicine, technique, fall-out, ...)
- 3.4.4 Define the dose limit values according to the Radiation Protection Ordinance

4. Radiation Protection Measuring Technique

4.1 BASICS OF RADIATION PROTECTION MEASURING TECHNIQUE

- 4.1.1 Define the purpose of radiation protection measurements

4.2 PERSONAL DOSE MEASUREMENT

- 4.2.1 Define suitable measuring systems for personal dose measurement
- 4.2.2 Define potential errors in a personal dose measurement
- 4.2.3 Define the difference between official personal dose measurement and self-monitoring
- 4.2.4 Define which personal dosimeters have to be carried how and where

4.3 INCORPORATION MEASUREMENT AND MONITORING

- 4.3.1 Define suitable methods for incorporation measurement

4.4 CONTAMINATION MEASUREMENT AND MONITORING

- 4.4.1 Define the term "Contamination"

4.5 EVALUATION AND ASSESSMENT

- 4.5.1 Compare measured results with the values defined in the legal requirements

5. Radiation Protection Technique

5.1 RADIATION PROTECTION PLANING

- 5.1.1 Define the importance of a radiation protection instruction

5.2 WORKING METHODS

- 5.2.1 List provisions and working methods to reduce radiation exposure
- 5.2.2 Define the use of personal protection equipment

5.3 MATERIAL DECONTAMINATION

- 5.3.1 State the difference between contaminated and non-contaminated material
- 5.3.2 State the prerequisites for the disposal and release of tools and instruments from controlled areas

5.4 RADIATION PROTECTION AREAS

- 5.4.1 State radiation protection areas and their essential distinguishing features
- 5.4.2 Define access rules for radiation protection areas.

5.5 RESPIRATORY EQUIPMENT

- 5.5.1 Define when and where the use of respiratory equipment is stipulated

6. Radiation Protection Safety

6.1 MEDICAL SAFETY PRECAUTIONS

- 6.1.1 Define need for medical monitoring
- 6.1.2 State prohibition and restriction of operation
- 6.1.3 Define provisions in case of exceeding the dose limit value (also in case of suspected exceeding)

6.2 PREREQUISITES FOR THE USE OF PERSONAL PROTECTION EQUIPMENT

- 6.2.1 State prerequisites for using personal protection equipment
- 6.2.2 List impediments while wearing personal protection equipment (heat accumulation, ...)

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CATALOG OF LEARNING OBJECTIVES

for the Expert Knowledge Directive
for General Managers of Radiation Protection or
Radiation Protection Supervisors in the Non-medical Field

Facilities whose Setup and Operation
are Subject to Approval

No. 7.3

Catalog of Learning Objectives

The catalog of learning objectives provides information about the entire know-how and skills of the respective expert knowledge group which are required for radiation protection.

The verbs selected to formulate the learning objectives possess a meaning that is tantamount to the scope of the know-how and skills.

The verbs *state, define, list, trace* mean:

INSIGHT INTO THE FIELD OF KNOWLEDGE

The verbs *explain, describe, distinguish, compare, write down* mean:

OVERVIEW OF THE FIELD OF KNOWLEDGE

The verbs *evaluate, judge, develop, compile, summarize, determine, interpret, conclude, draw up* mean:

OVERALL KNOWLEDGE OF THE FIELD OF KNOWLEDGE

The verbs *perform, apply, operate, estimate* mean:

BASIC PERFORMANCE SKILLS

The verbs *plan, evaluate* mean:

SKILL IN THE SENSE OF WARRANTY

1. Legal Basics

1.1 ATOMIC ACT

- 1.1.1 Explain the legal nature of regulations (law, ordinance, approval, directive, standard, recommendation)
- 1.1.2 Interpret the purpose and meaning of the Atomic Act
- 1.1.3 Interpret basic regulations made in the Atomic Act

1.2 RADIATION PROTECTION ORDINANCE

- 1.2.1 Summarize the area of application of the Radiation Protection Ordinance in terms of location and subject matter
- 1.2.2 Compile the protection goals radiation protection is aiming for when handling ionizing rays and assess the radiation protection principles
- 1.2.3 Describe who is General Manager of Radiation Protection and who is Radiation Protection Supervisor in accordance with the Radiation Protection Ordinance (§ 29 (1) and (2) StrlSchV)
- 1.2.4 Compile the paragraphs and sections of the Radiation Protection Ordinance pertinent to the present activities
- 1.2.5 Define the appropriate authorities in accordance with the Radiation Protection Ordinance
- 1.2.6 Interpret the legal consequences of the violation of regulations in accordance with the breach of the law paragraph of the Radiation Protection Ordinance (fine or penalty)
- 1.2.7 Interpret the purpose of § 20a of the Radiation Protection Ordinance
- 1.2.8 Summarize the division of the Radiation Protection Ordinance in monitoring regulations, protection regulations, fine regulations and transition and conclusion regulations

1.3 OTHER ORDINANCES REGARDING THE ATOMIC ACT

- 1.3.1 Interpret other important ordinances for radiation protection (e.g. X-ray regulations, coverage provision ordinance regarding the Atomic Act, rules of procedure regarding the Atomic Act) and describe the scope of application

1.4 SHIPMENT REGULATIONS

- 1.4.1 State the laws and ordinances that are valid for transportation of the radioactive materials to be transported in the expert knowledge field
- 1.4.2 Explain the paragraphs and ciphers of the respective transportation regulations that apply to the transportation of the items or materials to be transported in the expert knowledge field

1.5 WATER ACT

- 1.5.1 Define for which areas of radiation protection the regulations of the Water Act have to be observed

1.6 APPROVALS

- 1.6.1 Assess the meaning of approvals
- 1.6.2 Compile individual approval regulations (according to Radiation Protection Ordinance, Atomic Act)
- 1.6.3 Explain which legal effects approval requirements have for activities requiring approval, for the General Manager of Radiation Protection and the Radiation Protection Supervisor

- 1.6.4 Describe the major types of approval requirements

- 1.6.5 Explain the essential contents of the model approvals that are relevant to the expert knowledge field (§20 a; transportation, use and storage)

1.7 COMMUNICATIONS

- 1.7.1 Explain the meaning of the communication procedures (handling, import and export)
- 1.7.2 List all activities that need to be communicated in accordance with the Radiation Protection Ordinance

1.8 OTHER PERTINENT LAWS AND ORDINANCES

- 1.8.1 State the regulations defining the radiological units and the calibration of measuring systems (e.g. implementing regulations regarding the law on units in metrology, second ordinance on the calibration obligation of measuring systems, calibration validity ordinance)
- 1.8.2 State the consequences resulting from these regulations for routine radiation protection

2. Recommendations and Directives

2.1 ICRP

- 2.1.1 State task and objective of ICRP (ICRP: International Commission on Radiological Protection)
- 2.1.2 State legal status of the ICRP recommendation
- 2.1.3 Define the major recommendations and the areas affected by these recommendations

2.2 IAEA, NEA, EURATOM

- 2.2.1 State these organizations and their area of operations (IAEA: International Atomic Energy Agency; NEA: Nuclear Energy Agency; EURATOM)
- 2.2.2 Using examples, define which type of recommendations and directives have been issued by these

2.3 STANDARDS

- 2.3.1 Describe the DIN standards relevant to the respective expert knowledge group (DIN: German Institute for Standards) (DIN 54 115, page 1 – 5; DIN 6814; DIN 25400)

2.4 DIRECTIVES

- 2.4.1 Describe the directives relevant to the respective expert knowledge group (e.g. accident prevention regulations of the trade association "Precision Engineering and Electrical Engineering"; Directive of the Department of the Interior)

3. Tasks and Duties of the Radiation Protection Supervisor

3.1 LEGAL STATUS OF THE RADIATION PROTECTION SUPERVISOR

- 3.1.1 Explain the legal status of the Radiation Protection Supervisor and the General Manager of Radiation Protection
- 3.1.2 Compile the basic tasks of the Radiation Protection Supervisor ("Management and supervision ..." § 29 (2) StrlSchV)

- 3.1.3 Compile the prerequisites for appointing a Radiation Protection Supervisor (expert knowledge, area of competence, competence, ...)
- 3.1.4 Interpret the meaning of the area of competence of a Radiation Protection Supervisor (responsibility and competence)
- 3.1.5 Describe who appoints the Radiation Protection Supervisor, who will be notified about this appointment and which information has to be provided
- 3.1.6 Develop which conflict solution model the Radiation Protection Ordinance (§ 30) foresees if Radiation Protection Supervisor and General Manager of Radiation Protection do not come to an agreement concerning a radiation protection provision

3.2 ORGANIZING RADIATION PROTECTION

- 3.2.1 Interpret the possibility of dividing the radiation protection tasks between several Radiation Protection Supervisors
- 3.2.2 Interpret the requirement for defining areas of competence and describe them in writing
- 3.2.3 Define that alarm plans have been set up for incidents and that these plans have been discussed with the relief organizations
- 3.2.4 State the legal status, duties and responsibility of a General Manager of Radiation Protection
- 3.2.5 Interpret the purpose of the necessary regulations between the operating company and an external company (distinction between facility-related and not facility-related)

* "Facility-related radiation protection"

Radiation protection provisions which have to be observed during operation requiring permission of an occupationally exposed person in a facility (e.g. nuclear power plant) and which have to be ensured by the Radiation Protection Supervisor of the facility as per agreement

- 3.2.6 Interpret the meaning and purpose of a radiation protection instruction (§ 34 StrlSchV)
- 3.2.7 Interpret the possibility to support the Radiation Protection Supervisor by assistants and the prerequisites for this
- 3.2.8 Explain the differences between occupationally exposed persons of category A and B

3.3 INSTRUCTION

- 3.3.1 Develop the subject catalog for radiation protection instructions

3.4 RECORDS, BOOK-KEEPING

- 3.4.1 Describe the documentation regulations for acquisition, possession and disposal of radioactive materials
- 3.4.2 Compile which records have to be made, who has access to them and who is responsible for them
- 3.4.3 Define how long records have to be kept on file
- 3.4.4 Describe the purpose of a personal dose file as well as the information it should contain
- 3.4.5 Describe the purpose of a registered radiation passport and the information it should contain

3.5 LABELING DUTY

- 3.5.1 Describe what is to be labeled (facility, radioactive substances)
- 3.5.2 Explain how and by whom labeling is performed and which references are used
- 3.5.3 Explain the radiation risks the labeling should warn against
- 3.5.4 Describe standards and requirements for labeling
- 3.5.5 Describe which items are to be labeled in particular and which areas require special shielding off
- 3.5.6 Define in which cases labeling is to be removed

3.6 AREAS OF COMPETENCE

- 3.6.1 Explain that the area of competence has to be defined in writing
- 3.6.2 Interpret the intra-company area of competence in accordance with the Radiation Protection Ordinance
- 3.6.3 Explain how an assessment is made whether the area of competence corresponds to the tasks that have to be guaranteed
- 3.6.4 Develop the required competence
- 3.6.5 Summarize the type of definition of the areas of competence and the notification of persons and authorities and give examples
- 3.6.6 Interpret why areas of competence must not overlap
- 3.6.7 Compile which duties can be transferred

** "Not Facility-related radiation protection"

Radiation protection provisions which essentially have to be observed before starting and after finishing an operation requiring permission in a facility (e.g. nuclear power plant) and which have to be ensured by the authorized person in accordance with § 20a StrlSchV

3.7 MONITORING AND CONTROLS

- 3.7.1 Summarize which type of monitoring and control provisions are required (persons, workplaces, environment)
- 3.7.2 Compile how monitoring and controls are to be performed in individual cases
- 3.7.3 Develop plans and instructions for controls and monitoring
- 3.7.4 Interpret the meaning of reinsuring measures to avoid the consequences of human or machine failure or diminish their consequences

3.8 MAINTENANCE

- 3.8.1 Compile which maintenance has to be performed for radiation protection
- 3.8.2 Explain the duties of the General Manager of Radiation Protection with regard to maintenance and operational checks of facilities and devices

3.9 ANNOUNCEMENTS

- 3.9.1 Interpret the state of affairs of the area of competence about which the appropriate authority or the General Manager of Radiation Protection has to be informed
- 3.9.2 Develop how announcements have to be drafted at a given occasion
- 3.9.3 Explain the provisions regarding announcement duty

3.10 MEDICAL MONITORING

- 3.10.1 Describe the provisions for medical monitoring

- 3.10.2 Describe what kind of information has to be provided to the physician in charge
- 3.10.3 Explain the purpose of medical monitoring and the possible consequences
- 3.10.4 Define the usual time period between two medical checks for occupationally exposed persons
- 3.10.5 Compile the criteria which are relevant for classifying occupationally exposed persons in category A and B

3.11 STORAGE AND SAFEKEEPING

- 3.11.1 Explain aspects which have to be observed when storing sources (radioactive substances, minerals, sources)
- 3.11.2 Describe standards and rules for storing and safekeeping radioactive substances
- 3.11.3 Interpret who is responsible for storage and how storage has to be monitored (unauthorized access)

3.12 DAMAGE CONTROL IN CASE OF ACCIDENTS AND MALFUNCTIONS

- 3.12.1 Explain the regulations for damage control in case of accidents and malfunctions
- 3.12.2 Compile features of the radiation protection technical organization of damage control
- 3.12.3 Compile which priorities have to be observed during accidents
- 3.12.4 Compile which preparations have to be taken for damage control
- 3.12.5 Interpret actions that have to be taken immediately in case of accidents and malfunctions to limit the risks for life, health and belongings to a minimum

- 3.12.6 State the prerequisites under which the obligation of retaining employees and the obligation of providing proof can be omitted (activity limits, cooperation in various areas)
- 3.12.7 Explain the danger classes to be distinguished in order to prepare of fire fighting
- 3.12.8 Explain which locations inside and outside the company cooperate in case of accidents and malfunctions and explain the fundamentals of this cooperation

3.13 DISPOSAL OF RADIOACTIVE WASTE

- 3.13.1 Compile the legal procedures for disposal of radioactive waste
- 3.13.2 Define the definition of radioactive waste according to the Atomic Act
- 3.13.3 Interpret the obligation to dispose radioactive waste properly and the prohibition to dump radioactive waste
- 3.13.4 Compile the directives and conditions for disposal of radioactive waste

3.14 PROHIBITIONS AND RESTRICTIONS OF OPERATION

- 3.14.1 Explain which persons may or may not access certain areas and who may work there
- 3.14.2 Explain under which conditions an occupationally exposed person may enter a restricted area
- 3.14.3 Explain to which extent a restriction or prohibition of operation can be issued as a result of a medical examination
- 3.14.4 Define how the appropriate authority can issue prohibitions or restrictions of operation
- 3.14.5 Distinguish prohibition to stay in restricted areas, restrictions and prohibitions of operation

4. Scientific Basics

4.1 BASICS OF RADIATION PHYSICS

- 4.1.1 Describe the structure of matter (atomic nucleus and atomic shell, chemical element, ordinal number and mass number, nuclide, isotopes, isobar)
- 4.1.2 Explain origination and physical properties of ionizing rays encountered in the expert knowledge field
- 4.1.3 Define examples for electromagnetic radiation (radio waves, visible light, UV light, X-ray-, Gamma and bremsstrahlung)
- 4.1.4 Explain the term "Radiation Energy" and "Energy Spectrum" and define units of energy
- 4.1.5 Explain the terms "Radioactivity", "Activity", "Radioisotope" and "Radionuclide" as well as radioactive units
- 4.1.6 Explain ways of decay, decay schemes and the law of radioactive decay as well as the term "Half-life period"
- 4.1.7 Define examples of naturally occurring nuclides
- 4.1.8 Calculate the activity of a radioactive substance from a given nominal activity and the decay time
- 4.1.9 Explain the terms "Nuclear Fission" and "Criticality"
- 4.1.10 Summarize detection principles for ionizing radiation encountered in the expert knowledge field
- 4.1.11 Explain typical activation and nuclear reactions
- 4.1.12 Compile the interaction of ionizing radiation encountered in the expert knowledge field with matter and the consequences for radiation protection

- 4.1.13 Explain the effects of radiation in matter (heating up, changing the structure, generation of radionuclides)
- 4.1.14 Explain the emitted spectra on the basis of a given thermal scheme
- 4.1.15 Using examples, develop how wanted and unwanted types of radiation occur in facilities, how one type of radiation gives rise to another and how the interaction options change and various types of radiation occur depending on the energy (primary, secondary radiation, new particles, etc.)
- 4.1.16 Explain the generation process of neutrons by means of radioactive substances
- 4.1.17 Explain the meaning of radiation losses

4.2 BASICS OF RADIOCHEMISTRY

- 4.2.1 Describe the structure of the periodic system
- 4.2.2 Explain structure and contents of the nuclide table
- 4.2.3 Explain possible chemical changes of compounds and materials caused by ionizing radiation
- 4.2.4 Describe typical reaction processes with regard to the release of activity
- 4.2.5 Describe corrosion phenomena caused by ionizing radiation
- 4.2.6 Explain common labeling principles

4.3 BASICS OF RADIATION BIOLOGY

- 4.3.1 Define the basic component of the human body (cell) and define the essential components (membrane, plasma, nucleus)
- 4.3.2 Describe the biological effect of radiation

- 4.3.3 Explain the fundamental difference between somatic and genetic radiation effects
- 4.3.4 Explain early and late effects
- 4.3.5 Describe the difference between stochastic and non-stochastic effects
- 4.3.6 State examples for acute radiation-induced injuries and the doses causing these injuries
- 4.3.7 Describe the relationship between dose and effect (late effects, genetic injuries)
- 4.3.8 Explain unique exposure and accumulated doses in connection with recovery effects
- 4.3.9 Explain the terms "physical, biological and effective half-life period"
- 4.3.10 Explain the term "Radiotoxicity"

4.4 DOSE TERMS

- 4.4.1 Explain the physical units "Ion Dose" and "Energy Dose" and the associated legal units
- 4.4.2 Define the term "Equivalent Dose" and the associated legal unit
- 4.4.3 Define the terms "Dose" and "Dose Rate" and define their relationship
- 4.4.4 Explain the calculation of the equivalent dose
- 4.4.5 Explain the quality factor for various types of radiation
- 4.4.6 Explain the relationship between activity and dose rate (dose rate constant)
- 4.4.7 Explain the terms "Personal Dose" and "Area Dose"
- 4.4.8 Explain the term "Body Dose" (partial and whole-body dose)

4.4.9 Explain the term "Committed Equivalent Dose"

4.5 SHIELDING OF RADIATION

- 4.5.1 Describe the shielding effect of matter versus the types of radiation encountered in the expert knowledge field
- 4.5.2 Explain the distance law for photon radiation and its importance for radiation protection
- 4.5.3 Explain the terms "Attenuation Factor", "Attenuation Coefficient", "Half-value Depth", "Tenth-value Thickness", "Dose Build-up Factor", "Bragg Curve" and "Star Curve"
- 4.5.4 List suitable shielding materials for the various types of radiation and interpret their properties
- 4.5.5 Using the half-value depth and the tenth-value thickness, calculate the shielding of radiation sources (point-shaped Gamma) encountered in the expert knowledge field
- 4.5.6 Using tables and diagrams, calculate the attenuation factor of a material layer for the types of radiation (point-shaped Gamma) encountered in the expert knowledge field
- 4.5.7 Using tables and diagrams, calculate the thickness of a shielding with given attenuation factor for the types of radiation (point-shaped Gamma radiation source) encountered in the expert knowledge field
- 4.5.8 Describe the scattering of the types of radiation (Gamma, X-ray and Neutron radiation) encountered in the expert knowledge field and describe their dependence on the atomic number of the shielding material and on the energy
- 4.5.9 Explain the benefit of using materials containing hydrogen for shielding neutrons
- 4.5.10 Explain the design of a shielding for mixed radiation fields (e.g. Gamma, neutrons)

4.5.11 Explain calculation methods (including computer programs) for shielding particle radiation and assess the physical effects that were taken into account

4.6 THE RADIATION EXPOSURE OF HUMAN BEINGS

- 4.6.1 Compare the types of radiation exposure (natural, civilizational, medical, occupation)
- 4.6.2 Compare the natural radiation exposure from external and internal sources
- 4.6.3 Explain the external and internal radiation exposure due to civilizational activities (medicine, technique, fall-out, ...)
- 4.6.4 Compile the dose limit values according to the Radiation Protection
- 4.6.5 Explain the terms "Incorporation", "Ingestion", "Inhalation" and "Submersion"
- 4.6.6 Interpret the "30 mrem concept"

5. Radiation Protection Measuring Technique

5.1 BASICS OF RADIATION PROTECTION MEASURING TECHNIQUE

- 5.1.1 Summarize the purpose of radiation protection measurements
- 5.1.2 List various tasks of radiation protection measuring technique (area dose, area dose rate, personal dose)
- 5.1.3 Describe principle and application of radiation protection measuring instruments for various types of radiation

- 5.1.4 Explain physical effects and principles on which typical measurement methods for the types of radiation encountered in the expert knowledge field are based
- 5.1.5 Describe methods of environmental monitoring
- 5.1.6 Describe methods of area dose rate monitoring

5.2 DOSE RATE MEASUREMENTS

- 5.2.1 Explain the fundamental design of a dose rate measuring system
- 5.2.2 Describe suitable dose rate measuring systems for the types of radiation encountered in the expert knowledge field
- 5.2.3 Perform dose rate measurements and evaluate their results
- 5.2.4 Using a dose rate measurement, calculate the activity of a point-shaped Gamma source
- 5.2.5 Explain why usually the dose rate of a Beta source cannot be measured using conventional dose rate measuring systems
- 5.2.6 Explain the design and the principle of function of radiation warning instruments and explain their potential application
- 5.2.7 Compile potential errors in a dose rate measurement
- 5.2.8 Interpret dose rate measurements in mixed radiation fields

5.3 AREA DOSE MEASUREMENT

- 5.3.1 Describe measuring methods, instruments and detectors that can be used for the area dose measurement of the types of radiation encountered in the expert knowledge field
- 5.3.2 Interpret the purpose of performing an area dose measurement (definition of radiation protection areas, determination of body doses)

5.4 PERSONAL DOSE MEASUREMENT

- 5.4.1 Explain suitable measuring systems for personal dose measurement
- 5.4.2 Explain the principle of function of personal dosimeters
- 5.4.3 Explain potential errors in a personal dose measurement
- 5.4.4 Evaluate a radiation-exposed personal dosimeter and estimate the measurement error of the result
- 5.4.5 Explain the difference between official personal dose measurement and self-monitoring
- 5.4.6 Explain the purpose and use of the measuring method foreseen for personal dose measurement
- 5.4.7 Interpret which personal dosimeters have to be carried how and where

5.5 INCORPORATION MEASUREMENT AND MONITORING

- 5.5.1 Explain suitable methods for incorporation monitoring
- 5.5.2 Explain when there is a suspected incorporation and what has to be done about it (e.g. perform urine or whole-body measurements)
- 5.5.3 Describe suitable methods for incorporation measurement
- 5.5.4 Explain the result of an incorporation measurement

5.6 BODY DOSE MEASUREMENT

- 5.6.1 Explain when to determine the body dose through estimation (directive)

- 5.6.2 Explain how to estimate a body dose on the basis of personal and area dose measurements
- 5.6.3 Define how the body dose can be estimated on the basis of incorporation measured values

5.7 CONTAMINATION MEASUREMENT AND MONITORING

- 5.7.1 Explain the term "Contamination"
- 5.7.2 Explain when and how contamination measurements are to be performed
- 5.7.3 Explain the design of a contamination measuring system
- 5.7.4 Describe suitable measuring methods for contamination monitoring and perform measurements
- 5.7.5 Explain the result of a contamination measurement
- 5.7.6 State the limit values for surface contamination prescribed by the Radiation Protection Ordinance
- 5.7.7 Describe the provisions to be taken and the measuring methods to be used in case contamination is detected
- 5.7.8 Describe potential errors in contamination measurement
- 5.7.9 Explain the relationship between surface and air contamination (aerosols)

5.8 ACTIVITY MEASUREMENT (AIR, WATER, SOIL)

- 5.8.1 Describe suitable measuring methods for activity determination in solid substances, air and waste water
- 5.8.2 Explain how a representative sample is taken and define the sample preparation method

- 5.8.3 Explain the accuracy of the measuring methods of the activity determination
- 5.8.4 Explain how by means of the Radiation Protection Ordinance the concentration values are determined for inhalation and ingestion from the limit values of the annual activity supply
- 5.8.5 Summarize provisions to be taken in case the limit value is exceeded

5.9 NUCLIDE IDENTIFICATION

- 5.9.1 Explain the physical basis for nuclide identification
- 5.9.2 Explain suitable methods for qualitative distinction of various types of radiation
- 5.9.3 Evaluate a Gamma spectrum quantitatively
- 5.9.4 Distinguish suitable measuring systems for nuclide identification
- 5.9.5 Describe methods of Alpha and Beta spectroscopy in outline
- 5.9.6 Define chemical separation methods for sample preparation

5.10 OPERATIONAL CHECK OF MEASURING SYSTEMS

- 5.10.1 Describe to which area of competence the calibration obligation and the operational check of radiation protection measuring systems belong
- 5.10.2 Describe the meaning and purpose of an operational check
- 5.10.3 Perform the operational check of a dose rate measuring system
- 5.10.4 Perform the operational check of a direct-reading personal dosimeter
- 5.10.5 Perform the operational check of a contamination measuring system
- 5.10.6 Explain the necessity of book-keeping on operational checks

- 5.10.7 Explain how the working order of measuring systems can be ensured organizationally
- 5.10.8 Describe how the operational mode of indispensable measuring and warning instruments ("fail safe", locking) can be ensured.
- 5.10.9 Describe and perform control methods for the operational mode of dose rate measuring systems, dose measuring systems and warning instruments

5.11 POTENTIAL ERRORS DURING RADIATION MEASUREMENT

- 5.11.1 Explain potential errors of various types of measuring systems
- 5.11.2 Explain the accuracy of frequently used measuring systems
- 5.11.3 Explain provisions to avoid errors during radiation measurement

5.12 EVALUATION AND ASSESSMENT

- 5.12.1 Explain the importance of measured results
- 5.12.2 Compile which apparatus, methodical and systematic errors have to be expected during the evaluation of samples
- 5.12.3 Compare measured results with the values defined in the legal requirements

6. Radiation Protection Technique

6.1 RADIATION PROTECTION PLANNING (SEQUENCE OF OPERATIONS)

- 6.1.1 Explain basic rules of radiation protection (distance, shielding, duration of stay, preventing incorporation, restricting activity)

- 6.1.2 Explain why any unnecessary radiation exposure has to be avoided
- 6.1.3 Describe monitoring of persons and workplaces (also for external personnel)
- 6.1.4 Explain how to carry out monitoring programs
- 6.1.5 Explain critical situations in the sequence of operations and provide examples of possible malfunction or accident situations
- 6.1.6 From a measured dose rate with given duration of stay, calculate the radiation dose and with given dose limit value the duration of stay of the operating personnel
- 6.1.7 Explain protective precautions for work in slightly contaminated rooms
- 6.1.8 Describe waste collection and treatment
- 6.1.9 Explain a monitoring schedule for activity releases
- 6.1.10 Explain the importance of radiation protection instructions
- 6.1.11 Describe the organization concerning receipt and whereabouts of radioactive substances in the area of competence
- 6.1.12 Explain a measurement schedule for area dose monitoring in a facility

6.2 WORK SCHEDULING

- 6.2.1 Describe work schedule which ensures that the radiation exposure due to performing work is kept as low as possible
- 6.2.2 Summarize what has to be provided prior to starting special operations (e.g. measuring systems, shielding materials and other ancillary devices)
- 6.2.3 Explain typical errors in work scheduling which increase the radiation exposure (e.g. not planning of time and location, not planning the use of tools and ancillary devices, false personnel planning (inadequate deployment of personnel))

6.7 WASTE TREATMENT

- 6.7.1 Describe what is to be done with radioactive substances or devices that are no longer needed
- 6.7.2 Describe various types of radioactive waste
- 6.7.3 Describe suitable waste containers for the laboratory, the waste depot and transport within the company
- 6.7.4 Describe how to collect, sort and transport radioactive waste
- 6.7.5 Describe setup, organization and function of a waste depot

6.8 CRITICALITY

- 6.8.1 Describe the phenomenon of criticality
- 6.8.2 Define the radionuclides where criticality may occur
- 6.8.3 Define suitable provisions to rule out criticality

6.9 RADIATION PROTECTION AREAS

- 6.9.1 Explain radiation protection areas and their essential distinguishing features
- 6.9.2 Describe how radiation protection areas are defined and how they have to be marked
- 6.9.3 Compile access rules for radiation protection areas.

6.10 LABORATORY FACILITIES

- 6.10.1 Explain the types of laboratories encountered in the expert knowledge field (type A, B and C)
- 6.10.2 Describe special protection and control devices for laboratories handling open radioactive sources
- 6.10.3 Describe the measuring systems and monitors required for these laboratories
- 6.10.4 Describe which ancillary devices have to be available for radiation protection in radionuclide laboratories (e.g. decontamination agent)
- 6.10.5 Describe laboratory devices and instruments which facilitate occasional work with radioactive substances in normally equipped work rooms and which ensure radiation protection

6.11 MATERIAL BEHAVIOR UNDER RADIATION EXPOSURE

- 6.11.1 Describe changes in the property of materials (e.g. oil, concrete, glasses, plastics, metals) under the influence of ionizing rays and explain the resulting consequences for maintenance
- 6.11.2 Explain the significance of radiation damage on protection facilities and materials
- 6.11.3 Describe physical procedures that take place when neutrons take an effect on shielding materials

6.12 RESPIRATORY EQUIPMENT

- 6.12.1 Explain when and where the use of respiratory equipment is stipulated
- 6.12.2 Explain operational check, cleaning and maintenance of respiratory equipment and their ancillary devices

6.13 PACKAGING, TRANSPORT

- 6.13.1 Explain provisions while receiving radioactive substances.
- 6.13.2 Explain labeling of shipped goods containing radioactive substances
- 6.13.3 Explain provisions for packaging and shipping
- 6.13.4 Explain prerequisites for shipping radioactive substances

7. Radiation Protection Safety

7.1 MEDICAL SAFETY PRECAUTIONS

- 7.1.1 Explain need for medical monitoring
- 7.1.2 Explain prohibition and restriction of operation
- 7.1.3 Describe provisions in case of exceeding the dose limit value (also in case of suspected exceeding)

7.2 PERSONAL PROTECTION EQUIPMENT

- 7.2.1 List items of personal protection equipment and define when to use them
- 7.2.2 Explain what is to be done with personal protection equipment after use
- 7.2.3 Describe the effects of protective clothing and explain the protection equipment for eyes, hands and torso and estimate the effectiveness (eye glasses, lead gloves and aprons)

7.3 PREREQUISITES FOR THE USE OF PERSONAL PROTECTION EQUIPMENT

- 7.3.1 State prerequisites for using personal protection equipment

- 7.3.2 List impediments while wearing personal protection equipment (heat accumulation, ...)
- 7.3.3 Explain when and under which conditions persons should not work alone in radiation protection areas

7.4 PERSONAL DECONTAMINATION

- 7.4.1 Describe the operational sequence for personal decontamination
- 7.4.2 Explain decontamination agents (e.g. washing)
- 7.4.3 Explain how to decontaminate eyes
- 7.4.4 Explain provisions in case of open wounds
- 7.4.5 Explain when to consult a physician

7.5 TECHNICAL SAFETY PRECAUTIONS

- 7.5.1 Explain technical safety precautions against incorporation, contamination and external irradiation
- 7.5.2 Describe safety precautions for instruments and buildings (locking, seal, blocking, warning device, remote control) and how these safety precautions can be controlled
- 7.5.3 Describe technical safety precautions for setting up a workplace where high activity is being handled
- 7.5.4 Plan a permanent facility taking into account the duration of stay of occupationally exposed persons

7.6 ALARM PLANNING, ACTIONS AND BEHAVIOR IN CASE OF
ACCIDENTS AND MALFUNCTIONS

- 7.6.1 Explain the terms "Malfunction" and "Accident" in accordance with the Radiation Protection Ordinance
- 7.6.2 Explain potential malfunctions and accidents and their cause and explain countermeasures
- 7.6.3 Explain when the consequences of a malfunction can be remedied by the Radiation Protection Supervisor him/herself
- 7.6.4 Explain how to proceed when the Radiation Protection Supervisor cannot remedy the consequences of a malfunction him/herself
- 7.6.5 Describe the procedure for guarding the site if a source cannot be returned into its special container
- 7.6.6 Write down the essential contents of an alarm plan
- 7.6.7 Explain under which conditions an occupationally exposed person may be exposed to an extraordinary high level of radiation or when this can be permitted
- 7.6.8 Explain who is to be notified immediately about the occurrence of a malfunction or accident
- 7.6.9 Explain how the progress of a malfunction or accident has to be documented
- 7.6.10 Describe instruction, training program and measures to be foreseen to deal with malfunctions and accidents

7.7 ANTI-THEFT PROVISIONS

- 7.7.1 Describe organizational and constructional provisions to prevent theft
- 7.7.2 Define which steps are to be taken in the event radioactive substances have been stolen

7.8 SAFETY MEASURES

- 7.8.1 Explain organizational provisions for prophylactic fire prevention
- 7.8.2 Describe the involvement of the appropriate authorities and relief organizations in drawing up alarm plans for the event of a fire
- 7.8.3 Write down alarm plan for fighting a fire where radioactive substances are affected
- 7.8.4 Explain which steps have to be taken in the event radioactive substances get lost.
